Oil and economic growth in Egypt

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Abstract

This paper attempts to assess the oil and natural gas sector in Egypt using SWOT analysis. It also considers the effect of oil prices on the real economic activity in Egypt using annual data set from 1991 to 2010. Autoregressive Distribute Lag model (ARDL) is utilised. Even though Egypt is a net oil exporter in the last few decades, it was found that oil prices have an adverse impact on economic growth. This is attributed to the huge government subsidies on petroleum products that reached LE 134 billion in 2013-2014. The findings of this paper are useful to the policy makers and the private petroleum companies operating in Egypt.

Keywords: ARDL model; Economic growth; Egypt; Oil and natural gas sector; SWOT analysis.

ملخص

تحاول هذه الورقة تقييم قطاع البترول و الغاز الطبيعي في مصر باستخدام التحليل الرباعي. و تضع في الاعتبار تأثير اسعار البترول علي النشاط الاقتصادي الفعلي في مصر مستخدما مجموعة بيانات سنوية من عام 1999 إلي عام 2010. استخدمت هذه الدراسة نموذج الانحدار الذاتي للإبطاء الموزع لقياس أثر أسعار النفط علي النمو الاقتصادي. و بالرغم من تصدير مصر لصافي النفط في العقود الأخيرة فقد وجدت الدراسة ان أسعار النفط لها تأثير سلبي علي النمو الاقتصادي، يعزي هذا إلي الدعم الحكومي الضخم علي المنتجات النفطية الذي بلغ 134 مليار جنيه مصري في العام 2013–2014. و ما تستنتجه هذه الورقة يفيد صانعي السياسات و شركات البترول الخاصة العاملة في مصر.

كلمات مفتاحية: نموذج الانحدار الذاتي للإبطاء الموزع؛ النمو الاقتصادي؛ مصر؛ قطاع البترول و الغاز الطبيعي؛ التحليل الرباعي.

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1 Introduction:

The Egyptian oil and gas industry supplies energy and essential chemicals for homes, industries, and transport, and hence plays a key role in the Egyptian economy. It provides around 87% of Egypt's primary energy and accounts for about 35% of Egypt's export revenues (EIA, 2013). Nevertheless, the amalgamation of substantial increase in domestic consumption of energy, inefficient government subsidies on petroleum products, huge budget deficit, ubiquitous attacks on gas pipelines and continuous political unrest, means that Egypt oil and gas industry is facing copious challenges which will be felt for decades to come.

The first challenge is the substantial increase in domestic demand for energy. Egypt depends on oil and natural gas to produce electricity, whilst renewable energy resources are not used. The decisions regarding the use of energy have very vital implications for both short-run and long-run changes in economic, political and social performance of any economy. Hence, it has been a major importance to study oil demand patterns for precise forecasting of its future needs and the relationship between oil consumption and economic growth. At present, the fears of an outbreak of an energy crisis in Egypt are temporary resolved by new discoveries or by aid from the Gulf countries (mainly Kingdom of Saudi Arabia, United Arab Emirates and Kuwait). It is not a question of running out of oil but rather a matter of ceasing to look to oil as the main source of future increases in energy supply. In other words, the problem is the consumption pattern of energy in Egypt. Secondly, another challenge is how to use profits from oil and gas sector, and how the returns will be distributed and spent to attain economic welfare for the current generation, and at the same time taking the future generation into consideration. Egypt exploits its profits from oil and gas sector mainly as source of foreign currency in order to finance its deficit. The challenge, here, is investing such returns.

Another challenge is due to the political unrest since the 2011 revolution. The recent unrest in Egypt reached the oil and gas sector via a series of attacks on the Arab Gas Pipeline, which had transported natural gas to Jordan and Israel. Gas exports to both countries were significantly reduced in 2011. By April 2012, natural gas exports to Israel were totally stopped (EIA, 2013). Furthermore, continued protests and unrest led to energy shortages.

The Egyptian economy has been associated with high and low points over the years. During the period of 1980s- the first 10 years of Mubarak rule, Egypt experienced a downward spiral in economic growth, high rates of inflation, high unemployment rates, *inter alia*. As a result of the economic difficulties of the late 1980s, Egypt adopted an Economic Structural Adjustment Program (ERSAP) in 1991 under IMF and World Bank supervision. This program was divided into two phases and lasted til 1998. Although 1990s started to witness the positive effects of the ERSAP; economic growth slowed down in 1997 due to the Luxor incident, and then during the dotcom recession in the early 2000s. By 2007, economic growth rates reach its peak at 7%. Nevertheless, only a small percentage of Egyptians benefit from economic growth.

One key challenge facing Egypt is the huge budget deficits which partialy attribute to the provision of fuel subsidies by the government. This policy is expected to have some negative impact on the Egyptian economy. On a previous study by the author of this paper, it was stated that a major cause for the huge fiscal deficits in Egypt can be attributed to failure of the government to adjust domestic price of petroleum products to reflect the increase in the world price of crude oil. Thus, it is very crucial to examine the impact of oil price fluctuations on economic growth (Hamilton, 1983; Bernanke, 1983). Several studies suggests that oil price fluctuations have significant effect on economic activity which differs depending on whether or not the analysis related to an oil importing or oil exporting country. Thus, the main objective in this study is to examine such relationship in Egypt considering it is a net exporter for oil in the last few decades. This paper utilizes an autoregressive distributed lag (ARDL) approach to investigate the relationship between oil price and economic growth in Egypt. In addition, a descriptive approach and a SWOT analysis are used to closely examine the oil and natural gas sector in Egypt. Such analysis gives a snapshot of the strengths and weakness present today, and also looks ahead to future potential opportunities and threats.

The plan of this paper is as follows. Section 2 reviews the historical setting and the recent development of the oil and gas industry in Egypt. Section 3 examines the relationship between oil prices and economic growth using the ARDL model. In section 4, the results are represented, a SWOT analysis is considered and a discussion of the main recommendation is provided. Finally, Section 5 gives some concluding remarks.

2 Oil and natural gas in Egypt, 1886- 2011

In 1886, oil was first discovered in Egypt, in Ras Gemsah, on the coast of the Red sea south of the Suez Gulf by Belgian exploration specialists M. de Bay and M. Barois, with a production of 10 barrels per day. Then, the Egyptian government appointed two American specialists L.H. Mitchell and H. Tweedle to expand the search for oil; however, the government abandoned the project in 1888 due to the increasing debts. Oil exploration activities were resumed in 1911 in Ras Gemsah where Egypt's first refinery was first established and in Hurgada by the Anglo Egyptian oil fields Ltd. Oil production increases steadily to reach about 5,000 barrels per day and natural gas production began by 1930s. As a result, Egypt oil industry attracted several companies, such as Anglo Iranian Oil, Royal Dutch Shell, and Standard Oil of California. In the 1940s, the Egyptian government passed a law forbidding export of crude oil in order to encourage domestic refining and petrochemical sectors.

After the 1952 revolution and under the central planning, nationalisation and the domination of the public sector, a national oil company, the General Petroleum Authority (GPA), was established in 1956. Oil production grew steadily with new oil discoveries in Ras Bakr, Kreim and Ras Gharib, besides the first offshore oilfield was drilled in North Balayim in 1961. The following year, the GPA was renamed the Egyptian General Petroleum Corporation (EGPC) and operated through joint ventures with foreign companies. The state-run Egyptian General

Petroleum Company (EGPC) controls the petroleum industry and is the only company authorized to import and export crude oil and petroleum products. The EGPC is active in the upstream, downstream, and petrochemical sectors. The EGPC created the Gulf of Suez Petroleum Company (Gupco) a joint venture between BP-Amoco and EGPC which is the main producer of oil in the Gulf of Suez. This region has become the first and main basin to be explored in Egypt and remained as the most important until the beginning of the 1970s (Algarhi, 2005).

In 1970s, the Ministry of Petroleum was formed and Egypt joined the Organisation of Arab Petroleum Exporting Countries. Oil production reached 500,000 barrels per day. The fields in this region have been in operation since the 1960s and 1970s, with levels of production declining. Still, this area remains a significant source of Egypt’s production; contributing around 360,000 b/d. Gupco is trying to extend the operating life of the fields through investments in production efficiency and greater exploration.

The Gulf of Suez remains by far the biggest producing region in Egypt, accounting for over 70% of total oil production, although its share is falling. The second biggest oil-producing region is the Western Desert. Egypt also draws oil from the Sinai Peninsula and the Eastern Desert (APRC, 2003; OFE, 2001). Most of Egypt's production is derived from relatively small fields that are connected to larger regional production systems. Overall production is in decline, particularly from the older fields in the Gulf of Suez and Nile Delta. However, declines have been partially offset by small new finds, particularly in the Western Desert and offshore area. In addition, the use of enhanced oil recovery (EOR) techniques at mature fields has eased production declines.

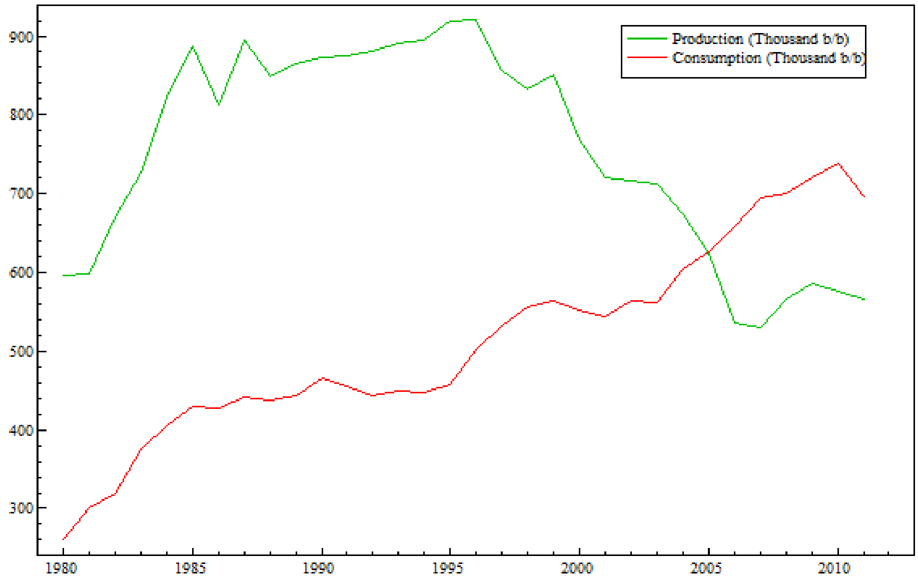
Egypt’s proven crude oil reserves are estimated at 4.4 billion barrels in January 2013, an increase from the average of 3.7 billion barrels between 2003 and 2010 and average 3.5 billion barrels from 1996 to 2002. This increase is due to several new oil discoveries conducted by the US Apache since 2008 (16 in 2011, 16 in 2010, 11 in 2009 and 17 in 2008) in Egypt's Western Desert (AmCham, 2003; EIA, 2013).

Egyptian oil production began to decline from a peak in 1996 of 922,000 barrels per day (b/d) as oil fields matured. Oil production in 2011 averaged 555,000 b/d, a decrease from 2003 averaged 618,000 barrels per day (b/d), and below the 631,000 b/d in 2002. In contrast, domestic demand for oil has been climbing from 501,000 b/d in 1996 to 585,000 b/d in 1999 due to rapid economic growth between 1995 and 1998. Then it reaches its peak in 2003 at 566,000 b/d (AmCham, 2003; EIA, 2013). The sharp increase in local oil consumption over the past decade can be attributed to two factors: economic growth in the late 1990s contributed to higher oil needs and government subsidies as most oil products are subsidized by the government to prevent rising prices. The prices of most types of fuel have not changed for the past decade, which has encouraged over-consumption (AmCham, 2003). Increased exploration, particularly in new areas, may lead to expectation of finding enough new discoveries to enable production above the 800,000 b/d level (Algarhi, 2005).

So despite the large level of exportation activity and the large number of discoveries made since 2008, which are brought into production as rapidly as possible, there seems little prospect of

Egypt reversing the decline in its crude oil output in the future. Not only is oil production steadily decreasing, but domestic oil consumption continues to rise, ceasing to be a net oil exporter since 2008. In 2011 Egypt exported around 100,000 b/d of crude oil, mostly were sent to India and the United States. Figure 1 plots the annual oil production levels and consumption for Egypt, from 1980 to 2011. It is quite clear to see the rapid increase in the demand of oil.

Figure 1: Oil production and consumption in Egypt, 1980- 2011

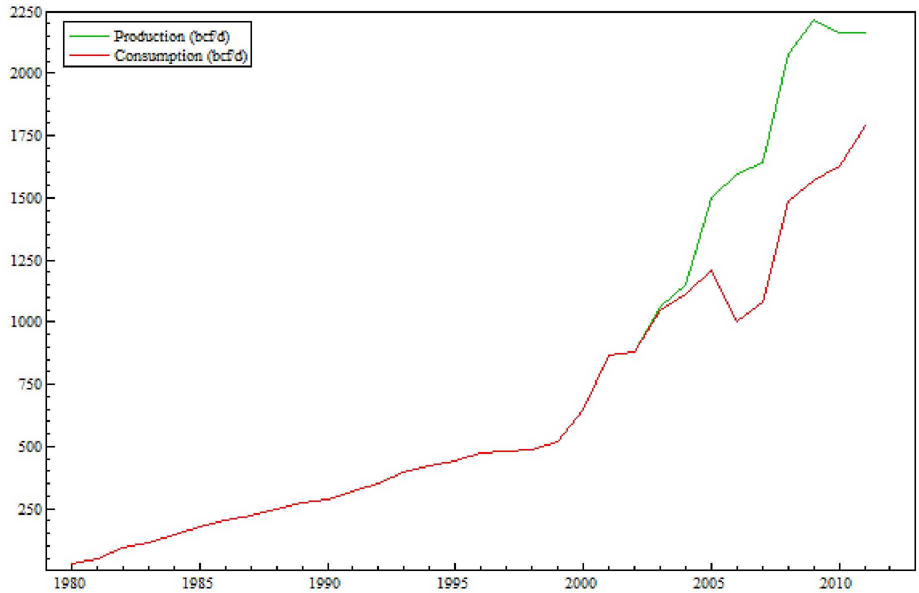


On the other hand, Natural gas is destined to become more and more important to the energy future of Egypt because of the major recent discoveries. There are vast reserves of natural gas with a strong potential for more discoveries. Beginning in the early 1990s, foreign oil companies began more attractive exploration for natural gas in Egypt, and very quickly found a series of significant natural gas deposits especially in the Western Desert, the Nile Delta, and under the Mediterranean Sea. Proven reserves stand at 77 trillion cubic feet (tcf) in 2011 up from 58 tcf in 2010 and 40 tcf in 2000, with probable reserves estimated at 120 tcf. Major discoveries between 1997 and 2000 in the Nile Delta and the Western Desert have doubled Egypt's proven reserves (EIA, 2013).

Egypt's natural gas sector has expanded rapidly, with production having nearly doubled from 1997 and 2002. Production stood at more than 3 billion cubic feet per day (bcf/d) from 1.6 bcf/d in1999. Output from the Abu Madi and Badreddin fields accounts for more than half of the country's production. Natural gas production increased since then. In 2009, Egypt produced 5.1

billion cubic feet per day, of which 400 million cubic feet per day is used by machinery on the site to extract the gas and 180 million cubic feet per day is obtained by foreign companies, and the rest is mainly used to satisfy the rising domestic demand. But after 2009 natural gas production began to fall. (Figure 2 shows the production levels and consumption of natural gas).

Figure 2: Natural Gas production and consumption in Egypt, 1980- 2011



On the consumption level, there is an average annual increase of 11% from 2001 to 2011. After a rapid increase in natural gas production since 1990s, the production started to fall after 2009 because of a decline in output from offshore gas fields. Consequently, Egypt's natural gas exports have fallen. The government may start to import natural gas for the first time, to satisfy rising domestic demand and continue to export natural gas to global markets.

Egypt has been increasing domestic gas demand by converting its power plants to run on gas. Thermal power plants account for about 65% of Egypt's total gas consumption. Large industrial consumers have also been switching to gas, including petrochemical plants, a large new fertilizer plant in Suez, and several major new steel projects in Alexandria, Suez, and south of Aswan. Some 20,000 taxis in Cairo have been modified to run on CNG as part of a pilot program. The construction of (17 CNG) service stations are supporting the project. Egypt is trying to improve the availability of natural gas for residential customers by allocating service areas to several private companies. British Gas heads a group that includes Orascom (an Egyptian construction firm), and Edison International SpA that will invest $220 million in a distribution network to serve Upper Egypt down to Assyout, an area with no existing gas service. The network may be expanded as far south as Aswan (Algarhi, 2005).

A decision by the government to form joint ventures with private companies and pay the world price for gas from any discoveries served to encourage exploration beginning in the late 1980s and early 1990s. This incentive led to major discoveries of gas deposits in the Nile Delta and Western Desert. However, these discoveries turned out to be a mixed blessing for Egypt -- the Egyptian government had to pay the going market price for gas that it was not using, and was unable to export this unused gas because it lacked the necessary infrastructure to liquefy or export any surplus natural gas. A remedy was finally implemented in November 1999, when the Egyptian government decided to allow the producers themselves to export the gas.

That decision spurred the creation of even more joint ventures between the government and the private sector. Gupco announced plans in March 2000 that would raise Egypt's gas production from 1.8 bcf/d to 3.8 bcf/d by the end of 2000, by starting operations at the Hapy Gas Field. In April 2000, BP-Amoco announced a deal with EGPC to build a gas treatment and separation facility around the Gulf of Suez. The Anglo-American Company plans two complexes on the Mediterranean coast to process and ship liquefied natural gas (LNG) throughout the region. Shell will cooperate with EGPC to explore for gas offshore in the Mediterranean. The two companies plan to have two wells online in 2000 or early 2001 with three more to follow. EGPC has agreed to supply a new LNG plant in Edku, east of Alexandria with gas from the West Delta Deep Marine Concession. The plant will be owned and operated by EGPC, British Gas and Edison International SpA.

Egypt currently consumes most of its natural gas production, but the host of deepwater discoveries offshore Egypt are starting to look more commercial. Turkey, Israel, Jordan, Libya, and the Palestinian territories have been mentioned as possible export markets. In December 1999, an agreement was reached with Israel to build a gas pipeline from El-Arish in the Sinai to Israel and Gaza by 2002. The pipeline would eventually go on to Lebanon, Syria, and Turkey. However, Israel has since become optimistic about offshore gas discoveries in its own waters and has frozen talks to import Egyptian gas until it can better gauge the size of its reserves.

The rapid rise in natural gas reserves has led to a search for export options, which has become particularly important to Egypt's future international balance of payments due to the decline in oil exports. In late 1999, the Egyptian government stated that natural gas reserves were more than sufficient for domestic needs, and that foreign firms producing gas in Egypt should seek export customers. In early 2000, the government announced a moratorium on new purchase agreements by EGPC for domestic consumption, as previously signed agreements would meet projected demand for the next several years. It also announced in September 2000 a new pricing policy which includes ceiling and floor prices, designed to protect both consumers and producers from the risks of prices indexed to oil.

Egypt exports natural gas via pipeline and in the form of liquefied natural gas. Dry natural gas exports started in 2003 and began to rise by the completion of the first stage of the Arab Gas

Pipeline (AGP) linking Egypt to Jordan and the startup of LNG production in 2004. After 2006, exports began to level off, and by 2012 natural gas exports decreased to 256 bcf, less than half of the peak export volume of 647 bcf in 2009. In 2011 and 2012, gas exports through the AGP were disrupted by continuous attacks, as a result the amounts sent to Jordan and Israel were substantially decreased. Growing domestic demand, stagnant domestic production, attacks and technical problems at the AGP have all contributed to reduced Egyptian exports of pipeline gas and LNG after 2009. Pipeline exports The AGP originates in Egypt and connects to Jordan, Syria, and Lebanon.

The idea of exporting natural gas to Israel has been under discussion since the mid-1990s, and after being sidelined for several years by the second Palestinian uprising which began in late 2000, seems to again be under serious consideration. The original version of the plan would have involved construction of an offshore pipeline from El-Arish in Sinai up the coast of Israel, with a possible extension onward to Turkey. The East Mediterranean Gas Company (a consortium of EGPC, Merhav of Israel, and Egyptian businessman Hussein Salem) had been set up to pursue the project. ENI completed a pipeline up Egypt's Mediterranean coast to El-Arish, which could serve as a starting point for the export pipeline. This would involve a short offshore pipeline to Ashkelon from northern Sinai, bypassing Gaza. A framework agreement between the two governments was concluded in February 2005, and negotiations for a binding natural gas sales contract with the Israel Electric Corporation (IEC) are underway. In 2008, the pipeline was built from the starting point in al-Arish in Egypt to Ashkelon in Israel running underwater. After the 2011 revolution, the AGP had been sabotaged by several attacks, which resulted in gas supply disruptions to recipient countries, especially Israel and Jordan as they were most dependent on Egypt's gas. By April 2012, Egyptian state-owned oil and gas companies announced that they were terminating their agreement to supply gas to Israel. Total exports via the AGP dropped to 19 bcf, of which the majority was sent to Jordan, with a smaller amount delivered to Israel before exports were terminated. This level is a substantial decrease from the gas volumes transported prior to the 2011 revolution, which reached 193 bcf in 2010.

Egypt's other option for exports is LNG. Two LNG projects are currently underway. The Spanish firm Union Fenosa is building a two-train liquefaction facility at Damietta, which shipped its first cargo in January 2005 upon the completion of the first train, with a capacity of 268 Bcf per year. Unlike most previous LNG projects, this one is not tied in directly with upstream natural gas production. Union Fenosa has contracted with EGAS for the supply of natural gas from its distribution grid, and will take 60 percent of the LNG output itself for use at the company's power plants and distribution to other users in Spain and elsewhere in Europe. ENI has also become involved in the project, purchasing a 50 percent stake in Union Fenosa's natural gas business in December 2002. BP signed an agreement for sales of natural gas from its offshore fields to supply the second train at Damietta in July 2004.

The second LNG export project ("Egyptian LNG"), at Idku, is to be built by BG in partnership with Petronas. The project is tied in to natural gas reserves from BG's Simian/Sienna offshore fields, and began production ahead of schedule in March 2005, with a second liquefaction train operational by late 2005. Gaz de France is to be the main offtaker for the Idku LNG project's first train, having signed a contract in October 2002 for 127 Bcf per year beginning in 2005. An agreement to purchase a similar quantity of LNG from the second train was signed in September 2003 by BG LNG Services. The LNG will initially be delivered to the Lake Charles, Louisiana import terminal for the U.S. market, starting in mid-2006. In 2007, BG switched the output from Idku to an import terminal under contrauction at Brindisi, Italy, and used additional production from Trinidad to supply the Lake Charles terminal. BP and Shell both are also contemplating potential LNG projects in Egypt (EIA, 2005). Another potential use for Egypt's natural gas reserves is gas-to-liquids (GTL) projects. Shell has proposed a 75,000-b/d GTL plant to be co-located with its LNG export terminal when it is built, using reserves from its offshore NEMED find as feedstock. No final agreements have yet been reached on the proposal Egypt's LNG exports have been cut in half over the past five years, from 496 bcf in 2008 to 237 bcf in 2012. LNG exports declined further in 2013 because increased domestic demand has diverted additional natural gas supply to the local market (EIA, 2013; Algarhi, 2005). Europe is the second-largest regional destination and absorbs 39 percent of Egypt's total LNG exports in 2012. Nevertheless, European LNG imports from Egypt dropped by about a quarter in 2012 compared with the previous year. This drop reflects the overall decrease of total European LNG imports in 2012 and increased competition for LNG on the global market. Egypt's LNG accounted for 4 percent of Europe's total LNG imports in 2012.

Egypt has strategic importance because of its operation of the Suez Canal and Sumed (Suez-Mediterranean) Pipeline, two routes for export of Arabian Gulf oil. The SCA offers a 35 percent discount to liquefied natural gas (LNG) tankers, with even deeper discounts for the largest LNG tankers, as well as other discounts for oil tankers (AmCham, 2003; OFE, 2001)

The SCA is continuing enhancement and enlargement projects on the canal. The canal has been deepened so that it can accept the world's largest bulk carriers, but it will need to be deepened further to 68 or 70 feet, from the current 58 feet, to accommodate fully laden very large crude carriers (VLCCs). The SCA has attempted to reach an agreement with its main competition for northbound crude traffic, the Sumed pipeline. Such an agreement could bar any tanker small enough to traverse the canal from transporting oil through the pipeline. The SCA offers incentives for tankers to off-load a portion of its cargo through the Sumed, allowing for passage through the canal, and reloading at the other end of the pipeline (AmCham, 2003; OFE, 2001).

The Sumed pipeline is an alternative to the Suez Canal for transporting oil from the Arabian Gulf region to the Mediterranean. The 200-mile pipeline runs from Ain Sukhna on the Gulf of Suez to Sidi Kerir on the Mediterranean. The Sumed's original capacity was 1.6 million b/d, but with completion of additional pumping stations, capacity has increased to 2.5 million b/d. The pipeline is owned by the Arab Petroleum Pipeline Company (APP), a joint venture between Egypt, Saudi Arabia, Kuwait, and the U.A.E.. The APP also has been increasing storage capacity at the Ain Sukhna and Sidi Kerir terminals (OFE, 2001; EIA 2013).

Furthermore, one of the most common measures of the economy’s energy substitution possibilities is the elasticity of substitution (σ). The elasticity of substitution defines the relative change in input proportions (in this case, we talk about oil and natural gas) in response to a relative change in their prices. In general, it is possible that the elasticity of substitution can vary; however, it is convenient to assume that elasticity of substitution is constant as it is assumed in this paper (LeBel, 1982; Nicholson and Snyder, 2011). The elasticity of substitution between oil and gas in Egypt is calculated for both the production and consumption side using the following model for the period 1991-2010:

$$\ln\left(\frac{Q_{OIL}}{Q_{NG}}\right) = \alpha + \sigma \ln\left(\frac{P_{NG}}{P_{OIL}}\right) + \varepsilon$$

where, Q_{OIL}= quantity of oil production or consumption (barrels of oil equivalent).

Q_{NG}= quantity of natural gas production or consumption (barrels of oil equivalent).

P_{OIL}= price of oil (US$ per barrel).

P_{NG}= price of natural gas (US$ per barrel).

σ= elasticity of substitution between oil and gas.

The value of σ is always positive, as the oil-gas ratio moves in the same direction as gas-oil price ratio. If σ is high (σ→∞), it means that oil and gas can be thought of as perfect substitutes for each other. On the other hand, if σ is very low (σ=0), this case shows that both oil and gas should be used in a fixed ratio regardless change in its price ratio. Running the above regression for Egypt for the period 1991-2010 for both production and consumption side, it was found that the elasticity of substitution between oil and gas in production is 3.5; while the elasticity of substitution between oil and gas in consumption is 3.9.

The period from 1991 to 2010 witnessed an economic growth due to implementing the ERSAP in Egypt from 1991. However, economic growth slowed down in 1997 due to the Luxor incident, then during the mild economic dotcom recession in the early 2000s and finally in late 2000s due to the financial crisis of 2007-2008. For expecting the growth of energy demand as a whole or growth of oil and natural gas consumption separately, Energy/GDP elasticity of 0.4 was calculated covering the period 1991-2010. This shows that when the Egyptian GDP grows at 1%, energy consumption would grow at 0.5%.

Therefore, by applying that for an anticipated 3% rate of Egyptian economic growth, then it should be expected that energy will grow by less than 1.5%. The Oil/GDP elasticity is 0.25 and the Natural Gas/GDP elasticity is 0.8. This indicates that for 1% GDP growth, oil would grow at 0.25% and natural gas at 0.8% which shows that natural gas consumption is related to the general demand in the Egyptian economy. This can be attributed to the heavily dependence on natural gas residentially and commercially especially for the last decade (Algarhi, 2005).

3 The connection between oil prices and economic growth:

Although there are various theoretical and empirical studies that examines the relationship between oil prices and economic growth, the main focus was on the developed economies (see Rasche and Tatom, 1977; Hamilton, 1983; Bernanke, 1983). The key motivation behind these studies was to check whether the 1973 oil shock attributes to the 1970s recession. Most of the studies found a negative correlation between oil prices and real output with a weak effect on the economic growth. Rasche and Tatom (1977) claimed that oil price fluctuations, as an important indicator of a supply side shock, can reduce the real output. An oil price increase means an increase in the scarcity of energy; as a result the potential output decreases due to the scarcity of oil. Thus, the output growth and productivity are reduced. Meanwhile, Hamilton (1983) concluded that oil-price increases were partially responsible for every post World War II US recession except the one in 1960s. Bernanke (1983) argued that oil price shocks would tend to reduce value added, because firms will defer irreversible investment decisions as they endeavour to find out whether the increase in oil price is transitory or lasting. Consequently, producers would delay permanent investment decisions when they are uncertain about future crude oil price changes. Such decisions are also likely to have a negative effect on economic growth of output.

On the other hand, Hooker (1996) finds that oil prices did not influence many of US macroeconomic indicators after 1973. Bernanke et al (1997) argued that an important part of the effect of oil price shocks on the economy attributes to the tightening of monetary policy and not from the change in oil prices. Yet, Rotemberg and Woodford (1996) claimed that an increase in oil prices leads to decrease in both output and real wages. Finn (2000) introduced a model with integrated energy as an essential input for the utilization of capital. The model considered variations in the utilization rates for productive capital as a function of energy use. This alteration added an indirect channel, which works through capital stock, and the usual direct production function channel, for channelling the impact of fluctuations in energy usage to the economy. Oil price increase causes sharp simultaneous declines in energy use and capital utilization, thus a reduction in output and labour's marginal productivity. Rogoff (2005) argued that higher energy efficiency, greater concentration of oil consumption in final demand, better anchored monetary policy, deeper financial markets and more flexible labour markets have weakened the effects of oil shocks.

The above studies showed that increases in oil price have adverse effect on industrial output and economic growth. Yet, they all concluded that this relationship has not been stable for the developed countries over time. Such claim was confirmed in a study by Blanchard and Gali (2007) who compared the present response of inflation and output to oil price shocks in a group of developed economies to those in the 1970s. Blanchard and Gali (2007) found out that the main cause behind the weak responses of economies in recent years is smaller energy intensity, a more flexible labour market and improvements in monetary policy. Furthermore, Hamilton (2009) argued that a key mechanism through which oil price shocks affects an economy is through disruption in the expenditure of consumers and firms on non-oil goods and services. However, if this disruption does not occur, the effects of an oil price hike on the economy will be governed by the factor share argument.

For developing economies, little studies have been done on oil price and economic growth relationship with varied results. Chang and Wong (2003) studied the effects of oil price fluctuations on the economic growth in Singapore and found an insignificant negative relationship between oil price shocks and Singapore's GDP, inflation and unemployment rate. Jumah and Pastuszyn (2007) argued that oil price tends to negatively affect real output in Ghana. Wakeford (2006) concluded a negative relationship between oil price and economic growth in South Africa, and Bouzid (2012) reached the same result for Tunisia, as opposed to Farzanegan and Markwardt (2009) that showed a strong positive relationship between oil price changes and industrial output growth in Iran. In addition, studies by Olomola (2006), Akpan (2009) and Oriakhi and Osaze (2013) have all found a positive relationship between oil price increases and growth of output in Nigeria. These results can be attributed to the fact that Iran and Nigeria are net exporters for crude oil.

A range of channels were identified in the literature through which changes in oil prices would affect economic growth, such as: supply side effect, inflation effect, real balance effect (For more discussion on the channels of transmission from oil price increase to growth of GDP, see Brown and Yücel, 2002; Jiménez-Rodríguez and Sánchez, 2005; and Bhanumurthy, Das and Bose, 2012). There first channel is the import channel which links the international oil price to the current account balance and GDP. Assume the demand for oil is inelastic to changes in the price level, any increase in the international price of oil will lead to higher import bill for net oil importing economies, given that other factors held constant. This will result in a higher trade deficit and consequently cause a deterioration of the country's current account balance. Eventually, economic growth rates will decline. This will eventually result in lower economic growth rates.

The second channel is the price channel where an increase in the international price of oil can affect an economy through an increase in the domestic price of the commodity. However not all increase in international oil price is passed on to domestic consumers of the commodity, which is the case in Egypt. The government absorbs part of the price increase via fuel subsidy. Nevertheless, The proportion that is passed onto the domestic market would lead to an increase in the level of inflation, which in turn, would cause an increase in the cost of production. This would lead to a decline in profit levels and in turn, would cause a reduction in investment and employment and GDP growth. On the demand side, high oil price increase would lead to an increase in prices of consumer goods. Real money supply falls as demand for money also increases. This results in a rise in interest rates. Monetary authorities may also respond to the increase in price levels by tightening monetary policy via raising interest rates. High interest rates discourage investment and this tends to affect GDP.

The above studies failed to count for the effect of fiscal policy response to changes in the price of oil. Fiscal policy response should be included as it is a major channel through which changes in international oil prices can affect the economic growth in developing economies. The Egyptian government spends an average of LE 134 billion in 2013-2014 on fuel subsidies only, consequently this is likely to have a significant impact on the relationship between oil price and economic growth in Egypt. An oil price increase would raise subsidy on oil and consequently, would increase government expenditure. One of the objective of this paper is to examine the dynamic dimension of the oil-economic growth relationship in Egypt and expand on the existing literature. The ARDL approach is utilised to capture how fiscal policy can influence the relationship between oil price and economic growth. It is also a suitable approach to analyse the underlying relationship using a relatively small sample size from 1991 to 2010 (annual data). The use of the ARDL approach has a main advantage that it gives robust results in small samples.

In order to study the relationship between oil price and economic growth, it is natural to start the analysis with Solow growth model,

$$GDP_t = F(K_t, L_t, A_t) \tag{1}$$

where GDP is the output, K is the capital stock, and L is the labour force. The variable A is the total factor productivity, and it changes with different production functions based on the factors being studied,

$$A_t = f(O_t, G_t, CPI_t, OG_t, D_t) \tag{2}$$

where is O_t real crude oil price, G_t is government expenditure, CPI_t is consumer price index, OG_t is the interaction between oil price and government expenditure to capture fiscal policy response to an increase in oil price and D_{1t} is a dummy variable for economic reforms that took place in Egypt in 2003. Equation 2 is substituted into equation 1 and by assuming a Cobb-Douglas production function, the following model is derived,

$$lnGDP_t = \beta_0 + \beta_1 lnK_t + \beta_2 lnL_t + \beta_3 lnO_t + \beta_4 lnG_t + \beta_5 lnCPI_t + \beta_6 lnOG_t + \beta_7 D_t + \varepsilon_t$$

The ARDL representation of the above model can be written as:

$$\begin{aligned}\Delta lnGDP_t = {} & \beta_0 + \lambda lnGDP_{t-1} + \beta_1 lnK_t + \beta_2 lnL_t + \beta_3 lnO_t + \beta_4 lnG_t + \beta_5 lnCPI_t + \beta_6 lnOG_t \\ & + \beta_7 D_t + \sum_{m=1}^{p} \alpha_m \Delta lnGDP_{t-i} + \sum_{i=1}^{p} \phi_{1i} \Delta lnK_{t-i} + \sum_{i=1}^{p} \phi_{2i} \Delta lnL_{t-i} \\ & + \sum_{i=1}^{p} \phi_{3i} \Delta lnO_{t-i} + \sum_{i=1}^{p} \phi_{4i} \Delta lnG_{t-i} + \sum_{i=1}^{p} \phi_{5i} \Delta lnCPI_{t-i} + \sum_{i=1}^{p} \phi_{6i} \Delta lnOG_{t-i} + \upsilon_t\end{aligned} \tag{3}$$

where Δ denotes the first difference operator, p is the lag order, and υ_t is the error term which is $N(0, \sigma^2)$. The parameters α_m and ϕ_{ji} are the short-run parameters and λ and β_i are the long-run multipliers. The above model is estimated with bounds test using the OLS method and F-test is used to test for the presence of long-run relationship among the variables.

The existence of cointegration among the variables under consideration is tested based on the F-statistic. Once cointegration is established from the ARDL model, the long run and error correction estimates of the ARDL and their asymptotic standard errors are obtained.

$$lnGDP_t = \kappa_0 + \sum_{m=1}^{p} \lambda lnGDP_{t-i} + \sum_{i=1}^{p} \beta_1 lnK_{t-i} + \sum_{i=1}^{p} \beta_2 lnL_{t-i} + \sum_{i=1}^{p} \beta_3 lnO_{t-i} + \sum_{i=1}^{p} \beta_4 lnG_{t-i} + \sum_{i=1}^{p} \beta_5 lnCPI_{t-i} + \sum_{i=1}^{p} \beta_6 lnOG_{t-i} + \beta_7 D_t + \eta_t \tag{4}$$

The ARDL error correction representation of the series is estimated as,

$$\Delta lnGDP_t = \mu_0 + \sum_{m=1}^{p} \alpha_m \Delta lnGDP_{t-i} + \sum_{i=1}^{p} \phi_{1i} \Delta lnK_{t-i} + \sum_{i=1}^{p} \phi_{2i} \Delta lnL_{t-i} + \sum_{i=1}^{p} \phi_{3i} \Delta lnO_{t-i} + \sum_{i=1}^{p} \phi_{4i} \Delta lnG_{t-i} + \sum_{i=1}^{p} \phi_{5i} \Delta lnCPI_{t-i} + \sum_{i=1}^{p} \phi_{6i} \Delta lnOG_{t-i} + \beta_7 D_t + \xi EC_{t-1} + \epsilon_t \tag{5}$$

where ξ is the speed of adjustment of the parameter to long-run equilibrium following a shock to the system and is expected to be negative and statistically significant to further confirm the existence of a cointegrating relationship among the variables in the model. The term EC_{t-1} is the lagged error correction.

4 Results and discussion:

This section presents the results of the analysis in the previous section, considers a SWOT analysis to the oil and nature gas sector in Egypt, and discusses the policy implications and the main recommendations to policy makers.

First, a unit root test is implemented to test whether the variables are not integrated of an order higher than one. Since the computed ADF test statistics is greater than the critical values -2.57, -1.94, -1.61 at 1%, 5% and 10% significant level respectively, we cannot conclude to reject the null hypothesis. That means all variables have a unit root problem and are integrated of order I(1)- all the variables involved in the analysis are first difference stationary. Table 1 includes the implementation of ADF tests.

Table 1: Test for order of integration

	ADF	
	Levels	First Difference
GDP	3.415	-4.276*
K	-0.386	-8.329*
L	-0.592	-7.810*
O	2.754	-8.043*
G	-0.376	-3.955*
CPI	2.971	-4.091*
OG	-0.224	-3.462*

Note: The critical values of ADF unit root tests are -2.57, -1.94, -1.61 at 1%, 5%, 10% levels of significance.
* denotes significance at 1% level

Secondly, Equation 3- written in the ARDL framework- is estimated in order to examine the long run relationship between economic growth and the explanatory variables and the impact of these variables on economic growth. Table 2 presents the long run estimates of the ARDL model. It shows a negative sign for oil price, consumer price index and the interaction between oil price and government expenditure, which means these variables has a negative impact on economic growth in Egypt; while, government expenditure, labour force and capital stock have a significant positive impact on the growth of output. These results are consistent with previous studies in the literature.

Table 2: The ARDL framework (Estimation of equation 3)

Variables	Coefficient	Standard Error
C	6.7825*	1.4901
$lnGDP_{t-1}$	0.7801	0.0620
lnK_t	0.0520*	0.0014
lnL_t	0.0437*	0.0011
lnO_t	-0.1023*	0.0016
lnG_t	0.4259*	0.0034
$lnCPI_t$	-0.0051*	0.0007
$lnOG_t$	-0.0774*	0.0008
D_t	-0.0211	0.0005

Note: * denotes significance at 1% level

One of the explanatory variables OG_t is an interaction term as in Equation 3. Thus, the interpretation of the marginal effect of the interacted variables must be carefully explained. For example; to get the actual effect of oil price on economic growth, the mean value of government expenditure should be included due to the interaction term. This implies that government intervention to reduce the impact of high oil prices on consumers via subsidies will increase the negative impact of any increase in oil prices on economic growth.

Same analysis can be applied to capture the effect of government expenditure on economic growth. In order to get the actual effect of government expenditure, it is important to include the effect of oil prices. This is due to the government intervention in domestic determination of oil prices, which in turn will reduce the positive effect of government expenditure on economic growth.

Next, the short run relationships are estimated as shown in table 3. The term ξ represents the rate of adjustment to restore equilibrium in the dynamic model. The coefficient of lag error correction is -0.5629, negative and significant at1% significance level, which confirms the existence of cointegrating relationship. This indicates that about 56% of the deviations from the long term output growth caused by previous year's shocks converges back to the long run equilibrium in the current year.

Table 3: Error Correction Model (Estimation of equation 5)

Variables	Coefficient	Standard Error
C	8.4297*	1.8746
$\Delta lnGDP_{t-1}$	0.2573	0.0833
ΔlnK_t	0.03491*	0.0046
ΔlnL_t	0.0206*	0.0035
ΔlnO_t	0.0854*	0.0011
ΔlnG_t	0.2283*	0.0140
$\Delta lnCPI_t$	-0.0037*	0.0003
$\Delta lnOG_t$	-0.0599*	0.0079
D_t	-0.0032	0.0258
EC_{t-1}	-0.5629*	0.0669

Note: * denotes significance at 1% level

Table 3 shows that the short run coefficient of oil price is positive and significant at 1% significance level. Again, to get the actual effect of oil price increase on economic growth, the mean value of government expenditure should be included due to the interaction term. The short run effect can be computed using the coefficients 0.0854 and -0.0599. The result in the table shows that deviation from short run equilibrium growth rate as a result of oil price is not as high as the long-run effect. This means that government subsidies on fuel prices helps in minimizing the effect of oil prices on economic growth in the short run as compared to the long-run. On the other hand, government expenditure has a positive effect on economic growth. The short run effect can be calculated using the coefficients 0.2283 and -0.0599. Thus, any increase in government expenditure will cause economic growth to increase.

The SWOT analysis is very useful for closely examining the oil and natural gas sector in Egypt. It gives a snapshot of the strengths and weakness present today, and also looks ahead to future potential opportunities and threats.

***S**trengths*	***W**eaknesses*
• Egypt is the largest non OPEC oil producer in Africa and the second largest dry natural gas producer. • The industry supports at least 1.3 million jobs across Egypt. • Production of oil and gas boosts the balance of payments. • Suez Canal and Sumed Pipeline are strategic routs for Gulf oil shipments to Europe. • Supply chain added another $ 7.5 billion in exports of goods and services.	• Fuel subsidies of LE 134 billion by the government in 2013-2014 tends to have negative effects on the economy. • Increasing domestic demand, accompanied by falling domestic production. • Net export of crude oil and petroleum products declined . • Absence of long term development strategy. • Operating costs are expected to increase sharply due to current poor production.
***O**pportunities*	***T**hreats*
• New discoveries expected to increase production. • High demand from the international market, especially India and the USA. • The nuclear option will provide a form of electric generation for the next hundred years and is cheaper than oil and natural gas. • Natural gas has the potential to be the fuel of the future with demand outpacing supply.	• Decline in oil and natural gas production since 1996 and 2008 respectively. • Decline in exploration drilling and success rates. • Ubiquitous attacks on gas pipelines causing Egyptian state-owned oil and gas companies to terminate their agreement to supply gas to Israel in April 2012. • Continuing government interference and political unrest.

The Egyptian government should maximise the domestic opportunities and minimise threats listed here. There would be a substantial impact on Egypt oil and natural gas output which in turn would be of tangible benefit to the whole Egyptian economy.

It is easier to put a set of analytical principles than to make policy recommendations. And it is not the aim of this paper to give detailed advice to the Egyptian government, to the policy makers or to the private petroleum companies operating in Egypt. Yet, there is particular set of policy implications that can be drawn together (Eden et al., 1981).

First, Egypt policy decisions are interdependent with other countries. The oil and natural gas industry is global. An awareness of this interdependence should increase the chances of action in the right direction.

Secondly, there is no particular or correct solution or technical fix which can be chosen and stuck to by policy makers to the exclusion of all other options. It has proved appropriate to back several horses simultaneously and to seek diverse and complementary methods of balancing supply and demand.

Thirdly, the time element is of crucial importance. Most forms of energy alternatives to oil require high capital investment and have long lead times, either for production, transport, conversion or conservation. This imposes on government and institutions a need for long-term planning and investment to a degree unusual amongst political decisions in general. Conversely, the long term interests of oil producers will not be served by restrictions on supply that force the price of oil so high that alternatives are prematurely and excessively developed, or economic growth so adversely affected that social and political instability become widespread.

Fourthly, once the strategy has been identified, the policy paths chosen, the question of instruments to be adopted still remains. On the supply side, the options available to governments increasingly involve direct or indirect decisions on the oil industry investments and inter country agreements on energy trade. Other instruments available for the Egyptian government to influence both supply and conservation include taxes, subsidies, controls, education and support of research and development. The government may also have a major impact on energy supply- positively or negatively- through their approach to environmental issues.

If the nuclear option is politically and environmentally acceptable, it will provide a form of electric generation for the next hundred years that may be significantly cheaper than oil and natural gas. Also, the contribution from solar power - may within fifty or a hundred years become significant, but we cannot see it making a substantial dent in the call on hydrocarbons and nuclear energy.

Finally, problems in oil and natural gas sector in Egypt are not going to be resolved by governments alone, no matter how well chosen their policies may be. Decisions on energy consumption are widely dispersed amongst institutions and particularly on conservation amongst individuals.

5 Conclusions:

Egypt will continue to experience obstacles in developing further oil and natural gas reserves, especially with a continuing decline in Egyptian oil and gas production and a subsidies system that encourages over consumption. As Egypt's oil and national gas industry has a widespread economic impact throughout all sectors of its economy, the Egyptian government should use all available policy instruments and all sorts of complementary packages in order to maximise the benefit of oil and gas for the Egyptian economy. At present, the fears of an outbreak of an energy crisis in Egypt are temporary resolved by new discoveries or by aid from the Gulf countries (mainly Kingdom of Saudi Arabia, United Arab Emirates and Kuwait). It is not a question of running out of oil but rather a matter of ceasing to look to oil as the main source of future increases in energy supply.

Egyptian government will need to take difficult decisions to put the public finances on a sustainable path. Education and awareness of our interdependence can be important factors, but the objectives and time horizons of decision makers vary widely and it would be naive to suppose that any ideal policy exists. Energy problems are embedded in wider economic and social issues and there will always be compromises and trade-offs. There is no single energy problem, there is no ideal strategy, there is no easy way out.

As returns of natural resources are the main drive to economic development, It is very important to correctly calculate the estimated reserves for oil and natural gas, hence revise the policies of exporting oil and gas as they are based on the estimated reserves. In addition, Egyptian government should take a long term plan in order to decide the 'best possible use' of such estimated reserves available. The Egyptian government should spend the returns from oil and natural gas sector in investing to develop the business in sustainable ways; such as, investing in new oil and gas drilling projects, refinery improvements, research and development of new products and new technology to reduce the cost of finding and producing oil and gas in order to extend the life of existing oil fields, etc.

Fuel subsidies should be gradually removed. Any sudden decrease in subsidies will have varying effects on the Egyptian economy. The decrease of subsidies will increase the inflation rate. Egypt should be in a position to start considering alternative sources of energy. The nuclear option should be at the top of the list as it will provide a cheaper source of electric generation for the next hundred years. Government should give incentives to companies that implement an alternative source of energy, such as: wind turbines and solar power. For example the Suez Cement Group is planning to produce electric energy using wind turbines. This project will secure 35% of electricity used by the Suez Cement Group.

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