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THE IMPACT OF CHANGE IN OIL PRICE ON DIFFERENT CPI CATEGORIES IN LEBANON

by
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AN ABSTRACT OF THE THESIS OF

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In this thesis we investigate the impact of change in oil price on the change of the total consumer price index (CPI) and on the change of different CPI expenditure categories using a vector autoregressive (VAR) model. The examined CPI expenditure categories are 1) clothing and footwear; 2) water, electricity, gas and other fuels; and 3) health. We start by applying the VAR model then proceed to execute the Granger causality test, the impulse response and finally the variance decomposition. The main findings in this thesis suggest first that the change in oil price does not Granger cause any of the variables in consideration except for the CPI expenditure category water, electricity, gas and other fuels. Second, we find that by applying a positive shock to the change in oil price, the water, electricity, gas and other fuels category has a positive and significant response which lasts for 2 months. Third, the variance decomposition shows that shocks in oil prices account for 34.5% of the variation in water, electricity, gas and other fuels.

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CHAPTER I

INTRODUCTION

The Consumer Price Index (CPI) serves as a central economic and social indicator and a key measure to inflation. It is very important to look at changes in the CPI as it reflects the evolution of the living standards of the consumers in an economy. In parallel, crude oil is one of the most demanded commodities in the world. Over the years, oil has been gaining a significant importance especially as the main energy source for transportation and production. The international price of oil was more or less stable in the 1970s until the Iranian crisis in 1979 that created a major disruption in oil supplies. Thus, oil price volatility started. Oil prices started to increase and peaked at 106.36 USD per barrel in 1980, but then experienced a very large decline in 1981 which lasted for several years. In 1998, a combined increase in supply and decrease in demand lead oil prices to fall dramatically down to 17.10 USD per barrel. However, the price of oil started rising again in 1999 and peaked at 134 USD per barrel in 2008. Prices remained high from 2011 till 2013, averaging at 110 USD per barrel, despite the announcement of the Organization of the Petroleum Exporting Countries (OPEC) to increase production by 10%. There are several reasons for this increase in oil prices over the years. In fact, the demand for oil expanded especially in emerging countries due to the growing rate of industrialization and the growth in the use of modern modes of transportation. Nonetheless, crude oil lost half of its value from 2011 till 2017, as the average price of oil in 2017 was 54.4 USD per barrel.

At the same time, Lebanon's inflation has been running at volatile rates during the last decade. According to the official data from the Central Statistical Administration (CAS)

in Lebanon, inflation rate recorded a high of 6.58% in 2012 compared to a negative 3.7% in 2015 and reached a high rate again of 6.07% in 2018.

On the macroeconomic level, Lebanon's economy is one that relies heavily on diaspora inflows rather than productive sector. On the fiscal level, chronic fiscal deficits lead Lebanon to face a growing public debt burden standing at 155% of the gross domestic product (GDP). This is the third highest debt-to-GDP ratio in the world and it is mostly held internally by Lebanese banks. The Lebanese economy seems to be stuck in a vicious circle where there isn't an incremental wealth generation. Despite experiencing some periods of economic prosperity, growth in Lebanon has been volatile. In fact, the growth of the GDP per capita has been negative since 2011, standing at -0.34% in 2018 compared to a positive World average of 1.8%. The largest government expenditures remain the service of debt and the large transfers to the electricity sector.

The Lebanese economy is service oriented and the main growth sectors include banking and tourism. The service sector holds the biggest contribution to the GDP with 74% compared to a share of 14% of the industrial sector and a 3% of the agriculture sector (World Development Indicators, 2018). The industrial sector suffers from a very low competitiveness due to the high costs of production. In addition to the rising land and labor costs, the unfavorable business environment, and the ineffective transportation network, one of the key challenges in this sector is the high cost of energy generation driven by poor quality of power. On the trade level, Lebanon relies heavily on imports. Data from the WDI shows that imports of goods and services constituted almost 40% of the GDP whereas exports constituted only 23% in 2018.

In addition, the conflict in Syria constituted a major challenge and burden to the Lebanese economy as Lebanon welcomed more than one million registered and an

estimated 300,000 unregistered Syrian refugees which increased social tensions, tightened the availability of low-skill jobs for the Lebanese, and weakened the already poor infrastructure.

All these macroeconomic and social factors constrain the ability of the government to invest in necessary infrastructure such as water, electricity and transportation.

The electricity sector in Lebanon particularly encounters many challenges. The financial deficit of Electricité Du Liban (EDL) reached 1.8 billion USD in 2018. Many factors contributed to this situation, including technical challenges as well as weak organizational and operational frameworks. The failure of the government to solve these challenges is leading to an expanded public deficit. The challenges in the electricity sector expand on various scales. Firstly, there exist a significant deficit in the generation capacity to meet demand. The shortage gap is increasing due to a continuous increase of demand compared to a decreasing rate of supply. Secondly, significant financial deficit is recorded annually, ranging between 1,5 and 2 billion USD, because of inadequate tariffs. The electricity tariff is largely subsidized, and it is much lower than the actual cost of electricity production. The average tariff stands at 9.5 cents for each kilowatt hour (kWh) consumed, compared to a cost of generation ranging between 17 and 23 cents per kWh. Thirdly, the electricity sector relies largely on oil rather than cheap natural gas which causes high generation costs. Despite that the power plants were originally designed to use natural gas, they are running using oil, thus making EDL reliant on oil prices.

Hence, in consideration to the above, oil is a major input in the Lebanese economy since it is exclusively used as an input in the power sector. Given that Lebanon relies heavily on imports and the electricity sector relies on oil, oil prices tend to have an effect on

Lebanon's CPI sub-categories. The changes in both global oil prices and inflation rates in Lebanon are quite remarkable and the simultaneous fall in both between 2014 and 2017 implies that there might be a link between oil prices and Lebanon's inflation which is measured by the change in CPI.

Previous literature has deeply studied the relationship between oil prices and inflation, or change in CPI, but no consensus has been reached.

This thesis work investigates the effect of oil prices on different categories of the CPI in Lebanon by applying a Vector Autoregressive model (VAR). The sample used starts from January 2008 and ends on September 2019. The VAR model applied enables the examination of causality by treating all variables as endogenous. More specifically, in this study we examine the effect of the change in oil price on the CPI growth, and three of the CPI's sub-categories: 1) water, electricity, gas and other fuels, 2) clothing and footwear, and 3) health. We start by applying the VAR model, determining the lag length, then proceed to execute the Granger causality test, the impulse response and finally the variance decomposition.

The remainder of the thesis is organized as follows. Chapter 2 presents the macroeconomic and sectoral developments during the period 2008-2019. Chapter 3 is devoted to explaining the methodology used and reviewing the related economic literature. Chapter 4 provides the data description and the empirical results of the VAR analysis applied to the variables. Chapter 5 covers the concluding remarks.

To the best of our knowledge, this study is the first attempt to investigate how oil price change affects the CPI and its sub-categories in Lebanon, taking the endogeneity of oil price into consideration.

CHAPTER II

MACROECONOMIC AND SECTORAL DEVELOPMENTS: 2008-2019

A. LEBANON

Prior to the 1975 civil war, the Lebanese economy had been one of the most prosperous economies in the Middle East. The Lebanese economy was known for its liberal approaches, its dominant private sector, which was primarily trade and services oriented, as well as for its connection between the developed countries such as Western Europe and the USA, and the underdeveloped countries of the East (at the time) like the Arab Gulf Countries and India. Lebanon was open to capital inflow from foreign investors and to remittances from emigrants which resulted in a high average annual growth rate of 7% from 1950 until 1974, a low annual inflation rate of 2 to 3 percent until 1971, in addition to a large balance of payment surplus and a low budget deficit. Income per capita was about 1,200 USD, one of the highest amounts for a back then developing country.

However, during the civil war period, Lebanon lost its position as the business hub of the Middle East. The war led the government to lose authority which resulted in a significant deterioration of public finances followed by a mass emigration of capital, labour and skills, in addition to an immense destruction in infrastructure and facilities. All of this damage contributed to an economic downturn and the depreciation of the Lebanese pound. In fact, during the period of 1982-1992, Lebanon witnessed a worsening economic and social condition due to the ongoing

civil war and the Israeli invasion, the budget deficit and inflation increased heavily which was reflected on the exchange rate. In 1984, the Lebanese pound fell in price rapidly and reached its highest value to the US dollars at 2,420 Lebanese pound in September 1992.

By the end of the war, losses were estimated at anywhere between 80 and 160 billion USD. Lebanon encountered economic challenges in terms of high government deficit and interest rates, a slowing output growth rate as well as a high share of public debt. Despite all these challenges, Paris I and II conferences were held in 2001 and 2002 to request external support from the international community donors in order to help Lebanon reduce and manage its rapid growth in public debt and debt service. The international community provided 2.4 billion USD in direct financial support in Paris II only. These conferences resulted in a significant decrease of interest rates which helped Lebanon decrease the amount of debt service as it represented 80% of total revenues, however they could not fully address the indebtedness issue. In 2004, real growth reached 7%, the overall budget deficit declined to less than 8%, and the primary budget surplus improved to more than 2% of the GDP. That performance exceeded all expectations and was mainly due to the introduction of the Value Added Tax (VAT) in 2002. However, strong political tensions began by the end of 2004 and surged at the beginning of 2005 which led to a real growth of only 1% in 2005. During that period, oil prices soared at very high levels which put pressures on the budget transfers to Electricité Du Liban (EDL) which reached 650 million USD.

After the mid-2005 parliamentary elections, financial indicators were showing strong improvements, real growth was expected to reach at least 5% with

expectations of a high record tourist season and an increase in exports by 30%. However, following the July 2006 war, all these expectations were not met. The direct damages from war included public and private infrastructure in addition to private houses which were estimated at 2.8 billion USD. Growth rate in output was negative 5% which represented a loss in output and income of 2.2 billion USD. A third conference, Paris III, was held in 2007, its main purpose was to help Lebanon seek donations in order to perform several reform programs in terms of financial reform, debt management and privatization program. However political tensions arose again by the end of 2007 and the beginning of 2008 until the election of a new president. Growth rates for the years 2007, 2008 and 2009 were significant and reached 7.5%, 9.3% and 8.5% respectively, despite the 2008 world financial crisis. Nonetheless, since the start of the Syrian crisis in 2011, the Lebanese economy transited into a new phase of slowdown. The GDP growth rate decreased significantly in 2011 and reached 2%. Expectations of growth fell from 3.5% to 1% in 2012 as the political and security situations deteriorated and there were no signs that the Syrian war would come to an end soon. That was followed by a vacancy of the head of state position. Expectations of growth for the forthcoming years were not significant as they reflected almost the same rates as the previous ones. Lebanon faced enormous challenges which were exacerbated by the war in Syria and the crisis of displaced Syrians in the country. Currently, after the election of a new president, Cedre I conference was held in 2018 to allow the international community to support the strengthening process of the Lebanese economy, through a comprehensive plan of reform and infrastructure investments. Lebanon secured over

11 billion USD; 10.2 billion USD in loans and 860 million USD in gifts/aids. The Lebanese government was looking for a 2.8% growth rate in 2018.

Lebanon had a floating exchange system since 1964. During the civil war, the Lebanese pound depreciated as a result of the deteriorated economic situation. As the war ended, Lebanon started the process of fixing its exchange rate and pegged the currency to the US dollars. Since 1997, 1 USD would be equivalent to 1,507.5 LBP and within a range between 1,500 LBP and 1,514 LBP. In order to maintain this rate, Lebanon's central bank main goal was to stabilize the value of the Lebanese pound and control the money aggregates.

Since the economy in Lebanon is highly dollarized, the country does not have much room to pivot its monetary policy. Trade becomes fragile as a depreciation in the USD could lead into European imports becoming more expensive. According to the International Monetary Fund (IMF), the rise in oil prices will lead to a rise in the import bill and will expand the account deficit already in place. Thus, the country will not be able to mitigate the impact through the currency depreciation since it is following a fixed exchange rate.

B. Oil

Crude oil is one of the most demanded commodities in the world. The energy sector in Lebanon depends entirely on imports of fuel. The consumption of primary energy sources has been steadily increasing over the years and crude oil consumption reached 134,000 barrels per day in 2019. Oil imports amounted to 5.11 billion USD in 2013. The petroleum products in Lebanon are imported from several countries, including Italy, France, Russia and Kuwait.

The change in oil prices altered the dynamics of many economies around the globe, leading decision makers to adapt to changes and handle the consequences of such changes. Lebanon received its share of this international shock in oil prices, as would oil prices affected private consumption. The fluctuation of oil prices originates from worldwide events that affect the mechanisms of supply and demand. Going back to 2010, this year was highlighted by the start of the Arab Spring and the weakening of the USD. Brent crude oil prices started going up in that year and reached 92 USD per barrel in December 2010. Prices continued increasing in 2011 with an appreciation of the USD and a new announcement made by Iran to stop its supply to British and French companies. Prices in that year peaked at 123 USD per barrel. During 2012-2013, oil prices witnessed a low variation, averaging at 110 USD per barrel, even though in 2012 the Organization of the Petroleum Exporting Countries (OPEC) announced a 10% increase in oil production. However, an unexpected free fall of oil prices was recorded in the second half of 2014, when prices declined to 62 USD per barrel. This has been mostly explained by the surge in the supply side, since many of the oil producing countries such as Venezuela, Libya, Iraq, Angola, Nigeria and South Sudan rejoined the market. Oil prices between 2015 and 2016 averaged at 48 USD per barrel and recorded a price as low as 30 USD per barrel in January 2016.

The OPEC is the international organization consisting of oil producing countries which was founded in Iraq in 1960 by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela and joined later by Qatar, Indonesia, Libya, UAE, Algeria, Nigeria, Ecuador, Gabon and Angola. OPEC used to control nearly 55% of the global oil production but this share is down to 42% in the present. As mentioned previously,

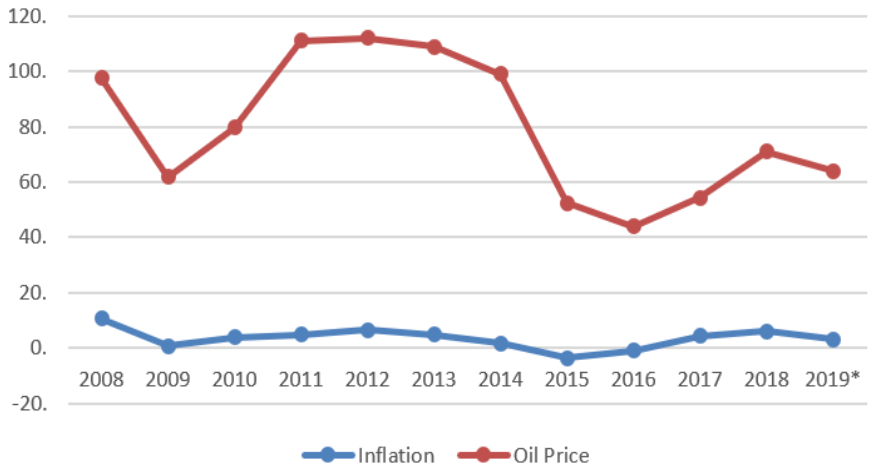
in 2014 the OPEC decided to retain market share and thus its output started to increase. Oil supply increased as Indonesia and Gabon returned as OPEC members in 2015 and 2016 respectively and as Saudi Arabia, Iraq and Iran produced more. In November 2016, the OPEC agreed to cut output by 1.2 million barrels per day to 32.5 million barrels per day for the first six months of 2017. In addition, independent producers such as Russia, Oman and Mexico also agreed to a cut of 558,000 barrels per day. The reasons behind this agreement were obvious and logical as there was a need to erase the global surplus and a need to support falling prices which fell to 30 USD per barrel. The OPEC however stated that it did not have a specific oil price in mind and that the exporting countries' decision to manage supply was mainly taken to tackle high inventories built-up in the period 2014, 2015 and 2016, which had started to fall. The objective, as stated, was to bring the market back into balance and stability.

It is important to note that Saudi Arabia is the OPEC's biggest producer. It faced many challenges during the last years and was even selling a stake in its national oil producer, Saudi Aramco. The reason why oil prices have been allowed to slide during these last few years is because Saudi Arabia has been trying to re-establish its position as the global oil market "swing" producer in which it has ultimate control over the oil prices by raising or cutting production. Saudi Arabia would change supply to defend prices. However, Saudi Arabia has seen that position eroded by the revival of the Russian and American production.

Hence, any change in the price of oil has an impact on both exporting countries as well as importing countries. As an oil importing country, all economic sectors in Lebanon were affected by these changes. In the case where oil prices dropped, both

consumers and producers benefited from this decline. In 2015, the CPI sub-index for "water, electricity, gas and other fuels" experienced an annual decline of 18%. Thus, figure 1 below shows that inflation in Lebanon somehow follows the trend in oil prices.

Figure 1: Evolution of Inflation and Oil Price



Normally, in a situation with lower prices, consumers should witness an increase in their real income which would lead to a higher propensity to save and consume. This however should be more investigated in the case of Lebanon since many economic factors could prevent that result. Hence, theoretically, the drop in oil prices would bring benefits to the Lebanese economy as it would reduce the subsidies to EDL and hence narrow the fiscal deficit of the country. In addition, it would narrow the trade deficit and have a positive impact on Lebanon's balance of payments.

On the micro level, the Association of Petroleum Importing Companies (APIC) which is a non-governmental association founded in 2007, constitutes of 13 oil importing and distributing companies including Total, Wardieh and IPT. The 13 companies share the market with each having around 8% of the total market share

and import oil mostly from Russia, France, Italy and Libya (as mentioned previously). From the distributing countries' side, the decline in oil prices had an unfavorable impact on their operations as the lag between the purchasing date and the actual selling date exposed them to negative price fluctuation.

The need to urgently address the oil dependence in Lebanon became essential especially after the attack on the Saudi oil facilities, Aramco, in September 2019. The attack implied a cut of 5% of the global supply which triggered a jump in oil prices on international markets. This proved the vulnerability of Lebanon with regards to increases of prices in the oil market.

C. Consumer Price Index

The CPI serves as an indicator of the sustained increase of prices in the Lebanese economy as it measures changes in the prices of a basket of goods and services. The price of oil is often seen as causing inflation. Theoretically, a rise in oil prices will have a significant impact on the CPI's sub-categories that directly reflect fuel prices.

This relationship between both variables was evident back in the 1970's. When the oil crisis hit in 1973, the price of oil went up from a nominal price of 3 USD per barrel to around 40 USD per barrel which translated in an increase in the CPI in the USA from 41.2 in 1972 to 86.3 in 1980, which is nearly more than its double. However, after 1980, this relationship between oil and inflation started to deteriorate. In the 1990's, while crude oil prices rose from 20 USD per barrel to 40 USD per barrel in six months, the CPI in USA remained relatively stable. This deterioration in the relationship was more evident in 2005 when oil prices reached

50 USD per barrel, up from 16.5 USD per barrel while the CPI rose to 196.8 in 2005, up from 164.3 in 1999. Hence, this shows that in the case of the USA, the correlation between oil prices and inflation has been weakening significantly throughout the years. In fact, referring to Friedman's theory, he argued that inflation remains a monetary phenomenon, meaning that it is rather affected by an increase in money than something else.

In 2018, Lebanon scored the highest inflation rate during the last decade with a rate of 6.07%. The year-on-year inflation has been increasing in Lebanon, in fact, inflation in the previous years was 4.48% in 2017, -0.82% in 2016, -3.75% in 2015, 1.9% in 2014 and 4.8% in 2013.

All of the expenditure categories under the CPI witnessed an increase in price driven by additional taxes and a continuous rise in global oil prices. Hence, the rise of inflation in some categories is suspected to be linked to the rise of the oil price per barrel. Some economists claim that the rising price of a barrel of oil could be a factor contributing to the inflation, especially that it recorded an increase by 60% between June 2017, when a barrel cost about 47 USD, and June 2018 when the cost reached about 75 USD. Oppositely, others argue that the impact of fuel prices on the CPI has weakened with the regulated price formula for fuel imports. According to the IMF, Lebanon's inflation in 2017, calculated at 5%, was mainly driven by a weakened USD and increasing oil prices. Another factor contributing to inflation could be the tax increase.

In details, the average cost of water, electricity, gas and other fuels, which constitutes a weight of 28.4 of the total CPI, recorded an increase by 6.35% year-on-year by June 2017 and a rise by 1.43% by November 2019.

In June 2011, Lebanon registered a 6% inflation rate which as reported by CAS, stemmed mainly from the 21.1% increase in clothing and footwear prices, compared to 2010. Similarly, in recent years, the clothing and footwear category, constituting a weight of 5.2 of the CPI, recorded a jump in its average costs which was attributed to a high correlation to the recovery of the tourism sector. In fact, in May 2017, the number of tourists registered a yearly increase of 12.81%, leading to a boost by 6% of tourist spending. However, some economists argue that the rise in the CPI cannot be attributed to the clothing and footwear category but rather to transportation costs and increasing prices of petroleum products. Moreover, the category climbed by an annual 7.89% in June 2017 due to the fact that 70% of tourist expenditures were on "Fashion and Clothing" (CAS, 2017).

Nonetheless, the average consumer prices for health, constituting a weight of 7.7 of the CPI, fell by 1.48% year-on-year by June 2017 and slipped by 0.52% year-on-year by November 2019. Despite this decline, the health sector in Lebanon remains expensive with unreasonable costs for hospital bills, medical expenses and medicine prices.

D. Electricity Sector

The electricity sector in Lebanon is run by the state-owned power utility Electricité du Liban (EDL), which is under the control of the Ministry of Energy and Water (MEW), and whose mission is to generate, transmit, and distribute electricity to all Lebanese territories (EDL, 2012). The EDL, was founded in 1964 by Decree No. 16878, and controls over 90% of the Lebanese electricity sector (EDL, 2012).

Over the years, the electricity sector in Lebanon has been facing increasing challenges that hinder its development. Due to the Civil War, the destruction of the electricity infrastructure, and the damage in operational and financial capacities of the state-owned EDL, the sector remains behind global and regional electricity trends. One of the main challenges faced by this sector is an unmet demand even when the electricity power plants are operating in their full capacity. The losses in transmission and distribution lead to a larger gap between supply and demand of electricity. It is important to note that 45% of produced electricity is distributed to household and business sectors compared to 23% for the industrial sector. Hence, with a growing population and a continuous increase in demand for energy, the strategy of the EDL is ineffective as the supply of electricity does not meet the demand. During the last decade specifically, the electricity system has been facing an amplified demand with the inflow of more than 1.5 million Syrian refugees. This has led to an increase in illegal electrical connections in the country. These illegal connections generate technical challenges and act as a barrier to the improvement of the sector as they cause technical damages and losses translated by a fall in the generation capacity to 50%. Another challenge faced by this sector is the obsolescence of the electricity power plants which are 25 to 45 years old. Some of these plants such as the Beddawi and Zahrani were originally designed to function using natural gas. However, these plants are currently functioning using gas oil due to the lack of natural gas supply.

All these technical and management challenges weakened the electricity system and pushed people to rely on an alternative, the private diesel generators which are also fuel-based. Thus, according to the World Bank, the back-up self-generation was

estimated to represent about 30% of all electricity generated in 2009. Considering all these facts, the Lebanese consumers end up paying high electricity bills for the lowest quality service. The average household consolidated electricity bill in 2008 was almost 180% higher than the average EDL bill.

The fuel bill contributed around 62% (1,165 million USD) of the total budget of EDL in 2009. In 2018, EDL contributed with only 0.3% to the total oil bill of 1.21 billion USD of gas oil and fuel oil. Its financial deficit reached 1.8 billion USD in that same year, resulting in a cumulative debt of 30 billion USD in 2019.

The present fiscal drain of the sector is the effect of lack of tariff adjustments since 1996. The electricity tariff is largely subsidized, and its level is too low to cover the cost of production. The fixed tariff is set below the cost of generation with an average tariff of 9.5 cents per kWh consumed compared to a generation cost between 17 and 23 cents per kWh. In fact, the tariff covers an oil price of 25 USD per barrel (World Bank, 2009). Oil prices reached a peak of 133 USD per barrel in 2008, which is more than 5 times what the tariff covers, and recorded very high levels (between 100 and 120 USD per barrel) during the period 2011-2014. As a consequence to its oil dependence, EDL faces significant financial losses, around 2 billion USD annually. This financial deficit is due to the fact that the government's contributions to EDL are used to cover for tariff subsidy and to purchase fuel. Therefore, since electricity rates are heavily subsidized, higher oil prices are expected to worsen the fiscal deficit.

Until nowadays, the government did not take any actions with regards to electricity production. Instead, electricity production is not efficient and still relies on petroleum. It is produced with oil products, mainly fuel oil, diesel and gas. This is a

major setback as it creates serious financial consequences from the increase of fuel prices.

This idea will be investigated in this thesis to see if a change in oil prices would have any effect on the electricity prices in Lebanon.

CHAPTER III

RELATED LITERATURE AND EMPIRICAL METHODOLOGY

A. Literature Review

A central issue in the economics literature that has been debated over the years is the effect of oil price shocks on the macroeconomic performance. Hence, examining the effect of oil price shocks on the aggregate price level has been trendy in the last decade. A considerable number of literature report on the topic in both developed and emerging countries.

Gubler and Hertweck (2013) evaluate the impact of commodity price shocks on the business cycle in the United States (U.S) using a structural vector autoregressive (SVAR) model on quarterly data from quarter 3 of 1955 to quarter 4 of 2007. The results show that these commodity price shocks have a significant role in increasing the U.S consumer price index (CPI) inflation rate. Besides, Yukino Sakashita and Yasunori Yoshizaki (2016) also examined the case of the U.S. In fact, in their paper, they investigate the impact of oil price changes on the CPI in the U.S in addition to five emerging countries (Brazil, Chile, India, Mexico and Russia), based on a two block SVAR model proposed by Kilian and Park (2009) and covering a period of 22 years from April 1994 to February 2016. In similarity to other literatures, the authors find that the impact of oil price shocks on the CPI strongly depends on the sources of these shocks. The study concludes that an increase in aggregate demand for oil leads to a rise in the CPI for the U.S compared to a significant fall in the CPI for the emerging countries.

Likewise, Ahmed, Joher, and Mokhtarul (2011) estimate in their paper an SVAR model to examine the effect of oil price uncertainty in Malaysia, using monthly data over 23 years, from 1986 to 2009. The authors find that a positive shock to oil prices leads to a decline in the levels of the CPI.

In the case of China, studies show opposite results. Yanfeng Wei (2019) analyzes the relationship between oil commodity prices and the CPI in China by applying an SVAR model and using quarterly data covering 20 years, from the first quarter of 1996 to the first quarter of 2016. The author shows that the study of this relationship crucially depends on the types of structural shocks proposed by Kilian (2009). This study finds that oil prices fail to predict the CPI at any period and concludes that oil aggregate demand and oil specific demand shocks have no effect on China's CPI.

On the contrary, different results have been confirmed by Xu Gong and Boqiang Lin (2018). They apply an SVAR model to empirically test the time-varying effects of the different sources of oil shocks (oil supply, oil aggregate demand, and oil specific demand shock) on China's economy using a sample period from 1995 to 2015. They find that oil aggregate demand and oil specific demand shocks have a non-negligible effect on China's CPI.

Other literature has also explored the Europe area. In their study, Peersman and Van Robays (2012) analyze the pass-through effect of the different oil shocks to consumer price inflation using an SVAR model with quarterly data covering the first quarter of 1986 to the first quarter of 2008. They find that the impact of oil shocks is strong in all energy importing countries.

Many authors report two limitations mentioned by Kilian (2009) in response to previous studies. The first limitation is that oil price shocks in these previous studies

are considered exogenous which pass over the possibility of existence of a reverse causality between the fluctuation of oil demand and the global economy. The second limitation is the failure of these studies to distinguish the types of structural shocks which originally had a role in increasing oil prices. In his study, Kilian (2009) identifies the types of these structural shocks, dividing them into three components: oil supply shocks, aggregate demand shocks, and oil-specific demand shocks. He applies this identification to an SVAR model of the global oil market. As proposed by Kilian (2009), many literatures underline that the effects of oil price shocks on the CPI strongly depend on the source of the shock. These studies specifically investigate which type of shock, whether oil supply, oil demand, or oil-specific demand related shock is affecting the CPI in different countries. In the U.S, Anzuini, Pagano, and Pisani (2013), evaluate the macroeconomic effects of oil specific demand shocks in the U.S by estimating a VAR model on monthly data from 1986 to 2008. Their results show that the oil specific demand shocks have a direct increasing effect on the CPI in the U.S.

In Spain specifically, Isidro Frias-Pinedo, Rosario Diaz-Vazquez and Ana Iglesias-Casal (2016) apply and use the impulse response analysis of the VAR model methodology to address the effects of oil shocks on prices. They use quarterly data covering 27 years from the first quarter of 1986 to the first quarter of 2013 and also distinguish the three main sources of oil shocks. According to the empirical results, the impact of an oil shock in Spain strongly depends on the source of shock, whether it is an oil supply shocks, oil demand shocks, and oil-specific demand shocks. Hence, the CPI in Spain is mainly affected by oil demand shocks.

Despite the existence of various literature on the effect of oil prices shocks on aggregate price, fewer discuss the effect of these shocks on the prices of the detailed categories of the consumer price index (CPI). A study done by Yoshizaki and Haomori (2014), examines the dynamic effect of higher oil prices on the detailed expenditure categories of the CPI in both the U.S and Japan, using the two-block SVAR model proposed by Kilian and Park (2009) and covering a period of 36 years (December 1974 – December 2010). The authors investigate whether oil price shocks act positively or negatively on the different expenditure categories. In addition, they specify which expenditure category index had a significant role in the response of the aggregate index to oil price shocks.

Yoshizaki and Haomori (2014) conclude that a same structural shock has different effects on each expenditure category price. They also find that the type of structural shock driving the changes in oil price has an important role in determining if the effect on the individual expenditure category prices is positive or negative.

In the same way, Liping Gao, Hyeongwoo Kim, and Richard Saba (2014) empirically investigate the impact of oil price shocks on six CPI sub-indices in the U.S through a VAR model, using monthly observations covering 37 years from 1974 to 2011. The authors find that the oil shocks have a significant impact on the energy intensive categories of the CPI, whereas the effect is limited on prices of some categories such as apparel, food, housing and medical care.

Investigating the impact of oil price on the CPI categories differs from a country to another. Castro and Jimenez-Rodriguez (2016) examine how oil price shocks are transmitted to consumer prices in the Euro area by applying a VAR model on monthly data over the period 2000-2015. The authors find that the oil pass-through

to consumer prices is very weak and of relevance in only the branches of mining, chemical, and metal.

There is a considerable body of literature that reports on the impact of oil price shocks on the CPI in many countries using the VAR methodology noting that a large number of these literature investigate the U.S particularly. In the U.S, all studies found that oil price shocks lead to an increase in the CPI, with Anzuini, Pagano, and Pisani (2013) specifying that the oil specific demand shocks have a direct increasing effect on the CPI. Oppositely, the result differed in Malaysia and some emerging countries that have been studies such as Brazil, Chile, India, Mexico and Russia, in which a positive shock in oil prices leads to a significant fall of the CPI. Some authors examined the case of China and found opposite results. While, Xu Gong and Boqiang Lin (2018) find that oil aggregate demand and oil specific demand shocks have an important impact on China's CPI, Yanfeng Wei (2019) argues that oil prices fail to predict the CPI at any period and concludes that oil aggregate demand and oil specific demand shocks do not affect China's CPI. When examining Europe, literature suggests that the impact of oil shocks is strong in all energy importing countries, noting that Spain is mainly affected by oil demand shocks.

However, fewer studies discuss the effect of oil price changes on the detailed categories of the CPI. In the U.S, Liping Gao, Hyeongwoo Kim, and Richard Saba (2014) specify that the energy intensive categories of the CPI are mostly affected by these changes and that effect is limited on other categories such as apparel, food, housing and medical care. Almost a similar result is presented in the case of Europe in a study done by Castro and Jimenez-Rodriguez (2016). They find that the effect

of oil price shocks on the CPI is very weak and of relevance in only the branches of mining, chemical, and metal.

B. Empirical Methodology

1. Testing for Unit Root

When running a model with time series data, it is necessary to test for stationarity. Tests such as the Augmented Dickey Fuller (ADF) (1979) and Phillips-Perron (PP) (1988) have been widely used to check for the presence of unit root and the stationarity of series. It is common to find that in practice oil price series and consumer price indices have unit root, which if not corrected might lead to spurious estimates and misleading results.

2. Augmented Dickey Fuller and Phillips Perron

In this study, we run the ADF test which estimates the following equation:

$$\Delta Y_t = \alpha + \beta_t + \gamma Y_{t-1} + \sum_{i=1}^{z} \gamma_i \Delta Y_{t-i} + \varepsilon_t$$

In the above equation:

- α is the constant
- β is the coefficient on a time trend
- i is the lag order of the autoregressive process

When running the test, the lag length z is determined to satisfy the non-autocorrelation specification. The null hypothesis and the alternative hypothesis of the ADF test are the following:

H0: β=0 indicating the presence of non-stationarity, which means unit root exists.

H1: $\beta<0$ indicating the stationarity of the series, which means unit root does not exist.

If the probability at level is higher than 0.05 that leads to accepting the null hypothesis and confirming the existence of unit root. Whereas, if the probability at level is less than 0.05, the null hypothesis is rejected, and therefore the alternative hypothesis suggests that there is no unit root and the data is stationary. In the case of existence of unit root, we can transform the process of non-stationarity by applying the first difference. If the series become stationary after differencing once, then the series are integrated of order 1: I (1). It should be noted that one should check the results of the ADF test at level for all models: intercept, trend and intercept and none, before moving to the first difference.

The PP test is also used in the analysis of time series to test for unit root and stationarity. This test is robust against heteroskedasticity and serial correlation since it includes the Newey-West standard errors. The null hypothesis and the alternative hypothesis of the PP test are the following:

H0: the series is integrated of order 1: I (1), which means existence of unit root

H1: the series is stationary, which means absence of unit root

In similarity to the ADF test, if the probability at level is higher than 0.05, the null hypothesis is accepted and therefore the existence of unit root is concluded. Whereas, if the probability at level is less than 0.05, the null hypothesis is rejected, and therefore there is absence of unit root and the data is stationary.

3. Vector Autoregressive Model

The VAR models were first introduced in macroeconomic models by Sims (1980). He argues that all variables introduced in a model can be endogenous and advocated the use of VAR models which have the following form:

$$Y_t = Z_i Y_{t-1} + \cdots + Z_p Y_{t-p} + \varepsilon_t$$

In the above equation:

- Y_t is a vector of the N variables included in the model
- Z_i are N*N parameter matrices
- p is the lag order
- ε_t is a white noise

Hence, in a VAR model, all variables are treated as endogenous and each variable depends on the previous changes which occurred in that variable and all other variables taken into consideration in the model. In VAR models, unit root must be treated, and the data must be transformed into the stationary form in order to proceed with the analysis. After specifying the model, in terms of choosing which variables to include and analyse, the choice of the lag length of the autoregression is therefore important. A very popular criteria is the Akaike information criterion (AIC) which can be used to decide on the number of lags to include when running the VAR model. After running the VAR model, the Granger causality is analyzed.

4. Granger Causality

The concept of Granger-causality is very common in econometric and time-series analysis (Granger (1969), Sims (1972)). The basic idea which Granger defined is

that the cause occurs at an earlier time than the effect. The Granger causality method is best suited to determinate the relationship between the variables, in this case to investigate the effect of changes in oil price on the different categories of the CPI in Lebanon. This method allows us to find out whether the series can predict one another or not. By applying the Granger causality, we investigate whether a change in one series is implying a change in another series (which is the dependent variable). The Granger causality test uses the block exogeneity Wald tests to assess the significance of the lagged variables on a dependent variable. Therefore, if the probability of the lagged variable is less than 0.05, then we can say than this lagged variable granger-causes the dependent variable.

5. Impulse Response

The Impulse Response Functions (IRF) are a very useful tool when running a VAR model as they lead to a better understanding of a model's dynamics and interactions between variables. The IRF serve as a method to trace the evolution of the variables mentioned in the model in reaction to a certain shock at a given moment in one of the variables. In this case, to investigate the response of the different CPI categories (clothing and footwear, water, electricity, gas and other fuels, and health) to a shock in oil prices. The test is reported in figures where the blue solid line represents the impulse response of the variable taken into consideration, and the dotted red lines represent the confidence interval. The response is supposed statistically insignificant if the upper and lower band (dotted red lines) cross the solid line.

6. Variance Decomposition

The variance decomposition is a common method used in statistics to analyze the relations between variables when running a VAR model. The variance decomposition indicates the proportion of the forecast error variation which affects its own shocks and the other variables in the unrestricted VAR model. In other words, it presents the percentage of the variance of a variable's forecast that is due to other variables.

CHAPTER IV

EMPIRICAL RESULTS

A. Data Description

The data used in this study is monthly data covering the period 2008-2019. The number of observations is 141, representing the period from January 2008 till September 2019. The variables that we are investigating in this thesis are oil prices, total CPI of Lebanon, and 3 sub-categories of the Lebanese CPI which are: 1) clothing and footwear, 2) water, electricity, gas and other fuels, and 3) health. To represent the change in oil prices in this thesis, we use the global price of Brent Crude oil, expressed in U.S. Dollars per barrel, on a monthly basis, and not seasonally adjusted. The data for oil prices is extracted from the website of the Federal Reserve Bank of St. Louis (FRED). The data for the remaining variables, total and CPI and its 3 sub-categories is extracted from the website of the Central Administration of Statistic (CAS) in Lebanon. This model will use the first difference of all variables, meaning the change in oil prices, the change or growth in total CPI and its 3 sub-categories. We will explain more about this choice in the results section.

1. Brent Crude Oil

Crude oil is one of most important energy sources in the World and a commodity of high value on the international commodity markets. There exist different types of

crude oil, out of which we have the most used one which is the Brent crude oil, produced in the North Sea region. The difficulty to find and develop new oil reserves resulted in a limited supply of crude oil. Since it is highly needed in industrial markets and other energy dependent markets, the price of oil holds a central role and has a great influence on the industrial and economic development of countries. Besides its usage in manufacturing, crude oil is also used in medicine and as a raw material in the production of other primary materials and other products. In addition, it is essential in the transportation sector as it is the base of transportation fuels: diesel, gasoline, jet fuel and fuel oils used for generating electricity.
With an increasing demand for crude oil over the years, and a limited supply, the price of crude oil is very difficult to predict and has been volatile over the ten past years reaching its highest value of 134 USD per barrel in 2008 and its lowest value of 30 USD per barrel in 2016.

2. Consumer Price Index

The Consumer Price Index serves as an important tool to report Lebanese prices on a monthly basis in order to determine any rise or fall in these prices. The CPI acts as a central economic and social indicator and is a key measure of inflation and consumers' welfare. Therefore, it is used to study the evolution of the living standards of households through the analysis of average changes in prices of goods and services and its impact on consumers. In addition, to posing as a central indicator which many economists track for its main role in predicting inflation or deflation and in determining the cost of living in an economy, the CPI also plays a key role in financial decisions. It is also very crucial to look for changes in the CPI

and adjust income, wages and other economic series. Central banks track closely the evolution of the CPI on a monthly basis as it is a warning that indicates any upcoming inflation risks and a guide to a change in policies. The Central banks in case of continuous changes (increasing or decreasing prices) need to adapt their policies and place them in the right direction. For instance, they must intervene in case they suspect an inflation by lowering interest rates. Therefore, many economic, social and political entities are interested in tracing changes in the CPI.

The CPI in Lebanon covers all goods and services bought and consumed by resident households. The Lebanese Central Administration of Statistics (CAS) collects the prices of 50,000 consumer products on monthly basis to conduct the index. The price information is collected from around 2,000 participating outlets. It is important to note that the CPI excludes the coverage of people in institutions such as prison, hospitals, army, and others.

The CPI in Lebanon includes the following 12 expenditure categories:

1- Food and non-alcoholic beverages
2- Alcoholic beverages, tobacco and narcotics
3- Clothing and footwear
4- Housing, water, electricity, gas and other fuels (including rents)
5- Furnishing, household equipment and routine household maintenance
6- Health
7- Transport
8- Communication
9- Recreation and culture
10- Education

11- Restaurants and hotels

12- Miscellaneous goods and services

The base month for the CPI from 2008 till 2013 is December 2007, while it is updated for the period 2014-2019 to be December 2013. The three highest weights 28.4, 20 and 13.1 are attributed to: 1) housing, water, electricity, gas and other fuels, 2) food and non-alcoholic beverages, and 3) transport respectively. The total CPI reached its highest value of 132.8 in March 2013 and its lowest of 94.4 in February 2016.

In this thesis, we choose 3 sub-categories to include in the VAR model. We are interested to include the housing, water, electricity, gas and other fuels category since it has the highest weight out of the 12 expenditure categories with 28.4 of total CPI. In addition, we will include data for clothing and footwear, and health since we also want categories that are not directly linked to oil prices. This is of an interest since Lebanon rely on imports in both the pharmaceutical sector and the apparel sector.

Although the transportation category has a high weight compared to other expenditure categories, we will dismiss including transportation data in our model because it is not part of our focus. It is commonly confirmed in many literatures that any change in oil prices would certainly affect the transportation sector since it is a direct relation.

a. <u>Housing: water, electricity, gas and other fuels</u>

The breakdown of the housing category includes water, electricity, gas and other fuels. Although rent is measured in the housing category starting 2014 in its sub-

categories: actual rent (old rent and new rent) and owner occupied, it is not included in this thesis. Hence, the housing category in this study will only take into consideration prices of water, electricity, gas and other fuels.

b. Clothing and footwear

This index measures price changes in apparel: clothing and footwear. The subclass indices included in this category are clothing, textiles, shoes and laundry.

c. Health

The health index measures changes in fees paid for consultations or clinic visits, dentists, cost of medicine and pharmaceutical products, cost of hospital accommodation and medical equipment.

B. Empirical Results

1. Unit Root Test for series

When conducting the unit root test for the series as spot prices and indices, we find that the series are not stationary according to both ADF and PP tests in their levels. Results, presented in table 1 and table 2, show that for all models in levels: intercept, trend and intercept and none, all probabilities for all series are higher than 0.05, which leads to conclude that the series have unit root. The results differ when we apply both tests at the first difference. All probabilities become less than 0.05 which means that the series become stationary at the first difference.

Hence, we decide to proceed with this model using the change in oil price instead of the spot price and the change or growth in CPI instead of the indices. When applying the ADF and PP tests to the series change in oil and change in CPI of each category (clothing and footwear, water, electricity, gas and other fuels, and health), we find that the series are stationary since all probabilities are less than 0.05. The latter results are reported in table 3.

Table 1: Augmented Dickey Fuller test results

	Augmented Dickey Fuller					
	Level			**First Difference**		
	Intercept	Trend and intercept	None	Intercept	Trend and intercept	None
Oil Price	0.136 (-2.42)	0.24 (-2.69)	0.28 (-0.99)	0.00 (-7.13)	0.00 (-7.10)	0.00 (-7.15)
CPI	0.31 (-1.93)	0.49 (-2.17)	0.6 (-0.008)	0.00 (-11.71)	0.00 (-11.67)	0.00 (-11.75)
Clothing and footwear	0.99 (0.95)	0.94 (-0.94)	0.97 (1.67)	0.02 (-3.22)	0.03 (-3.61)	0.009 (-2.5)
Water, electricity, gas and other fuels	0.64 (-1.25)	0.80 (-1.56)	0.52 (-0.42)	0.00 (-9.95)	0.00 (-9.91)	0.00 (-9.98)
Health	0.49 (-1.57)	0.32 (-2.49)	0.62 (-0.17)	0.00 (-14.06)	0.00 (-14.02)	0.00 (-14.11)

Table 2: Phillips Perron test results

	Phillips Perron					
	Level			**First Difference**		
	Intercept	Trend and intercept	None	Intercept	Trend and intercept	None
Oil Price	0.305 (-1.95)	0.46 (-2.23)	0.33 (-0.86)	0.00 (-6.68)	0.00 (-6.64)	0.00 (-6.71)
CPI	0.043 (-2.93)	0.07 (-3.28)	0.68 (0.02)	0.00 (-20.21)	0.00 (-20.18)	0.00 (-20.28)
Clothing and footwear	0.81 (-0.80)	0.75 (-1.67)	0.98 (1.91)	0.00 (-12.94)	0.00 (-13.52)	0.00 (-11.26)
Water, electricity, gas and other fuels	0.53 (-1.48)	0.69 (-1.81)	0.52 (-0.42)	0.00 (-9.98)	0.00 (-9.94)	0.00 (-10.01)
Health	0.43 (-1.68)	0.21 (-2.75)	0.62 (-0.16)	0.00 (-14.08)	0.00 (-14.04)	0.00 (-14.13)

Table 3: ADF and PP tests at first difference

	Augmented Dickey Fuller			Phillips Perron		
	Intercept	Trend and intercept	None	Intercept	Trend and intercept	None
Oil Price	0.00 (-7.68)	0.00 (-7.65)	0.00 (-7.70)	0.00 (-7.48)	0.00 (-7.44)	0.00 (-7.51)
CPI	0.31 (-1.93)	0.49 (-2.17)	0.67 (-0.008)	0.04 (-2.93)	0.07 (-3.28)	0.68 (0.02)
Clothing and footwear	0.003 (-3.86)	0.009 (-4.05)	0.00 (-3.47)	0.00 (-14.23)	0.00 (-14.28)	0.00 (-12.52)
Water, electricity, gas and other fuels	0.00 (-10.08)	0.00 (-10.05)	0.00 (-10.11)	0.00 (-10.13)	0.00 (-10.10)	0.00 (-10.17)
Health	0.00 (-14.09)	0.00 (-14.05)	0.00 (-14.14)	0.00 (-14.12)	0.00 (-14.07)	0.00 (-14.17)

2. VAR Model

The estimated VAR model in this study is the following:

- COP = C(1,1)*COP(-1) + C(1,2)*COP(-2) + C(1,3)*GCPI(-1) + C(1,4)*GCPI(-2) + C(1,5)*CF(-1) + C(1,6)*CF(-2) + C(1,7)*WEGF(-1) + C(1,8)*WEGF(-2) + C(1,9)*H(-1) + C(1,10)*H(-2) + C(1,11)
- GCPI = C(2,1)*COP(-1) + C(2,2)*COP(-2) + C(2,3)*GCPI(-1) + C(2,4)*GCPI(-2) + C(2,5)*CF(-1) + C(2,6)*CF(-2) + C(2,7)*WEGF(-1) + C(2,8)*WEGF(-2) + C(2,9)*H(-1) + C(2,10)*H(-2) + C(2,11)

- CF = C(3,1)*COP(-1) + C(3,2)*COP(-2) + C(3,3)*GCPI(-1) + C(3,4)*GCPI(-2) + C(3,5)*CF(-1) + C(3,6)*CF(-2) + C(3,7)*WEGF(-1) + C(3,8)*WEGF(-2) + C(3,9)*H(-1) + C(3,10)*H(-2) + C(3,11)
- WEGF = C(4,1)*COP(-1) + C(4,2)*COP(-2) + C(4,3)*GCPI(-1) + C(4,4)*GCPI(-2) + C(4,5)*CF(-1) + C(4,6)*CF(-2) + C(4,7)*WEGF(-1) + C(4,8)*WEGF(-2) + C(4,9)*H(-1) + C(4,10)*H(-2) + C(4,11)
- H = C(5,1)*COP(-1) + C(5,2)*COP(-2) + C(5,3)*GCPI(-1) + C(5,4)*GCPI(-2) + C(5,5)*CF(-1) + C(5,6)*CF(-2) + C(5,7)*WEGF(-1) + C(5,8)*WEGF(-2) + C(5,9)*H(-1) + C(5,10)*H(-2) + C(5,11)

Where:

COP	represents the change in oil price
GCPI	represents the growth of CPI
CF	represents the clothing and footwear category
WEGF	represents the water, electricity, gas and other fuels category
H	represents the health category

3. Lag Criterion

After running the model, we must check which is the right lag length to include. To do so, we run the VAR lag order selection criteria test, in which we get different results according to different criterions: the sequential modified LR test statistic (LR), the final prediction error (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SC) and the Hannan-Quinn information criterion (HQ). The selected lag order by each criterion is indicated in a summary table. According to many literatures, the FPE and AIC are the mostly recommended for

the estimation of the autoregressive length. As shown in the results presented below in figure 2, both AIC and FPE suggest that the optimal number of lags to include is 2

Figure 2: Lag Order Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: CHANGE_OIL_PRICE CPI_GROWTH WATER_ELECTRICITY_GROWTH
Exogenous variables: C
Sample: 1 141
Included observations: 132

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1183.851	NA	1.20e-14	-17.86138	-17.75218*	-17.81701
1	1241.174	109.4337	7.38e-15	-18.35112	-17.69593	-18.08488*
2	1270.990	54.66260	6.87e-15*	-18.42408*	-17.22292	-17.93599
3	1291.115	35.37172	7.43e-15	-18.35023	-16.60307	-17.64026
4	1310.091	31.91514	8.20e-15	-18.25896	-15.96582	-17.32714
5	1322.846	20.48497	9.99e-15	-18.07343	-15.23430	-16.91974
6	1350.906	42.93949	9.72e-15	-18.11978	-14.73468	-16.74423
7	1394.483	63.38558*	7.53e-15	-18.40126	-14.47017	-16.80385
8	1412.408	24.71480	8.68e-15	-18.29407	-13.81699	-16.47479

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

4. Residuals Autocorrelation

The residuals autocorrelation test allows to accept the null hypothesis that there is no autocorrelation from lags 1 to h since the probabilities are less than 0.05.

Figure 3: Autocorrelation LM test

VAR Residual Serial Correlation LM Tests
Sample: 1 141
Included observations: 138

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	21.99050	25	0.6363	0.878434	(25, 439.9)	0.6366
2	39.58329	25	0.0322	1.612671	(25, 439.9)	0.0323
3	28.05593	25	0.3053	1.128350	(25, 439.9)	0.3056

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	21.99050	25	0.6363	0.878434	(25, 439.9)	0.6366
2	62.48026	50	0.1108	1.265811	(50, 518.7)	0.1115
3	77.21696	75	0.4076	1.031970	(75, 521.5)	0.4113

*Edgeworth expansion corrected likelihood ratio statistic.

5. Granger Causality

Based on the Akaike criterion, we run the VAR model again but this time we specify the lag order of 2. Once the VAR model is re-estimated, we want to determine next whether one series is effective in forecasting another, and to know the direction of causality between the variables that we are taking into consideration. We apply the Granger-causality test and get the results reported in figures 4, 5, 6, and 7.

Figure 4: Granger Causality Test: CPI

Dependent variable: CPI_GROWTH

Excluded	Chi-sq	df	Prob.
CHANGE_OIL	0.783291	2	0.6759
WATER_ELEC	1.777540	2	0.4112
CLOTHING_F	5.272023	2	0.0716
HEALTH_GRO	1.707799	2	0.4258
All	11.35453	8	0.1824

Figure 5: Granger causality test: Clothing and footwear

Dependent variable: CLOTHING_FOOTWEAR_GROWTH

Excluded	Chi-sq	df	Prob.
CHANGE_OIL	2.842069	2	0.2415
CPI_GROWTH	2.126989	2	0.3452
WATER_ELEC	9.025322	2	0.0110
HEALTH_GRO	2.672287	2	0.2629
All	15.70495	8	0.0468

Figure 6: Granger causality test: Water, electricity, gas and other fuels

Dependent variable: WATER_ELECTRICITY_GROWTH

Excluded	Chi-sq	df	Prob.
CHANGE_OIL	58.15250	2	0.0000
CPI_GROWTH	0.721647	2	0.6971
CLOTHING_F	0.065858	2	0.9676
HEALTH_GRO	5.756260	2	0.0562
All	70.78599	8	0.0000

Figure 7: Granger causality test: Health

Dependent variable: HEALTH_GROWTH

Excluded	Chi-sq	df	Prob.
CHANGE_OIL	1.872915	2	0.3920
CPI_GROWTH	0.589042	2	0.7449
WATER_ELEC	5.972814	2	0.0505
CLOTHING_F	1.567629	2	0.4567
All	10.12624	8	0.2563

In this study, we are interested in investigating the relation between the lagged variable change in oil prices and all the other 4 dependent variables: 1)the total CPI

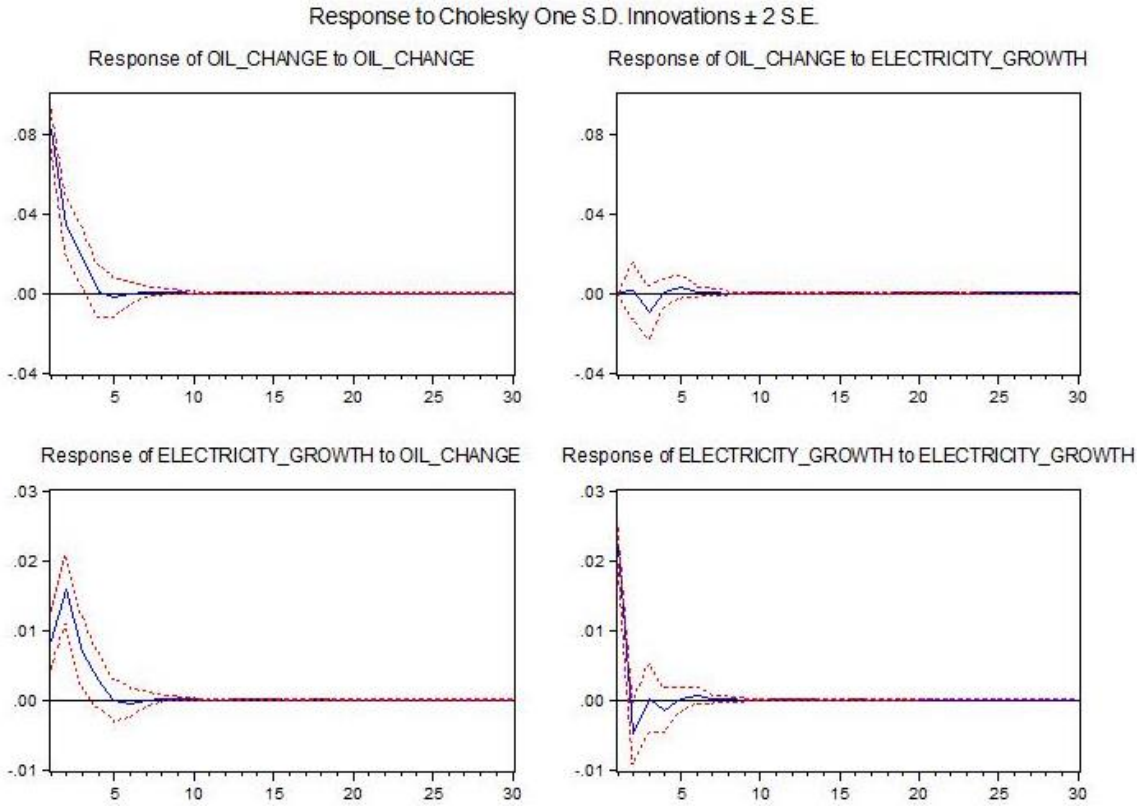
growth, 2)clothing and footwear, 3)water, electricity, gas and other fuels and 4) health. According to figure 3, the change in oil prices does not granger cause the total CPI growth since the reported probability is 0.67 which is greater than 0.05. Similarly, figure 4 shows that the probability of the change in oil prices is 0.24 which exceeds 0.05, meaning that the change in oil prices does not granger cause the clothing and footwear category. Opposite results are reported in figure 5. The test shows a probability of 0 which is less than 0.05 meaning that the change in oil price does granger cause the category of water, electricity, gas and other fuels. In figure 6, the reported probability of 0.39, which is greater than 0.05, suggests that the change in oil price does not granger cause the health category.

6. Impulse Response

The aim of using a VAR model is to ascertain the relation between the variables. The Granger-causality test allowed us to determine that the change in oil prices is causing a change in the category of water, electricity, gas and other fuels. In order to analyse the effect of a onetime shock in the change in oil price, we proceed to check the impulse response test of this shock on the category in question (water, electricity, gas and other fuels) for 30 years forecast period. Each set indicates the effect of a positive shock in the change of oil prices on the present and future value of each of the variables (total CPI, clothing and footwear, and health). Figure 8 shows the impulse response of water, electricity, gas and other fuels to a shock in change in oil prices. A positive shock in the change of oil prices resulted in a positive response of the water, electricity, gas and other fuels category. This positive response gradually falls after 2 months and lasts for 6 months in the positive area

before adjusting back to zero. Hence, we can say that in general, there is a positive impact of oil prices to the CPI's sub-category: water, electricity, gas and other fuels.

Figure 8: Impulse response functions



7. Variance Decomposition

The estimation of the VAR model allows us to further analyse the variance decomposition. The percentages presented in the table indicate the variance of the forecast of the water, electricity, gas and other fuels category as attributed to each the other variables such as change in oil prices, total CPI growth, clothing and footwear, and health.

The variance decomposition results in figure 9 reveal that the change in oil prices explains the growth of the CPI's sub-category water, electricity, gas and other fuels but with a lag of 2 periods (2 months). Within 2 months, the changes in oil price explain 34.3% of the fluctuations in the category of water, electricity, gas and other fuels. Subsequently, this explanation increases by 3% in the following period to reach 37.5%. In other words, in the short run, second period, shocks to oil prices account for 34.3% fluctuation in water, electricity, gas and other fuels. In the long run, period 20, shocks to oil prices contribute to 37.5% variation of the fluctuation in the category of water, electricity, gas and other fuels. Therefore, we can say that a shock in oil prices accounts for 34.3% variations in the CPI value of the sub-category water, electricity, gas and other fuels.

Figure 9: Variance Decomposition results

Variance Decomposition of WATER_ELECTRICITY_GROWTH:

Period	S.E.	CHANGE_OI	CPI_GROWT	WATER_ELE	CLOTHING_	HEALTH_GR
1	0.044806	10.82157	14.09853	75.07990	0.000000	0.000000
2	0.050544	34.30233	9.751763	52.96708	0.126294	2.852534
3	0.050730	37.51292	9.255568	50.29057	0.233589	2.707355
4	0.051058	37.35583	9.096562	49.56939	1.288900	2.689321
5	0.051176	37.33246	9.097754	49.54513	1.336077	2.688582
6	0.051199	37.31482	9.120524	49.53187	1.346960	2.685822
7	0.051204	37.31130	9.120161	49.52520	1.353224	2.690111
8	0.051206	37.31135	9.122741	49.52260	1.353341	2.689969
9	0.051207	37.31080	9.122580	49.52194	1.354594	2.690081
10	0.051207	37.31073	9.122564	49.52191	1.354724	2.690076
11	0.051207	37.31074	9.122548	49.52189	1.354748	2.690072
12	0.051207	37.31073	9.122560	49.52187	1.354758	2.690076
13	0.051207	37.31073	9.122565	49.52187	1.354760	2.690077
14	0.051207	37.31073	9.122565	49.52187	1.354761	2.690077
15	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
16	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
17	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
18	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
19	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
20	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
21	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
22	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
23	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
24	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
25	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
26	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
27	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
28	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
29	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077
30	0.051207	37.31073	9.122565	49.52187	1.354762	2.690077

Hence, the results above allow us to conclude firstly that oil prices do not Granger cause the CPI growth in Lebanon. This weak relationship between the change in oil prices and total CPI growth can be attributed to the fact that there are 12 expenditure sub-categories in the CPI with each a different weight. Hence, the effect that is seen in one category can be offset by another category, especially that relatively higher weights are allocated to the services categories in the consumption basket, noting that these categories rely less on oil. In addition, as reported, the change in oil prices does not Granger cause neither clothing and footwear nor health. Nonetheless, we notice that the change in oil prices does Granger cause the water, electricity, gas and other fuels category. In addition, a change in this category is 37.5% explained by the change in oil prices. This makes perfect sense as the electricity sector in Lebanon is very dependent on oil. We already have this direct relationship between both variables. The result presented is expected as electricity production in Lebanon relies heavily on oil. Any increase in oil prices would be reflected in the cost of production and hence the consumers would bear the increased price of electricity.

CHAPTER V

CONCLUSION

This thesis empirically examines the impact of changes in oil price on the CPI growth and three of the CPI's sub-categories: 1) water, electricity, gas and other fuels, 2) clothing and footwear, and 3) health. It is not clear in the observed literature whether changes in oil price have an impact on the CPI, as some studies find a positive relation while other confirm a negative one. Some literature argues that the increase in oil prices is not the cause of a higher inflation rate. The observations in this thesis confirm the latter approach that increased oil prices do not necessarily increase inflation.

To assess the reality of this relation between the variables, we estimate a VAR model and show through the Granger causality test that the change in oil prices only Granger causes the water, electricity, gas and other fuels category. The findings suggest that oil price shocks play a role and do affect the water, electricity, gas and other fuels category, as the impulse response function indicates that a positive shock in oil prices impact a response from the category in question which lasts for 2 months. The effect of such a shock is absorbed within 6 months. It is clear from the impulse response function that following an increase in oil prices, Lebanese consumers will have to bear the increased cost of electricity which will be reflected as an increase in the CPI's sub-category water, electricity, gas and other fuels. The variance decomposition results also reveal that changes in oil price is an important variable to explain the variations in the water, electricity, gas and other fuels index. Results show that a significant portion of the variation in water, electricity, gas and other fuels, 34.5%, is explained by changes in oil

price. These results are expected to shed light on whether Lebanon is immune to oil price changes given its status as a net oil importing country.

Based on overall findings, we conclude that the changes in oil price have a strong and direct impact particularly on the electricity sector in Lebanon. That reveals that a higher price of oil is negatively affecting the financial status of EDL and therefore increasing the price of electricity paid by consumers. This can be explained by the fact that the country relies heavily on expensive fuel and diesel oil for electricity generation unlike the rest of the Middle East.

It is clear that EDL faces great challenges translated in a serious deficit in the generation capacity to meet demand. Hence, one implication in terms of policymaking is that a national strategy should be implemented to reduce oil dependence. EDL cannot sustain and provide effective electricity generation without conducting a national strategy that includes radical solutions.

Although this VAR model enabled us to reveal the response of the CPI and three of its expenditure categories to changes in oil price, the effects of these changes on the remaining nine expenditure categories is still unknown. It is worth examining the impact of oil price changes on all of the CPI categories (twelve categories). In addition, different results can be attained if we take into consideration the source of the shock or change in oil price.

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