Forecasting Natural Gas Demand in the Short-term

Kamran Niki Oskoui, Ph.D. [1]

Mahdjouba Belaifa [2]

Abstract

Understanding the driving factors of global gas demand is of great importance for gas exporting countries such as Gas Exporting Countries Forum (GECF). Particularly, when we aim at developing a tool to forecast global gas consumption in the near future, it is necessary to identify the role of driving factors in explaining the fluctuations of natural gas consumption. Indeed, demand for natural gas not only depend on economic growth, but also, on gas price as well as use of other competing fuels, policies, seasonality and other factors which are directly or indirectly linked to the natural gas market.

The aim of this paper is to address the relationship between natural gas consumption and its drivers including economic growth, gas prices and energy demand, in order to forecast natural gas demand in the short term. For this aim, and after identifying and assessing the driving factors of natural gas demand, we have developed a Variance Decomposition based on Vector Autoregressive (VAR) Model.

The results of the Variance Decomposition suggest that GDP growth, gas price fluctuation and changes in energy demand describe around 32%, 35% and 16% of gas consumption fluctuation respectively. The remaining unexplained 17% could be the effects of other factors that are not modelled in this paper such as weather condition, policy and regulation.

Moreover, by estimating a Regression model, we developed an econometric tool to forecast short term demand for natural gas at global level, while bearing in mind that energy mix is structurally different from one region to another, and there is no homogeneity across the regions and countries. Having said that forecasting gas demand in the short term is a difficult task, this regression model gives us a preliminary projection which could be analyzed. For having a preliminary projection, we considered three scenarios namely Base-Case, Low-Case and High-Case Scenarios. According to our Base-Case scenario, global gas demand is expected to grow by 2% in 2017 and 2.1% both in 2018 and 2019.

Key Words: Natural Gas Demand, Economic Growth, Short Term Forecasts, VAR Model, Variance Decomposition Analysis.

1 . Market Research Analyst, Gas Market Analysis Department, GECF   Email: Kamran.Oskoui@gecf.org
2 . Head, Gas Market Analysis Department, GECF   Email: Mahdjouba.Belaifa@gecf.org

1. Introduction

Natural gas is one of the vital components of the global energy mix which has a diversity of usages in power generation, residential, transportation, petrochemical and industrial sectors. The share of natural gas in the global energy consumption was around 21% in 2016 During the last decades, natural gas has experienced the fastest growth rate among fossil fuels, around 2.3% CAAR, and its consumption increased from 1957.9 Bcm in 1990 to 3542.9 Bcm in 2016. The share of natural gas in the energy mix increased from 15% in 1990 to 21% in 2016 (Figure 1).

Figure 1: Global Energy Mix in 2016
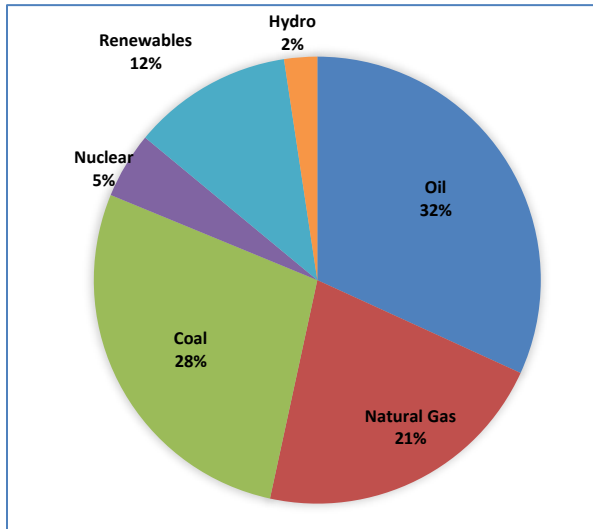
2016

Source: GECF database

Figure 2: World Natural Gas Demand by Sectors-
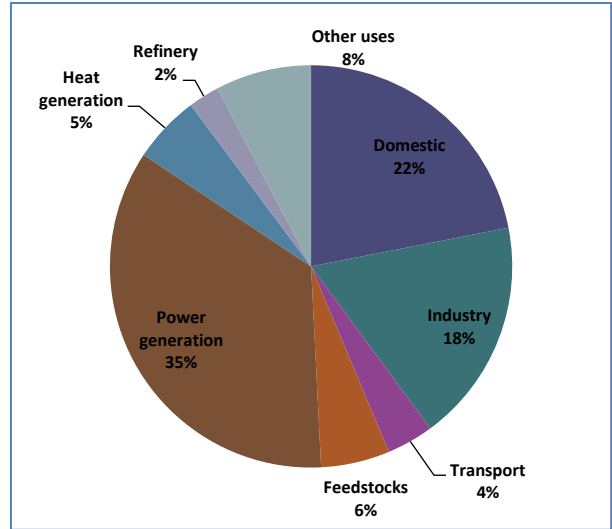
Source: GECF database

At global level, around 35% of natural gas is used for power generation; while domestic and the residential sectors account for 22% and 18% in terms of gas consumption respectively. Natural gas is also used as a feedstock for petrochemical industry and as a fuel for transportation, though at a lesser level, when compared to crude oil and oil products. Figure 2 shows the world natural gas demand by sector in 2016.

All market players acknowledge that natural gas is a versatile, clean, cost-effective, and an efficient fuel that has multiplicity of usage and applications. This can shows that natural gas has a promising future and could be the fuel of choice for decades to come. However, demand for natural gas not only depends on economic growth, but also, on gas price as well as use of other competing fuels, policies, seasonality and other factors which are directly or indirectly linked to the natural gas market.

Understanding the driving factors of global gas demand is of great importance for exporter countries producer such as the Gas Exporting Countries Forum members, GECF. In order to engage huge amount of money along the production chain of natural gas, there is a dire need to have a visibility on where this production of gas would land. Particularly, when we aim to develop

1

a tool to forecast global gas consumption in the near future, it is necessary to identify the role of driving factors in explaining the fluctuations of natural gas consumption.

There are number of studies that analyzed natural gas demand at country level and identified drivers of natural gas in specific country. Also some of the studies, used regional approach to understand which region or countries are deriving natural gas demand in the future.

The particularity of this paper is that, it aims to address the relationship between natural gas consumption and its driving factors including economic growth, gas prices and energy demand at global level in order to forecast natural gas demand in the short term. This forecast will suggest the future trends of natural gas demand at global level, but a more detailed analysis by regional and by specific country will help to explain who is driving this trend.

The remain of this paper was organized as follow: In section 2, we tried to identify the main driving factor of natural gas demand. In section 3, we applied Vector Auto Regressive (VAR) model to analyze Variance Decomposition of global natural demand. In Section 4, we have estimated a Regression model to forecast natural gas demand in the short-term. Then, we considered three scenarios to give a range of variations for our forecasts considering the possible situations of the developments of gas market. Finally, section 5 is devoted to concluding remarks and some recommendations.

2. Driving Factors of Natural Gas Demand

In general, demand for natural gas like other kinds of energy sources, results from demand for energy services in different sectors including residential, industry, power generation and transportation. In other words, the demand for natural gas is a derived demand for energy; so the factors that drive demand for energy can influence demand for natural gas (Dilavar, 2014).

Natural gas is used for generating electricity in power plants, heating in residential and industrial sectors, feed stock for petrochemical and fuel in transportation. Therefore, in addition to factors like price and income which influence demand for energy, other variables like seasonality and weather conditions, availability of infrastructure (pipeline, LNG facilities, Storage,…), policies and domestic production can affect natural gas demand.

In general, the driving factors that can affect demand for natural gas can be categorized as follow:

- **GDP growth**: GDP growth is one of the drivers of demand for natural gas which is mainly derived demand for energy in power generation and industrial sectors. When the economy improves, need for energy as a factor of production will increase. This factor is valid in producing countries as well as consuming countries. Industrial and power generation are the most demanding sectors for energy and mainly for natural gas. Also, GDP growth can increase the disposable income of the people and enhance purchasing power for gas

consumption in residential sector. In economic theory, this is so-called income elasticity of gas demand (Solarin and Ozturk, 2016).

- **Price:** price of natural gas can affect gas demand and supply. It has reverse effect on gas consumption i.e. if the price increases, the demand for natural gas will decrease. This is the combination of income effects and fuel substitution. Phenomenon of fuel substitution is mainly explained by economics that is reflected by fuel prices. The percentage change in demand in response to a one percent change in price is called price elasticity of demand.

- **Population:** Growth in population will lead to a need for more energy and need for more natural gas and it has long term effects on gas demand. Currently, more than 1.2 billion of people are without access to energy, and for the different energy outlooks around the world, population growth is considered as one of the main factors. Being a driver of energy consumption of long term nature, in this paper we don't consider population growth as we are focusing at a short-term horizon (2017-2019).

- **Policy and Regulation:** Policy and regulation can affect demand for natural gas directly or indirectly. In some countries like Iran, policies are established to promote natural consumption in the energy mix instead of coal and oil. But, on the other hand, some advanced countries such as Britain, Germany and Japan they provide generous subsidies to support renewable energies instead of fossil fuels. China's recent energy policy is showing more push for clear energy such as natural gas, renewable and nuclear to tackle air quality issues. This factor is implicitly modeled through energy demand and prices.

- **Whether conditions and seasonality:** weather condition can directly affect natural gas consumption particular in residential and heating sectors. Demand for natural gas hike in cold winter and decrease in mild weather during spring and autumn. Even, hot summer can result in more demand for cooling. However, some countries with stock building in the low demand season and releasing the peak demand could manage to neutralize this seasonality effects. This parameter is not modeled as an exogenous factor, but implicitly modeled through energy demand and prices.

- **Technology:** technology improvement can shape the entire energy consumption and energy mix. The changes in the structure of demand depends on how the technology is evolving and what are the obstacles to its progress and where the cost is determinant (eg. Intermittency for renewables, electricity storage batteries, CCS & CCUS,...). Being of a long term impact, we have not explicitly considered this parameter in our model.

- **Energy efficiency:** improvement in energy efficiency and energy conservation can inversely affect demand for energy and natural gas in each sector. This was observed in some countries such as China, and OECD countries where we could see the decoupling of GDP growth with energy consumption over the last few years. According to the IEA energy efficiency market report, while primary energy demand increased only by 0.9% in 2015, the lowest growth rate since 1997, GDP grew by 6.9%.

As mentioned above, analysis of demand for natural gas depends mostly on time horizon. Because some factors like price and seasonality have short term effects, while other factors like policy and regulation have long term effect, our analysis considers the factors that can affect natural gas demand in short term.

3. Variance Decomposition of Global Gas Demand Growth

Empirical literatures on the relationship between economic growth and energy consumption in a specific country, at regional or global level are plentiful. Most of these studies have investigated the causality between energy consumption and economic growth. Treating energy as a unit, many studies have found three types of causality between two macro variables including unilateral causality from energy consumption to economic growth, unilateral causality from economic growth to energy consumption and bilateral causality from economic growth to energy consumption and vice versa (Apergis and Payne, 2010)

However, the link between economic growth and gas consumption is weaker than energy consumption in general. Because the share of natural gas in the global energy mix is around 21% and cannot drives economic growth as much as energy consumption does as a whole. On the other side, the main channel between economic growth and gas consumption is in industrial, petrochemical and partly power sectors; and the remaining gas demand including residential, heating and transportation has weak tie with economic growth.

Having mentioned that there is a weak tie between gas consumption and economic growth, but observing the historical trend of these variables shows patterns of co-movements between the two variable. Figure 3 illustrates the trend of economic growth, energy consumption growth and gas consumption growth in the world during 1990-2016.

As it was depicted in this figure, in 2008 when economic growth as a result of global financial crisis sharply fell, gas consumption similarly to energy consumption dropped. In 2010, when the global economy started to recover, gas consumption increased, partly because of energy consumption recovery, but also because of lower gas prices.

Observing such pattern opens an area of research to understand the relationship between gas consumption and economic growth and how it is possible to forecast global gas demand by econometric tools in the short term. Unlike the numerous studies which investigated the relationship between economic growth and energy consumption, the number of studies which considers the relation between natural gas consumption and economic growth is limited. Moreover, it should be taken into consideration that gas demand dose not only depend on the economic growth, but also, energy prices and gas prices in particular, the need for energy, policies, seasonality and other factors can affect gas consumption. But the contributions of these factors in explaining gas demand's fluctuation are homogenous.

Figure 3: Trend of world economic growth, energy consumption growth and gas consumption growth (%)
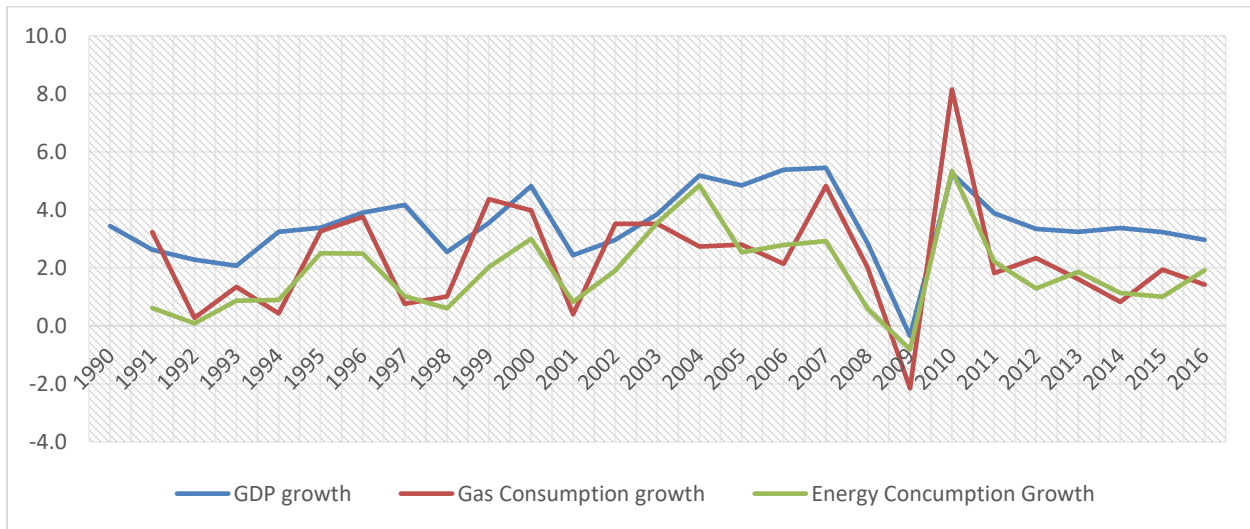
Source: GECF GGM database, World Bank

In order to understand the share of these factors in explaining gas demand fluctuations, we developed a Variance Decomposition analysis based on Vector Autoregressive (VAR) Model. Accordingly, a four variable VAR model has been estimated. World GDP growth (WGDP), world energy demand growth (WENG), gas price (PRICE) as well as world gas consumption growth (WGAS) were selected to estimate VAR model.[1] As the price of natural gas is regional and there are different prices in regional markets, we calculated weighted average price for natural gas and LNG, in which weights are traded volumes. The result of Variance Decomposition analysis is reported in table 1.[2]

This table shows the share of change in each variable in explaining gas demand fluctuation. The results of Variance Decomposition suggest that on average GDP growth explains around 32% of gas demand fluctuations, which means GDP growth accounts for 32% of gas demand fluctuations at global level. Changes in average gas price has highest share in describing gas demand variations and around 35% of fluctuations are explained by gas price changes. Energy demand growth (excluding energy demand driven by GDP growth) are explaining 16% of natural gas consumption changes. This reflects the need for energy mostly in residential and transportation and other sectors which are not linked to GDP growth. The remaining 16.8% could be attributed to other factors like seasonality and energy policies and energy efficiency. Therefore, according to the results of Variance Decomposition analysis, GDP growth, gas price and energy demand account for more than 83% of gas demand fluctuations at global level.

---

1 . The sources of data for these variables are GECF database, BP statistical review and World Bank.
2 . The results of Eviews estimation is available upon request of the reader.

Table 1: Variance Decomposition of Natural Gas Demand

Period	WGDP	WENG	PRICE	WGAS
1	27.6	15.5	39.2	17.7
2	28.4	14.6	39.1	17.9
3	26.8	16.9	38.6	17.6
4	29.3	16.3	36.8	17.6
5	31.2	16.6	35.2	17
6	33	16.2	34.1	16.7
7	34.5	16	33.3	16.2
8	35.7	15.9	32.5	15.9
9	36.9	15.8	31.7	15.5
10	38.1	15.7	31	15.2
Average	32.1	16	35.1	16.8

4. Forecasting natural gas demand in short term

Based on the variance decomposition analysis in the previous section we have shown that GDP growth, gas price and energy demand are the main drivers of gas demand fluctuations. We used this three variables to estimate a regression model in order to forecast short term gas demand at global level[1]. We have estimated a regression model according to equation 1 below:

$$WGAS = C(1)*WGDP + C(2)*WENG + C(3)*DLPRICE + C(4)*DUM1 + C(5)*DUM2 \tag{1}$$

In which:

WGAS: World gas demand growth, is the dependent variable.
WGDP: World GDP growth
WENG: World energy demand growth
DLPRICE: Percentage changes of weighted average gas price
DUM1: Dummy Variable reflecting 2008 global financial crisis.
DUM2: Dummy Variable reflect Fukushima nuclear disaster in 2011
C(1): Coefficient of GDP growth which reflect income elasticity of gas demand
C(2): Coefficient of energy demand growth
C(3): Coefficient of price changes which reflect price elasticity of gas demand
C(4): Coefficient of dummy variable
C(5): Coefficient of dummy variable

Equation 2 below represents the estimated regression model:

$$WGAS = 0.34*WGDP + 0.56*WENG - 0.01*DLPRICE - 1.6*DUM1 + 3.31*DUM2 \tag{2}$$

Adjusted R-square of the estimated equation is around 70%.

According to our estimated equation, income elasticity of gas demand (C(1)) is around 0.34, which means on average 1% growth in global GDP growth can drive 0.34% growth in global gas demand.

---

1. Not considering the heterogeneities and characteristics of and across the regions and countries. At this stage and for simplicity reasons, we looked at the global gas demand.

Price elasticity of gas demand was estimated around -0.01 which implies that 1% increase in weighted average of gas price (C(1)), can decrease gas demand growth by 0.01%. The estimated figures for income and price elasticities are significant.

Figure 4, shows the forecasted gas consumption growth in Ex-post period, in which WGAS shows the real gas consumption growth and WGASF represents the forecasted gas consumption growth. Having said that, forecasting gas demand in short term is a difficult task, this equation gives us a baseline for projection and analysis.

Figure 4: Forecasted versus real natural gas demand growth in Ex post period (%)
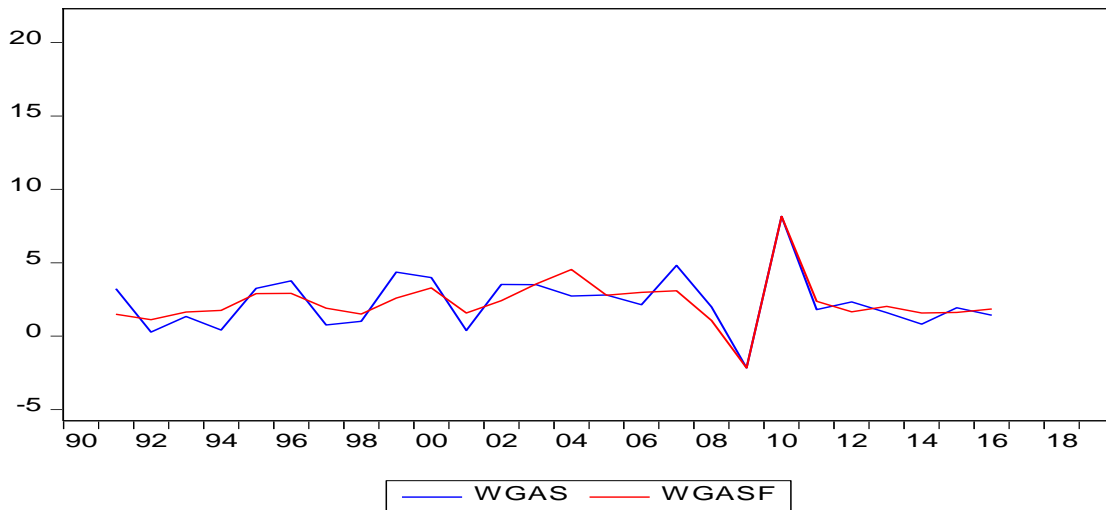
In order to forecast gas demand growth, we considered three scenario including Base case, low-case and high-case Scenarios. Our assumption for the scenarios are as follow:

Table 2: Assumptions for Scenarios (%)

	GDP growth			Energy Demand			Gas Price		
Scenario	2017	2018	2019	2017	2018	2019	2017	2018	2019
Base-Case	3.4	3.6	3.7	1.6	1.6	1.6	5.30	4.35	4.35
Low-Case	3.3	3.4	3.5	1.05	1.05	1.05	6.0	4.8	4.7
High-Case	3.5	3.6	3.7	1.76	1.76	1.76	4.5	3.7	3.7

- **Base-Case scenario:** In the base case scenario, our assumption for economic growth is based on World Bank projections for the global economic growth, as the historical data for GDP growth were also based on World Bank. For energy demand, we used the average growth rate estimated for average energy growth rate for 2016-2020 in GECF GGM model. Our assumption for the price in the Base case scenario is calculated based on the forecasted

price by Wood Mackenzie, EIA and experts assessment in GECF Gas Market Analysis Department (GMAD).

- **Low-Case scenario:** In our low-case scenario, we assume that economic growth would be lower than projected by World Bank. For energy demand, we also considered IEA average growth rate over the period 2015-2020 as the energy demand growth rate at 1.05% which is the pessimistic growth rate for energy demand in our view. For the price, our assumption is that the price of LNG and piped gas will not decrease as much as the base case scenario due to the market condition.
- **High-Case scenario:** In the High-case scenario, we assume economic that growth would be the same as base-case, but a little bit higher in 2017. We also selected BP estimation for energy demand growth at level of 1.76% for the period 2015-2020.

Our assumptions for the scenarios are based on the GECF Secretariat expertise and judgment. However, the estimated equation is flexible to make any scenario and assumption that can change significantly from the scenarios we have considered in this paper.

According to our base case scenario, it is projected that global gas demand grow by 2% in 2017 and 2.1% in 2018 and 2019. The range of global gas demand growth for the years 2017, 2018 and 2019 are reported in table 3.

Table 3: Forecasted natural gas demand growth in short-term (%)

	Scenario	2017	2018	2019
Global Gas Demand Growth Forecast	High-Case	2.2	2.3	2.3
	Base-Case	2.0	2.1	2.1
	Low-Case	1.7	1.7	1.8

Moreover, Figure 5 illustrates the forecasted gas demand growth based on three scenarios.

Figure 5: Forecasted gas demand growth

8
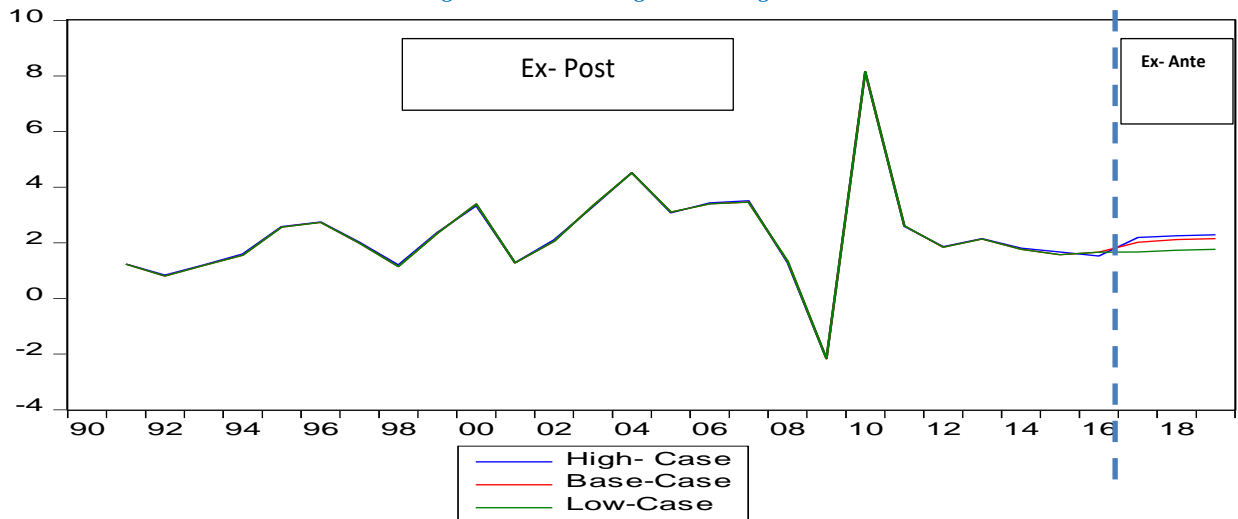
5. Concluding Remarks

In this paper, we tried to identify the main drivers of global gas demand and the share of each driving factor in explaining gas demand fluctuations in the short term. To do so, after explaining driving factors of natural gas demand, we developed a Variance Decomposition analysis based on Vector Autoregressive (VAR) Model. The results of Variance Decomposition analysis suggests that GDP growth, gas price fluctuation and change in energy demand describes around 32%, 35% and 16% gas consumption fluctuation respectively. These three factors accounts for more than 83% of gas demand fluctuation in global level in the short term. The remaining unexplained 17% could be the effects of other factors that are not modelled in this paper such as weather condition, policy and regulations.

Moreover, by estimating a Regression model, we developed an econometric tool to forecast short term demand for natural at global level. Having said that forecasting gas demand in short term is a difficult task, this equation gives us a baseline for projection and analysis. In order to forecast gas demand growth, we made three scenarios including Base case, low-case and high-case Scenarios. According to our base case scenario, it is projected global gas demand would grow by 2% in 2017 and 2.1% both in 2018 and 2019.

After having established a preliminary forecast for global gas demand, it is important to indicate what does this mean for natural gas market:

First, global gas demand is expected to grow but still at a lower rate than expected (2%-2.1%). However, there are still uncertainties and risks when assessing and forecasting gas demand:

- Future of nuclear power and restart of nuclear reactors in Japan in the next upcoming year would impact calls for natural gas;
- Competition against coal and energy prices and lower price of coal would play in favor of coal and against natural gas despite the environmental issues;
- Competition against renewable energy that are largely subsidized, but with potential long term effect;
- Seasonality is an important factor, where demand can peak up the pace because of unexpected cold weather in some regions that could drive more call for gas in power and heating sectors.
- And of course, environmental policies which are much more of long term impact will determine the trend for gas demand. Current carbon price are so low that gas is easily replaced by coal in some regions in the world.

References:

- Apergis, N., and Payne, J. E. 2010. Natural gas consumption and economic growth: A panel investigation of 67 countries. Applied Energy. 87:2759–2763.
- Dilaver, Ö; Dilaver, Z and Lester C. Hunt. 2014. What drives natural gas consumption in Europe? Analysis and projections, Journal of Natural Gas Science and Engineering, Volume 19, July 2014, Pages 125-136
- Solarin, S. A., Ozturk, I, 2016, The relationship between natural gas consumption and economic growth in OPEC members, Renewable and Sustainable Energy Reviews 581348–1356.
- Fumitaka, F., 2016. Natural gas consumption and economic development in China and Japan: An empirical examination of the Asian context, Renewable and Sustainable Energy Reviews 56,100–115
- BP Statistical Review of Energy 2017
- BP energy outlook
- IEA, World Energy Outlook 2016
- GECF GGM data base
- https://www.woodmac.com/
- IEA energy efficiency market report (2016)