T.C.
ANKARA YILDIRIM BEYAZIT UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES

LONG TERM NATURAL GAS CONTRACTS AND ECONOMIC PERFORMANCE: A HISTORICAL DECOMPOSITION ANALYSIS FOR TURKEY

DOCTORAL THESIS

GÖKTUĞ ŞAHİN

DEPARTMENT OF ECONOMICS

ANKARA 2020

T.C.
ANKARA YILDIRIM BEYAZIT UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES

LONG TERM NATURAL GAS CONTRACTS AND ECONOMIC PERFORMANCE: A HISTORICAL DECOMPOSITION ANALYSIS FOR TURKEY

DOCTORAL THESIS

GÖKTUĞ ŞAHİN

DEPARTMENT OF ECONOMICS

ASSOC. PROF. DR. ABDÜLKADİR DEVELİ
THESIS SUPERVISOR

ANKARA 2020

APPROVAL OF THE INSTITUTE OF SOCIAL SCIENCES

The thesis, prepared by Lecturer Göktuğ ŞAHİN and titled "LONG TERM NATURAL GAS CONTRACTS AND ECONOMIC PERFORMANCE: A HISTORICAL DECOMPOSITION ANALYSIS FOR TURKEY" is accepted as a doctoral thesis at Ankara Yıldırım Beyazıt University, Institute of Social Sciences, Department of Economics by unanimous vote.

Title Name Surname	Institution	Signature
Assoc.Prof.Dr. Abdülkadir DEVELİ	Yıldırım Beyazıt University	
Prof.Dr. M. Hakan BERUMENT	Bilkent University	
Assoc.Prof.Dr. İbrahim DEMİR	Yıldırım Beyazıt University	
Assist.Prof.Dr. Koray GÖKSAL	Yıldırım Beyazıt University	
Assist.Prof.Dr. M. Levent YILMAZ	Turkish National Police Academy	

Thesis Defense Date: 08.10.2020

I certify that this thesis fulfills all the requirements to be deemed a doctoral thesis at Ankara Yıldırım Beyazıt University, Institute of Social Sciences, Department of Economics.

Director of Institute of Social Sciences Assoc.Prof.Dr. Seyfullah YILDIRIM

PLAGIARISM

I hereby declare that all information in this thesis has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work; otherwise I accept all legal responsibility. 08.10.2020

Göktuğ ŞAHİN

ACKNOWLEDGMENTS

First of all, I would like to express my grateful thanks to my professors **Assoc.Prof.Dr. Abdülkadir Develi** and **Prof.Dr. M. Hakan Berument** for their invaluable contribution to writing, developing and most importantly completing my thesis. In addition, I would also like to thank valuable members of my thesis defense committee; **Assoc.Prof.Dr. İbrahim Demir**, **Assist.Prof.Dr. M. Levent Yılmaz**, **Assist.Prof.Dr. Koray Göksal** for sparing their appreciated time, advices, guidance and support.

Words are too insufficient to express my sincere appreciation to the members of my beautiful family, **Dr. Elif Tuğba Şahin**, **Göktuğ Ateş Şahin**, **Murşide Şahin**, **Nevin Peker**, **Dr. Şevki Şahin**, **Kaya Peker, Gökhan Peker** and **Prof. Dr. Afşin Şahin** but I would like to thank endlessly for their unlimited moral support, unconditional love and trust in me. I can't really say enough how thankful and grateful I am to them. I would also like to thank my beloved friend and energy mentor **Serkan Şahin** for being a great source of wisdom, joy and happiness beyond his unwavering encouragement and guidance for my thesis process.

I would also like to express my warmest and sincerest thanks to **Prof. Dr. Nükhet Doğan**; **Prof. Dr. Fuat Oğuz**; **Prof. Dr. Erdal Tanas Karagöl**; "**the PhD Crew**" **Dr. Mahmut Günay**, **Dr. İsmail Kavaz**, **Dr. Sezai Ata**, **Enis Memiş Müçteba**, **Dr. Ömer Toprak**, **Assist.Prof.Dr. Cem Korkut**, **Lecturer Yunus Emre Aydınbaş**; **Gökhan Yardım**; **Burak Yitgin**; **Sertaç Uslu** for sparing their appreciated time and advices, guidance, support.

At the last, but not the least, I wish to express my deepest appreciation to my **friends**, **colleagues**, **students**, **music crew** and **everyone who contributed on my life and academic career**. For the last words, I'm grateful to those whom **I love** and **have been walking by my side** with all their love, support, inspiration, motivation, and guidance to me in every part of my life.

Hurraay!

Dedicated to my little rock star son **ATEŞ** and my wife **TUĞBA**…

ABSTRACT

Long Term Natural Gas Contracts and Economic Performance:
A Historical Decomposition Analysis for Turkey

In the thesis, it was intended to capture a better relationship between the determined macroeconomic variables and natural gas prices via the long-term natural gas contracts of Turkey, due to the upcoming expiry dates for some of the long-term natural gas contracts that Turkey signed before. Especially, the long-term contracts between Turkey and Russia are taken as a basis and examined because Turkey mostly imports natural gas as well as crude oil and products from Russia, and the nearest long-term natural gas contract expiry date is the one with them. The main underlying cause of such a thesis study is based on Turkey's need of ensuring energy supply security for its ever-growing population and economy as well as accessing clean and cheaper energy sources like natural gas, as a net energy importer country via alternative long-term natural gas contracts more suitable for both sides. Solely with the help of the Historical Decomposition Method by benefitting the Near-VAR Model, the missing part about the quantitative examination of long-term natural gas contracts and economic performance of Turkey was attempted to be executed by applying econometric techniques explained in the methodology part of the thesis. These econometric techniques implemented in three different scenarios and, besides, five different natural gas price formulas are offered for Turkey's long-term natural gas contracts to be discussed in detail. The scenarios are based on concerning different energy commodities and different regional benchmarks by considering the effects on many macroeconomic variables or vice versa. Consequently, as an empirical finding, it has been obtained that a better performance can be demonstrated in terms of industrial production with one of the formulas produced as an alternative. In a nutshell, this thesis is constructed upon four chapters beyond the introduction and organized as follows: General information and literature review; methodology; empirical results and discussion; conclusion and recommendations.

Keywords: Energy Economics, Historical Decomposition Method, Natural Gas, Natural Gas Contracts, Near-VAR Model

ÖZ

Uzun Vadeli Doğal Gaz Sözleşmeleri ve Ekonomik Performans: Türkiye için Bir Tarihsel Ayrıştırma Analizi

Bu tezde, Türkiye'nin daha önce imzaladığı uzun vadeli doğal gaz sözleşmelerinden bazılarının yakın zamanda vadelerinin dolacak olması nedeniyle, belirlenen makroekonomik değişkenler ile doğal gaz fiyatları arasında daha iyi bir ilişki yakalanması amaçlanmıştır. Türkiye'nin ham petrol ve petrol ürünleri ile doğal gaz ithalatını çoğunlukla Rusya'dan gerçekleştirmesi ve ayrıca en yakın uzun vadeli doğal gaz sözleşmesi bitiş tarihinin Rusya ile olması nedeniyle özellikle Türkiye ile Rusya arasındaki uzun vadeli sözleşmeler esas alınarak inceleme yapılmıştır. Böyle bir tez çalışmasının temel nedeni, Türkiye'nin sürekli artan nüfusu ve büyüyen ekonomisi için enerji arz güvenliğini sağlama ihtiyacının yanı sıra her iki taraf için daha uygun alternatif uzun vadeli doğal gaz sözleşmeleri ile net enerji ithalatçısı bir ülke olarak doğal gaz gibi temiz ve daha ucuz enerji kaynaklarına erişme ihtiyacına dayanmaktadır. Çalışmada, özellikle Near-VAR Modelinden faydalanılarak kullanılan Tarihsel Ayrıştırma Yöntemi ve tezin metodoloji bölümünde açıklanan diğer ekonometrik teknikler uygulanarak Türkiye'nin uzun vadeli doğal gaz sözleşmelerinin kantitatif incelemesinde eksik olan kısımlar doldurulmaya çalışılmıştır. Bu ekonometrik teknikler üç farklı senaryo üzerinde uygulanmıştır ve ayrıca Türkiye'nin uzun vadeli doğal gaz sözleşmelerinin detaylı olarak tartışılması için beş farklı doğal gaz fiyat formülü sunulmuştur. Senaryolar, birçok makroekonomik değişken üzerindeki etkiler göz önünde bulundurularak farklı enerji emtialarına ve farklı bölgesel karşılaştırma ölçütlerine veya bunun tersine dayanmaktadır. Sonuçta ampirik bulgu olarak, alternatif olarak üretilen formüllerden birisi ile sanayi üretimi açısından daha iyi bir performans ortaya konabileceği elde edilmiştir. Özetle, bu tez girişin ötesinde dört bölüm üzerine inşa edilmiş ve şu sırayla düzenlenmiştir: Genel bilgi ve literatür taraması; metodoloji; ampirik sonuçlar ve tartışma; sonuç ve öneriler.

Anahtar Kelimeler: Doğal Gaz, Doğal Gaz Kontratları, Enerji Ekonomisi, Near-VAR Modeli, Tarihsel Ayrıştırma Yöntemi

TABLE OF CONTENTS

APPROVAL OF THE INSTITUTE OF SOCIAL SCIENCES ii

PLAGIARISM iii

ACKNOWLEDGMENTS iv

DEDICATION v

ABSTRACT vi

ÖZ vii

TABLE OF CONTENTS viii

LIST OF SYMBOLS AND/OR ABBREVIATIONS xii

LIST OF FIGURES xv

LIST OF TABLES xvii

1 INTRODUCTION 1

2 GENERAL INFORMATION AND LITERATURE REVIEW 5

2.1 General Information about Energy and Natural Gas 5

2.1.1 What is Energy? 5

2.1.2 What is Natural Gas? 6

2.1.2.1 Natural Gas and Pipelines 9

2.1.2.2 Liquefied Natural Gas 10

2.1.3 Energy Markets 11

2.1.4 Natural Gas Markets 13

2.1.4.1 Europe 18

2.1.4.2 Asia 23

2.1.4.3 The United States 26

2.1.5 Natural Gas Pricing and Contracts 28

2.1.5.1 Pricing 28

2.1.5.2 Natural Gas and LNG Contracts 30

2.2 Turkey’s Economy in General, Energy Position and Natural Gas Market 39

2.2.1 Turkey’s Economy in General 39
2.2.2 Turkey's Energy and Natural Gas Markets 44
2.2.2.1 Turkey's Energy Market 45
2.2.2.2 Turkey's Natural Gas Market 50
2.2.3 Turkey’s Natural Gas Pipelines and Pipeline Projects 69
2.2.3.1 Russia - Turkey Natural Gas Pipeline (West Line) 70
2.2.3.2 Blue Stream Gas Pipeline 70
2.2.3.3 Eastern Anatolian Natural Gas Main Transmission Line (Iran - Turkey) 70
2.2.3.4 Baku - Tbilisi – Erzurum Natural Gas Pipeline (BTE) 70
2.2.3.5 Turkey - Greece Natural Gas Interconnection (ITG) 71
2.2.3.6 Trans - Anatolia Natural Gas Pipeline Project (TANAP) . 71
2.2.3.7 TurkStream Gas Pipeline Project 72
2.2.4 Other Important Subjects About Turkey’s Natural Gas Market Structure 72
2.2.4.1 Market Access 72
2.2.4.2 Market Restrictions 73
2.2.4.3 Share Transfer Restrictions 73
2.2.4.4 Licensing 73
2.2.4.5 Certification 74
2.2.4.6 Tariffs 74
2.2.4.7 Wholesale 75
2.2.4.8 Distribution 76
2.2.4.9 Transmission 78
2.2.5 Institutions 79
2.2.5.1 Ministry of Energy and Natural Resources (MENR) 79
2.2.5.2 Energy Market Regulatory Authority (EMRA) 79
2.2.5.3 Energy Exchange İstanbul (EXIST) 80

2.2.5.4 Petroleum Pipeline Company (BOTAŞ) 80
2.2.6 Turkey's History of Natural Gas and Market Liberalization 81
2.2.6.1 History of Natural Gas in Turkey 81
2.2.6.2 Liberalization of Turkish Natural Gas Market 84
2.2.7 Turkey’s Long-term Natural Gas Contracts 86
2.3 Literature Review 88
2.3.1 Institutional Economics and Long-term Contracts 89
2.3.2 Industrial Economics and Long-term Contracts 91
2.3.3 Natural Gas Pricing and Factors Affecting Natural Gas Price 93
2.3.4 Integration and Linkage Between Other Energy Sources and Natural Gas Prices 100
2.3.5 Oil-Indexed vs. Hub-Based Natural Gas Contracts 108
3 METHODOLOGY 110
3.1 Variable Determination and Data Explanation 110
3.2 Method 111
3.2.1 Unit Root and Stationarity Tests 111
3.2.1.1 Augmented Dickey-Fuller (ADF) Test 112
3.2.1.2 Phillips-Perron (PP) Test 113
3.2.1.3 Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Test . 114
3.2.2 Factor Analysis 114
3.2.3 Vector Autoregression Model and Near-Vector Autoregression Model 116
3.2.4 Historical Decomposition and Impulse Response Functions 119
4 EMPIRICAL RESULTS AND DISCUSSION 122
5 CONCLUSION AND RECOMMENDATIONS 139
6 REFERENCES 143
7 APPENDICES 161
APPENDIX A..... 161

APPENDIX B 162
APPENDIX C 163
CURRICULUM VITAE 164

LIST OF SYMBOLS AND/OR ABBREVIATIONS

ADF	Augmented Dickey-Fuller
ARDL	Autoregressive Distributed Lag
BASKET	Basket of USD/TRY and EURO/TRY Exchange Rates
Bcm	Billion Cubic Meters
BOTAŞ	Petroleum Pipeline Company of Turkey
BRENTP	Brent Oil Price
BS	Black Sea
BTE	Baku-Tbilisi-Erzurum
CAPEX	Capital Expenditures
CIF	Cost Insurance Freight
CNG	Compressed Natural Gas
CPI	Consumer Price Index of Turkey
DF	Dickey-Fuller
EMRA	Energy Market Regulatory Authority
EU	European Union
EXIST	Energy Exchange Istanbul
FOB	Free on Board
FOHIGHP	Fuel Oil 3.5% (High) Sulphur Price
FOLOWP	Fuel Oil 1% (Low) Sulphur Price
FSRU	Floating Storage and Regasification Unit
GASOILP	Gasoil Price
GDP	Gross Domestic Product
GERNGP	Russian Natural Gas Border Price in Germany
GOG	Gas-on-Gas
GPA	Government Procurement Agreement
GPL	Gaspool Balancing Services
HS6	The World Customs Organization’s Harmonized System with Six Digits
IEA	International Energy Agency
IGU	International Gas Union
INTEREST	CBRT Interest Rate of Turkey
IP	Industrial Production Index of Turkey
ITG	Turkey-Greece Natural Gas Interconnection
KPSS	Kwiatkowski–Phillips–Schmidt–Shin

LNG	Liquefied Natural Gas
LNGP	LNG Price
m^3	Cubic Meter
Mcm	Million Cubic Meters
MED	Mediterranean
MENR	Ministry of Energy and Natural Resources
NARDL	Nonlinear Autoregressive Distributed Lag
NBP	National Balancing Point
NBPP	National Balancing Point (NBP) Price
NCG	Netconnect Germany
Near-VAR	Near Vector Auto-regression
NGM	Natural Gas Market
NGML	Natural Gas Market Law
NGOP	Henry Hub Price
NGP	Natural Gas Contract Price
NGP1	Natural Gas Contract Price 1
NGP2	Natural Gas Contract Price 2
NGP3	Natural Gas Contract Price 3
NGP4	Natural Gas Contract Price 4
NGP5	Natural Gas Contract Price 5
NYMEX	New York Mercantile Exchange
PP	Phillips-Perron
PSV	Punto di Scambio Virtuale
PUE	Market Procedures and Principles
PVB	Punto Virtual de Balance
SCPXP	The Southern Caucasus Pipeline Expansion Project
SVAR	Structural Vector Autoregressive
TANAP	Trans-Anatolian Natural Gas Pipeline Project
TAP	Trans Adriatic Pipeline
TEİAŞ	Turkish Electricity Transmission Company
Tmc	Trillion Cubic Meters
TOP	Take-or-Pay
TPAO	Turkish Petroleum Corporation
TRF	Trading Region France
TTF	Title Transfer Facility

TTFP	Title Transfer Facility (TTF) Price
TURLNGP	Turkey LNG Landed Price
UK	United Kingdom
US	United States
VAR	Vector Auto-regression
VEC	Vector Error Correction
VOB	Virtuální Obchodní Bod
VTP	Virtual Trading Point
WTI	West-Texas Intermediate
ZEE	Zeebrugge Hub
ZTP	Zeeburgge Trading Point

LIST OF FIGURES

Figure 2. 1. International natural gas and oil value chains. 8

Figure 2.2. Schematic geology of types of natural gas resources. 8

Figure 2.3. The classification and properties of global natural gas markets. 14

Figure 2.4. The dynamics of gas market developments. 17

Figure 2.5. Methods for determining the price of natural gas. 29

Figure 2.6. Balance of commitments in long-term gas contracts. 34

Figure 2.7. European gas regions, markets and hubs in 2018. 38

Figure 2.8. Republic of Turkey's existing natural gas pipelines and pipeline projects. 39

Figure 2.9. Number of existing licensed power plants in Turkey in 2018. 46

Figure 2.10. Monthly comparison of natural gas production between 2013-2018 in Turkey (Mcm). 56

Figure 2.11. Natural gas entry points of Turkey. 66

Figure 2.12. Actual and prospective oil and gas pipeline projects of Turkey. 69

Figure 2.13. The major natural gas related institutions of Turkey 79

Figure 2.14. Turkey's long-term gas contracts according to expiry date between 2020-2042. 88

Figure 4.1. Historical decomposition of industrial production for the first natural gas contract price 125

Figure 4.2. Impulse Responses of First Natural Gas Contract Price, Basket, Interest Rate, Industrial Production and Consumer Price Index shocks 126

Figure 4.3. Historical Decomposition of Industrial Production for the Second Natural Gas Contract Price 128

Figure 4.4. Impulse Responses of Second Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, Interest Rate, Industrial Production Index and Consumer Price Index shocks 129

Figure 4.5. Historical Decomposition of Industrial Production for the Third Natural Gas Contract Price 131

Figure 4.6. Impulse Responses of Third Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, CBRT Interest Rate, Industrial Production Index and Consumer Price Index shocks 132

Figure 4.7. Historical Decomposition of Industrial Production for the Fourth Natural Gas Contract Price 133

Figure 4.8. Impulse Responses of Fourth Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, CBRT Interest Rate, Industrial Production Index and Consumer Price Index shocks 134

Figure 4.9. Historical Decomposition of Industrial Production for the Fifth Natural Gas Contract Price 135

Figure 4.10. Impulse Responses of Fifth Natural Gas Contract Price, Basket, Interest Rate, Industrial Production and Consumer Price Index shocks 136

Figure 4.11. Effects of actual alternative natural gas contract prices on IP 137

Figure 4.12. Effects of modelled alternative natural gas contract prices on IP 138

LIST OF TABLES

Table 2.1. Unit conversion guide for natural gas 7

Table 2.2. Developments in natural gas markets in 2017 and 2018 18

Table 2.3. The properties and comparison of the most common natural gas hubs 35

Table 2.4. Summary of the five key elements of natural gas hubs in 2018 37

Table 2.5. Some selected informative data about Turkey between 2014-2018 41

Table 2.6. Export and import data of Turkey via all products with major trade partners in 2017 42

Table 2.7. Export and import data of Turkey with major product groups in 2017 43

Table 2.8. Export and import of fuels data of Turkey according to the major trade partners in 2017 44

Table 2.9. Import values and percentage changes of main subcategorized fossil fuel related products of Turkey in 2018 44

Table 2.10. Targets of energy sector in Turkey for 2023 in 11th Development Plan for 2019-2023 47

Table 2.11. Shares of sources in Turkey's total primary energy supply between 1975 and 2017 (%) 48

Table 2.12. Turkey's total primary energy consumption between 2008-2018 (Mtoe) in Sources 49

Table 2.13. The primary energy consumption distribution according to the sectors in Turkey in 2017 (%) 49

Table 2.14. Turkey's dependence on foreign energy between 1990-2017 (%) 50

Table 2.15. Turkey's crude oil and natural gas production between 2008-2018 50

Table 2.16. Share of domestic production over total supply of natural gas in Turkey between 2004-2018 52

Table 2.17. Recoverable natural gas reserves remaining and company reserve shares of Turkey in 2018 53

Table 2.18. Turkey's natural gas import distribution by country share (%) 53

Table 2.19. Amounts of total production and total consumption of natural gas in Turkey between 2002-2018 (Mcm) 54

Table 2.20. Shares of wholesale licensed production companies in 2017 and 2018 in Turkey (%) 55

Table 2.21. Share of natural gas production in 2017 and 2018 by provinces in Turkey (%) 56

Table 2.22. Consumer shares of natural gas sold by wholesale licensed production companies in 2017 and 2018 in Turkey (%) 56

Table 2.23. Comparison of sectoral natural gas consumption of 2016, 2017 and 2018 in Turkey (Mcm) 58

Table 2.24. Effects of monthly sectoral consumption distribution in Turkey (Mcm) 60

Table 2.25. End of month and yearly average natural gas total stock amounts between 2011-2018 in Turkey (Mcm) 62

Table 2.26. Turkey's delivered natural gas amounts from LNG terminals in 2017 and 2018 (Mcm) 63

Table 2.27. Total imported and total exported natural gas amounts between 2008-2018 in Turkey (Mcm) 63

Table 2.28. Turkey's total imported natural gas amounts by source country between 2002-2018 (Mcm) 64

Table 2.29. Types of natural gas imported by companies (Mcm) and shares (%) between 2013-2018 in Turkey 65

Table 2.30. Imported natural gas amounts by the companies in 2017 and 2018 in Turkey (Mcm) 65

Table 2.31. Comparison of Turkey's imported amount of natural gas via entry points in 2017 and 2018 (Mcm) 66

Table 2.32. Share of Turkey's natural gas import by long-term licensed companies by source countries in 2017 and 2018 (%) 67

Table 2.33. Share of Turkey's imported spot LNG by countries in 2017 and 2018 (%) 67

Table 2.34. Share of spot LNG importers between 2008-2018 in Turkey (%) 68

Table 2.35. Export of BOTAŞ's natural gas in 2017 and 2018 68

Table 2.36. Turkey's natural gas pipelines and pipeline projects 69

Table 2.37. The distribution of the number of the licenses in natural gas market by the types of licenses for 2016, 2017 and 2018 74

Table 2.38. Average unit prices of natural gas sold by distribution and supplier companies to household and industrial consumers in 2017 and 2018 (TL/m^3) 75

Table 2.39. Share of import and production companies in natural gas supply in 2017 and 2018 (%) 76

Table 2.40. Data related to usage of natural gas in Turkey between 2016-2018 77

Table 2.41. Increase and total length of network lines in Turkey in 2017 and 2018 78

Table 2.42. Timeline of liberalization of Turkish natural gas market 85

Table 2.43. Turkey's long-term natural gas purchase contracts according to countries 87

Table 2.44. Turkey's long-term natural gas purchase contracts according to suppliers 88

Table 3.1. Variables of time series used in the analysis with the source of data obtained 111

Table 4.1. Unit root and stationarity tests for nominal energy prices 123

Table 4.2. Factor analysis of fuel oil 3.5% sulphur and Brent prices 124

Table 4.3. Factor analysis of National Balancing Point, Henry Hub, TTF and Russian Natural Gas Border Price in Germany prices 127

Table 4.4. Factor Analysis of Fuel Oil 3.5% Sulphur, Brent, Fuel Oil %1 Sulphur, Gasoil, National Balancing Point, Henry Hub, TTF, LNG and Russian Natural Gas Border Price in Germany prices 130

1 INTRODUCTION

Energy is the fundamental of global economic growth and development and mainly for the countries struggling of lack of energy sources, it is a vital component to be emphasized in terms of production, current account, unemployment, and inflation. Especially following the Industrial Revolution, it is observed that energy demand comes to the fore in many subjects (Mokyr, 1977). As stated by Mokyr, after the Industrial Revolution, the rapid economic growth resulted with vast build up in energy demand that created a congestion. Reallocation of sources became decisive addition to emphasis of the energy production. Moreover, in the following decades, energy and, yet, its economics has developed into being more critical input for the entire countries.

Following 1980s, influence of natural gas has increased all around the world including Turkey. Along with the industrial consumption, many different areas of usage such as residential emerged that has increased natural gas demand further. Nonetheless, concerning the transportation of natural gas from supply locations to demand points, significance of pipelines has increased in reach of the technology at that time and thus, concept of natural gas has become a cross-border policy tool. This development has converted the international natural gas trade into a phenomenon which is not only a commercial activity but also a subject of international policy. Furthermore, considering the natural gas trade, factors such as gas price, contract types, duration and conditions of trade contracts have become more of an international political economy subject, rather than a commercial factor. Some producers have benefited from this power as a policy tool based on the dependency level of their resources over the importing countries. Furthermore, importing countries with substantial energy shortages have been in various pursuit. The best and the most substantial outcome of this effort was the proposal of Liquefied Natural Gas (LNG). Amidst arrival of LNG, a gas trading opportunity for reaching distant buyers and wider markets has arisen while importing countries maintained resource diversification. However, the time being, the countries have had to make a decision between the high cost of LNG and the political affinity of the pipelines.

There are several distinct contract models each of which is associated with different price schemes. Different countries use different models based on their interests and also their strategic posture. In particular, the oil indexation method, long-term take-or-pay contracts,

and hub pricing models are few examples that frequently utilized in today's natural gas market. At present, within continental Europe and Asia, an oil-indexed pricing method yet to determine the natural gas prices, and within European market, long-term take-or-pay contracts are currently used for pipelined gas contracts. The phrase "long-term contract" is defined by the Energy Charter Secretariat (2007) as:

> A contractual relationship between two parties beyond a single transaction with a minimum duration usually of at least one year up to 20 years and longer. While single parts of a long-term contract, like pricing provisions, may be changed over time under the rules of the contract, the contractual relationship between the parties will remain for the term of the contract (p. 232).

Such agreements are mainly designed in order to protect the large investments of supplier as, on the contract basis, the demanding party has the obligation to buy contracted amount of gas or to pay for the unpurchased gas. Therefore, even if the supplier does not fall under massive financial liabilities in case of various fluctuations in demand, the consumer side is ought to undergo a substantial material burden. To serve this purpose, the European natural gas market aims to pursue the hub pricing method by adopting the integrated market introduced by the European Union (EU) to determine the imported pipelined gas price into Europe. Additionally, different alternatives progressively arise on natural gas pricing and contracting globally.

Thanks to its precious geostrategic location, Turkey is as a crossroad between Europe and Asia, shortly named Eurasia, which are outstanding energy markets. The country has a great potential to be transformed into a hub or a multi-source transit country nourished by many suppliers of the Caspian region, the Middle East and Russia as shown in Figure 2.8. The main objective of Turkey's energy projections is not only playing a transit country role but also being a hub location for the whole region mainly for natural gas. Turkey embodies many advantages in this respect with its compelling economy, existing natural gas pipelines infrastructure, current pipeline projects and geostrategic location of which more information can be obtained from studies like Balat (2010), Cağaptay and Evans (2013), Skalamera (2016), Berk and Schulte (2017) and the following chapter of this thesis. Furthermore, according to Balat (2010), four challenges for Turkey's energy security, which ensures the region's energy security as well, can be determined as: (1) high dependency on imported fossil fuels, (2) reliability of energy suppliers, (3) high energy intensity, and (4) investment needs of the Turkish energy sector.

Essentially, Turkey's natural gas imports took place via pipelines with long-term oil-indexed contracts of which remarkably supplied from Russia. In addition to that, Turkey mainly imports natural gas via pipelines in line with the ever-increasing demand for limited resources and tries to implement a source diversification strategy by increasing in both pipelined gas and LNG imports. As mentioned before, the process cannot be accounted as a simple commercial activity, and thus, this fact revealed obligation of more detailed and extensive research in order to examine what alternatives would be more beneficial for Turkey. As a result of such investigation, on such an important matter, it was observed that significant literature in Turkey still has not been developed, especially in the quantitative sense. Studies on contracting, benchmarking, pricing and other related topics have mostly been carried out within the context of international relations and more in line with qualitative policies.

According to our pre-research conducted on previous literature, as mentioned before, the main rationale behind this thesis is based on that analytically there are limited amount of empirical studies about the long-term oil-indexed natural gas contracts, the natural gas pricing formula and its effects on economy and energy security of Turkey. This thesis aims to demonstrate Turkey's conditions analytically and empirically on natural gas contracts negotiations. Additionally, this thesis anticipates in helping policymakers to gain an incentive about the problem and the solutions from the view of economic perspective in order to contribute to the provisions and regulations about tangible justifications of such problem. In order to extract and contribute to the problem via analytically obtained findings, Historical Decomposition Method has been applied to Turkish market data that were extracted from several sources which is the most original contribution of this thesis to the economics literature.

Regarding Turkey's natural gas contracts to meet the needs on behalf of the contribution to the literature, it contemplates an alternative offering for approaching renegotiations to renew the existing contracts in the coming period. Even if the hub-based pricing methods efficiency is being questioned today, it provides an opportunity to determine natural gas demand and natural gas prices when reviewed from the demand side. Alongside with this issue, in order to investigate and contribute to the answers of the following questions for Turkey, a quantitatively supported study has been carried out in this thesis;

- Would hub-based pricing application would useful in practical terms for a country with high energy bills such as Turkey?
- Can Turkey benefit from these contractual factors to be renegotiated with the suppliers?
- Can Turkey improve the contract system in order to force the source country under any obligation or to find any alternative solution?

Since the thesis topic is an interdisciplinary subject, it aims to provide detailed information on natural gas, as well as the econometric method used in this thesis, and to introduce a study that can be applied in social sciences by using numerical methods.

This thesis is constructed upon four main parts beyond the introduction. Firstly, a relatively detailed information about energy, natural gas, natural gas markets globally and in Turkey, Turkish economy is presented. A literature review on several aspects of natural gas pricing and contracting is utilized to show relevant studies, to give information about these topics and to emphasize the lacking content in literature which is being tried to be filled with this thesis by contributing into the literature. Secondly, the methodology is described detailly in the empirical study in order to construct the quantitative analysis about the subject. The variable determination strategy, consisting Unit Root and Stationarity Tests, Factor Analysis, Near-Vector Autoregression Model, Historical Decomposition and Impulse Response Functions are explained that benefited during the analysis. Thirdly, the findings of the empirical study are presented in detail about the proposed alternative long-term oil-indexed natural gas contracts for Turkey and the results obtained from the study are discussed. And finally, conclusion and recommendations about the further possible research are provided.

2 GENERAL INFORMATION AND LITERATURE REVIEW

2.1 General Information about Energy and Natural Gas

In this section, it is aimed to provide a brief information for economists about energy and natural gas especially, the main subject of this thesis, to give insight about the subject as an introduction. Additionally, pipelined gas and LNG subjects are examined in relatively more detail which are important issues in Turkey's natural gas imports and energy import contracts. In a nutshell, the section consists of the energy concept, natural gas concept, energy markets, natural gas markets and the natural gas pricing and contracting subjects.

2.1.1 What is Energy?

Energy has been a critical requirement for humanity. Throughout the history, generating energy by different sources has been one of the main points for many political encounters. At present, some of the energy sources being used are including, but not limited to, crude oil, natural gas, coal, solar, wind or water (U.S. Department of Energy, n.d.). All these sources exist in nature so human activity solely focuses on generating energy out of them. In parallel, finding a reliable and secure energy source has shaped the political and economic approach of nations and countries. Energy is simply defined as capacity for doing work. According to the Oxford Learner's Dictionary, energy is defined as "the power derived from the utilization of physical or chemical resources, especially to provide light and heat or to work machines". So, this explanation practically shows how energy stands within our daily activities and is a vital part of the industrialized world. Based on Oxford's definition, one might claim that energy is a common term for any kind of natural and artificial activity on Earth that is dependent on a source to generate it. Although energy itself is vital, the laws of physics limits the creation of energy. Based on the first law of thermodynamics, also known as Law of Conservation of Energy, "energy can neither be created nor destroyed" (Khan Academy, n.d.). This advocates of which the aggregate energy amount in the universe is constant and one can only discuss transfer of energy rather than creation of it. During this study, we will be focusing on the energy generated from energy commodities mainly despite the large variety of forms of energy sources in nature.

As there are different sources to generate energy, a common term is used to calculate the amount of energy generated or used. One Joule is equal to “the work done over a one-meter distance by a one-newton force”. The very first energy measurement definition was proposed by Isaac Newton as the amount of power needed to raise 100 gr of apple (Techopedia, n.d.). Understanding the physical definitions behind energy generation and energy sources is vital to study macroeconomic impact of energy. The technical and physical limitations would be expected to limit the economic boundaries of any subject related to generating or consuming energy. Energy economics might be assumed to have structured around these physical and engineering limitations intentionally or unintentionally. However, this thesis will not be going in the technical details of energy matter, as this is beyond what this study aims.

2.1.2 What is Natural Gas?

Natural gas is a form of fossil fuel that is composed of one carbon atom and four hydrocarbon atoms (American Gas Association, n.d.). Natural gas, also called methane, is colorless and odorless in nature. It is actually an organic feedstock buried underground for million years and was converted into natural gas with the help of heat and pressure at thousands of meters of depth in Earth’s cluster.

Natural gas has a cooking and migrating phase in order to create a natural gas reserve as what is used as a source for natural gas today (ExxonMobil, n.d.). After organic feedstock was converted into natural gas in “kitchen” underground, natural gas migrated within porous structure of sediment rocks until it was trapped by impermeable rocks, which do not let the fluid to flow anymore, like shale, salt or clay. In present world, natural gas reserve is where the organic materials were trapped and accumulated after being cooked in the kitchen.

Another issue is that whether natural gas should be defined as renewable or non-renewable source. Energy sources are divided into two categories as renewable energy sources and nonrenewable energy sources based on the fact whether the source is limited in availability or not. In other words, whether the total amount of the source is short of the total demand for a foreseeable future. The second definition comes from the fact that every form of energy source has a limited lifecycle including the Sun, the source for solar energy, or total amount water in the world, the source for hydropower. However, the life of the Sun or the extinction of all water in the world is believed to take much longer than the foreseeable

period of human energy demand, so the term “renewable” reflects the fact based on such definition (Conserve Energy Future, n.d.; SciDevNet, 2014). Natural gas, one of the energy sources and the main focus of this study, goes under the term of “non-renewable energy source” due to the fact that total volume of natural gas sources on Earth is limited compared to the total lifespan of humankind (Greentumble, 2017).

Natural gas is known as the cleanest among all hydrocarbon fuels (EIA, n.d.). After burning natural gas, the residuals left are mostly carbon dioxide and water vapor. The amount of nitrogen oxides produced is small that makes natural gas a much cleaner source of energy compared to other forms of fossil fuels. Natural gas itself is odorless but the producers add a harmless chemical “mercaptan” in order to make the natural gas detectable in case of a leakage (Fore River Residents Against the Compressor Station, n.d.). This is the reason of a rotten egg-like smell of commercialized natural gas.

Table 2.1. Unit conversion guide for natural gas

Conversion				
	m^3	cf	MMBtu	GJ
from	(multiply by)			
Cubic meters (m^3)	**1.0**	35.301	0.0353	0.0373
Cubic feet (cf)	0.0283	**1.0**	0.001	0.001055
Million British thermal units (MMBtu)	28.3278	1000	**1.0**	1.0551
Gigajoules (GJ)	26.853	947.817	0.9478	**1.0**
Units				
1 metric tonne	= 2204.62 lb		= 1.1023 short tons	
1 kiloliter	= 1 cubic meter		= 6.2898 barrels	
1 kilocalorie (kcal)	= 4.187 kJ		= 3.968 Btu	
1 kilojoule (kJ)	= 0.239 kcal		= 0.948 Btu	
1 British thermal unit (Btu)	= 0.252 kcal		= 1.055 kJ	
1 kilowatt-hour (kWh)	= 860 kcal		= 3600 kJ	= 3412 Btu

Source: (IGU, n.d.)

As unit conversion methodology is presented in Table 2.1, natural gas can be measured in metric or imperial units such as joules or British thermal units and by volume content as cubic meters or cubic feet (IGU, n.d.). In this thesis, the conversions are conducted according to the Table 2.1 in terms of unity in the matter. Additionally, the international

value chain of natural gas and oil can be seen in Figure 2.1 and a general comparison can be made between these two energy sources.

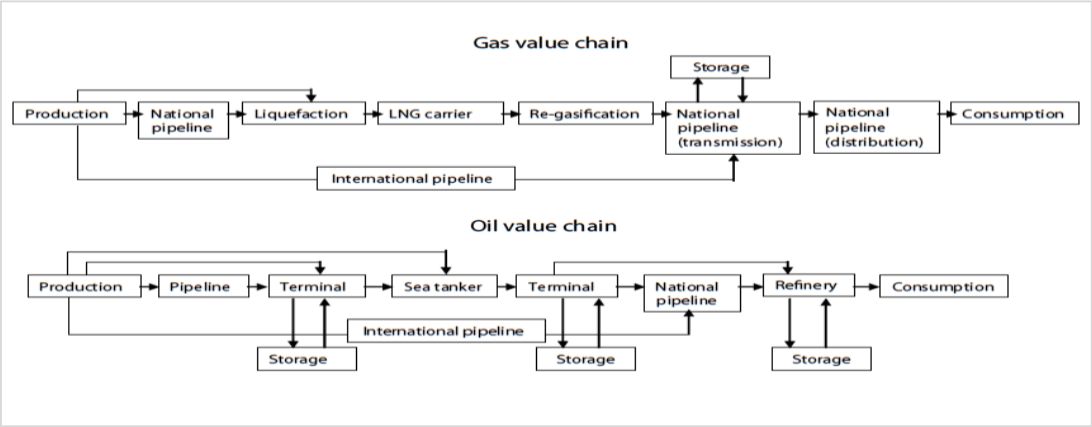


Figure 2. 1. International natural gas and oil value chains. Source: Energy Charter Secretariat (2007, p. 37)

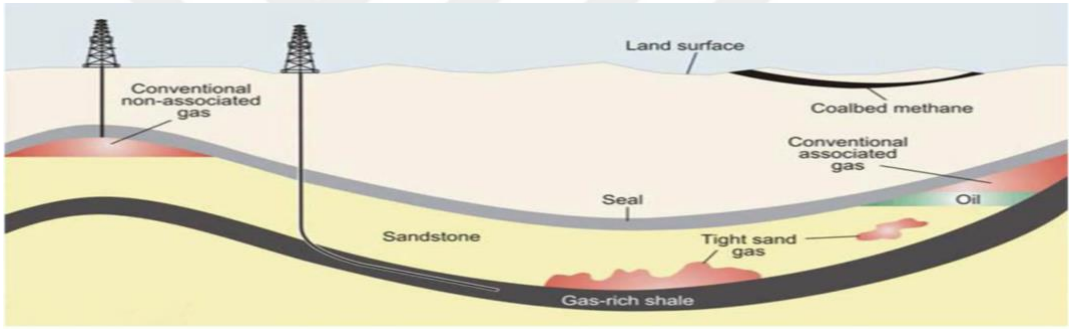


Figure 2.2. Schematic geology of types of natural gas resources. Source: (Natgas, n.d.)

As it can also be seen in Figure 2.2, in some cases, the flow of natural gas into large openings can be observed between overlying rock layers. This type of hydrocarbon depositions is called as “conventional natural gas”. In other instances, natural gas is trapped into small pores of low porosity formations. This type of deposition is called unconventional natural gas, or as shale gas/tight gas as used in the industry (EIA, 2019b).

Moreover, natural gas is produced from associated and non-associated gas fields (2B1st Consulting, n.d.). Associated gas fields are natural gas reservoirs with oil where natural gas and oil collected at the same basin. Non-associated gas fields are the natural gas accumulations that only consist of natural gas. In either associated or non-associated natural gas reservoirs, natural gas could be produced together with other hydrocarbon liquids like

condensate or natural gas liquids. In most of the cases, natural gas is produced together with other liquids that needs to be separated.

Physical separation of natural gas generally takes place before commercialization. However, from the operator's point of view, total capital and operational expenditures incurred in all liquids produced from a field are accounted under shared aggregated expense. That says, with the fact that most of the produced natural gas comes from associated gas fields, extraction costs of natural gas are heavily dependent on crude oil-indexed costs. Hydrocarbon upstream and midstream services reflect the oil industry trends, as oil is still the major driver for all upstream and midstream activities. As a result, upstream expenses of natural gas are evaluated as a function of crude oil prices. In sales side, this translates into pricing of natural gas needs to be indexed into crude oil prices.

Transferring natural gas from the production location to the end-users necessitates many complex processes. According to EIA (2019c), the infrastructure of natural gas transmission is categorized in three stages as processing, transportation and storage.

2.1.2.1 Natural Gas and Pipelines

As natural gas itself is in gas form in its natural phase in atmospheric pressure, the common way of transporting natural gas is using pipelines. According to EIA (2019c) pipelined natural gas can be defined as:

> Continuous pipe conduit, complete with such equipment as valves, compressor stations, communications systems, and meters for transporting natural and/or supplemental gas from one point to another, usually from a point in or beyond the producing field or processing plant to another pipeline or to points of utilization.

Pipelines consist of most of the share in global natural gas transportation and it is also used as a tool for geopolitics. Carrying natural gas in gas form is much cheaper than carrying it as LNG and this makes pipelines as more sustainable solution for longer-term commercial agreements. However, pipelines need a direct land or sea connection in between production and consumption locations. Building a pipeline passing from third countries has also been a subject of politics.

The biggest challenge besides the initial gas field discovery is transporting the gas from the field to the consumer. The natural gas chain, as seen in Figure 2.1, follows the

produced gas through its processing, transportation, and delivery to the consumers. Gas markets are generally residential and commercial users (utilizing gas for space heating), industry (directly burning natural gas), transport (for natural gas–powered vehicles), and electrical power generation. (Natgas, n.d.).

As stated by Cranmore and Stanton (2000), pipelines are not a flexible method of natural gas transportation besides their opportunities as the destination is limited between the source and the only arrival point. Moreover, Mokhatab et al. (2018) indicate that the production and the arrival facilities must be shut down along with the pipeline shutdowns because the natural gas cannot be stored with ease. Therefore, due to any reasons that might interrupt the natural gas flow, there ought to be a contract for the advantage of both the buyer and seller sides of the pipeline gas trade to ensure transaction securely.

2.1.2.2 Liquefied Natural Gas

Other way of transporting natural gas in long distances is liquefying it and carrying in liquid form which is known as Liquefied Natural Gas (LNG). LNG is a form of natural gas to be cooled at around -162 °C for shipping and storage purposes. LNG is 600 times less volumetric compared to natural gas at room temperature. Natural gas liquification, which was advanced in 19th century, made transporting natural gas easier to locations where pipelines are neither economically nor technically feasible. LNG is a way to carry natural gas to locations in which there are no feasibility of pipelines or do not have any commercial sense, such as inward or outward of the United States, Asia or Europe. Asia LNG market, as a combined market, is the largest globally. LNG is transported by specialized vessels, from export terminals, liquefaction plants, into import terminals with re-gasification facilities. Large specialized vessels with super-cooled tanks installed onboard are used to transport LNG (EIA, 2019a).

Natural gas liquefying facilities consist of complex machinery and special refrigerated vessel for supplying LNG into market (Cranmore and Stanton, 2000). LNG plant building investment requirements declined since the mid-1980s due to enhanced thermodynamic efficiencies, therefore, transforming LNG into a major global natural gas export method, and many existing plants have been expanded or new plants are being built (Mokhatab et al., 2018).

LNG projects are initial-capital-expenditure-sensitive projects that require a long plateau sale period for around 15 to 20 years so that the project could be economically feasible (Understanding LNG and Natural Gas Options, p.82). This requirement also dictates that the feed-gas volume for any LNG project need to be continual for a long period. When analyzing the production profiles of associated and non-associated gas fields, a non-associated gas field typically has a relatively longer plateau period than an associated gas field (Gudmundsson, 2017). Therefore, for a large scale and feasible LNG project, a non-associated gas field would provide better economics. Another issue is that making long-term contracts in LNG trade has advantages before the period spot prices broke down. But after that period, making long-term LNG contracts would not be so sensible to unless the supply alternatives are not limited.

LNG and pipelined gas are homogeneous products. However, both way of natural gas transportation would offer diversification opportunities in strategic and economic terms at commercial and political aspects. The fact that LNG is exactly the same product as pipelined gas, just two different means of transportation, so the competition between the two is in reality in midstream segment of natural gas markets. The key difference comes in that LNG offers the opportunity for redirection to any customer prepared to pay the highest price contrary to the natural gas pipelines (Henderson, 2019).

2.1.3 Energy Markets

As energy itself is fundamental for an industrialized world, understanding the commercial motivations behind the so-called energy markets is important to assess the link between energy generation and cash generation. Generated energy might be consumed in manufacturing, transportation, heating or any other daily activity for sustainable human development. The main activity is generating energy with different types of sources.

Nearly all activities of generating energy are directly or indirectly subject to a commerciality in modern world. Therefore, understanding the term “market” is important. Energy market is mainly referred as a network of different service providers within the supply chain from the energy generation to the final consumer (Energy UK, n.d.). Generally, the chain starts with the producing/generating energy source by using engineering applications with business limitations. That is the producer needs either to extract the energy source, like in oil or natural gas industry, or generate it by a secondary application, like in

power industry. Either way the producers' main attempt is to have a source of energy accessible to be conveyed into a transportation network. Transportation network could be handled by vessels or pipelines as in oil and gas industry, or by transmission and distribution lines in power market. For each energy source, there are different distributors to buy the energy from wholesale market and sell it to the end users. Relations among all these actors within supply chain are termed as the energy market.

Energy market is defined as the commercial relation between providers and users which is reliant on each other to have a continuous operation. This relation could either be both a business to business and from business to individuals. Either way the market generally has its own dynamics and regulatory system. Even before state regulations were imposed in energy markets, market participants or commercial bodies used to assemble for creating a systematic regulation on behalf of the market itself (Fuellers, n.d.). The ancient regulation systems, such as the British "worshipful companies" were the first examples of energy market regulations that helped the sellers and buyers to have a sustainable market condition with settlement of fair price.

In our modern world, countries try to have a balanced energy mix within their aggregated energy consumption. They tend to benefit from energy markets to create a secure and sustainable source for their energy need. Although each energy market seems to have its own independent system, due to the nature of supply chain of energy sources, the markets have been linked with each other. Especially, oil and natural gas markets have more global link compared to the power market mainly because both oil and natural gas are consumed at locations far from their supply area.

Energy markets tend to be unpredictable due to this linked structure. Although for immensely volumetric commodity markets like oil and natural gas have a worldwide system, each supply or demand region has its own unique dynamics related to their individual secondary factors such as economics, politics or geography. Each factor has its own sovereign secondary factors with direct impact which complicates the accurate analysis or forecasts for global or regional energy markets. This study aims to analyze these regional and global interactions between supply and demand locations and their intra-dependent structure.

2.1.4 Natural Gas Markets

In this section; natural gas market concept, three major natural gas markets, Europe, Asia and North America, and their characteristics will be discussed within a historically developmental perspective. By examining and comparing these three markets, we aim to achieve insight about how different structured markets with different geographical, political, economic circumstances are functioning which are further major factors on natural gas price formation in the market.

Natural gas is traded in commercially structured markets where buyers and sellers meet to have a defined term of agreement on a pre-defined price. Natural gas markets can be designed as either for long-term or short-term agreement utilities (Levine et al., 2014).

Traditional natural gas market structure in Europe has been built on long-term oil-indexed contracts due to the limited supply options for the continent. Yet again, this was believed to have created a natural monopolist environment for the European natural gas market (Hamhaber, 2015). However, as described before, it is not surprising to see a natural gas supplier in need of an oil-indexed price in order to secure a long-term supply for its buyers. In that case, a market structure is formed in a way to secure a long-term supply security rather than short term price expectations or buyer's desire to have lower-priced nature gas price.

As specified by the IGU (n.d.), according to the contract lengths, natural gas trade contract types can be classified as; short-term contracts with volumes traded on a spot basis or under contracts of less than two years; medium-term contracts with volumes traded under contracts of between two to five years; long-term contracts with volumes traded under contracts for more than five years. The natural gas market is believed to have been in a transition phase in the last decade from a long-term utility market to a short-term market where natural gas is expected to be priced in a relatively competitive environment. The recent trends in the natural gas contracts are that "there's a gradual shift from long-term, fixed destination contracts to short-term and medium-term ones, due to increase in the number of contracts that have the flexible destination option and also due to the emergence of new producers and consumers" (IGU, n.d.). In this new context, different natural gas supply options will compete in a free market which is supposed to occur with a fairly assessed price rather than oil-indexed pricing. With the increased LNG supply, these new

producers help sellers by transporting their gas to distant locations and new technologies yielded large amount of gas extracted such as happened in US shale gas industry. Increased supply of gas caused more affordable energy solution to the emerging and emerged markets that caused a shift from crude oil and coal to natural gas which globalized the gas industry. This global presence of natural gas markets increased flexibility of lateral agreements between buyers and sellers. In addition, geographically limited consumers like South Korea and Japan could have access in natural gas markets. This increased global competition raised a requirement for buyers to have different contract options.

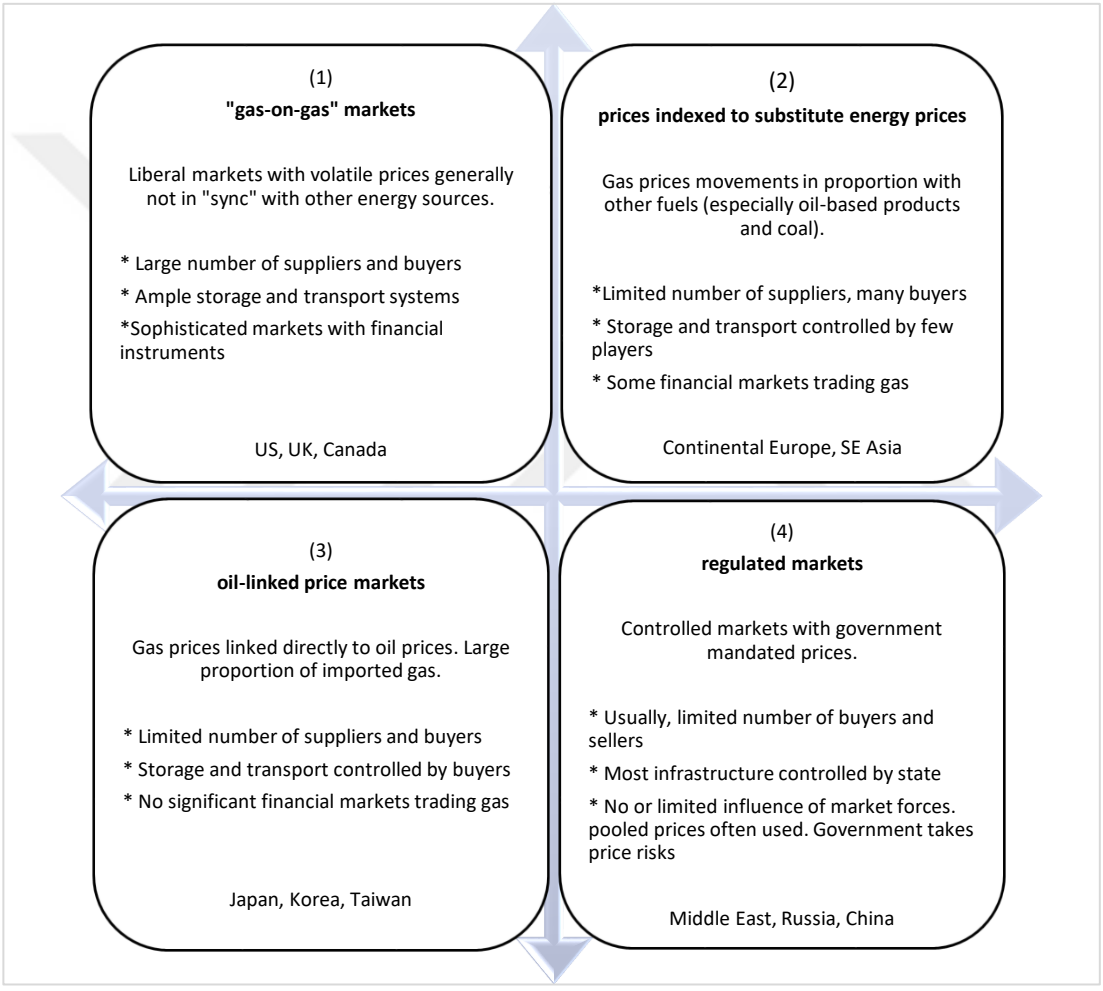


Figure 2.3. The classification and properties of global natural gas markets. Source: Natgas (n.d.)

As the properties can be seen in Figure 2.3, the global natural gas markets can be categorized into four groups; gas-on-gas markets, markets where prices indexed to substitute energy prices, oil-linked price markets and regulated markets.

As Hamhaber (2015) states that it is reasonable for a buyer to demand lower price for its natural gas demand; however, extracting and transporting natural gas is a heavily investment sensitive operation with technical and political risks on it such as Russian gas imported into Europe. In cases, such as Europe, where the supplier diversification is limited but the demand is high, and, commercially as well as structurally unified, a natural monopoly could evolve itself. It is known that, by establishing physical and virtual hubs for its own market, European Union explores for a natural gas market priced competitively. However, the success of these hubs is still being debated whether to create a natural gas price totally independent from oil priced indexation.

On the other hand, according to Bowden (2019), markets like Asia, where supply options are more diversified collectively with the option to buy LNG from major suppliers like Qatar and Australia, have a buy-side competitive advantage due to the aggregated natural gas demand volume compared to Europe. Due to the geographical limitations, Asian countries are more reliant on LNG supplies, but their total demand is so large to have naturally formed physical and pricing hubs. However, Asian countries do not have a unified structure unlike in Europe, so this is expected to limit their capability to ever reach a regional physical or pricing hub.

Apart from these two abovementioned markets, the United States natural gas market has its own unique structure. US is the only market with its own large volume of domestic supply and demand parties compared to European and Asian natural gas markets (ICE, n.d.). These unique characteristics of having this entirely unified structure is believed to have changed in last few years the US shifted into an LNG exporting country. Although, total supply to the market is still fully domestically sourced, definition of total demand has changed from entirely domestic to partially domestic.

Based on the three major natural gas markets, we can summarize that having supply diversification options and unification in demand could create an ideal market structure. However, in most cases, this theoretical expectation might not meet the reality as both diversification in supply and unification in demand pose their own risks which would cast additional stress on any market and its price structure. As in European case, trying to include new supply sources by presenting LNG would add cost risk and logistics risk of LNG into European market which is mainly supplied from distant suppliers (Bowden, 2019). Similarly, increased unification in a multi-country demand region might force the market

and price structure to converge into the requirements of the highest demand country which could harm relatively smaller buyers.

Another important question should be answered is that whether if we have reached the peak point in natural gas supply. The important component in this context is the commercialization of natural gas. It should be noticed that commercialized gas and extracted gas concepts are concepts that should be examined separately. There is a lot of wasted natural gas resources that cannot be commercialized due to lack of infrastructure. And most of the gases in the reserves would never be commercialized which brings the question needs to be technically answered: Can we have a supply problem? According to Energy Charter Secretariat (2007), the natural gas markets' and their trading instruments' development is in conjunction with Hubbert's curve which is defined as "a bell-shaped curve for production over time of a finite resource like oil or gas; initially proposed by and named after M. King Hubbert in relation to US oil production.". And, in general terms, natural gas follows the developments in oil because natural gas is a byproduct of oil. Gas market development is in its infancy period, compared to oil market. The limited development of gas market hinges on its expensive infrastructure in production, storage and distribution. Therefore, it evolved only into a regional context and became economically attractive in time. After the Second World War, natural gas was used nationally following the discovery of new large gas structures. The Groningen Field in the Netherlands was the first natural gas field used for exporting gas.

As seen in Figure 2.4, the development of the gas market will be similar to oil market and operational stages, even though it may not be in the same speed and trajectory. The first liquid gas market was the North American market in the 1980s. First, the sales were unplanned but later transactions occurred with long-term contracts. The UK followed the North America in establishing a similar market structure. These two markets' development was because of the large number of small and medium sized domestic gas fields which is now in decline in both regions. Gas markets in other regions persist to be formed by enormous natural gas fields and long-term import contracts.

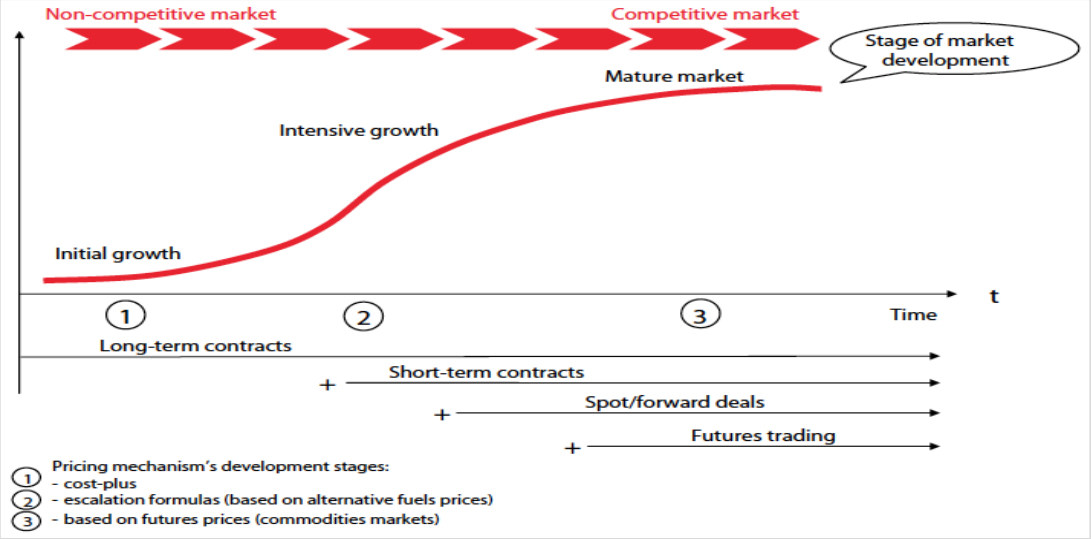


Figure 2.4. The dynamics of gas market developments. Source: Energy Charter Secretariat (2007, p. 60)

Overstated by Energy Charter Secretariat (2007), the question that should be answered is whether the gas would follow similar market development stages as the oil sector did due to the differences between gas and oil in terms of its physical properties, transportation methods and pricing. In North American and the UK gas markets, the commodity type market pricing is well developed, and natural gas spot and futures markets are advanced. Trade of spot LNG has started as mostly long-term contracts are prevalent. Nevertheless, according to Energy Charter Secretariat (2007), it should be considered that

> …to what extent physical, technical, and economic differences, as well as different traditions, will result not only in a delay but also restrict the application of these pricing mechanisms for gas outside of the US and the UK, and what will be the relationship between commodity pricing mechanisms and traditional long-term pricing mechanisms. (p. 99).

For having a brief assessment according to BP Statistical Review of World Energy (BP, 2018; BP, 2019), developments in the natural gas markets in 2017 and 2018 can be summarized from the global perspective as;

Table 2.2. Developments in natural gas markets in 2017 and 2018

2017
• Natural gas consumption rose by 96 Bcm or 3%. • Demand growth was driven by China with 31 Bcm, the Middle East with 28 Bcm and Europe with 26 Bcm. • Natural gas production increased by 131 Bcm or 4% with Russian growth was the largest at 46 Bcm, followed by Iran with 21 Bcm. • Natural gas trade expanded by 63 Bcm or 6.2% via growth in LNG outpacing growth in pipeline trade. • The increase in gas exports was driven largely by Australian LNG with 17 Bcm and the US LNG with 13 Bcm, and Russian pipeline exports with 15 Bcm.
2018
• Natural gas consumption rose by 195 Bcm or 5.3%. • Growth in natural gas demand was driven mainly by the US with 78 Bcm, China with 43 Bcm, Russia with 23 Bcm and Iran with 16 Bcm. • Natural gas production increased by 190 Bcm or 5.2% the almost half of this came from the US with 86 Bcm which recorded the largest annual growth seen at any country in history with the next largest contributions to growth were from Russia with 34 Bcm, Iran with 19 Bcm and Australia with 17 Bcm. • Growth in inter-regional natural gas trade was 39 Bcm or 4.3% driven largely by continuing rapid expansion in LNG; LNG supply growth came mainly from Australia with 15 Bcm, the US with 11 Bcm, Russia with 9 Bcm and China accounted for around half of the increase in imports with 21 Bcm.

Source: BP (2018); BP (2019)

2.1.4.1 Europe

Natural gas is comparingly expensive to transport and store, due to its low energy density. Similarly, from commercial side, complex structure of natural gas provided complex adjustments in European industrial organization. This was parallel to the mutual commercial and national interests of producing and consuming countries. Natural gas is valuable for Europe but only limited to Norway, the Netherlands, Great Britain, and

Denmark with sufficient amount of domestic consumption and export capacity. Connecting limited production areas with Europe's entire regional consumption locations required significant investment. Supplying and consuming countries have built specific transferable relations in the form of legally binding long-term contracts and conditional to international arbitration with these investments.

In Continental European form of long-term gas contracting, pricing of natural gas is indexed into oil products with periodic price audits and a Take-or-Pay level, typically around 85% of Annual Contract Quantity (ACQ), is set. (Stern, 2012). A time lag adjustment is applied on oil product prices that is averaged over the earlier period of minimum six and maximum nine months in order to reduce the price risk on the gas price, so does eradicate volatility.

Despite being a large onshore discovery, Groningen dilemma was mainly due to the low development and production costs, In parallel, instead of applying a cost-based pricing allocation, "market value principle", which is a pricing principle dependent on the weighted average concept of the gas competing with other fuels, was used with adjustments to storage and transportation costs. This pricing methodology helped Dutch government and operators to make much higher revenues compared to cost-based pricing. This method also helped the natural gas to gain more share in the market to displace oil products (Correljé et al., 2003; Correljé, 2016).

Contrary to OECD Europe's oil-indexed pricing structure, pricing mechanism between Britain's producers and British Gas has changed in many forms from the 1970s onwards. Production cost of the Dutch Groningen natural gas field was much higher than the UK's production cost as nearly all high-profile discoveries were offshore fields. Due to this fact, negotiations were dominated by a price level to provide producers a feasible rate of return after providing a high seasonal "swing factor". This was in need of larger production and transportation infrastructure than average offtakes. So, Britain averted additional storage facilities need in the early years of its natural gas industry. The purchase contracts between field operators and British Gas, also known as depletion contracts, were field specific. These contracts had similar nature as Continental Europe's long-term TOP contracts. However, these contracts did not have periodic price reviews, but included an initial pricing. This price had cost-inflation based provisional indexation mechanism rather than competing alternative fuels (Stern, 2012, p. 60). The cost-based pricing mechanism

provided a good advantage over oil products. This advantage resulted with developments of large-scale domestic gas fields that converted all domestic consumption to natural gas from town gas, or coal gas (Stern, 2012). This helped the gas to be affordable source for household consumption, as well as, fueled the rapid economic growth and gas-fired domestic space heating.

In 1970s, growth in European natural gas industry was performing better than any demand predictions, although the market had uncertainties. The strong rise in demand was due to the shift in commercial space heating source, and in 1990s, in power generation, from coal and oil products to natural gas, addition to the economic growth. The expanding dependence on pipelined gas and LNG imports were obvious in that period. During late 1970s and onwards, civil mediation and market systematization were progressively condemned. Introduction of competitive free market, as well as Margaret Thatcher and Ronald Reagan to have granted more efficient arrangement of public transport, water, energy and all other public services. In 1985, Single European Market was adopted by the European Community as a general strategy to liberalize the European Union economy in late 1980s, the Internal Energy Market followed and supported a similar restructuring in the markets (CEC, 1988). The primary debate was held on removing bottlenecks in trade of services and goods. However, debate extended into keeping a vision on productivity and competition efficiency, and business activities took a major role in a neo-liberal way (Matlary, 1997).

As a result of that, Europe slowly spread a new context which was designed to create a competition in upstream, wholesale and retail segments. In order to achieve that, traditional long-term agreements were considered to execute interim purchases. Market price, and supply/demand balance of gas, would be regulated by the scarcity conditions. In conditions where different supply sources would connect with demand locations, liquid spot market would be expected to appear. A perquisite for this to take place was that the all trading bodies would have access in the essential distribution, transport and storage facilities in order to arrive at the buyer's location. To achieve this, Europe grasped three fundamental regulatory principles (Dediu, 2019):

Firstly, critical facilities should be disconnected from upstream and downstream activities. This suggests that of these critical facilities' operators would not have gain commerciality based on the manipulation of the gas flows, or their business activities would not favor from the intelligence coming from their operations of their systems. A progressive

and forceful extent of legal and managerial disconnection was required for transmission and distribution pipelines. Majority of transportation and distribution network were freed from the previous wholesale companies and local utilities These networks could be conducted as system or transmission operators, for LNG storage and conversion facilities. Different establishments were granted with viable exemptions from mediator access concerns.

The second principal included the arrangement of indiscriminatory access into the critical facilities for trading individuals. This access is limited both to the transport systems and to the storage systems. In early years, the right of access was arranged by simple line up contracts. Over time, this approached was replaced by a more complex path. This complex approach was based on a so-called "entry-exit model" that formed the right to access in the transmission system. In the system, gas "shippers" schedule their rights for entry or exit so they pumped into or offset their gas from the system at certain locations (Hallack & Vazquez, 2013). The basis of this model is that the gas molecules would be discrete from their actual destination. This model gives maximal flexibility to traders in trading with buyers and sellers, no matter what location they are at. All shippers have equal entry/exit tariffs at certain points of access. When working in distribution networks, sellers pay so-called postage stamp tariffs that they book their entry at a certain point where their buyer is based at a pre-defined tariff. Others have their own access conditions depending on whether their status to be excluded or not; either way any interested user should be given access at pre-specified location or the facilities owners allowed to regulate how they use their own capacity. In addition to the tariff structure, another important aspect of providing access is that the capacity allocation should be open to all interested shippers. The evolution of the system from line up rule to complicated applications is to maximize the usage of physically limited capacity available while declining the bottlenecks caused by contractual issues. Contrarily, the aspiration was to reward the shippers who add the highest value on the capacity with the access rights in scarce capacity. The basic aim was to empower the shippers to pair their market arrangements with opportune handling arrangements to reach storage facilities or, more importantly, their buyers. This would increase the gas market functionality while maximizing the allocated volume of gas efficiency at market price, to reflect its value for producers and consumers.

The third principle contained concerns of natural monopoly condition of natural gas that were still depicted the gas infrastructure left from the traditional gas industry. Main

issues from this notion were high operational expenses, overinvestments in assets, high tariffs far from reflecting real and economically adequate transportation costs, and practices segregating different types of consumers and regions. DSOs and TSOs would be compelled to become more efficient in their operations and utilization of their systems, s that infrastructure cost, tariff and revenue regulation could decline. Ultimately, this caused wider price cap, gauge or certain regulations. Each member state imposed non-discriminatory rules by established their National Regulatory Authority (NRA) for tariff controls and approvals to ensure equitable entry to the unbundled networks.

The European Gas Directives and Implementations

During early 1990s, this liberal approach for a gas market was carried out in multiple levels. The European Commission implemented definitive and binding approach for the Member States with the 1998 Gas Directive, the 2003 Gas Directive and the 2009 Gas Directive. The Third Package, also known as the 2009 Directive, was crucial by having unified various domestic policies.

Advanced corporation throughout the European Union was another major aspect emerging from the Third Package a. The Agency for the Cooperation of National Energy Regulators (ACER) was established in 2009. The Council of European Energy Regulators has been the focal coordination point for the European state regulators since March 2000. European Regulators Group for Electricity and Gas was another working group. ACER was assembled to level national market and operational legislations to ease trans-European infrastructure investments, in order to fill the cross-border regulatory gaps and to facilitate coordination in regulations throughout entire European Union.

Additionally, European Network of Transmission System Operators for Gas created a basis for the unbundled TSOs to employ EU-wide cooperation in 2009 in order to increase gas trade over borders and establishing the transmission network. Increased EU-wide cooperation resulted with additional steps taken to smooth the EU wide cross-border gas trade by the gas target model (GTM) initiative (Glachant et al., 2013). The main purpose of the GTM is to coordinate the national and regional entry/exit points. This way to achieve a virtual spot market for gas pricing could be determined by instantaneous supply and demand. Market price is formed at the entry or exit area borders when there was a successful delivery

of contracted long-term gas volumes. This is also influenced by short-term based random purchased inter-area volumes.

2.1.4.2 Asia

In this section, the Asian natural gas markets will be discussed in order to examine its market structure which is yet to have a form with low liquidity and is dominated by a small group with greater volumes of transactions. Asian natural gas markets have large demand and play a key role in the global natural gas market with major importing countries especially China, South Korea, Japan. In Asian market, the natural gas demand is attempted to be met by both pipelined gas and LNG. The major natural gas suppliers for Asian markets are Russia, Qatar, Australia and the US. While Australia and the US recently increased their LNG exports to Asia, the importance of the Middle Eastern gas has started to diminish. According to IEA (2019), LNG has dominated the Asian market. Japan imported first LNG in 1969 from Alaska and followed by Korea in 1986, Chinese Taipei in 1990, India in 2005 and China in 2006. As stated by Rogers (2012), the assembly of local natural gas markets throughout Asia limits competition because of the predilection of monopolies which are regulated that supply LNG with long-term oil indexed contracts. Vertically integrated state-owned companies, possess and operate regasification terminals to be seen as an evidence for state's intervention in domestic natural gas markets (IEA 2013).

Moreover, in some aspects, Asian pricing mechanism and market structure differ from the European or American markets. "The Asian natural gas market is complex and fragmented. Unlike its European and North American counterparts, it is not well connected by pipelines, and is dominated by LNG trade." (Vivoda, 2014, p. 5). Especially, Japan and South Korea import large amounts of LNG because of the geographical limitations while China imports both pipelined gas and LNG. In the US market, a fully domestic market with its own supply and demand elements can be observed. The integrated system of the European Union helps the European market to act as a singular body to create leverage against suppliers in terms of price competition. However, Asian market is a completely mixed market in which multiple sellers and buyers compete with each other. Despite being the highest consumption region, lack of unified structure and pipeline connection to the main suppliers result with a higher gas price for Asian countries compared to Europe (Jaganathan, 2019; Zawadzki, 2019). The spot LNG prices in Asian market can be monitored by JCC or dividing the Brent

oil price by a factor of six. Asian market will definitely be the main driver of the natural gas markets globally. Current major producers and keen promising suppliers have direct focus in the region, especially non-OECD Asian countries.

China is the biggest natural gas consumer in Asia with 7.3 quadrillion Btu in 2018 according to the EIA and IEA figures. China is followed by Japan, India and South Korea. Non-OECD Asian countries like China, India, Thailand, Vietnam and Bangladesh are estimated to be the main driver of natural gas demand in the region for the following decades. Total non-OECD Asia natural gas demand is estimated to reach around 43 quadrillion Btu in 2025 while Japan and South Korea total is estimated to be at only eight quadrillion Btu. Japan total natural gas demand is even estimated to shrink in 2050 compared to its 2018 values (EIA, 2019f), with more nuclear capacity will come online, Japan LNG imports are estimated to decrease continuously in longer term. South Korean natural gas demand is estimated to build due to energy policy changes resulting from nuclear phase-out and reduction of coal-fired power plants that already exists or being built. Further electrification in other developing Asian economies is expected to develop with incremental growth in country's population. Although there are uncertainties over policy and price level sensitivities, growing power consumption will create opportunities for Asian natural gas demand growth (IEA, 2019, p. 2).

China has the advantage of having a pipeline connection to Russia that helps the country to limit its LNG import dependency (Liang, Abreu, & Fan, 2019). Northern part Russia-China pipeline Eastern route was completed end of 2018 and the middle part is planned to be completed in 2019-2020 (Liang, Abreu, & Fan, 2019; Xin, 2019). In addition to the existing pipeline systems between the two countries, the new pipeline is estimated to provide an additional 38 Bcm of gas per annum and will increase Russia's growing share in total Chinese imports. China also imports natural gas from Central Asian countries like Turkmenistan and Kazakhstan via pipelines. Total non-Russia pipeline imports are forecasted to cover around 25% of China's total natural gas consumption. Moreover, China starts to import LNG from the US to meet the growing energy demand.

Furthermore, non-OECD Asia demand is the main driver of the Asian natural gas market as well as the pricing mechanisms. As the Asian market does not have a unified structure, there is no trading or pricing hub for natural gas or LNG. However, Japan Crude Cocktail (JCC) has been evolved as the benchmark for the LNG prices imported in Asia

(CME Group, n.d.). JCC is the average landed price for Japanese crude oil imports and is published by Japanese Customs. The price is a benchmark for Japanese LNG imports, as well as, first-generation buyers in South Korea and Taiwan (Miyamoto, 2009). Additionally, term contracts from Australia, Malaysia, and Indonesia have also been benchmarked against JCC. To provide a hedging instrument, JCC Futures Contracts have been traded in NYMEX based on the JCC price which is published by the Japanese Customs. JCC is also known to have been traded over-the-counter in between banks and international trading houses for the last ten years.

The Asian natural gas market is estimated to be the main driver of the increase in natural gas demand for the coming decades. According to IGU (2019), Asia Pacific persisted to be the major importing area even though its natural gas import share compared to the global trade fell to 48% in 2018. China has strong connections and growing infrastructure with major producers like Russia, Turkmenistan, and Kazakhstan. India also has plans to increase its pipeline capabilities such as Iran-India or Turkmenistan-Afghanistan-Pakistan-India pipelines (see SAGE, 2016; Corbeau et al., 2018; LiveMint, 2017). Such pipelines will support India's gas-based economy and could cut the expenses against high LNG prices despite the technical and economic risks of the proposed pipelines. As LNG is a midstream dependent source, it is sensitive to transportation costs and both China and India prefer limiting their dependency against the unknown risks associated with LNG suppliers and supply routes.

Japan and South Korea mainly import natural gas in LNG form as being the two top three largest LNG importing countries in the world. Russians have been less successful in their progress into Eastern Asian energy markets, namely South Korea and Japan. Russia's main competition would be against other majors like the Middle Eastern and Latin American states that produce analogous crude oils. Addition to the support in the diversification of supply sources. Kozmino loadings would only take five days to arrive in Asian markets, compared to two weeks of voyage time form the Middle East. Additionally, Japan and South Korea aim to diversify supply options due to increasing LNG supply into Asia-Pacific by 2020 (Kim, 2017).

2.1.4.3 The United States

The United States (US) is one of the most promising markets that have the potential to be a major oil and natural gas exporter in the world. In this section, the US natural gas market will be examined from a market structure perspective, the impacts of shale gas revolution, functioning of Henry Hub as a decisive benchmark, and being a key player in the natural gas & LNG markets.

According to EIA (2019d), the US petroleum and natural gas output raised by 16% and 12%, respectively in 2018. In 2018, the US natural gas production reached 28.5 billion cubic feet per day (Bcf/d), or 31.5 quadrillion Btu, an increase of 12%. The US natural gas production is supported by increased LNG export capacity and its ability to reach in new markets. The US LNG exports are estimated to reach 8.9 billion Bcf/d by the end of 2019. This makes the US third-largest LNG producers after Australia and Qatar. Currently, the US LNG export capacity stands at 3.6 Bcf/d and two new liquefaction units would increase this capacity to 4.9 Bcf/d. Remarkably, in February 2016 the first US LNG cargo was exported from the Sabine Pass liquefaction terminal in Louisiana (EIA, 2019d).

United States' gas market has been reshaped after the increased volume of shale gas was extracted and pumped into the market as a part of the so-called "shale boom" (Brown and Yücel, 2013). The US gas market could be defined as the most competitive market in terms of the number of suppliers, buyers, and distributors. The country also has a thoroughly domestic market with its domestic supply source. Most of the natural gas output is sourced by the Appalachian region, joint of Marcellus and Utica basins, Permian region, and Haynesville region. Most of the production from these basins comes from states of Texas, Pennsylvania, Oklahoma, and Louisiana. Alaska also has significant natural gas production (EIA, 2019e).

As a major production and demand area, the South Texas region has been a natural trading hub for entire US natural gas market (Chen, 2019). The natural gas pipeline hub in Erath, Louisiana, which is also known as Henry Hub, has been the pricing benchmark for the US market. Henry Hub is the physical delivery point for NYMEX futures contracts. NYMEX started trading Henry-Hub-delivery futures natural gas contracts in 1990. The contracts are 18-month forward deliverable in the future. The market settlement price at Henry Hub's physical deliveries is used as the benchmark price in the US natural gas market.

Additionally, the export price for US LNG is also benchmarked at Henry Hub for the FOB basis.

There are some trends to use Henry Hub as a benchmark price for global LNG deliveries. Some exporters like Qatar and Australia prefer spot pricing mechanism; however, the settlement price could have a risk of liquidity. Henry Hub is presented as a liquidity solution for the LNG market pricing which can be a favorable solution for Europe and Asia markets that are benchmarked in oil-indexed prices, especially when oil prices are increasing. (Sung, 2015).

The US natural gas market, especially the Southwest region relies on crude oil producing assets and its economics due to the geological limitations (The Baker Institute, 2007). Permian and Eagle Ford regions are crude oil and condensate producing regions which also provides natural gas as a part of shale oil activity. Due to the enormous upstream activity in shale oil in these regions, gas production is also very large. However, their economics are correlated to oil prices and oil activities rather than natural gas-related demand/supply relations. This might pose a threat against the US' ambition to have Henry Hub as a benchmark for global LNG pricing, as Henry Hub supply would be driven by oil prices. This relation is technically not possible to be broken shortly soon as South Texas' natural gas demand still heavily relies on Permian and Eagle Ford production.

The US dry shale gas production is heavily supplied by the Appalachian region located in Eastern cast states like Pennsylvania, Ohio, and West Virginia. Marcellus and Utica basins in these states are the most promising dry shale gas production areas for the US and are expected to supply more than half of the total US natural gas supply in the coming decades. However, increasing complaints about the techniques used in shale gas drilling are adding more threat on the limitations for how much of these sources could be extractable. The environmental concerns over hydraulic fracking that could contaminate water sources and the debates over whether hydraulic activities trigger earthquakes grew the opposition against shale gas activities on the Eastern Coast of the US (Earthworks, n.d.; Vaidyanathan, 2016).

Unlike the Texas region, the Eastern Coast of the US has not been native with the upstream activities. Additionally, Eastern states have much higher population densities compared to the Southwest states like Texas, New Mexico, or Louisiana so increasing shale

gas activity in Eastern states would very likely have a growing opposition. This might limit the total amount of natural gas resources to be extracted in Marcellus and Utica basins which need to be taken into consideration when analyzing future supply of the US shale gas (New York State, 2020; Winstel, 2020).

2.1.5 Natural Gas Pricing and Contracts

This thesis focuses on Turkey's options for having improved trading and political conditions while securing and renewing natural gas contracts in the short to medium term. However, let alone, it is not possible to understand the complete coverage of options by only examining the current contracts and existing structure of the Turkish natural gas market. It is also important to understand other applications of pricing and contracting terms globally to offer a better option or to design a new pricing and contracting system. This section of the thesis examines pricing and contracting applications globally so that we would be able to determine whether existing conditions in Turkey could be improved or modified for advantage. This section mainly focuses on different methodologies in pricing and contracting, in a very generic term, to create a basis for the recommendations of this study.

2.1.5.1 Pricing

Contracts arise from the regional market conditions which are related to the regional pricing methodology used. For this reason, before examining the natural gas contracts, one needs to understand the natural gas pricing methodologies. It varies among the main global markets where natural gas is priced and sold. Furthermore, it is important to apprehend that the natural gas pricing models are fundamental for energy regulators, consumers, and suppliers because natural gas is becoming a gradually significant energy source.

According to the (IGU, n.d.), there are different pricing methods to achieve more open pricing regimes, summarized in Figure 2.5:

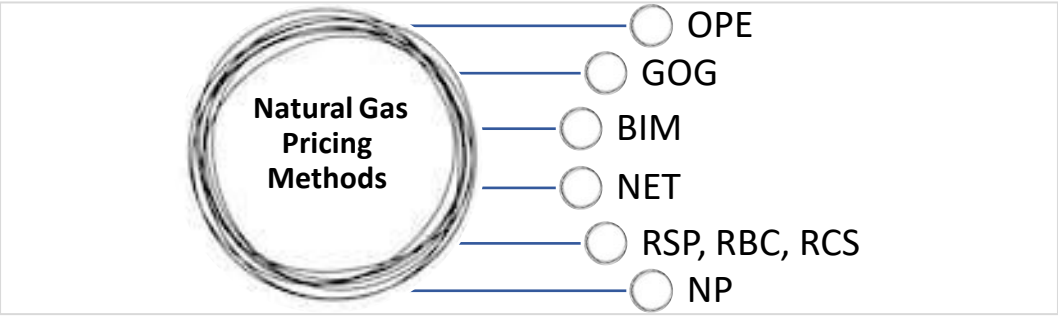


Figure 2.5. Methods for determining the price of natural gas. Source: IGU (n.d.)

- Oil Price Escalation (OPE): Price is linked to competing fuels, typically crude oil or products.
- Gas on Gas Competition (GOG): Price is linked to a competitor gas priced in physical or virtual hubs. Developed futures markets are to support and there are different contractual terms for the gas. Sometimes it might include spot LNG, as well.
- Bilateral Monopoly (BIM): This is when price determined by bilateral discussion and agreements. Typically, price is fixed for a certain time and one of the sides is a dominant buyer or seller.
- Netback from Final Product (NET): Price is derived from the final product of the buyer, generally when gas is used as a feedstock and is the major variable cost in the process.
- Regulation: Social and Political (RSP): Price is determined and approved by an official regulator. "Cost of service" is included to provide a reasonable rate of return for the seller.
- Regulation: Below Cost (RBC): Price is calculated as below-average cost of producing and transporting which is generally derived as a state subsidy.
- Regulation: Cost of Service (RCS): Price is set below the cost of production and transportation as a state subsidy similar to RBC.
- No Price (NP): This is when there is no price and gas is provided free. This gas is generally a by-product of another commercialized fuel.

One or more of these price mechanisms could be applied depending on supply and demand-side factors which are import/export, level of economic growth, seasonal weather conditions, and others. Regional prices may differ at different locations to meet market needs. Based on that, any natural gas or LNG contract could be priced by a combination of one or any other of the pricing mechanisms mentioned above.

2.1.5.2 Natural Gas and LNG Contracts

In principle, natural gas contracts are not different than any other commodities trade contract (Zlámal, 2009). Although there are specials terms and conditions for natural gas contracts, this is a typical application in most of the short-term or long-term commodities trading. In this section, information about natural gas contracts will be given to enlighten this thesis's main objective that is Turkey's natural gas contracts.

By simple basics of any trade, buyers and sellers would like to secure themselves in the course. The natural gas market is no exception and has adapted itself too many different contract types to create an efficient and sustainable trading system. As natural gas supply is reliant on the upstream activities that require extensive investment and operational expenditures, natural gas contracts have evolved to secure suppliers. However, increasing LNG supply in the markets, shifted the contract mechanisms to a more competitive level that buyers started to dictate their requirements. In theory, no matter what contract type is preferred for any physical trade agreement, the basis would be to build a risk-minimized mutual environment for both parties. In practice, each side pushes for their favor, which created different types of contracts to be questioned in terms of their practicality.

In most cases, natural gas contracts are long-term contracts due to the nature that buyers and sellers need a long-term commitment from the other side of the trading. Additionally, natural gas prices in spot markets are always much more expensive than contracted gas.

In regions like Europe, where there is a supply-side monopoly and it is assumed that natural gas can be substituted by crude oil or oil products in case of a gas supply shortage, the price of gas is oil indexed. This is also realistic for the seller side of whose upstream investments are a function of oil prices. However, this is a problem for the buyer side in high and/or volatile oil price market conditions. There are different mechanisms to find a balance between the seller's expectations and buyer's commitments.

The assumption that gas to be substituted by oil has caused the market to price natural gas with oil-indexed pricing mechanisms. However, different markets have different dynamics so different price formulations have evolved to reflect how the changes in oil prices could be reflected in gas prices (Müller et al., 2015). The main difference comes from the demand pattern differences between oil and gas markets. On the other hand, gas also has

different demand patterns at different time frequencies. Natural gas demand is generally low at weekends, or household heating gas demand peaks in winter days. According to Müller et al. (2015) this yields different oil-indexed price formulations based on three parameters: The number of averaging months, the time lags, the number of validity months. These parameters are set in a formulation in an X-Y-Z structure to reflect the above-mentioned parameters. As an example, a price formulation of 6-0-1 means the price is determined by the average of the last six months, there is no lag between the new price and its validation, and the price is valid for one month. After a month there will be a new price-fixing. The most common formulations are 3-1-1, 3-1-3, 6-1-1, 6-1-3, and 6-3-3 although the price formulation for nearly all the natural gas contracts is unknown to the public.

As stated by Energy Charter Secretariat (2007), each contract has its unique terms and conditions. In some cases, different alternatives are computed in variable prices such as spot LNG example in Germany (Nexant, 2017). There are also cases that spot contracts are priced against hub prices such as in NBP or TTF; however, in current market conditions, physical gas, especially the gas supplied by Russia, still arrives in European gas hubs with oil-indexed contracts. Natural gas contracts continue to evolve with market needs, upstream developments, demand structure changes, and long-term risk assessments in the natural gas market.

Formulation of gas has two components; fixed term, which is a basic price for the gas, and variable term, which links the gas price to its substitutes. The substitutes are alternative energy sources that are assumed to be able to replace natural gas in case of a supply disruption. The main alternative sources are gasoil, light or heavy fuel oil, coal, and electricity. The common usage of variable terms is generally having a combination of more than one alternative in a weighted average principle. Different formulations depend on a different combination of these alternatives. Basis price is generally a pre-evaluated price of the gas at the time of commencement of the contract. Each alternative is calculated to have different weighs in the variable term based on their competitive power against natural gas or market conditions (Zlámal, 2009).

The price re-opener clause is generally added in each contract based on the fact even the best formulation would not be able to reach all probabilities during the long period of the contract. The clause helps both sides to be able to reassess their contract terms and a new settlement during the time course.

Most of the long-term gas contracts also have an option for the buyer to off-take some amount of gas from the seller with the contracted price which is called off-taking flexibility. This option is generally favorable for the buyers with high demand volatility which is either created by their customers or weather anomalies. The difference between ACQ and buyer's contracted Annual Minimum Quantity (AMQ) is practically referred to as the Annual Option Quantity (AOQ) which represents the buyer's off-taking flexibility (Energy Charter Secretariat, 2007).

The natural gas contract types for natural gas and LNG which as Long-term LNG Contracts, Short-term Spot LNG Contracts, Spot LNG Contracts, Long-Term Take-or-pay Natural Gas Contracts, and Hub-based Pricing are explained below in detail.

Long-term LNG Contracts

This type of contract is designed to provide a long-term basis for buyers and sellers on monthly or annual contractual obligations. This is similar to the take-or-pay system of pipelined gas contracts. These contracts are mainly based on the fact that the buyer side is also included in the upstream segment of the project such as in Qatar. According to QatarGas (QatarGas, n.d.), seven phases of QatarGas and RasGas have been developed together with the buyers of their LNG. This way secures both sides. Qatar takes advantage of sharing the development expenses of its vast resources and securing a long-term buyer for its LNG, while buyers' side is directly involved in the development of the project so that they have better confidence in the feasibility and the reliability of their supply source. These types of contracts are generally based on the existence of a joint venture operating company that is owned by the buyer and seller side and is based on providing longer-term cooperation (Wikipedia, n.d.).

Short-term Spot LNG Contracts

LNG is a commodity with a strong dependence on the shipping industry. As some countries, with a lack of geographical advantage of having direct pipeline access in natural gas sources, must have longer and stronger relations with LNG producers, like the example between Japan and Qatar. However, for some countries with good pipeline natural gas capacity and alternatives, LNG is an option to substitute seasonal or regional demand fluctuations as in Turkey. In this example, the consumer country would like to secure the

availability of spot cargoes in need without being bounded by longer term and period trade obligations. Long-term spot LNG contracts are kind of hybrid contracts between spot and term contracts that helps the consumer countries to secure spot cargoes in unexpected needs. These contracts also help the producers to sell access production, if there is any, as the demand pattern of their term contract buyers could also change in time (IGU, 2019, p. 13).

Spot LNG Contracts

Apart from the two abovementioned LNG contracting systems, there still might be access LNG supply in the market. Upstream conditions, demand patterns for term buyers, and the cost of freight for certain routes could yield the existence of spot cargoes in the market that is ready to be purchased on an over-the-counter basis. These types of contracts are generally one-off contracts with no future binding and obligations. These cargoes might be a good solution for any buyer with unexpected demand due to weather conditions or economic activities. As LNG facility outputs globally are pretty much fixed and the fluctuations in total output are not very common, the price of spot contracts could be higher than of those in term contracts or long-term spot contracts; however, the absence of demanded energy could cost more for the buyer so this is a good alternative when consumers have unexpected demand shocks (IGU, 2019, p. 13).

Take-or-Pay Natural Gas Contracts

Long-term pipeline natural gas contracts also have a Take-or-Pay (TOP) mechanism which dictates the buyer to either buy the contractually committed amount of gas or pay the same amount as if the gas had been taken (Zlámal, 2009). The buyer might have an option to have a shortfall amount from the Annual Contracted Quantity (ACQ), which is called Downward Quantity Tolerances (DQT). Take-or-pay is calculated based on ACQ minus DQT minus any shortfall in the seller's deliveries.

TOP mechanism has many debates over as this is generally an unfavorable condition for the buyer. It creates security for the seller on the buyer's ability on going for other suppliers or spot markets during the contract period. Additionally, it also provides guaranteed cash flow for the seller as 90% of the seller's production and transportation costs are fixed sunk costs. TOP mechanism also helps the seller to have better access to lending opportunities as TOP acts like guaranteed cash flow. For both sides, the mechanism avoids

going to court with its simple and clear mechanism. For the buyer side, one big advantage would be that discouraging the buyer to oversize its contract so forcing the buyer to have a proper forward-looking projection on its gas demand (Zlámal, 2009).

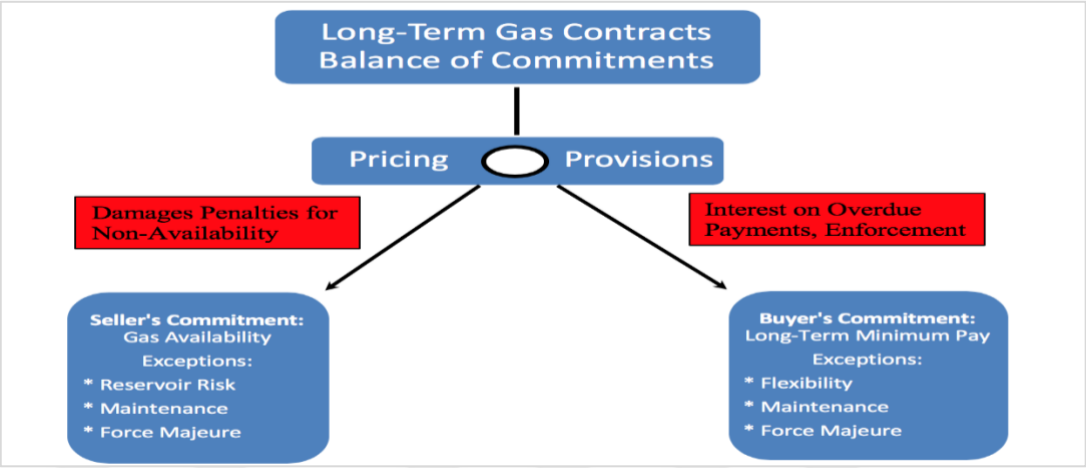


Figure 2.6. Balance of commitments in long-term gas contracts. Source: World Bank/ESMAP (1993, p. 33)

The factors in Figure 2.6 can be detailed with the answers to the following issues (see World Bank/ESMAP, 1993 for more details): Who are the players (the partners of the contract)?; What are the rules for handling the contract?; What common interest might the partners have offside the actual deal?; What are the commercial aspects of the deal which of by clarifying the commitments on both sides to invest to make the gas flow, defining the balance between the partners when the gas is flowing in terms of the gas flow itself, the money flow and the information flow, addressing the technicalities of each aspect.

Natural Gas Trading Hubs and Hub-based Pricing

Turkey's one of the objectives of its natural gas market is to become a regional hub. In this section, we will examine the hub-based pricing systems and the natural gas trading hubs in the world with their development and the structures in detail. Furthermore, at the end of the section, a brief assessment of the hub situation of Turkey is evaluated.

A Natural Gas Trading Hub is simply described as a distribution center between upstream and downstream segments of natural gas (ERGEG, 2007) and provides an opportunity for a sufficient number of traders to buy and sell natural gas at a fair price in a predictable habitat (Topuz, 2019). For sellers and buyers, finding a fair price level is essential to have a long-term sustainable, and profitable business and trading hubs are expected to

provide such an advantage. A hub would enable an opportunity to form a fair and competitive price with a vast number of participants which can yield an advantageous market condition contrary to the impenetrable structure of bilateral markets. A properly working gas hub would provide open and definite market condition which would ease risk management and trade options (Turkish Competition Authority, 2012, p. 56). In natural gas trading, a hub could either be a physical hub at which pipeline infrastructures are connected, such as Henry Hub or Hub Zeebrugge, or a virtual hub at which gas is traded at a point inside the pipeline as a balancing, such as National Balancing Point (NBP), as also summarized in Table 2.3 and more information is given in the following.

Table 2.3. The properties and comparison of the most common natural gas hubs

Physical Gas Hub	Virtual Gas Hub
1. The hub is existing in a certain location.	1. Whole trade has done in a hypothetical location.
2. Trade is affected by its environment like weather conditions.	2. Adequate stability must be ensured to be recognized as a hub with a hypothetical system.
3. Arbitrage on the prices can be observed due to physical constraints in transmission system.	3. Arbitrage opportunities between markets occur much less, since the hypothetical system has lack of physical problems.
4. Henry Hub (USA) and Zeebrugge (Belgium) are prominent examples.	4. National Balancing Point (UK) and Title Transfer Facility (the Netherlands) are prominent examples.

Source: Topuz (2019, p. 16)

Topuz (2019) indicates that;

> Gas trading hubs are classified as either virtual or physical hubs. A virtual gas trading hub assumes the whole network has a single point in which gas is traded. The hubs that have the biggest market share in Europe, NBP and TTF, are the prominent examples for virtual natural gas hubs. A physical hub is a large gas storage facility in a specific location or locations within a gas network that is interconnected to suppliers and customers and capable of closing natural gas contracts with physical sales and purchases with the hub serving as the point of delivery or purchase. The most prominent example of such a gas hub is Henry Hub in Louisiana, United States which has the largest market volume (p. 15).

A well-designed hub provides access to all buyers and sellers in the system. By using the combined infrastructure within a hub, gas can flow through transmission systems

conveniently that can help buyers and sellers to increase their options. This way would increase the portfolio of traders, hence the competition in the market.

Generally, regulations are expected to develop a hub by providing a clear guideline on how to operate within the hub, rules on suspending operations, or helping investors in the hub system by providing transparency. The nature of regulation or regulators might differ from region to region but also could be based on the needs of the market. Regulations should ensure a non-discriminatory environment for all participants within the hub so the expenses could be applied fairly. For different participants, the less there is unclarity on how expenses will be incurred, the better hub structure could be established.

Physical hubs are mainly designed to serve physical trading rather than balancing. So, the infrastructure capabilities of a physical hub are vital to ensure the provide physical options for the movement of natural gas. Pipelines and storage facilities are critical for a physical trading hub as well as the location of the hub so that the traders could have access to a well-supplied and well-demanded environment. There are examples like Central European Gas Hub converted into a virtual hub from a physical hub when regulation and market conditions allow gas movements via entry and exit points rather than point-to-point (CEGH, n.d.).

Virtual hubs mainly serve to balance the market by using the flexibility of taking the gas at any point via the entry-exit regime. According to Heather (2019), balancing points could also be combined to have a regional balancing point that can support cross-border trade between countries such as in the European balancing points. In practical terms, within all the eleven hubs in European area balancing hubs, only two of them, TTF and NBP, are practically mature markets. Four of them can be considered as active hubs, which are NCG, GPL, PSV, and VTP. TRF, ZEE, ZTP, PVB, and VOB are considered poor hubs so they are not active enough. Although the European Union is pushing too hard to establish a continent-wide regional hub, it has been a challenge to have all the hubs as liquid and active as they aspire.

When considering all the hubs in Europe, only NBP and TTF could evolve to a benchmark point. NBP is the British Pound benchmark for gas into British islands and the LNG supplies, while TTF is the Euro benchmark for the North Western European gas market. Real importance of these two hubs comes from the fact that both are used for risk

management (Heather, 2019). The decline in total output in Groningen region gas production has been a concern over TTF's capability to be a price benchmarking and pricing hub but physical shreds of evidence do not support the concerns.

Europe is a good example of how virtual hubs could provide benchmarking and risk management options for physical traders. Europe is expected to have a single gas market by 2025 in case its hub strategy would work as to how it has been planned.

According to Heather (2015), five key elements to comprehend a well-organized hub from the perspective of depth, liquidity, and transparency to meet and to what degree are;

a. Market participants: The number of active participants is an important indicator as to the development of that hub
b. Traded products: An important consideration when comparing traded markets, to determine whether they are used for balancing or for risk management and so can produce a benchmark hub
c. Traded volumes: This element is associated with market activity and development and is a clear sign of a hub's relative importance
d. Tradability Index: ICIS assessment for determining liquidity and, in itself, it is not an indicator of depth, liquidity, and transparency
e. Churn rates: The ratio of traded volume to actual physical throughput. The most important Key Element and a measure of a gas hub's commercial success (p. 2).

Table 2.4. Summary of the five key elements of natural gas hubs in 2018

	Five Key Elements					
Hub	Active Market Participants	Traded Products	Traded Volumes	Tradability Index (Q4)	Churn Rate	Score/15*
TTF	189	50	28 220	20	70.9	15
NBP	151	44	15 105	16	16.9	14
NCG	137	23	1 760	15	3.8	9
GPL	105	21	1 150	14	2.8	9
PSV	102	20	1 060	14	1.4	9
VTP	83	16	650	10	6.9	8
TRF	50	17	780	12	1.7	7
ZEE	47	16	460	7	3.1	7
ZTP	45	12	150	3	3.1	7
PVB	41	11	100	0	0.3	5
VOB	19	11	80	5	0.9	5

Source: Heather (2019, p. 12)
* Score based on each of the Key Elements scoring one point for Red; two points for Amber; three points for Green.

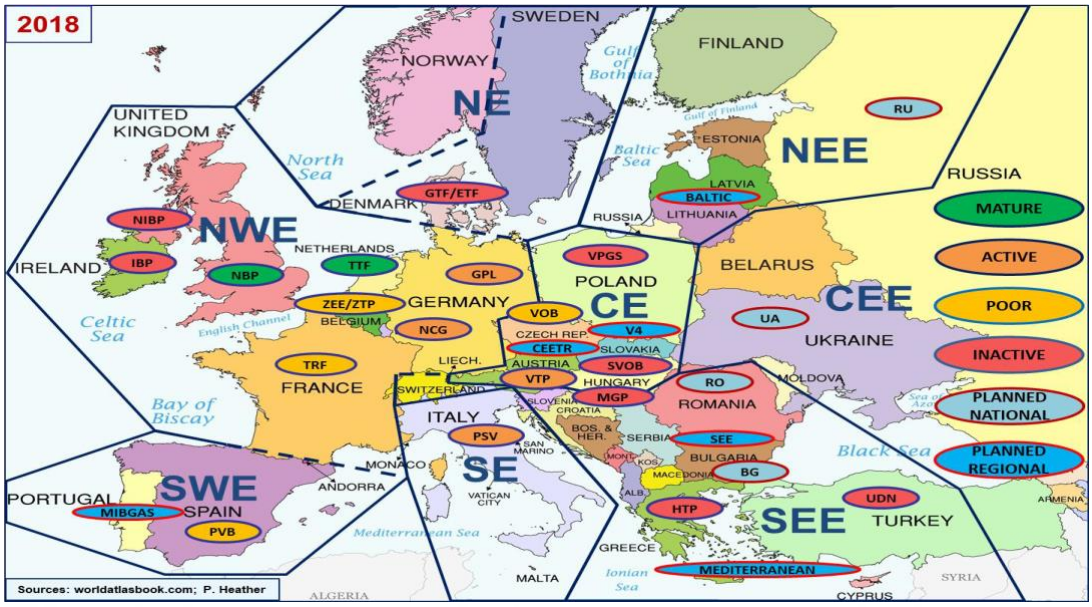


Figure 2.7. European gas regions, markets and hubs in 2018. Source: Heather (2019, p. 3)

Heather (2019) states that the North West is the most developed natural gas market in Europe in terms of maturity and liquidity. Based on his color-coding mature hubs are dark green, active hubs are orange, poor hubs are amber, and illiquid hubs are red. The final ordering of the hubs is derived from a simpler scoring methodology is shown in Figure 2.7. In total scoring, based on key elements, a total maximum score of 15 could be secured of which the results are shown in Table 2.4. It is stated that "a hub is classified as being 'mature' if the score is 12-15, 'active' if the score is 8-11, 'poor' if the score is 5-7, and 'inactive' if the score is 1-4". A gradual grouping was made based on a total score in which 12-15 points is considered as a mature market. TTF and NBP are the hubs that are considered as mature, deep, transparent, and liquid whereas NCG, GPL, PSV, and VTP are considered as active and auspicious hubs.

As reviewed by Topuz (2019), evaluation of Turkey's position to be a natural gas hub based on ACER and EFET criteria; Turkey has to improve its (i) commercial issues, (ii) physical structure iii) regulatory issues iv) network operations. Turkey is considered as a potential physical hub rather than a virtual hub with its attributes to direct the author. The potential benefits of a regional natural gas hub in Turkey that is categorized in the study can be summarized as following concerning the crucial questions that must be answered and main topics concerning with the answers of them; "1) Why is it beneficial for Turkey?: Energy security objectives; macroeconomy related benefits; environmental performance; new services and other value add from a new business in Turkey. 2) Why a Turkish Hub is

beneficial for Turkey's Natural Gas suppliers?: Rebranding gas molecules; resources and suppliers in the region; increased exports; more demand is better than restrictive contracts; hedging and risk management by means of a liquid growth market. 3) Why a Turkish Hub is beneficial for demanding markets?: Increased competition in European Gas Markets; increased availability and flexibility of gas in Southeastern Europe." (See Topuz, 2019, p. 16-27).

2.2 Turkey's Economy in General, Energy Position and Natural Gas Market

In this thesis, it is aimed to capture a better operating natural gas contract formula for Turkey according to the effects of natural gas price on macroeconomic variables, especially on industrial production. So, it is essential to go over Turkey's macroeconomic conditions for a better understanding on this subject. General information about Turkey's economy will be given besides energy posture and several issues regarding natural gas market in Turkey will be examined in this section. It is vital to see the general situation about these topics for understanding Turkey and its aims to have better conditioned natural gas contracts for a more competitive and natural gas market.

2.2.1 Turkey's Economy in General

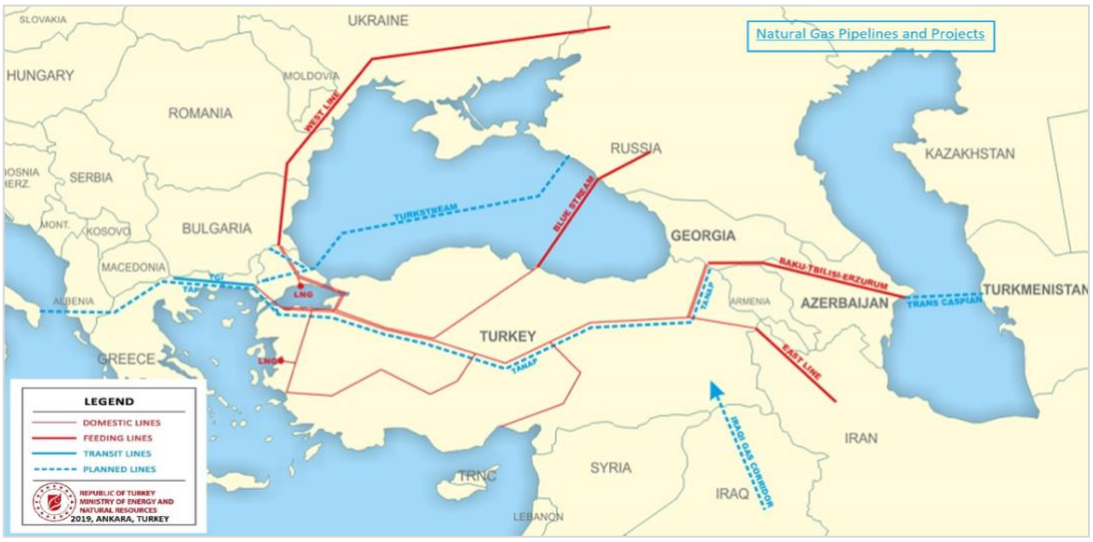


Figure 2.8. Republic of Turkey's existing natural gas pipelines and pipeline projects. Source: MENR (n.d.)

Republic of Turkey is an upper-middle income country according to the Worldbank. Turkey is located between two continents. 3% of Turkish territory is at Europe whereas 97%

of Turkish territory is in Asia. Total population of Turkey is 81 101 892 in 2017, 82 319 724 in 2018 and surface area of 785 350 km^2 (The World Bank, n.d.). Turkey's geostrategic location has a focal characteristic of the its history, civilization, culture and politics. As stated by Ministry of Foreign Affairs of Turkey "Turkey is geographically located between energy producing countries of its region with more than 75% of the world's proven oil and gas reserves and the well-developed European energy consumer markets." (Ministry of Foreign Affairs, n.d.). Turkey's unique geostrategic position creates opportunities for Turkey to secure its energy supply and make the country to create a hub for the regional energy security. Turkey aims to strengthen its position in energy markets with its geostrategic position and converting this advantage into a hub which is also highlighted in Turkey's energy security strategy.

Turkey is in a continual search of new cross-border energy projects with its geostrategic superiority. Turkey is in the heart of the Southern Gas Corridor (SGC) which is an essential project for delivering natural gas from Caspian region to Europe in which TAP and TANAP are the core parts of this motivation. The delivery of gas to Turkey through TANAP part of SGC started in 30.06.2018 and gas supply to Europe will start in 2020 (MENR, n.d.). Turkey's enthusiasm to form an intense market where crude oil and natural gas transacted and furthermore being a regional trade hub for energy. Turkey also aims to gradually enlarge its energy mix by taking into different energy sources like renewable energy, nuclear energy for environmental concerns, decreasing the dependency on fossil fuel imports to secure supply for the increasing demand in energy.

Selected macroeconomic data can be given as following can be also seen from Table 2.5 to give brief assessment about Turkey. GDP of Turkey was $ 851 549 million in 2017 and $ 766 509 million in 2018 as current GDP. In 2018, GDP growth decreased to 2.6% from 7.4% comparing 2017. GDP per Capita is $ 10 546.15 in 2017 and $ 9 311.4 in 2018. Inflation rate according to the annual change of GDP Deflator was 10.8% in 2017 and 16.2% in 2018 (The World Bank, 2019a). Turkey's percentage of exports of goods and services in GDP was 24.8% in 2017 and 29.6% in 2018; percentage of imports of goods and services in GDP was 29.3% in 2017 and 30.8% in 2018 (The World Bank, n.d.). In 2017, Turkey exports were $ 156 993 million (FOB), imports were $ 233 800 million (CIF), trade volume was $ 390 793 million and trade balance was $ -76 807 million (TURKSTAT, 2017). The annual trade growth of Turkey is 5.33% compared to the world trade growth of 5.68% in 2017. 4292

different types of product were exported to 215 countries and 4336 different types of product were imported from 218 countries in 2017 at HS6 digit level (The World Bank, n.d.). In 2018, Turkey has a trading value of with$ 167 921 million (FOB) exports, with$ 223 047 million (CIF) imports, total trade volume was $ 390 968 million and trade balance was $ -55 127 million (TURKSTAT, 2018). The trade growth of Turkey is 4.55% compared to the world trade growth of 3.5% while 4281 products were exported to 220 countries and 4322 products were imported from 214 countries in 2018 at HS6 digit level (The World Bank, n.d.).

Table 2.5. Some selected informative data about Turkey between 2014-2018

Variable	2014	2015	2016	2017	2018
Surface area (km^2) *	785 350	785 350	785 350	785 350	785 350
Population (mid-year) *	77 231 907	78 529 409	79 821 724	81 101 892	82 319 724
Population (end of year) **	77 695 904	78 741 053	79 814 871	80 810 525	82 003 882
GDP (current million $) *	934 186	859 797	863 722	851 549	766 509
GDP (constant 2010 million $) *	1 025 467	1 087 876	1 122 512	1 206 040	1 236 994
GDP per capita (current $) *	12 096	10 949	10 821	10 500	9 311
GDP per capita (constant 2010 $) *	13 278	13 853	14 063	14 871	15 027
GDP growth rate *	5.17	6.09	3.18	7.44	2.57
Unemployment rate (%) *	9.88	10.24	10.84	10.84	10.89
Unemployment rate (%) **	9.90	10.30	10.90	10.90	11.00
Annual GDP Deflator change (%) *	7.42	7.83	8.10	10.80	16.20
Annual CPI change (%) *	8.86	7.67	7.78	11.14	16.33
Annual CPI change (%) **	8.17	8.81	8.53	11.92	20.30
Trade in % of GDP *	51.41	49.30	46.82	54.12	60.40
Exports (current million $) *	222 003	200 728	189 717	211 220	226 982
Exports (constant 2010 million $) *	224 906	234 570	230 187	257 695	276 987
Number of exported products *	4 311	4 291	4 293	4 292	4281
Number of countries for export *	216	217	220	215	220
% of exports in GDP *	23.8	23.4	22.0	24.8	29.6
Annual export growth rate (%) *	8.16	4.30	-1.87	11.95	7.49
Imports (current million $) *	258 300	223 151	214 640	249 655	236 011
Imports (constant 2010 million $) *	245 823	250 041	259 409	286 189	263 443
Number of imported products *	4 370	4 377	4 354	4 336	4322
Number of countries for import *	218	214	215	218	214
% of imports in GDP *	27.70	26.00	24.90	29.30	30.80
Annual import growth rate (%) *	-0.36	1.72	3.75	10.32	-7.95

Table 2.5 (continued). Some selected informative data about Turkey between 2014-2018

Variable	2014	2015	2016	2017	2018
Trade growth rate (%) *	2.58	-4.07	1.50	5.33	4.55
Current Account Balance (BOP, current million $) *	-43 610	-32 145	-33 139	-47 347	-27 252
Exports (FOB) (million $) **	157 610	143 839	142 530	156 993	167 921
Imports (CIF) (million $) **	242 177	207 234	198 618	233 800	223 047
Foreign trade balance (million $) **	-84 567	-63 396	-56 089	-76 807	-55 127
Volume of trade (million $) **	399 787	351 073	341 148	390 793	390 968
Proportion of imports covered by exports **	65.10	69.40	71.80	67.10	75.30

Sources: * The World Bank (2019b) (Accessed on 20.10.2019)
** TURKSTAT (2019) (Accessed on 20.10.2019)

Export and import data of Turkey with trade partners can be seen from Table 2.6. In 2017, major trading partner of Turkey in all products were Germany with $ 15 119 million with a share of 9.63%; United Kingdom with $ 9 603 million with a share of 6.12%; United Arab Emirates with $ 9 184 million with a share of 5.85%; Iraq with $ 9 055 million with a share of 5.77%; United States with $ 8 655 million with a share of 5.51% for exports and China with $ 23 371 million with a share of 10.00%; Germany with $ 21 302 million a partner share of 9.11%; Russian Federation with $ 19 514 million with a share of 8.35%; United States with $ 11 952 million with a share of 5.11%; Italy with $ 11 305 million with a share of 4.84% for imports.

Table 2.6. Export and import data of Turkey via all products with major trade partners in 2017

Partner Name	Year	Export (Million $) (FOB)	Export share (%)	Partner Name	Year	Import (Million $) (CIF)	Import share (%)
Germany	2017	15 119	9.63	China	2017	23 371	10.00
United Kingdom	2017	9 603	6.12	Germany	2017	21 302	9.11
United Arab Emirates	2017	9 184	5.85	Russian Federation	2017	19 514	8.35
Iraq	2017	9 055	5.77	United States	2017	11 952	5.11
United States	2017	8 655	5.51	Italy	2017	11 305	4.84

Source: The World Bank (2019b) (Accessed on 20.10.2019).

Turkey's import and export data are given in Table 2.7 as categorized into commodities. In 2017, major traded product groups were Consumer Goods with $ 73 291 million with a share of 46.68%, Intermediate Goods with $ 38 718 million with a share of 24.66%, Capital Goods with $ 31 437 million with a share of 20.02%, Raw materials with $ 11 203 million with a share of 7.14% for exports and Intermediate goods with $ 78 124

million with a share of 33.42%, Capital goods with $ 62 016 million with a share of 26.53%, Consumer goods with $ 49 253 million with a share of 21.07%, Raw materials with $ 21 799 million with a share of 9.32% for imports; major traded products were Transportation with $ 26 869 million with a share of 17.11%, Textiles and Clothing with $ 28 815 million with a share of 17.08%, Machine and Electronics with a share of 13.96% with $ 21 911 million for exports and Mach and Elec with $ 48 299 million with a share of 20.66%, Fuels with $ 37 205 million with a share of 15.91%, Metals with $ 29 578 million with a share of 12.65% for imports.

Table 2.7. Export and import data of Turkey with major product groups in 2017

Export			Import		
Product	Export (Million $) (FOB)	Export Product Share (%)	Product Group	Import (Million $) (CIF)	Import Product Share (%)
All Products	156 993	100	All Products	233 800	100
			Product Groups		
Consumer goods	73 291	46.68	Intermediate goods	78 124	33.42
Intermediate goods	38 718	24.66	Capital goods	62 016	26.53
Capital goods	31 437	20.02	Consumer goods	49 253	21.07
Raw Materials	11 203	7.14	Raw Materials	21 799	9.32
			Products		
Transportation	26 869	17.11	Mach and Elec	48 299	20.66
Textiles and Clothing	26 815	17.08	Fuels	37 205	15.91
Mach and Elec	21 911	13.96	Metals	29 578	12.65
Metals	18 984	12.09	Transportation	23 201	9.92
Stone and Glass	13 964	8.89	Raw materials	21 799	9.32
Raw materials	11 203	7.14	Stone and Glass	19 148	8.19
Plastic or Rubber	7 970	5.08	Chemicals	19 119	8.18

Source: The World Bank (2019b) (Accessed on 20.10.2019)

Turkey's fuels import and export data are given in Table 2.8 according to the major fuels trade partners. In 2017, major trading partner for Turkey in fuels were United Arab Emirates with $ 827 million with a share of 9.01%; Egypt Arab Rep. with $ 447 million with a share of 18.92%; United States with $ 430 million with a share of 4.96%; Greece with $ 273 million with a share of 16.41%; Singapore with $ 269 million, with a share of 39.68% for exports and Russian Federation with $ 11 449 million with a share of 58.67%; Unspecified with $ 8 177 million with a share of 99.16%; Iran Islamic Rep. with $ 6 102 million with a share of 81.44%; India with $ 1 997 million with a share of 32.13%; Colombia with $ 1 593 million with a share of 98.90% for imports. The total trade volume of fuels is $ 4 327 million for exports and $ 37 205 million for imports.

Table 2.8. Export and import of fuels data of Turkey according to the major trade partners in 2017

Year	Export			Import		
	Partner Name	Export (Million $) (FOB)	Export Product Share (%)	Partner Name	Import (Million $) (CIF)	Import Product Share (%)
2017	United Arab Emirates	827	9.01	Russian Federation	11 449	58.67
2017	Egypt, Arab Rep.	447	18.92	Unspecified	8 177	99.16
2017	United States	430	4.96	Iran, Islamic Rep.	6 102	81.44
2017	Greece	273	16.41	India	1 997	32.13
2017	Singapore	269	39.68	Colombia	1 593	98.90

Source: The World Bank (2019b) (Accessed on 20.10.2019)

Table 2.9. Import values and percentage changes of main subcategorized fossil fuel related products of Turkey in 2018

Products	Value ($)	Change compared to 2017 (%)
Processed petroleum oils	12.7 billion	29.2
Coal, solid fuels made from coal	4.4 billion	12.2
Petroleum gases	1.9 billion	16.3
Petroleum oil residues	640.6 million	38.1
Coke, semi-coke	255.7 million	-45.4
Coal tar oils (high-temperature distillation)	79.1 million	45.6
Electrical energy	57.0 million	-33.3
Petroleum jelly, mineral waxes	44.2 million	11.2
Peat	13.0 million	-23.0
Asphalt/petroleum bitumen mixes	3.7 million	18.0

Source: World's Top Exports (2019) (Accessed on 03.06.2019)

According to the Table 2.9, amongst the given products; purchase amount of coal tar oils, petroleum oil residues, processed petroleum oils increased significantly besides the decrease in coke & semi-coke, electrical energy, peat from 2017 to 2018 in Turkey. Furthermore, it can be stated that Turkey's major energy demand based on several types of imported fossil fuel-related products.

2.2.2 Turkey's Energy and Natural Gas Markets

Turkey has a continuous increase in its energy demand as a developing country. Due to Turkey's location and proximity to the world's top crude oil and natural gas suppliers, its primary energy sources have been hydrocarbon sources. Addition to that, Turkey has also

adapted usage of coal in its primary electricity generation cycle, as a country having important domestic coal reserves. Turkey's close relations with Soviet Union helped the country to access in important natural gas imports that has been a vital catalyzer in Turkey's economic growth for the last few decades.

It is important to analyze the country's total energy consumption profile and the diversity of the sources in order to design a working contractual system with its major natural gas suppliers. As a fundamental point, the main aim would be to compare any energy sources with its alternatives, so this is a necessary step for the purpose of this thesis. On top of all, Turkey also has a growing renewable energy generation in its overall portfolio, so one might argue that the share of natural gas in total primary energy sources could be negatively affected by growing renewable energy usage within the country. In that sense, we would need to have a general look on Turkey's energy sector and the share of natural gas. This section of the thesis aims to provide this necessary information to provide a better understanding on the importance of re-designing its long-term natural gas contracts with existing and new contracts.

This section provides a general look on Turkey's primary energy sources, their share in total, energy consumption distribution per economic activity, outlook for its natural gas market, its import sources and their share in total imports, domestic production, energy consumption per sector, storage capacities and country's international trade of natural gas.

2.2.2.1 Turkey's Energy Market

In the last decade, energy sector is one of intensely growing sectors in Turkey where it is obviously in parallel with the recorded economic growth. Turkey is amongst the leading emerging economies with significant energy consumption and demand in world. Moreover, Turkey's energy market has been in a rapid liberalization progression with the strategic alliances in the market with licensing processes thus this condition provides new opportunities for growth in a highly competitive structure. As it can be seen from Figure 2.9, Turkey has a total number of 3 098 existing power plants with 33 geothermal, 40 coal, 186 wind, 288 natural gas plants, 613 hydro, 1773 solar and 165 other types of plants in 2018.

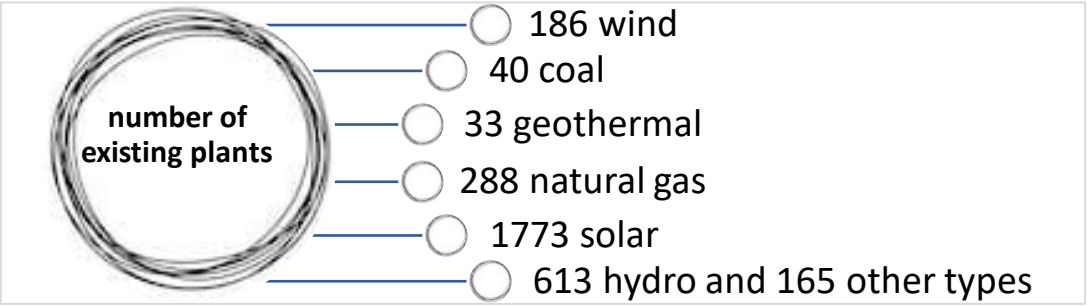


Figure 2.9. Number of existing licensed power plants in Turkey in 2018. Source: MENR (n.d.) (Accessed on 04.03.2019)

Based on MENR Strategic Plan for 2015-2019 (MENR Strategic Plan for 2015-2019), the current needs of the energy sector, the required policy development in the scope of natural resources and expectations for the future are the main interests. The updated Strategic Plan consists of eight themes, 61 purposes and 16 objectives. In the plan, "good governance and stakeholder interaction; technology, R&D and innovation; regional and international activity; improving the investment climate" about energy and natural resources are discussed. Moreover, in the energy sector "security of supply; energy efficiency and saving" are discussed and "efficient use of raw materials; security of raw materials supply" in the natural resources sector is constituted in the framework of the plan. The formation of energy storing systems and the legislative infrastructure for the integration into the network are also mentioned in the Strategic Plan. Another aim is the completion of legislation for nuclear energy. Moreover, a project-supervision structure in mines need to be observed. In order to ensure that, the project audit is conducted in the most rational and result-oriented manner, so necessary legislative environment should be established (MENR Strategic Plan for 2015-2019).

According to MENR, Turkey's continuously increasing demand in energy is projected to be fulfilled with an $ 110 billion investment by 2023 which is the date for the Centennial Foundation of the Republic of Turkey also called 2023 Vision of Turkey. Turkey foresees the following objectives in the electricity market:

> Raising the total installed capacity to 120 GW, increasing the share of renewables to 30%, maximizing the use of hydropower, increasing the installed capacity based on wind power to 20 000 MW, 1 000 MW of geothermal and 5 000 MW of solar. extending transmission lines to 60 717 km, reaching a power distribution unit capacity of 158 460 MVA, extending the use of smart grids, increasing the natural gas storage capacity to more than 11 Bcm, commissioning nuclear power plants (two operational nuclear power plants, with a third under construction), increasing the coal-fired installed

capacity from the current level of 17.3 GW to 30 GW (Presidency of the Republic of Turkey Investment Office, n.d., p. 13).

According to Turkey's 11th Development Plan (2019) for 2019-2023 of Turkey prepared by the Presidency of Strategy and Budget, the main objective is "continuous, high quality, sustainable, safe and bearable costed energy supply" and as it can be seen from Table 2.10 "to satisfy the increasing needs of the country, the current capacity is expected to reach 120 GW by 2023 through further investments to be commissioned by the private sector". Moreover, the important topics about energy and natural gas in the 11th Development Plan can be summarized as follows which is translated by the author;

Table 2.10. Targets of energy sector in Turkey for 2023 in 11th Development Plan for 2019-2023

	2018	2023 estimates
Primary Energy Demand (thousand toe)	147 955	174 279
Electricity Energy Demand (TWh)	303.30	375.80
Primary Energy Consumption per capita (toe/person)	1.81	2.01
Electricity Energy Consumption per capita (kWh/person)	3 698	4 324
Share of Natural Gas in Electricity Generation (%)	29.85	20.70
Share of Renewals in Electricity Generation (%)	32.50	38.80
Electricity Generation from domestic resources (TWh)	150.00	219.50
Installed Electric Power Capacity (MW)	88 551	109 474

Source: 11th Development Plan (2019)

1) In order to meet the increasing demand in energy, a competitive investment environment will be developed and the continuity of an energy market that is financially strong, stable, transparent, predictable, consumer protected, and sustainability will be considered.

2) Rehabilitation of the publicly operated power plants will be completed.

3) Nuclear Power Plants (NGS) will be included in the electricity generation portfolio whereas efforts will be continued to increase the share of nuclear energy in electricity generation and institutional capacity will be strengthened.

4) The use of our lignite reserves in the production of electrical energy in accordance with environmental standards will be increased.

5) Natural gas supply security will be strengthened and access to natural gas will be increased.

6) Electricity generation from renewable energy sources will be increased and necessary planning and investments will be realized in order to ensure the safe integration of renewable energy production to the grid.

7) More efficient and self-energy generating buildings will be expanded.

8) Electricity networks and systems will be further empowered and made more flexible.

9) Cross-border trade opportunities will be improved by increasing international electricity interconnection capacity.

10) Activities will be carried out effectively to become an energy trade center by using the geostrategic position of Turkey, which is among the producer and consumer regions in energy, and to develop electricity and natural gas trading platforms within EXIST with new market products.

11) The operation of the energy infrastructure will continue in an effective and safe manner. (11th Development Plan, 2019).

Medium Term Programme for 2018-2020 of Turkey gives the energy objectives as follows; reducing dependency on imported energy stated as "exploration of oil, natural gas, shale gas and coal will be increased in order to ensure the increase in domestic reserves" (Medium Term Programme for 2018-2020).

Table 2.11. Shares of sources in Turkey's total primary energy supply between 1975 and 2017 (%)

Resource Type	Coal	Oil	Natural Gas	Hydroelectricity	Other
1975	21.5	51.7	0	1.9	24.9
1980	22.1	50.3	0.1	3.1	24.4
1985	21.4	46.0	0.2	2.6	29.8
1990	30.9	45.1	5.9	3.8	14.3
1995	27.2	46.0	9.9	4.8	12.1
2000	30.0	40.1	17.1	3.3	9.5
2005	26.4	35.2	27.3	3.7	7.4
2010	30.6	26.7	31.9	4.1	6.7
2017	27.2	30.5	30.5	3.4	8.4

Source: Türkiye Petrolleri (2018), Türkiye Petrolleri (2019), EMRA (2012)

According to the National Energy Balance of Turkey as seen in Table 2.11 in 2017, 33.6 Mtoe evaluated for the cycle and energy sector and 111.6 Mtoe evaluated for the total final energy consumption of 145.3 Mtoe primary energy supply. Natural gas ranked first in the total primary energy supply with approximately 30.5%, followed slightly by crude oil with 30.5% and coal with 27.2% in 2017. Moreover, according to the Investment Office of the Presidency of the Republic of Turkey (n.d.), primary energy supply of Turkey has increased from 78.4 Mtoe in 2002 to 155 Mtoe in 2018. Additionally, Turkey's consumption amounts of primary energy sources between 2008 and 2018 are given at Table 2.12 for a broad demand picture of each energy sources in Turkey and to be able to compare it with Europe and the World. Also, coal, oil and natural gas have the biggest shares in Turkey's primary energy consumption.

Table 2.12. Turkey's total primary energy consumption between 2008-2018 (Mtoe) by sources

Year	Coal	Oil	Natural Gas	Nuclear	Hydroelectricity	Renewables	Turkey Total	Europe Total	World Total
2008	29.6	33.1	30.4	-	7.5	0.3	100.8	2173.3	11705.1
2009	30.9	33.6	29.0	-	8.1	0.5	102.2	2048.4	11540.3
2010	31.4	32.8	30.8	-	11.7	0.9	107.6	2124.6	12099.9
2011	33.9	32.1	36.0	-	11.8	1.3	115.1	2077.7	12403.7
2012	36.5	33.8	37.2	-	13.1	1.7	122.3	2072.3	12575.5
2013	31.6	36.5	37.8	-	13.4	2.2	121.5	2054.7	12819.4
2014	36.1	37.2	40.1	-	9.2	2.7	125.4	1978.3	12939.8
2015	34.7	44.0	39.5	-	15.2	3.7	137.2	1996.8	13045.6
2016	38.5	47.4	38.3	-	15.2	5.2	144.6	2027.5	13228.6
2017	39.5	49.2	44.3	-	13.2	6.6	152.7	2050.0	13474.6
2018	42.3	48.6	40.7	-	13.5	8.5	153.5	2050.7	13.864.9
2018 (%)	1.1	1.0	1.2	0.0	1.4	1.5	1.1*	14.8*	100.0

Source: BP Statistical Review of World Energy 2018, BP Statistical Review of World Energy 2019 (Accessed on 10.06.2019) * share compared to the world

Primary energy consumption distribution according to the sectors in Turkey analyzed for 2017 can be seen from Table 2.13. According to the data, 24% of the demand comes from industry, 23% demand comes from conversion sector, 20% demand comes from transportation, 16% demand comes from households, 9% demand comes from trade and services sector.

Table 2.13. The primary energy consumption distribution according to the sectors in Turkey in 2017 (%)

	Industry	Transportation	Trade and Services	Conversion	Residence	Other	Total
2017	24	20	9	23	16	8	100

Source: Türkiye Petrolleri (2019)

It is realized that the ratio between primary energy demand and domestic production was 24.3% in 2017 so Turkey's dependence on foreign energy increased about 1.6% compared to 2016 and as seen from Table 2.14 it was executed as 75.7%. The import dependency ratio has increased significantly because of the incremental progress in natural gas consumption in the early 1990s. This ratio has followed a path of 70-76% from the beginning of the 2000s. Turkey's primary energy consumption between 2007-2016 (except

for 2008) was constantly rising however the ratio between consumption of oil, as well as natural gas, and the primary energy consumption stayed approximately at 60%. The share of oil and natural gas consumption in primary energy was recorded as 59% mostly due to the decrease in natural gas consumption in 2016.

Table 2.14. Turkey's dependence on foreign energy between 1990-2017 (%)

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
%	51.6	57.7	67.2	72.4	72.7	73.8	71.8	70.6	69.4	71.9	73.4	73.5	75.0	74.0	74.1	75.7

Source: Türkiye Petrolleri (2018), Türkiye Petrolleri (2019)

Table 2.15. Turkey's crude oil and natural gas production between 2008-2018

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Crude oil (barrel/day)	43 379	48 233	50 127	47 540	46 943	48 166	49 319	50 520	49 315	49 171	54 911
Natural Gas (Mcm/year)	1 015	729	726	793	664	562	502	399	382	354	428

Source: Jodidata

Approximately 20 million barrels of crude oil and 428 Mcm of natural gas are produced in 2018 in Turkey according to Table 2.15. Also, Turkey's natural gas and oil production is mainly made from onshore fields except production of natural gas in offshore fields of Akçakoca.

Because of low oil prices, the cost of oil and natural gas imports of Turkey and other countries have decreased. When oil prices began to fall in 2014, $ 43.6 billion current account deficit recorded in Turkey and following values of $ 32.1 billion and $ 32.6 billion respectively in 2015 and 2016 as oil prices remained low. In 2017, oil prices increased relatively compared to the previous two years and the country's current account deficit was recorded as $ 47.1 billion. In 2018, although it has shown some higher increase in oil prices compared to 2017, Turkey's current account deficit has declined by reaching the lowest level of the last nine years to $ 27.6 billion level due to currency effects (CBRT, 2019).

2.2.2.2 Turkey's Natural Gas Market

Turkey benefits natural gas from many different perspectives besides the political, geopolitical, and economic power. For example; natural gas is the cleanest and most

environmental source of energy among fossil fuels. And, these issues make it necessary for demanding and using natural gas more in Turkey.

In 2018, over 15 million people used natural gas in their homes, workplaces and in all aspects of their lives, contributing to a cleaner environment for future generations in Turkey. In 2018, the use of natural gas in households has prevented 7.25 million tonnes CO2 of air pollution and other gas emissions comparing to other hydrocarbons. The use of natural gas in residences in 2018 has reduced pollution by 235 kilograms of particles and 250 kilograms of NOx and SOx emissions. (GAZBİR, 2019; EMRA, 2019). When we consider another benefit of the natural gas market for Turkey, it creates job opportunities with the distribution companies' when total annual employment data investigated as of the end of 2018, 72 natural gas distribution companies employed 9,986 people by the end of December. As when we look at the gender distribution of employees, 1,502 women and 8,484 men are employed by the natural gas distribution sector. 31% of employees of the natural gas distribution sector are under the age of 30 and most employees are within the 30-40 age range with 40% share. 59% of the employees have tertiary education. In addition, at the end of 2018, 310 of employees have post graduate degrees, nine have PhD degrees (GAZBİR, 2019).

According to data retrieved from EMRA (2019), GAZBİR (2019) and Presidency of the Republic of Turkey Investment Office (n.d.), Turkey's natural gas market in 2018 can be summarized as following to get a brief understanding;

- Import: 50.4 Bcm
- Export: 0.7 Bcm
- Production: 0.4 Bcm
- Consumption: 49.3 Bcm
- Stocks: 3.2 Bcm
- Provinces Natural Gas Used: 81
- Number of Distribution Companies: 510
- Distribution Network Growth: 8%
- Investment of Distribution Companies: 1.7 billion TRY
- Number of Gas Subscribers: Over 15 million
- Population Having Access to Natural Gas: 66 million

- Population Actively Using Natural Gas: 50.6 million
- Turkey's rank in gas consumption in Europe: 4
- Number of Direct Employees: 8 803
- Number of Indirect Employees: 9 288

According to MENR (n.d.), Turkey gives core importance to exploration and production of domestic oil and natural gas, as well as being a transit and natural gas hub country in the region. Moreover, Middle East, Caspian region, Russia, Central Asia, EU countries are dependent to Turkey with its precious geostrategic location for oil and natural gas supply and transportation projects. However, Turkey is highly dependent on energy imports and this is a very important fact to emphasize in terms of energy security.

Table 2.16. Share of domestic production over total supply of natural gas in Turkey between 2004-2018

Year	Domestic Natural Gas Production (Bcm)	Natural Gas Import (Bcm)	Total Supply (Bcm)	Domestic Production Ratio (%)
2004	0.7	21.4	22.1	3.2
2005	0.9	26.0	26.9	3.3
2006	0.9	29.6	30.5	3.0
2007	0.9	35.2	36.1	2.5
2008	1.0	36.5	37.5	2.7
2009	0.7	35.0	35.7	2.0
2010	0.7	38.3	39.0	1.9
2011	0.8	43.9	44.7	1.8
2012	0.7	45.9	46.6	1.5
2013	0.5	45.3	45.8	1.2
2014	0.5	49.3	49.8	1.0
2015	0.4	48.4	48.8	0.8
2016	0.4	46.4	46.7	0.8
2017	0.4	55.1	55.5	0.6
2018	0.4	50.4	50.8	0.8

Source: EMRA (2018), EMRA (2019), Author

As seen from Table 2.16, share of domestic natural gas production over total supply in Turkey in 2018 increased compared to 2017 and stood at 0.8%. Turkey's domestic natural gas production reached a total of 354 Mcm in 2017 and 428 Mcm in 2018. Turkey's natural gas imports were 50.4 Bcm while total supply in market was approximately 50.8 Bcm in 2018. So, the dependence on natural gas imports in Turkey was 99.3% in 2017 and has been

slightly decreased to 99.2% in 2018 solely because of the weather conditions above the seasonal standards and decreasing demand for natural gas.

Table 2.17. Recoverable natural gas reserves remaining and company reserve shares of Turkey in 2018

	TPAO	Other Companies	Total
Reserve (Mcm)	1 946	1 854	3 800
Share (%)	51	49	100

Source: Türkiye Petrolleri (2019)

At Table 2.17, Turkey's natural gas reserves with TPAO and other companies' reserve shares in these reserves are shown. Hence, natural gas reserves of Turkey are 3800 Mcm in 2018. According to Turkish Petroleum, the remaining generation of natural gas reserves has a lifetime of about nine years in a condition that no new explorations are made which takin into account the current amount of production. For this reason, efficiency of the wells in domestic production is important however the studies carried out in the basin areas not sufficiently searched and especially in the marine areas of the Mediterranean and Black Sea have gained momentum in recent years. On the other hand, advance of unconventional oil and natural gas is restructuring the natural gas markets in the world is developing therefore Turkey can have likewise searches for those resources especially in Thrace Area and Southeast Anatolia Area.

Table 2.18. Turkey's natural gas import distribution by country share (%)

Year	Russia	Iran	Azerbaijan	Algeria (LNG)	Nigeria (LNG)	Other (spot LNG)
2008	62.0	11.0	12.3	11.1	2.7	0.9
2009	54.3	14.7	13.8	12.5	2.5	2.2
2010	46.2	20.4	11.9	10.3	3.1	8.1
2011	57.9	18.7	8.7	9.5	2.8	2.4
2012	57.7	17.9	7.3	8.9	2.9	5.4
2013	57.9	19.3	9.4	8.7	2.8	2.0
2014	54.8	18.1	12.3	8.5	2.9	3.4
2015	55.3	16.2	12.7	8.1	2.6	5.2
2016	52.9	16.6	14.0	9.2	2.6	4.6
2017	51.9	16.7	11.9	8.4	2.4	8.7
2018	47.0	15.6	15.0	9.0	3.3	10.2

Source: EMRA (2017), EMRA (2018), EMRA (2019)

According to Table 2.18 when Turkey's natural gas import share by countries investigated, Russia ranked first with 47% share in 2018 while in 2017 this ratio was 51.9%. In 2018, Iran ranked second with a share of 15.6% while Azerbaijan ranked third with a share of 15%. This is followed by Algeria (9%), Nigeria (3.3%) and the share of countries that spot LNG imported from was 15%.

Table 2.19. Amounts of total production and total consumption of natural gas in Turkey between 2002-2018 (Mcm)

Year	Total Production	Total Consumption
2002	378	17 065
2003	561	21 384
2004	707	22 505
2005	896	27 467
2006	907	31 128
2007	874	35 395
2008	969	36 865
2009	684	35 219
2010	682	37 411
2011	759	43 697
2012	632	45 242
2013	537	45 918
2014	479	48 717
2015	381	47 999
2016	367	46 480
2017	354	53 857
2018	428	49 329

Source: EMRA (2012), EMRA (2014), EMRA (2017), EMRA (2018), EMRA (2019), MENR (2017)

In Table 2.19, Turkey’s total production and total consumption of natural gas data are given between 2008 and 2018. According to the data for production, in 2017, 354 Mcm of natural gas was propounded for selling by ten producer companies that have active wholesale license and in 2018, 428 Mcm of natural gas was propounded for selling by 12 producer companies that have active wholesale license. The domestic production of natural gas in 2017 decreased by 3.58% compared to 2016 and in 2018 increased by 20.9% compared to 2017. According to the data for total national consumption, in 2017 53 857

Mcm of natural gas was consumed while it was estimated as 46 030 Mcm by the Board Decision No. 6884 (with a deviation of 15.87%) and in 2018 49 329 Mcm of natural gas was consumed while it was estimated as 54 524 Mcm by the Board Decision No. 6884 (with a deviation of -9.50%). The amount of consumption in 2017 increased by 15.87% compared to 2016 and in 2018 decreased by 8.41% compared to 2017.

Production

In 2018, the produced natural gas in Thrace, South East Anatolia and Western Black Sea regions was supplied to licensed CNG companies at well head, commercial and industrial enterprises near the production regions, distribution companies, import companies, and wholesale companies (EMRA2019).

The shares of wholesale licensed production companies can be seen from Table 2.20 that the majority of production was done by TPAO, Thrace Basin Natural Gas Corporation, Amity Oil in 2017 and TPAO, Thrace Basin Natural Gas Corporation, Marsa Turkey in 2018.

Table 2.20. Shares of wholesale licensed production companies in 2017 and 2018 in Turkey (%)

Company Name	2017	2018
Amity Oil (Headquarters: Australia)	2.34	0.53
Arar	-	0.01
Corporate Resources (Headquarters: India)	2.06	0.49
Foinavon Energy (Headquarters: Canada)	0.78	-
Marsa Turkey (Headquarters: Holland)	0.42	10.16
Park Place (Headquarters: Canada) (License was terminated on 20.09.2018)	1.70	0.08
Park Place Limited (Headquarters: Canada)	0.64	0.89
Petrogas (Headquarters: Ireland)	0.05	1.06
Thrace Basin (Headquarters: Holland)	19.31	12.30
TPAO	72.71	74.47
Transatlantic Exploration (Headquarters: Australia)	0.00	0.01

Source: EMRA (2018), EMRA (2019)

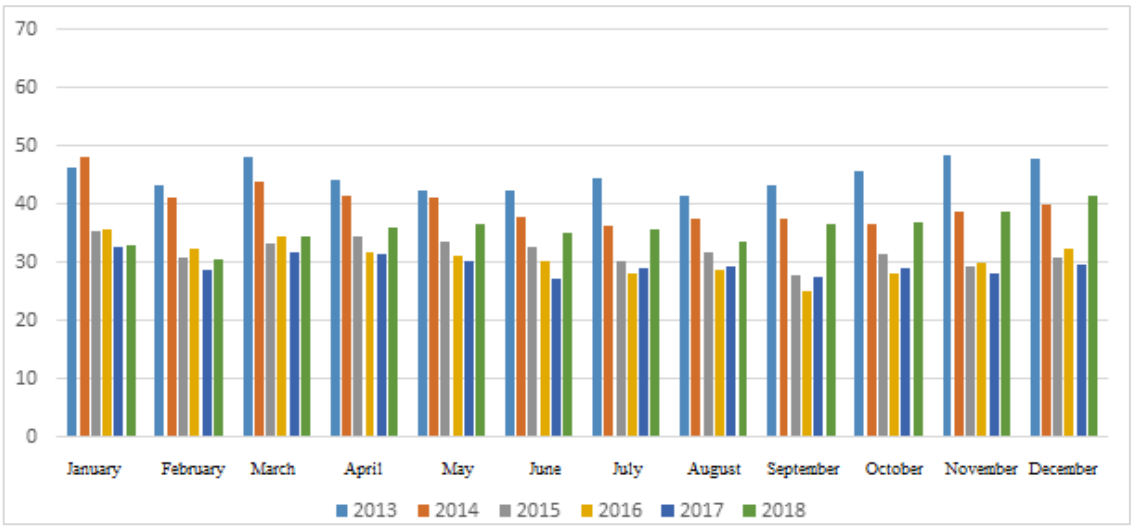


Figure 2.10. Monthly comparison of natural gas production between 2013-2018 in Turkey (Mcm). Source: EMRA (2019)

The monthly comparison of natural gas production between 2013 and 2018 is given at Figure 2.10. In 2017 and 2018, it can be seen that the amount of monthly production didn't change so much in throughout the year.

Table 2.21. Share of natural gas production in 2017 and 2018 by provinces in Turkey (%)

Province	2017	2018
Adana	3.67	0.41
Adıyaman	0.17	0.15
Çanakkale	0.42	10.16
Düzce	6.36	1.97
Edirne	0.00	0.02
Hatay	-	0.01
İstanbul	23.72	36.57
Kırklareli	14.83	9.52
Tekirdağ	50.84	41.19

Source: EMRA (2018), EMRA (2019)

Table 2.21 indicates that the greater part of natural gas production by provinces were Tekirdağ, İstanbul, Kırklareli in 2017 and Tekirdağ, İstanbul, Çanakkale in 2018.

Table 2.22. Consumer shares of natural gas sold by wholesale licensed production companies in 2017 and 2018 in Turkey (%)

Type	2017	2018
Distribution License	6.31	5.81
Final Consumer	59.68	60.68
Import License	18.84	26.55
Wholesale License	15.17	19.63

Source: EMRA (2018), EMRA (2019)

The consumer shares of natural gas sold by producer companies which have wholesale license in 2017 and 2018 are seen at Table 2.22. These companies sold 59.68% in 2017 and 60.68% of natural gas in 2018 to final consumers.

Consumption

The volumes and the sectoral shares of national natural gas consumption in 2016, 2017 and 2018 are given at Table 2.23. National natural gas consumption increased by 15.87% in 2017 and was down by 8.41% in the following year. This was mainly because of the increase of natural gas demand for power generation and household consumption in 2017; decrease of natural gas demand for power generation, and consumption in industry and household consumption in 2018. When the industrial consumption is broken down; in 2017 25.09% was residential consumption, 38.13% was power generation, 24.83% was industrial consumption. In 2018, the distribution was 25.75%, 36.89%, and 24.30%, respectively. These breakdowns include also other main sectors. The distribution of national natural gas consumption by provinces was 53 857 Mcm in 2017 and 49 329 Mcm in 2018. In 2017, sales distribution was as 49.71% sold directly by importer companies, 39.30% sold by distribution companies, 9.29% traded by wholesale companies, and 0.41% traded by CNG companies to final consumers. In 2018, it was such as 50.31% consumption was sold directly by importer companies, 44.23% was supplied by distribution companies, 5.02% was supplied by wholesale companies, and 0.43% was supplied by CNG companies to final consumers.

Table 2.23. Comparison of sectoral natural gas consumption of 2016, 2017 and 2018 in Turkey (Mcm)

Sector	2016	2017	2018	2016 Share (%)	2017 Share (%)	2018 Share (%)	Change (%) 2016 → 2017	Change (%) 2017 → 2018
1. Conversion Sector	16 736.28	20 536.52	18 197.51	36.06	38.13	36.89	22.71	-11.39
1.1. Power plants	12 509.80	19 367.08	15 644.87	27.09	35.96	31.72	54.82	-19.22
1.2. Auto producer power plants	3 490.31	351.13	1 025.19	7.52	0.65	2.08	-89.94	191.97
1.3. Combined heating and power (CHP) plants	33.21	72.67	46.13	0.07	0.13	0.09	118.81	-36.53
1.4. Auto producer heating and power plants	482.05	738.46	1 476.73	0.78	1.37	2.99	53.19	99.97
1.5. Heating plants	25.62	0.00	0.00	0.06	0.00	0.00	-100.00	0.00
1.6. Auto producer heating plants	195.22	7.09	2.30	0.54	0.01	0.00	-96.37	-67.53
1.7. Other Conversion Sector Consumers	0.07	0.1	2.30	0.00	0.00	0.00	56.24	2 198.35
2. Energy Sector	1 756.54	2 056.51	1 735.04	0.75	3.82	3.52	17.08	-15.63
2.1. Petroleum refineries	1 665.72	1 898.38	1 592.46	0.41	3.52	3.23	13.97	-16.11
2.2. Blast furnaces	0.03	0.03	0.01	0.00	0.00	0.00	7.56	-59.48
2.3. Consumed as fuel in Power, CHP and Heating Plants	5.28	5.23	0.59	0.01	0.01	0.00	-0.88	-88.66
2.4. Other Energy Sector Consumers	85.52	152.87	141.98	0.32	0.28	0.29	78.75	-7.13
3. Transportation Sector	456.05	529.42	430.50	0.86	0.98	0.87	16.09	-18.68
3.1. Vehicular fuel	82.37	83.62	92.32	0.17	0.16	0.19	1.53	10.40
3.2. Pipeline transportation	372.59	444.47	337.97	0.68	0.83	0.69	19.29	-23.96
3.3. Other Transportation Sector Consumers	1.09	1.32	0.21	0.00	0.00	0.00	21.85	-84.16
4. Industry Sector	12 600.34	13 372.13	11 987.95	30.38	24.83	24.30	6.13	-10.35
4.1. Woodworking	200.02	195.66	76.77	0.43	0.36	0.16	-2.18	-60.76
4.2. Alcohol and alcoholic products	19.92	19.87	20.57	0.04	0.04	0.04	-0.27	3.53
4.3. Nonmetallic minerals (glass, ceramics, cement, etc.)	1 718.02	1 775.34	1 354.69	3.70	3.30	2.75	3.34	-23.69
4.4. Iron and Steel	1 287.19	1 521.70	1 238.92	2.77	2.83	2.51	18.22	-18.58
4.5. Nonferrous metal mining and metalworking (chrome, copper, etc.)	586	446.95	259.14	1.26	0.83	0.53	-23.73	-42.02
4.6. Food and beverages	1 088.14	1 163.48	912.28	2.33	2.16	1.85	6.92	-21.59
4.7. Fertilizers	588.50	493.28	840.69	1.27	0.92	1.70	-16.18	70.43

Table 2.23 (continued). Comparison of sectoral natural gas consumption of 2016, 2017 and 2018 in Turkey (Mcm)

Sector	2016	2017	2018	2016 Share (%)	2017 Share (%)	2018 Share (%)	Change (%) 2016 → 2017	Change (%) 2017 → 2018
4.8. Construction (building products, road construction, etc.)	550.57	610.86	479.07	1.18	1.13	0.97	10.95	-21.57
4.9. Paper, cellulose and printing	275.26	246.47	214.02	0.59	0.46	0.43	-10.46	-13.16
4.10. Chemistry (including petro-chemistry)	961.45	1 035.49	1 083.60	5.25	1.92	2.20	7.70	4.65
4.11. Mining and quarrying	109.96	144.05	155.18	0.24	0.27	0.31	30.99	7.72
4.12. Machine industry	63.38	72.93	69.51	0.14	0.14	0.14	15.07	-4.68
4.13. Textiles, leather and clothing industry	788.66	799.74	691.94	1.70	1.48	1.40	1.40	-13.48
4.14. Tobacco and tobacco products	17.94	10.36	31.70	0.04	0.02	0.06	-42.23	206.01
4.15. Transportation vehicles industry (automotive, airplane industry, etc.)	165.39	156.13	102.73	0.35	0.29	0.21	-5.60	-34.21
4.16. Organized Industrial Sites	3 256.98	3 788.85	3 587.38	7.03	7.03	7.27	16.33	-5.32
4.17. Other Industrial Sector Consumers	922.96	890.99	869.74	2.07	1.65	1.76	-3.46	-2.38
5. Service Sector	3 123.33	3 725.76	4 043.15	6.68	6.92	8.20	19.29	8.52
5.1. Businesses	1 360.48	1 694.60	2 205.00	3.04	3.15	4.47	24.56	30.12
5.2. State offices	1 474.08	1 692.56	1 511.22	3.09	3.14	3.06	14.82	-10.71
5.3. Other Service Sector Consumers	288.76	338.6	326.93	0.55	0.63	0.66	17.26	-3.45
6. Other Sectors	11 804.14	13 632.78	12 931.81	25.27	25.31	26.22	15.49	-5.14
6.1. Household	11 701.25	13 514.94	12 701.85	25.05	25.09	25.75	15.50	-6.02
6.2. Agriculture-Forestry	17.87	20.39	18.54	0.04	0.04	0.04	14.09	-9.06
6.3. Stockbreeding (fisheries, poultry raising and cattle dealing	50.20	58.62	41.62	0.11	0.11	0.08	16.76	-29.00
6.4. Other	34.81	38.83	169.80	0.08	0.07	0.34	11.55	337.28
7. Losses	4.10	4.02	2.97	0.01	0.01	0.01	-2.06	-26.13
Total	46 480.78	53 857.14	49 328.93	100.00	100.00	100.00	15.87	-8.41

Source: EMRA (2017), EMRA (2018), EMRA (2019)

Furthermore, Turkey's natural gas consumption distribution by sector data in Table 2.23 proves that Turkey's natural consumption fails to generate the industrial added value despite its large cost on country budget. Around 1/3 of the natural gas has been consumed in power plants to generate electricity. Although it is unknown how much of this generated electricity is used in industrial productivity, problems of losses in electricity distribution system is a known problem with large cost impacts. Therefore, one might argue that Turkey's large usage of natural gas in electricity generation could have a multiplied impact on country's budget deficit.

It can also be depicted from the Table 2.23 that around quarter of natural gas is consumed in households either heating or daily purposes. This also suggests that quarter of the consumption is far from creating economic value, so this adds pressure on the industrial consumption and the final natural gas price dictated to the industry. BOTAŞ has recently lifted the subsidies on the final price for the individual consumers in order to soften the impact of this problem.

Lastly, we see that organized industrial areas has an important share in total consumption. However, this share is small compared to power generation and household usage, so tells us the structural problems in Turkey's natural gas consumption portfolio.

Table 2.24. Effects of monthly sectoral consumption distribution in Turkey (Mcm)

Subject	2017	2018
Month - Minimum consumption	June - 3 043.93	June - 2 696.34
Month - Maximum consumption	January - 6 485.44	January - 6 237.48
Monthly Average consumption	4 488.09	4 110.74
Months Above average	January, February, March, November, December	January, February, March, November, December

Source: EMRA (2018), EMRA (2019)

The distribution of monthly sectoral consumption effects of natural gas on total consumption can be seen from Table 2.24. In 2017, maximum monthly consumption was occurred in January as 6 485.44 Mcm. Minimum monthly consumption occurred in June as 3 043.93 Mcm. In 2018, peak monthly consumption was in January with 6 237.48 Mcm and base monthly consumption was in June with 2 696.34 Mcm. 2017 monthly average consumption was 4 488.09 Mcm. In 2017, January, February, March, November and December consumption levels were above the annual average. In the following year,

monthly average consumption was 4 110.74 Mcm whereas the natural gas consumption in January, February, March, November and December were above the year's average.

Storage

Storage activity is defined as storing natural gas or LNG to meet the demand fluctuations and the shortfall arising from decreasing or disruption of the supply according to the NGM Law. Storage license applicants must have technical and economical competency, ability to ensure coordinated and secure storage system operations. According to 2015-2019 Strategic Plan, the natural gas storage capacity is planned to increase to 5.4 Bcm by 2023 to meet minimum 10% of the annual gas consumption by 2019 and even up to 20% in the long-term (MENR Strategic Plan for 2015-2019).

As a part of LNG infrastructure, an expansion in underground storage and LNG liquification capacities have been seen following the investments in storage capacity of natural gas market. In parallel, there is a noteworthy increase in storage volumes by years. In 2017, remarkably the natural gas storage capacity and stored volume increased rapidly compared to 2016; with the start in operations of Etki LNG facility in 2016 and BOTAŞ Tuz Gölü's underground natural gas storage facility in 2017.

In 2017, licensed capacity of underground storage was 3.191 Bcm increased by 19.9% and capacity of LNG storage was 0.943 Bcm increased by 76.3% compared to 2016 while in 2018, total capacity of underground natural gas storage facilities was 3.391 Bcm increased by 19.9% and the capacity of LNG storage was 0.943 Bcm increased by 6.27% compared to 2017. Table 2.25 shows existing storage facilities' end of month and yearly average natural gas total storage volumes in 2011-2018 by converting stored volume of LNG terminals to Mcm.

Table 2.25. End of month and yearly average natural gas total stock amounts between 2011-2018 in Turkey (Mcm)

Date	2011	2012	2013	2014	2015	2016	2017	2018
January	1 640.47	862.62	1 439.00	1 137.03	1 324.09	1 708.55	1 183.18	2 742.08
February	1 155.12	320.47	1 356.08	771.25	1 019.49	1 274.3	919.16	2 777.72
March	950.51	336.18	1 128.64	760.34	599.13	884.75	976.92	2 888.64
April	1 042.20	653.97	1 217.72	1 197.15	249.76	1 191.85	1 205.73	3 021.92
May	1 451.92	1 173.39	1 824.32	1 586.83	644.68	1 485.92	1 611.42	3 094.31
June	1 849.10	1 551.44	1 901.1	1 796.99	927.09	1 787.8	2 142.49	3 243.02
July	1 857.11	1 780.45	1 991.8	2 023.92	1 306.61	2 125.45	2 533.83	3 190.54
August	1 923.99	2 000.68	2 211.89	2 383.78	1 597.04	2 484.97	2 884.04	3 245.63
September	1 860.55	2 381.40	2 477.99	2 611.47	2 181.86	2 773.51	3 144.58	3 274.47
October	1 825.61	2 436.64	2 477.33	2 566.16	2 377.36	2 820.56	3 194.05	3 359.33
November	1 617.27	2 513.48	2 085.64	2 346.69	2 661.03	2 285.98	2 906.36	3 362.98
December*	1 295.12	1 979.97	1 493.41	1 873.08	2 126.76	1 695.34	2 948.37	3 167.23
Yearly Average**	1 539.08	1 499.22	1 800.41	1 754.56	1 417.91	1 876.58	2 137.51	3 113.99

Source: EMRA (2014), EMRA (2017), EMRA (2018), EMRA (2019)

*This value is also the end of year value. **Generated by the author.

Table 2.25 shows that storage volumes of the facilities are higher in 2018. Until 2018, stocks start to increase by early May and start to decrease rapidly by the end of November. As also seen from Table 2.25, the import volumes stay similar during summer months while the injection starts in May and this causes the stored volume levels to increase with the decline in consumption. Moreover, although the import level is expected to increase during winter periods, heavy consumption causes the injection levels to decrease.

Underground Gas Storage

BOTAŞ Tuz Gölü Underground Gas Storage Facility came into operation in 2017, as Turkey's second storage facility. Same year, 15 import licenses holding and eight wholesale licenses holding importers started to use BOTAŞ Silivri Underground Gas Storage Facility to reach the total number to 23 from eight. However, only one importer used the storage facility in 2017. The number of importers that used BOTAŞ Silivri Underground Gas Storage Facility decreased by 10 in 2018 compared to 23 in 2017. Among 13 users in whole year, 10 of these suppliers were import license holders and three were wholesale

license holders. BOTAŞ Tuz Gölü Underground Gas Storage Facility offered storage service to only one import license holder in 2018.

LNG Storage

Despite the BOTAŞ Dörtyol FSRU facility was not effective in practice, the stored amount of LNG in tanks increased due to the increase in total LNG trade and the technical problems in Etki Liman FSRU facility. In 2017, BOTAŞ Dörtyol LNG FSRU, ETKİ Liman LNG plant became operational as of the end of 2016, and the increase in LNG imports caused a large increase in LNG storage volumes. In 2017 and 2018, the natural gas volumes sent to the transmission network by gasification with LNG volumes transported via road tankers by LNG storage license companies are shown on Table 2.26.

Table 2.26. Turkey's delivered natural gas amounts from LNG terminals in 2017 and 2018 (Mcm)

Type	2017	2018
Sent to Transmission Network	9 816.28	10 529.03
Delivered to Road Tankers	653.51	604.65
Total	10 469.79	11 133.68

Source: EMRA (2018), EMRA (2019)

International Trade

Table 2.27. Total imported and total exported natural gas amounts between 2008-2018 in Turkey (Mcm)

Year	Import	Export
2008	37 350	435.8
2009	35 856	708.5
2010	38 036	648.6
2011	43 874	714
2012	45 922	611
2013	45 269	682
2014	49 262	632.6
2015	48 427	623.94
2016	46 352	674.68
2017	55 250	630.67
2018	50 361	673.28

Source: EMRA (2017), EMRA (2018), EMRA (2019)

Natural gas production is a matter based on Turkish Petroleum Law provisions even though it is not considered as a natural gas market activity. Turkey's imported and exported

natural gas amount data between 2008 and 2018 are given in Table 2.27. In conformity with the data, the natural gas imports were 55 250 Mcm and natural gas exports were 630.67 Mcm in 2017; the natural gas imports were 50 361 Mcm and the natural gas exports were 673.28 Mcm in 2018. The changes in natural gas trade volumes were 19.20% increase in imports and 6.52% decrease in exports in 2017 compared to 2016; 8.85% decrease in imports and 6.76% increase in exports in 2018 compared to 2017.

Import

According to the NGM Law the natural gas import by LNG form or gas form for supplying to eligible consumers, wholesale companies, exporter companies or import license holders who directly export. Each import license grants the license holder for various import connection and a separate license should be secured for every additional connection. The total import share of any import licensed companies can't exceed 20% of the estimated domestic consumption in each calendar year drafted by EMRA in January of every year. EMRA has the authority to enforce the legal obligations on the importers to store natural gas in national storage within the first five years of their license term. If there is adequate underground natural gas storage capacity available, EMRA also has the power to increase storage obligations up to 20% of the imported natural gas for all importers.

Table 2.28. Turkey's total imported natural gas amounts by source country between 2002-2018 (Mcm)

Year	Algeria (long-term LNG)	Azerbaijan	Iran	Nigeria (long-term LNG)	Russia	Spot LNG Imported Countries
2002	3 722	-	660	1 139	11 574	-
2003	3 795	-	3 461	1 107	12 460	-
2004	3 182	-	3 498	1 016	14 102	-
2005	3 786	-	4 248	1 013	17 524	-
2006	4 132	-	5 594	1 100	19 316	79
2007	4 205	1 258	6 054	1 396	22 762	167
2008	4 148	4 580	4 113	1 017	23 159	333
2009	4 487	4 960	5 252	903	19 473	781
2010	3 906	4 521	7 765	1 189	17 576	3 079
2011	4 156	3 806	8 190	1 248	25 406	1 069
2012	4 076	3 354	8 215	1 322	26 491	2 464
2013	3 917	4 245	8 730	1 274	26 212	892
2014	4 179	6 074	8 932	1 414	26 975	1 689
2015	3 916	6 169	7 826	1 240	26 783	2 493
2016	4.284	6.48	7 705	1.22	24 540	2 124
2017	4 617	6 544	9 251	1 344	28 690	4 804
2018	4 521	7 527	7 863	1 668	23 642	5 140

Source: EMRA (2014), EMRA (2017), EMRA (2018), EMRA (2019), MENR (2017)

The volume of natural gas imports in accordance with the source countries between 2008 and 2018 is given at Table 2.28. According to the Table 2.18 and Table 2.28, the most of natural gas imports in 2017 were via Russia with a share of 51.93% and in 2018 were again via Russia with a share of 46.95% throughout pipeline. Therefore, one can state that Turkey's natural gas imports are solely depending on the Russian natural gas with pipelines.

Table 2.29. Types of natural gas imported by companies (Mcm) and shares (%) between 2013-2018 in Turkey

Gas Type	Pipeline Gas		LNG	
Year	Amount (Mcm)	Share (%)	Amount (Mcm)	Share (%)
2013	39 419.44	87.08	5 849.54	12.92
2014	41 981.41	85.22	7 280.87	14.78
2015	40 778.11	84.21	7 648.96	15.79
2016	38 724.48	83.54	7 627.68	16.46
2017	44 484.67	80.52	10 765.28	19.48
2018	39 032.13	77.51	11 328.45	22.49

Source: EMRA (2018), EMRA (2019)

The import volumes and shares of companies between 2013 and 2018 are given in Table 2.29. In 2017, total of 10 765.28 Mcm of long-term contracted and spot LNG was imported as 19.48% of the total imports. 11 328.45 Mcm of long-term contracted and spot LNG was imported in 2018. This indicates 22.49% of total imports in that year. LNG spot imports consisted of 37.79% of total imports. and rest of the LNG imports were from long-term contracts with Algeria and Nigeria in 2017. In 2018, share of spot LNG was 45.37%, while the rest was long-term contracted LNG from Algeria and Nigeria. Share of LNG compared to total imports increased in 2017 while the amount of imported natural gas also increased in the same year. Pipeline gas imports increased two years consecutive in 2017 and 2018, compared to 2016 levels.

Table 2.30. Imported natural gas amounts by the companies in 2017 and 2018 in Turkey (Mcm)

Importer	2017	2018
Akfel Gaz Sanayi ve Ticaret Anonim Şirketi	2 082.35	1 697.55
Avrasya Gaz Anonim Şirketi	491.24	262.39
Batı Hattı Doğalgaz Ticaret Anonim Şirketi	962.07	910.39
Boru Hatları ile Petrol Taşıma A.Ş.	45 584.37	42 631.93
Bosphorus Gaz Corporation Anonim Şirketi	2 081.99	1 551.15
Ege Gaz Anonim Şirketi	517.14	380.12
Enerco Enerji Sanayi ve Ticaret Anonim Şirketi	2 325.01	1 922.88
Kibar Enerji Anonim Şirketi	961.79	820.33
Shell Enerji Anonim Şirketi	244.00	183.84

Source: EMRA (2018), EMRA (2019)

The amount of natural gas imports by companies and their shares in 2017 and 2018 are shown in Table 2.30. The major importer company was BOTAŞ in both 2017 and 2018. BOTAŞ imported 82.51% of the total amount (pipeline gas and LNG totally) in 2017 and 84.65% of the total amount (pipeline gas and LNG totally) in 2018.

Table 2.31. Comparison of Turkey's imported amount of natural gas via entry points in 2017 and 2018 (Mcm)

Entry Points	Amount of Imported Natural Gas	
	2017	2018
Dörtyol FSRU Terminal	109.44	157.05
Durusu Entry Point	15 584.85	12 972.39
Egegaz Aliağa LNG Terminal	4 235.28	4 097.12
Etki LNG Terminal	2 744.23	2 556.37
Gürbulak Entry Point	9 250.64	7 862.88
Malkoçlar Entry Point	13 104.78	10 669.65
Marmara Ereğlisi LNG Terminal	3 676.33	4 517.91
TANAP Seyitgazi Entry Point	-	956.33
Türkgözü Entry Point	6 544.40	6 570.88

Source: EMRA (2018), EMRA (2019)

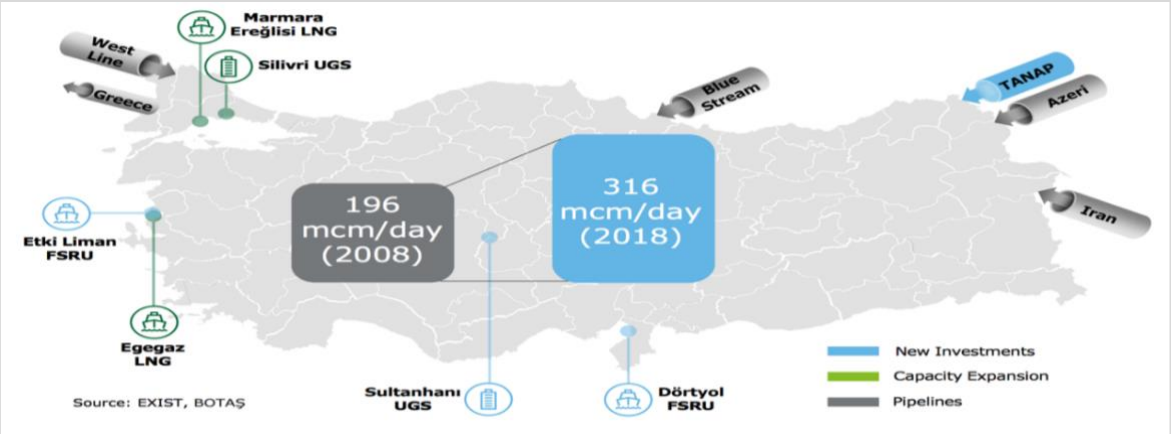


Figure 2.11. Natural gas entry points of Turkey. Source: Deloitte Türkiye (2018, p. 5)

Imported natural gas volumes according to entry points in 2017 and 2018 are shown at Table 2.31 and Figure 2.11. As it is given, the entry points of Russian natural gas [Durusu (28.21% and 25.76%) and Malkoçlar (23.72% and 21.19%)] took the first two place with highest shares that it also can be seen from Table 2.32.

Table 2.32. Share of Turkey's natural gas import by long-term licensed companies by source countries in 2017 and 2018 (%)

Country	2017	2018
Algeria	9.15	10.00
Azerbaijan	12.97	16.65
Iran	18.34	17.39
Nigeria	2.66	3.69
Russia	56.87	52.28

Source: EMRA (2018), EMRA (2019)

According to EMRA (2018) and EMRA (2019), while 91.30% of total natural gas imports in 2017 consist of long-term import contracts (44 484.66 Mcm pipeline, 5 961.08 Mcm long-term LNG), 8.70% was spot LNG (4 804.20 Mcm) and while 89.79% of total natural gas imports in 2018 consist of long-term import contracts (39 032.13 Mcm pipeline, 6 188.47 Mcm long-term LNG), 10.21% was spot LNG (5 139.98 Mcm). The long-term import license holders imported natural gas mostly from Russia and Iran both in 2017 and 2018. In 2017, 77.45% of imported LNG from Algeria and 22.55% from Nigeria consists of long-term contracts and in 2018, 73.05% of imported LNG from Algeria and 26.95% from Nigeria consists of long-term contracts.

Table 2.33. Share of Turkey's imported spot LNG by countries in 2017 and 2018 (%)

Country	2017	2018
Algeria	-	1.53
Angola	-	1.89
Egypt	-	3.94
England	1.94	-
Equatorial Guinea	5.96	1.65
France	-	3.42
Netherlands	1.80	-
Nigeria	15.31	9.32
Norway	17.77	1.72
Qatar	32.51	57.99
Spain	-	1.81
Trinidad and Tobago	8.73	8.09
USA	15.98	8.64

Source: EMRA (2018), EMRA (2019)

The ratio between imported Spot LNG and imported total natural gas in 2017 was 8.7% and in 2018 was 10.2%. According to Table 2.33, Turkey imported spot LNG via eight

countries that from Qatar in the first place with a share of 32.51% and Norway following with a share of 17.77% in 2017 and again via eight countries that in the first place with a share of 57.99%, from Qatar and following Nigeria with a share of 9.31% and the US with a share of 8.64% in 2018. Spot LNG was imported in 11 months of 2017 except May and 11 months of 2018 except September. 43 companies were holding spot LNG import license in 2017. Moreover, just BOTAŞ and EGEGAZ imported spot LNG while 13 of the importer companies sold natural gas supplied from domestic wholesale market. The remaining 28 companies had no operation within the scope of their licenses that year. In 2018, 47 companies were holding spot LNG import licenses. Again, just BOTAŞ and EGEGAZ imported spot LNG while 10 out of them sold gas supplied from domestic wholesale market. The other 35 companies had no operation within the scope of their licenses in 2018. Shares of spot LNG imported are shown in Table 2.34.

Table 2.34. Share of spot LNG importers between 2008-2018 in Turkey (%)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
EGE GAZ	-	8.46	37.66	13.83	2.80	24.62	5.36	10.79	11.89	10.76	5.10
BOTAŞ	100.00	91.53	62.33	86.17	97.20	75.38	94.64	89.21	88.60	89.60	94.90

Source: EMRA (2018), EMRA (2019)

Export

In Turkey, purchasing natural gas via production companies, import or wholesale and exporting natural gas are carried out by the import license holders in accordance with the terms of licenses. Domestically produced or imported natural gas can be exported by export license holders to countries which are permitted within their licenses.

Table 2.35. Export of BOTAŞ's natural gas in 2017 and 2018

Year	Country	Amount (Mcm)	Change to previous year (%)
2017	Greece	630.67	-6.52 %
2018	Greece	673.28	-6.76 %

Source: EMRA (2018), EMRA (2019)

As it can be seen from Table 2.35; in 2017, just BOTAŞ was functioning among licensed eight exporter companies. In 2017, 630.67 Mcm of natural gas was exported by BOTAŞ to Greece and volume of exported natural gas declined by 6.52% compared to 2016.

In 2018, again just BOTAŞ was functioning among licensed eight exporting companies and 673.28 Mcm of natural gas was exported by BOTAŞ to Greece. It can be seen that the exported amount of natural gas in 2018 declined by 6.76% compared to 2017.

2.2.3 Turkey's Natural Gas Pipelines and Pipeline Projects

Turkey, with its geostrategic position, both by playing a leading role in the regional oil and gas projects in ensuring the national security of supply as well as also has a great potential to contribute to regional supply stability, especially in Europe. In this context, the current and planned pipeline project names and characteristics are listed in Table 2.36 and illustrated in Figure 2.12 which are the projects for Turkey to become a reliable, stable and economic energy hub between the rich hydrocarbon resources of the Central Asia, Caspian Area, Middle East and leading demand from Europe. Information on these projects can be outlined as following according to MENR (n.d.).

Table 2.36. Turkey's natural gas pipelines and pipeline projects

Name of the Project	Russian – Turkey Natural Gas Pipeline (West Line)	Blue Stream Gas Pipeline	Eastern Anatolian Natural Gas Main Transmission Pipeline (Iran - Turkey)	Baku – Tbilisi – Erzurum Natural Gas Pipeline (BTE)	Turkey – Greece Natural Gas Interconnection	Trans – Anatolia Natural Gas Pipeline Project (TANAP)	Turk Stream Gas Pipeline
Construction Start Date	1986	2001	1996	2004	2005	2015	2017
Gas Flow Start Date	1988	2003	2001	2007	2007	2018	2020
Length	845 km	1 213 km	1 491 km	980 km	296 km	1 841 km	1 090 km
Source Country	Russia	Russia	Iran	Azerbaijan	Azerbaijan	Azerbaijan	Russia
Entry point	Kırklareli	Samsun	Ağrı	Kars	Bursa	Erzurum	Kırklareli

Source: MENR (n.d.), EIA (2017), Deloitte Türkiye (2016), BOTAŞ (n.d.)



Figure 2.12. Actual and prospective oil and gas pipeline projects of Turkey. Source: Presidency of the Republic of Turkey Investment Office (p. 36)

2.2.3.1 Russia - Turkey Natural Gas Pipeline (West Line)

The potential of natural gas consumption and practicable transportation routes are figured out in 1985 after the intergovernmental agreement between Turkey and the former USSR. The West Line or Russia-Turkey Natural Gas Pipeline is about 845 km long. The route of the pipeline is throughout Hamitabat, Ambarlı, İstanbul, İzmit, Bursa, Eskişehir and Ankara. The entering point of this pipeline to Turkey is Malkoçlar which is located on the Bulgarian border. Partially 4 Bcm by BOTAŞ and 10 Bcm by private sector so in a total of 14 Bcm of natural gas is being imported annually to Turkey by the West Line Natural Gas Pipeline.

2.2.3.2 Blue Stream Gas Pipeline

The natural gas transportation from Russia throughout a transit line to Turkey below the Black Sea via Blue Stream Natural Gas Pipeline that is 1 213 km long in total with three pipelines which are on the Russian territory; in the Black Sea pass, between Djubga and Samsun; in the territory of Turkey between Samsun and Ankara. The route of the Blue Stream Natural Gas Pipeline in Turkey borders is through Samsun, Amasya, Çorum, Kırıkkale and Ankara.

2.2.3.3 Eastern Anatolian Natural Gas Main Transmission Line (Iran - Turkey)

With the Eastern Anatolian Natural Gas Main Transmission Line or Iran-Turkey Natural Gas Pipeline project, transportation of the eastern natural gas resources, particularly Iran's, to Turkey by natural gas pipeline is approximately 1 491 km with a diameter of ranging between 48" and 16". Annually, 9.6 Bcm in plateau period of natural gas is being imported to Turkey. The rout of the Eastern Anatolian Natural Gas Main Transmission Line is Doğubayazıt, Erzurum, Sivas, Kayseri to Ankara and to Seydişehir, Konya with a division in Kayseri.

2.2.3.4 Baku - Tbilisi – Erzurum Natural Gas Pipeline (BTE)

The Baku-Tbilisi-Erzurum Natural (BTE) Gas Pipeline is approximately 980 km long with maximum capacity of 20 Bcm and 42" in diameter constructed for the

transportation of the natural gas from Azerbaijan to Turkey. This pipeline is developed from the Shah Deniz field. Annually 6.6 Bcm of natural gas is imported to Turkey by BTE. The first natural gas transportation to TANAP is started at the end of June 2018 by the extension project of the BTE which is South Caucasus Natural Gas Pipeline.

2.2.3.5 Turkey - Greece Natural Gas Interconnection (ITG)

The Turkey-Greece Natural Gas Interconnection (ITG) is approximately 296 km long and has a maximum capacity of 11 Bcm per year of natural gas is supplied to Greece through or from Turkey. An Intergovernmental Agreement has been made between Turkey, Greece and Italy on 2007 proposing ITG to extend to Italy from Greece but no progression in natural gas transportation via this extension is realized yet.

2.2.3.6 Trans - Anatolia Natural Gas Pipeline Project (TANAP)

An agreement was signed on 24.12.2011 between Turkey and Azerbaijan to transfer 6 Bcm Azerbaijani natural gas to Turkey and the first gas supply to Turkey started at the end of June 2018. 10 Bcm of Azerbaijani natural gas will be exported annually to Europe through Turkey via a newly constructed pipeline. This pipeline agreement signed on 26.06.2012 annex to the Intergovernmental Agreement made before that the first gas supply to Europe planned to start in 2020. For these reasons, assessment of final investment of the Shah Deniz Phase II development, SCPXP, TAP and TANAP were agreed in December 2013 where Turkey takes an important part in the supply chain of natural gas from the origin to the end-user. Within the TANAP Project, it is intended to extend the Greece border from Georgia via 1,841 km long pipeline along with 16 Bcm initial capacity and 32 Bcm maximum capacity annually. Within the scope of the engineering, construction and procurement works of the project, maximum effort was made to have contribution to the project by Turkish contractors and suppliers, and 80% of the line pipes were supplied from Turkish manufacturers, while Turkish companies were also involved in construction activities. TANAP Project passes through 20 provinces, 67 districts, 600 villages and for this reason it is called as a new silk road.

2.2.3.7 TurkStream Gas Pipeline Project

TurkStream Gas Pipeline Project is a 31.50-Bcm-annual-capacity project to supply Russian natural gas to Turkey and, as well as, to Europe through Turkey. Project consists of a twin pipeline system with 15.75 Bcm capacity each, passing Black Sea to reach Turkey from Russian territory. One line is designed to supply Turkey and other line is planned to supply European market. According to the agreement signed on 10.10.2016, West Line gas commitment of 14 Bcm will be supplied solely by TurkStream without any changes in the terms or conditions of the existing contract. Both pipelines are planned to be operational at the end of 2019 and the project ensures that the Russian natural gas coming to Turkey will not be subject to any third country disruption which is crucial for Turkey's natural gas supply security.

2.2.4 Other Important Subjects About Turkey's Natural Gas Market Structure

Although long-term natural gas contracts and negotiated and finalized by governments and state companies, it is still important to understand the structure of Turkish natural gas market to have a better understanding on its availability for a successful and working commercial system for all actors. The last, but not the least, it is important to provide information on Turkey's natural gas distribution system, applied tariffs on commercialized gas and transmission structure. In this section of the thesis the following topics are examined in order to have more information about Turkey's natural gas market and to understand the structure in deep. Moreover, this section is designed to enhance the clarity for Turkey's domestic market condition and capacity and how the structure works with existing tariffs.

2.2.4.1 Market Access

EMRA has the sole authority to reward licenses and certificates for the legal entities that can perform free commercial activities in the natural gas market according to the NGM Law. Turkish Competition Authority might perform antitrust investigation to any of market participants of the Turkish natural gas market in connection with their statutory activities relying on the Natural Gas Market Study (Turkish Competition Authority, 2012).

2.2.4.2 Market Restrictions

According to the NGM Law, restrictions in the market can be summarized as: NMG Law has limitations in the market for natural gas market license holders. License holders should not cause any burden, loan or promise on transmission, distribution and storage facilities without authorization of EMRA. Only production companies obligated to Turkish Petroleum Law can sell more than 20% of predicted yearly national gas consumption determined by EMRA. Any legal participant of natural gas market can take part in only one field of business other than its own field of business; license holders may not be not allowed to participate any business activities outside the natural gas market, other than business activities stated in their relevant licenses as businesses done formerly without permission of EMRA. If license holders obtain a separate license for different market activity and facility, they can involve in more than one business field. On the other hand, if license holders are engaged in natural gas wholesale activity, they cannot conduct transmission or distribution activities and cannot collaborate with businesses engaged in those businesses. If license holder has several natural gas licenses for different natural gas market activities and has several facilities to carry out same activities, the license holder should keep separate financial records. Also, financing those businesses between among each other is forbidden.

2.2.4.3 Share Transfer Restrictions

According to the NGM Law, license share transfer is possible for license holder companies that is limited under the permission of EMRA except for storage license holders. In case a license holder would like to transfer 10% of, which 5% or more is for publicly offered companies, to an individual or company, would result the individual and company to have at most 10% for the license holder company. EMRA's approval is also required for direct or indirect transfers of 10% which of 5% for publicly offered companies of the license holder's share capital. EMRA's approval is also required for the take-over of natural gas market license holders, issuance of privileged shares and insurance of right of usufruct certificates.

2.2.4.4 Licensing

Basis and the process for any license to be given to legal bodies to engage commercial activities in the natural gas market are set in the NGM Law's License Regulation. The

regulation dictates the guidelines applicable to "issuance, cancellation, termination, renewal and amendment of licenses" as well as "the rights and obligations of the license holders". Any legal body willing to enter in commercial activities must obtain a license from EMRA for the related activity. EMRA issues licenses for import, export, wholesale, storage, distribution and transmission activities. The number of the licenses in natural gas market of Turkey by the types of licenses for 2016, 2017 and 2018 are given at Table 2.37.

Table 2.37. The distribution of the number of the licenses in natural gas market by the types of licenses for 2016, 2017 and 2018

License Type	2016		2017		2018	
	License	Active License	License	Active License	License	Active License
Long Term Import	17	13	17	13	18	15
Spot LNG Import	42	13	43	13	47	14
Pipeline Transmission	1	1	1	1	1	1
LNG Transmission	16	9	16	9	16	9
LNG Storage	3	3	4	3	4	4
Underground Storage	5	1	5	2	5	2
Wholesale	37	21	38	23	45	22
Wholesale Producer	10	10	11	10	14	12
CNG Transmission and Distribution	40	23	39	25	41	26
CNG Sale	62	43	42	32	43	35
Auto CNG	-	-	15	14	17	15
Export	8	1	8	1	11	1
Distribution	68	68	72	69	72	72
Total	309	206	311	215	334	228

Source: EMRA (2017), EMRA (2018), EMRA (2019)

2.2.4.5 Certification

Any construction work and services in natural gas market is subject to certificates. Principles and procedures of such certificates are dictated by The Natural Gas Market Certificate Regulation. Internal installations and service line certificates might be given by public or private entities authorized by EMRA and local distribution companies.

2.2.4.6 Tariffs

According to the NGM Law, basis and processes of "preparation, review, evaluation, determination, approval, announcement and revision of tariffs applicable to natural gas market activities" depends on the approval of EMRA. EMRA's any decision on tariffs terms

and conditions are binding for any legal entities or individuals and these cover the essentials and processes of market activities.

Table 2.38 shows the 2017 and 2018 average unit prices for distribution and supply companies selling to the household and industrial users. When we look at the breakdown of these average unit prices, we see that the order of share in price is Natural Gas Cost, System Usage Cost, VAT, SCT.

Table 2.38. Average unit prices of natural gas sold by distribution and supplier companies to household and industrial consumers in 2017 and 2018 (TL/m^3)

Year	Period	Type	Natural Gas Cost	System Usage Cost	VAT	SCT	Total
2017	First Half	Household	0.7636	0.1468	0.023	0.1680	1.1014
		Industry	0.7041	0.0782	0.023	0.1450	0.9503
	Second Half	Household	0.7636	0.1566	0.023	0.1698	1.1130
		Industry	0.7041	0.0841	0.023	0.1460	0.9573
2018	First Half	Household	0.7636	0.1902	0.023	0.17582	1.15262
		Industry	0.8388	0.1154	0.023	0.17590	1.15310
	Second Half	Household	0.9116	0.2207	0.023	0.20795	1.36325
		Industry	1.1788	0.1362	0.023	0.24084	1.57884

Source: EMRA (2018), EMRA (2019)

2.2.4.7 Wholesale

According to the NGM Law; wholesale companies can receive natural gas from importer companies, production companies, or alternatively importer wholesale companies and sell their supplies to importers, exporters, CNG companies, distributors and alternative wholesaler companies in Turkey.

The agents in the natural gas market should equalize the amount of natural gas entering the transmission system of natural gas with the ejected from the system. If a producer or seller leads to a natural gas shortage in the system, the system operator gives a punishment which is paying an imbalance fee. In addition, as of 01.09.2018, EXIST launched the natural gas trade as a forward-looking approach for the transparency and development of the natural gas market with the establishment of the Organized Wholesale Natural Gas Market (OTSP). (MENR, 2018).

According to Table 2.39, in 2017, BOTAŞ supplied 80.39% of the total natural gas. Moreover, 17.38% was supplied by other import licensed companies and 0.64% was supplied by producer wholesale companies. BOTAŞ supplied 84.12% the total natural gas in the following year. Same year, 15.25% of total supply was met by other import licensed companies and 0.63% was met by companies which are producer wholesalers in 2018.

Table 2.39. Share of import and production companies in natural gas supply in 2017 and 2018 (%)

Company	2017	2018
BOTAŞ	80.39	84.12
Producer Wholesale Companies	0.64	0.63
Other Importers	17.38	15.25

Source: EMRA (2018), EMRA (2019)

The liberal market structure envisaged in the NGM Law is based on the establishment of competition in the area of wholesale transactions with competitive undercurrents, therefore it is essential that the number of market player in the natural gas market should increase on wholesale transactions and dominant structures must be avoided. There were 54 companies with wholesale license and 11 of them were natural gas production companies in 2018.

Wholesale activities are carried out by companies holding import licenses except for the companies holding wholesale licenses. As it can be seen from Table 2.37, when the import license companies are examined; there were 18 import (long-term) licenses of which seven companies with eight import licenses (Shell, Avrasya Gaz, Enerco, Kibar, Batı Hattı, Akfel and Bosphorus Gaz), except BOTAŞ had carried out the wholesale import of imported and domestic gas in 2018. As the end of 2018, there were 47 spot-LNG import licensees. Among those, only BOTAŞ and EGEGAZ imported LNG in the spot market while 14 of the remaining 45 license holders performed wholesale activity with the natural gas they supplied from the domestic market. The remaining 35 license holders did not operate within the scope of their licenses in 2018.

2.2.4.8 Distribution

As it can be seen from Table 2.40, in Turkey there were 69 distribution companies supplying natural gas to 78 provinces in 2017 and 72 distribution companies supplying

natural gas to 81 provinces in 2018. Consumer in the specified regions should be provided with the distribution network in line with principles and procedures defined EMRA regulations and notifications by natural gas distribution companies. Also, natural gas companies support these consumers while selling and delivering natural gas to them. EMRA might conduct routine inspections on distribution companies through accredited institutions. Maximum amount of gas to be purchased by a distribution license folder would be 50% from the same legal entity within a calendar year, unless otherwise decided by EMRA.

As end of 2017, the total number of the subscribers increased to 14.2 million by 9.96% year-on-year. The number of eligible consumers increased by 10.48%, reaching 552 thousand as end of 2017. Additionally, the total number of the subscribers of natural gas distribution companies increased by 8.71% which reached to 15.4 million. The number of eligible consumers increased by 8.94%, reaching 601 thousand as end of 2018 (see Table 2.40).

The total consumption of the above-mentioned subscribers was 13 082 Mcm which was increased by 15.19% and the consumption of eligible consumers was 8 191 Mcm which was increased by 13.63% as end of 2017. Besides, as end of 2018, the total consumption of the subscribers was 12 040 Mcm which was decreased by 7.96%, and the consumption of eligible consumers was 9 782 Mcm which was increased by 19.45%. The average number of subscribers in five years by 2018 has enlarged by 9%. Investments made in 2018 meant that the five-year growth trend sustained (EMRA, 2018; EMRA, 2019).

Table 2.40. Data related to usage of natural gas in Turkey between 2016-2018

Year ->	2016	2017	2018
Population	79 814 871	80 810 525	82 003 882
Population reached	59 507 256	61 901 502	66 014 273
Population having signed agreements for natural gas connections	45 240 832	49 607 282	53 286 798
Population actively using natural gas	43 100 800	47 962 650	50 622 458
Provinces using natural gas	76	78	81
Number of subscribers	12 999 559	14 162 930	15 400 892

Source: EMRA (2017), EMRA (2018), EMRA (2019), TURKSTAT (2019), GAZBİR (2018), GAZBİR (2019)

As it can be reviewed from Table 2.40, at the end of 2018 the population of Turkey has increased by 1% compared to 2017 and reached approximately 82 million. With 2018 investments of distribution companies, an additional 4.1 million persons of the population

were reached, raising this number to 66 million. By the end of 2018, distribution companies have provided access to natural gas for 80% of the Turkish population. The number of persons signing natural gas connection agreements increased to 53.2 million, increasing by 7% in comparison with figures of 2017. In the last five years by 2018, the number of persons who have signed agreements with natural gas distribution companies for connections increased by 13.8 million. In 2018, the population actively using natural gas increased to 50.3 million. Out of 76% of the population reached by the distribution companies, 95% of those having signed connection agreements are actively using natural gas.

When the investments made by the natural gas companies in 2017 and 2018 are briefly reviewed; according to Table 2.41 a total of 21.5 billion TL concluding 130 585 km network (which resulted in 12% increase compared to 2016) by the end of 2017 and 30 billion TL concluding with 137 535 km (which resulted in 8% increase compared to 2017) network by the end of 2018 network investment realized by the natural gas distribution companies via annually investments of 1.75 billion TL with 11 778 km network built in 2017 and was 1.7 billion TL with 10 708 km network in 2018. In the past five years by 2018, the natural gas distribution network has grown by 38% and an average of 9 900 km of network investments were realized. The average network expansion only in 2018 was 8% above the five-year average as well as the distribution companies have made investments of an average of 2 000 TL per subscriber.

Table 2.41. Increase and total length of network lines in Turkey in 2017 and 2018

Type	2017 (km)	2018 (km)	2017 Total (km)	2018 Total (km)
Steel Pipeline	1 040	1 075	11 800	12 875
Polyethylene Pipeline	6 500	8 472	80 130	88 602
Service Pipeline	4 238	1 161	38 655	36 058
Total	11 778	10 708	130 585	137 535

Source: EMRA (2017), EMRA (2018)

2.2.4.9 Transmission

According to the NGM Law, BOTAŞ holds the national transmission license; therefore, its role is to provide natural gas flow and control the national gas services and operations network. Furthermore, taking all the required precautions and ensuring transmission of natural gas through pipelines securely, effectively and cost-efficiently are

the responsibility of BOTAŞ as a transmission holder. A separate transmission license is required for filling, transporting and delivering LNG.

2.2.5 Institutions

Turkey's major institutions concerned to the Natural Gas Market are given at Figure 2.13 in order to help understanding how the market is functioning and their roles are explained briefly as follows;

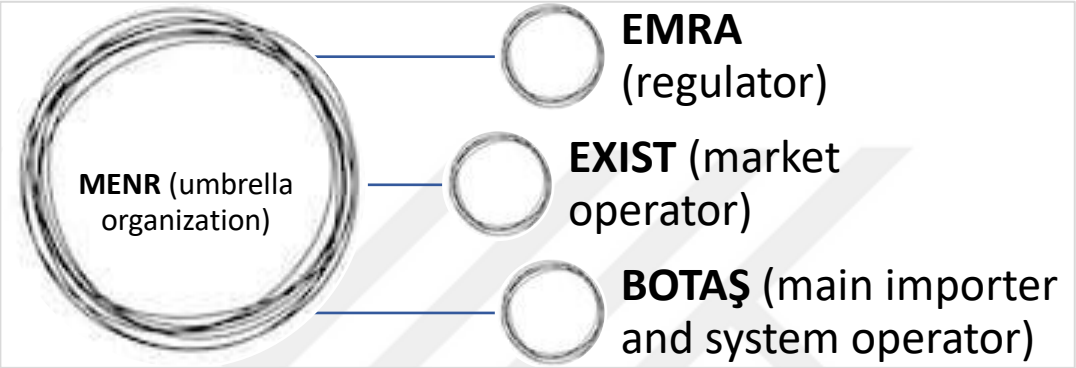


Figure 2.13. The major natural gas related institutions of Turkey

2.2.5.1 Ministry of Energy and Natural Resources (MENR)

The Ministry of Energy and Natural Resources was established upon the approval of the Presidency dated 25.12.1963 and no. 4-400 based on the power vested by the Law no. 4951. Organizational Law of the Ministry was regulated by the Statutory Decree dated 13.02.1983 and was finalized by the Law no. 3154 issued on 01.03.1985 and the Statutory Decree dated 02.11.2011 and no. 662 stipulating some amendments in this Law. Accordingly, the Ministry has eight main service departments, five consultancy and audit departments and three ancillary service departments (MENR Strategic Plan for 2015-2019).

2.2.5.2 Energy Market Regulatory Authority (EMRA)

EMRA was established under the name of Electricity Market Regulatory Authority with the former Electricity Market Law No. 4628 published in the Official Gazette dated 03.03.2001 and numbered 24335. Later, its name changed to Energy Market Regulatory Authority (EMRA) with Natural Gas Market Law (Amendment to the Electricity Market Law and the Law on Natural Gas Market) No. 4646 published in the Official Gazette dated 02.05.2001 and numbered 24390. The Authority is a public legal entity and has administrative and financial autonomy. The related Ministry is the Ministry of Energy and Natural Resources. It fulfills the duties assigned to it and uses its powers to provide

electricity, natural gas, oil and LPG with the objective to create a financially strong, stable and transparent energy market that can operate in a competitive environment subject to the provisions of private law in order to make it available to consumers in an adequate, quality, continuous, low cost and environmentally compatible manner and to ensure an independent regulation and supervision in this market (EMRA, n.d.).

2.2.5.3 Energy Exchange İstanbul (EXIST)

Energy Exchange Istanbul (EXIST) was officially established on 12.05.2015 upon the registration processes completed subject to the provisions of the Electricity Market Law of 14.03.2013 numbered 6446 and Turkish Trade Law of 12.03.2015 numbered 6102. Main objective and principal business activities are to plan, establish, develop and manage energy market within the market operation license in an effective, transparent, reliable manner that fulfills the requirements of energy market and to be an energy market management that procures reliable reference price without discriminating equivalent parties and maximizes the liquidity with increasing number of market participants, product range and trading volume as well as allowing to merchandise by means of market merger. EXIST is vested with private law legal entity pursuant to 6362 numbered Capital Market Law. EXIST makes its internal regulations within the subjects and areas it is entitled to (EXIST, n.d.).

2.2.5.4 Petroleum Pipeline Company (BOTAŞ)

BOTAŞ was established based on the Decree No. 7/7871 with the purpose of transporting Iraq's crude oil to İskenderun Bay, in accordance with the Crude Oil Pipeline (COP) Agreement signed between the Governments of the Republic of Turkey and the Republic of Iraq on 27.08.1973. BOTAŞ, initially operates only in transportation of crude oil through pipelines, has engaged in natural gas transportation and trade activities with the aim of meeting the increasing energy demand of Turkey. BOTAŞ was restructured as a State-Owned Enterprise (SOE), subject to the Decree Law No. 233 and holding its activities in line with profitability and efficiency principles, based on the Decree of the Council of Ministers No. 96/6526 dated 08.02.1995. BOTAŞ currently carries out the following activities: Crude Oil and Natural Gas Transportation and Pipeline Operations; LNG Terminal Operations; Marine Terminal Operations; Project Design, Engineering, Land Survey, Expropriation and Construction Of Crude Oil and Natural Gas Pipelines and Compressor Stations; Natural Gas and LNG Trade; Natural Gas and LNG Storage Facilities; International Natural Gas and Oil Transportation Projects (BOTAŞ, n.d.).

BOTAŞ has two affiliated companies which are named BOTAŞ International Limited Company (BIL) and Turkish Petroleum International Company Limited (TPIC) and two participation companies which are named TANAP Natural Gas Transmission Company

(TANAP Doğal Gaz İletim A.Ş.) and Turusgaz Contracting Marketing and Trade Inc. (Turusgaz Taahhüt Pazarlama ve Ticaret A.Ş.). BOTAŞ actually executes;

> …the crude oil and natural gas transportation and pipeline operation; LNG terminal operations; marine terminal operations; project design, engineering, land survey, expropriation and construction of crude oil and natural gas pipelines and compressor stations; natural gas and LNG trade; natural gas and LNG storage facilities; international natural gas and oil transportation projects activities (BOTAŞ, n.d.).

2.2.6 Turkey's History of Natural Gas and Market Liberalization

In this section, a brief history of natural gas market in Turkey; after fore the steps towards liberalization and developments in the market will be discussed with the information gathered and summarized from the sources of MENR, EMRA, BOTAŞ, PETFORM, Yardımcı (2011).

2.2.6.1 History of Natural Gas in Turkey

Until the mid 1980s, the total natural gas consumption was approximately 800 Mcm (GDPA 2011). After the first discovery of natural gas in Kırklareli in 1970, it was used in Pınarhisar Cement Factory for the first time and following that in Çamurlu Field of Mardin in 1975, it was used in Mardin Cement Factory. One of the most important developments on behalf the natural gas market in Turkey in this period was the foundation of BOTAŞ, which holds by more than 80% of the market today. The first electricity generation via natural gas was carried out with Turkey's domestic resources at Hamitabat Natural Gas Combined Cycle Power Plant in 1985 and then at Ambarlı Natural Gas Combined Cycle Power Plant in 1989.

In 1984, Turkey had its first natural gas import contract agreement with the former USSR via Cabinet Decision No. 84/8806 as it can be seen from Figure 2.14 (see Appendix A). The ongoing rules in the Natural Gas Market of Turkey has changed with this agreement. In 1986, the agreement of import-export of natural gas signed with Soyuzgaz export of the former USSR. It was proposed 6 Bcm in plateau yearly import for 25 years to meet increasing demand and in 1987 the first gas import was executed. In 1988, industry and houses in Turkey met with natural gas firstly in Ankara. Afterwards, extension of procuring of natural gas has continued with the new agreements signed with Russia, Iran and Azerbaijan. Thus, Turkey's natural gas imports obtained via three different countries by pipeline projects with long-term purchasing agreements. BOTAŞ started LNG import from

Algeria in 1994 as part of the purchase agreement signed in 1988. The company also started to import Nigerian LNG in 1999 following the purchase agreement signed in 1994 in order to diversify the sources for increasing the elasticity and security of energy supply in Turkey.

In the beginning of 1990s, the rapidly developing natural gas market was administered by the public in a vertically integrated structure. During this period, only private sector activities continued in the field of production and other areas were not open to entry. In 1990 Decree No. 397, the framework about the usage of natural gas was defined and as mentioned before almost all the market was under the control of BOTAŞ. In 1992 and 1996, the natural gas market expanded to İstanbul, Bursa, Eskişehir, İzmit with gas delivery and in 1994 first LNG Terminal in Marmara Ereğli by BOTAŞ executed. In 1995 BOTAŞ was reconstituted as a State Economic Enterprise, another important milestone for the market. In 1996 GPA with Iran and Russia (Blue Stream); in 1998 GPA with Russia (West Line); in 1999 GPA with Turkmenistan; in 2001 GPA with Azerbaijan were contracted. The main reasons for the progressive increase of natural gas demand in Turkey in consecutive periods can be summarized as geopolitical importance and its position for being an energy trade point.

Another very important milestone that took place in the natural gas market was the reappearance of the neo-liberal policies in the beginning of 1980s. These milestones showed its impact also on the energy sector and the general policy changes towards the market approach. In the energy markets as in other markets and countries, the process of opening-up the monopolistic markets to the competition has begun and has progressed rapidly over time in Turkey. Therefore, Natural Gas Market Law No. 4646 enacted on 02.05.2001 (NGML, 2001). And, objectives in the following are aimed according to the law in line with the stated targets. The first objective became the natural gas delivery to consumers within the framework of quality, continuity, cheapness and competitiveness principles. The other objectives were a transparent, strong and stable market; to regulate the market with an independent regulatory authority; liberalizing the market and opening it to competition; ensuring the security of supply. The Law envisions that regulation and supervision will be carried out by an independent financial and administrative authority EMRA. The regulations stipulated by the Law are basically the licensing of the companies engaged in market activity by EMRA; decoupling and restructuring BOTAŞ's operations; imposing BOTAŞ to transfer existing purchase and sale agreements until the import rate has been reduced to 20% of

national consumption; privatization of non-transmission activities which are storage and trade of BOTAŞ; privatization of existing distribution companies; the operation of private companies to be determined by tender in the new distribution regions; reduction of eligible consumer limits; executing EMRA to regulate tariffs in areas where there has been no competition.

Also, the first natural gas transfer realized from Iran in 2001 and from Russia via Blue Stream Pipeline in 2002. The ITG pipeline construction started in 2005 and the first natural gas export to Greece executed in 2007. Again in 2005, exclusively private sector natural gas companies agreed with Gazprom rather than BOTAŞ. In 2006 EGEGAZ LNG Terminal in Aliağa and in 2007 TPAO storage facility in Silivri executed. In Turkey, the first private importer was Shell Energy and the first private shipper was Aksa by 2007. Afterwards, the cost-based pricing decree executed in 2008. When it comes to year 2009 the quantity of the private sector's share of natural gas supply increased to 4 Bcm per year and to 6 Bcm per year by the year 2010.

The legal framework that forms the TANAP Project that is "The Agreement Between the Republic of Turkey Government and the Republic of Azerbaijan Government Relating to the TANAP System" with the addition of the "Trans-Anatolian Natural Gas Pipeline System About the Host Government Agreement" was signed in İstanbul on 26.06.2012. Those agreements were published in the Official Gazette dated on 19.03.2013 and entered into force. The said "Host Government Agreement" was subsequently amended and resigned on 26.05.2014 and the "Amendment Agreement" published in the Official Gazette dated on 21.10.2014 and afterwards entered into force (TANAP, n.d.). In Turkey, the first FSRU Project was launched by private sector and moreover Tuz Gölü Underground Natural Gas Storage Facility project has begun in 2016 and began gas storage in 2017. Another important progress was that legislation for Organized Wholesale Natural Gas Market (OTSP) to be established under EXIST. The regulation and market usage procedures and principles were published in the Official Gazette in 2017 and authorized in 01.09.2018 which the up-to-date natural gas data are presented on EXIST Transparency Platform. Another important event occurred in the energy sector in 2018 is that programme of offshore drilling which was started in the 1970s has not been carried out because of the scarcity of domestic sources until this year. In summer of 2018 the Fatih drilling ship realized the first domestic drilling in Mediterranean.

2.2.6.2 Liberalization of Turkish Natural Gas Market

Turkey's efforts for creating an open natural gas market with market driven pricing has been at the core of the Turkish state's natural gas market strategy. While the state is pushing for diversified natural gas supply sources and creating a physical trading hub for its region, they also know that this is not possible without free market conditions. Liberalization of the natural gas market is vital to attract more companies within the system to build a free market condition for Turkish natural gas system. This is by far more difficult to achieve than saying but it is important to note country's proven success in the last few years. This section provides a better understanding what and how Turkey achieved a much more liberalized system for its natural gas market.

BOTAŞ had occupied the quasi-monopoly position in Turkish natural gas market for many years. The NGM Law was executed to create a liberalized and transparent market by taking majority of the monopoly advantages from BOTAŞ. The main intention of this law was to form a competitive market in line with coordinated domestic legislations with European Union. In parallel, the NGM Law presented a new licensing regime by removing the barriers against involvement of private investors to the natural gas market. In addition, in order to regulate and direct Turkish natural gas market, EMRA declares secondary legislation as regulation, communiqué and adopts decisions.

After the NGM Law was announced in 2001, tenders in distribution segment were opened by EMRA to provide access for domestic companies in Turkish natural gas market. Total number of companies concerned with distribution increased from six to 72 by the tenders held by EMRA between 2003 and 2017. As private spot LNG importer companies entered in the market in 2007, this was the milestone for the liberalization of Turkish natural gas market, the imports of natural gas by private companies started. in 2011 after BOTAŞ released its contracts. The total number of import holder companies increased to 17 except BOTAŞ. Turkey has been one of the major natural gas markets in Europe with its large demand. Moreover, the segments that the natural gas is consumed majorly are the electric generation, residential consumption and industry and service sectors. Turkey's natural gas imports were mostly supplied via Russia, Iran and Azerbaijan (see Table 2.18).

In the past, Turkey experienced many natural gas supply disruptions. In the late 2000s, the deficit caused by the Ukraine and Russia conflict and cutbacks regarding to

technical issues from Iran, resulted in the shortage of storage capacity in Turkey. Turkey's domestic production has very little share in total supply, so Turkey decided to avoid cyclical inconsistences due to high dependency on imports. Turkey also decided to improve its existing natural gas storage capacity to avoid occasional supply disruptions. The primary act to form a competitive natural gas market was the NGM Law enacted in 2001 even some actions were achieved on liberalization targets before 2001. One can state that the involvement of private sector to distribution of natural gas is one of the most noticeable achievements in development of the competitive market. Additionally, other important progresses are reviewed in Table 2.42.

Table 2.42. Liberalization timeline of Turkish natural gas market

Year	Developments
2001	• The Natural Gas Market Law (NGML) was first issued and published in Turkish Official Gazette on 05/02/2001. • Independent Energy Market Regulatory Authority was established. (Total contracted volume 29.3 Bcm, total consumption 16.0 Bcm) (Total import BOTAŞ %100, private %0)
2003	• The first greenfield distribution tender was conducted. (Total contracted volume 45.3 Bcm, total consumption 20.6 Bcm) (Total import BOTAŞ %100, private %0)
2004	• The NGML and the Regulation about Natural Gas Market Transmission Network Operations Principles sets the basic rules related to Third Party Access to transmission network. (Total contracted volume 45.3 Bcm, total consumption 22.1 Bcm) (Total import BOTAŞ %100, private %0)
2005	• The first contract release tender to release 4 Bcm of BOTAŞ contract from GazProm to private sector was conducted. (Total contracted volume 45.3 Bcm, total consumption 26.9 Bcm) (Total import BOTAŞ %100, private %0)
2007	• A natural gas wholesale company signed a Standard Transportation Contract and gained access to the transmission network, as the first "Shipper" apart from BOTAŞ. • Re-export of Azeri gas to Greece started. (Total contracted volume 51.9 Bcm, total consumption 35.1 Bcm) (Total import BOTAŞ %100, private %0)
2008	• Spot LNG imports are liberalized with an amendment to the Natural Gas Market Law No. 4646.
2009	• Regulation related to Third Party Access to LNG Terminals was issued. • First LNG cargo by private sector was brought into the system. (Total contracted volume 51.9 Bcm, total consumption 35.2 Bcm) (Total import BOTAŞ %92, private %8)
2011	• 6 Bcm of gas contract of BOTAŞ from West Line ended. • Regulation related to the use of underground storage executed. • Tariff regulation for natural gas distribution companies conducted.

Table 2.42 (continued). Liberalization timeline of Turkish natural gas market

Year	Developments
2012	• Gas import contracts of private sector companies increased to 10 Bcm. (2012; Total contracted volume 51.9 Bcm, total consumption 44.1 Bcm) (Total import BOTAŞ %89 private %11) (2013; Total contracted volume 51.9 Bcm, total consumption 45.9 Bcm) (Total import BOTAŞ %78 private %22)
2016	• NGML was amended about licensing of distribution regions. • The first FSRU investment by private sector was initiated. • Studies have been initiated in opening a spot natural gas market at EXIST. (Total contracted volume 51.9 Bcm, total consumption 48.0 Bcm) (Total import BOTAŞ %84, private %16)
2017	• EMRA board approved Organized Wholesale Natural Gas Market (OTSP) regulation on 31.03.2017. Upon approval of EMRA board, PUE was published at Official Gazzette on 22.09.2017 • First FSRU Project was launched. • Tuz Gölü Underground Natural Gas Storage Facility began gas storage. • The tender process of natural gas distribution of 81 provinces has been completed.
2018	• OTSP has been launched on 01.09.2018. • TANAP has been 99.9% completed and the first commercial gas flow to Turkey via the pipeline has begun in 30.06.2018. • NGML was amended about LNG, CNG and spot pipeline natural gas imports.

Source: Deloitte Türkiye (2016), PWC (2014), NGML (2001), NGML (2018)

2.2.7 Turkey's Long-term Natural Gas Contracts

Turkey's first long-term natural gas purchase agreement was with Russia in 1984 as stated historically before along with the other contracts made via other supplier countries. In this part, an outline and the details of the contracts of Turkey will be given. Turkey's natural gas contract agreements and their properties can be seen in Table 2.43. According to Table 2.43, these contracts in total represent nearly 50 Bcm of gas supply that will expire by 2020's.

Table 2.43. Turkey's long-term natural gas purchase contracts according to countries

Agreement with	Signature Date	Operation Date (Date effective)	Duration (Year)	Volume During the Plateau Period) (Bcm/Year)	End Date (Expiry date)	Status	Contract Type
Russian Federation (West Line)	14.02.1986	1987	25	6	2011	Ended	Oil indexed
Algeria (LNG)	14.04.1988	1994	20 + 10	4.4	2024	In operation	Long-term LNG
Nigeria (LNG)	09.11.1995	1999	22	1.3	2021	In operation	Long-term LNG
Iran	08.08.1996	2001	25	9.6	2026	In operation	Oil indexed
Russian Federation (Blue Stream)	15.12.1997	2003	25	16	2025	In operation	Oil indexed
Russian Federation (West Line) *	18.02.1998	1998	23	14	2021	In operation	Oil indexed
Turkmenistan	21.05.1999	-	30	16	-	Pending	-
Azerbaijan (SD Phase-I)	12.03.2001	2007	15	6.6	2021	In operation	Oil indexed
Azerbaijan (SD Phase-II)	25.10.2011	2018	15	6	2033	In operation	Oil indexed
Azerbaijan (BIL)	2011	2011	35	0.15	2046	In operation	Oil indexed
Qatar (LNG)	01.10.2017	2017	3	2.1	2020	In operation	Long-term LNG

Source: BOTAŞ, PETFORM, MENR, GAZİD

* A total of 10 Bcm contract transfer to four companies took place in 2007 which are Enerco Energy (2.5 Bcm), BosphorusGas (0.75 Bcm), Avrasya Gas (0.50 Bcm), Shell Energy (0.25 Bcm) and again to four companies took place in 2013 which are Akfel Gas (2.25 Bcm), BosphorusGas (1.75 Bcm), Kibar Energy (1.0 Bcm), West Line (1.0 Bcm). 4 Bcm amount of these contracts expire in 2021.

Moreover, the long-term natural gas purchase contracts of Turkey with the information of the suppliers, importer companies, annual contract quantities, contract expiry dates and the pricing base of the contracts are given at Table 2.44 .Turkey's long-term gas contracts according to expiry date between 2020-2042 are given in Figure 2.15 for comparison. Turkey's natural gas contracts are mostly as long-term and oil indexed contract agreements. Also, one can see that Turkey should be well prepared for the approaching renegotiations on natural gas contracts and so for the prices which is an issue that will indeed affect the Turkey's economy for many years.

Table 2.44. Turkey's long-term natural gas purchase contracts according to suppliers

Supplier	Importer	Annual contract quantity (Bcm/year)	Contract base	Contract end
AGSC 1	BOTAŞ	6.6	Oil products	April 2021
NLNG	BOTAŞ	1.34	Oil products	October 2021
Gazprom A	BOTAŞ	4	Oil products	December 2021
Gazprom B	BOTAŞ	4	Oil products	December 2021
Sonatrach	BOTAŞ	4.44	Arab crude basket	October 2024
Gazprom BS	BOTAŞ	16	Oil products	December 2025
NIGC	BOTAŞ	9.6	Oil products	July 2026
AGSC 2	BOTAŞ	< 6.00	Oil products	June 2033
Gazprom C	Private	6	Oil products	2042

Source: IBS Research & Consultancy (2019, p. 19)

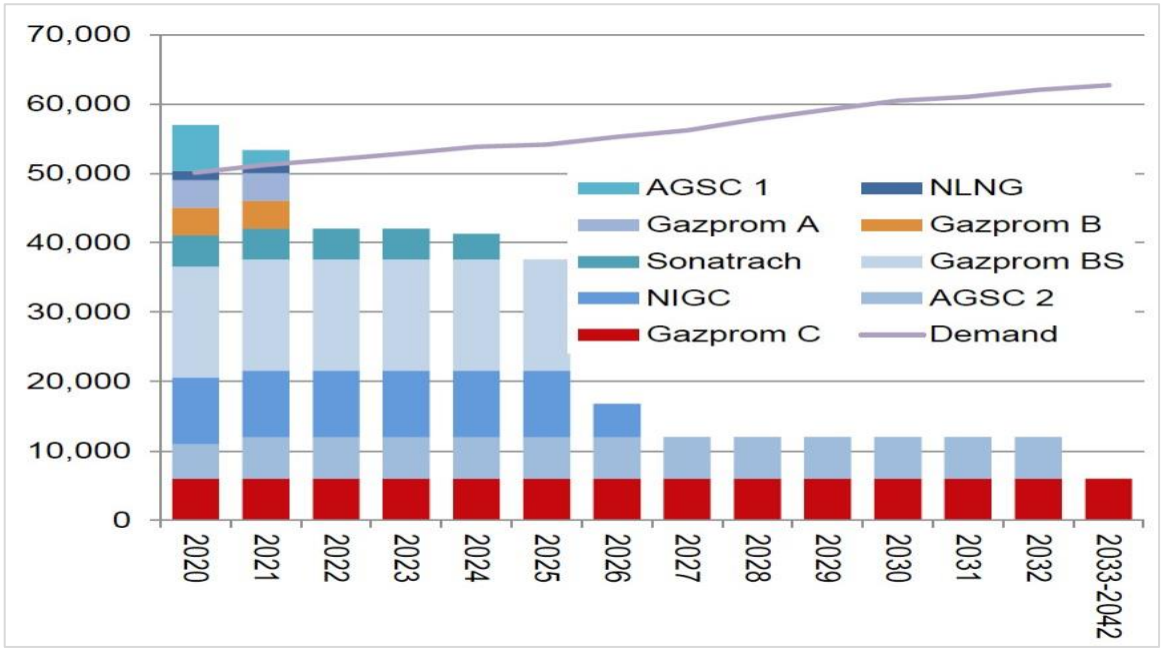


Figure 2.14. Turkey's long-term gas contracts according to expiry date between 2020-2042. Source: IBS Research & Consultancy (2019, p. 19)

2.3 Literature Review

In this section of the thesis, academic studies on the perspective of the institutional economics and industrial economics for natural gas contracts, pricing of natural gas, factors affecting the natural gas price and the debate on oil-indexed and hub-based natural gas contracts are examined in a historical manner. Natural gas pricing mutually in long-run and short-run is the core factor behind the economics of natural gas and the contracts between suppliers and demanders. There are considerable amount of literature and different approaches about natural gas pricing in the world, but the empirical results haven't reached

a consensus. Moreover, in Turkey there are not many studies conducted about the topic, especially in a quantitively manner. The review in this section is based on two main distinctions: duration of the contract and subject-wise classification of the literature. The classification is based upon institutional economics and long-term contracts; industrial economics and long-term contracts; natural gas pricing and factors affecting the natural gas price; integration and linkage between other energy sources and natural gas prices; oil-indexed and hub-based natural gas contracts.

2.3.1 Institutional Economics and Long-term Contracts

As it is examined, long-term contracts are majorly related to the institutional economics study field. Long-term contracts are acknowledged in the institutional economics literature as a method to prevent opportunistic behavior jeopardy in transactions concerning excessive sunk investments. The natural gas industry is in line with this characteristic, so this topic has been investigated by several institutional economists all around the world. In the early years of the sector, the natural gas industry was monopolistic in many cases and highly regulated, so long-term contracts were used to maintain the monopoly rents besides sharing the risks. The oil-indexed long-term contracts had come up as a solution to this method however it seen like not a very competitive method. Moreover, the natural gas prices fixed to a delayed oil price and this method used for decades [See The Energy Charter Secretariat (2007) for more detailed information].

The several studies of institutional economists actually tested the inspiring study of Ronald Coase (1937) on questioning the transactions of markets as firms versus organized pecking orders as other types of vertical organization.

Klein et. al. (1978) discuss the challenge on capturing quasi-rents in peculiar investments by vertical integration or long-term contracts. Combining opportunism with transaction-specific investments, exclusively named appropriable quasi-rents by them, is a leading factor in explaining vertical integration decisions. The potentially viable specialization part of the quasi-rent is the portion that exceeds its value to the second most valuable user, if any.

Masten and Crocker (1985) and Crocker and Masten (1988) are the pioneers of demonstrating theoretical models and empirically testing them in the natural gas industry.

According to their studies, the long-term take-or-pay contracts are recommended as a useful tool to give opportunity of sharing the risk between buyers and sellers with indexation of gas price to oil products.

Mulherin (1986) emphasizes that provisions in the take-or-pay long-term natural gas contracts avoid the opportunistic behavior and protect the continuity of quasi-rents.

Hubbard and Weiner (1986) emphasize the price determination with an empirical investigation of contracting and they established a theoretical price contract model of long-term contracts with nonprice provisions between demanders and producers extending the total compensation of producers with price ceilings. Moreover, they discovered that the liabilities of the take-or-pay liabilities differ by the alternative value of gas reserves. They also back the alternative view that these contracts provide circulation or risk sharing purposes.

Bolle (1989) compares the take-or-pay contracts and cost-based contracts and offers that take-or-pay contracts are more favorable in order to reduce the moral hazard.

Masten and Crocker (1991) examine that the existence of quasi-rents ought to support redetermination clauses of price formulas which decrease the frequency level of negotiations and jeopardy of opportunistic bargaining while the existence of uncertainty ought to support renegotiation in the surrogate price adaptation clauses. Doane and Spulber (1994) display the shifts in the regulative structures toward raising spot trading.

Dailami and Hauswald (2000) support the essential influence of particular contract design in guaranteeing long-term investment. They also suggest that the risk-shifting as an uncomplete agreement in a contract would result with the effective distribution of risks with a large LNG export case study,

Jensen (2004) primarily and extensively depicts the scopes of additional long-term contracts and later, the following writers continued towards the global market of the natural gas market phenomenon.

Creti and Villeneuve (2004) deliberate the economic perspective of the EU provision about long-term natural gas agreements. Their study also debated that other intentions for fundamentals of long-term natural gas contracting are the recurrence of deals and unpredictability.

Brito and Hartley (2007) and Hartley (2015) deliberate about the effect of changes in regulatory perspective on market structure of natural gas, especially on market of LNG, and propose that increase in liquidity and trade of spot markets, higher destination and volume elasticity affect long-term natural gas contracts contrarily towards short-term natural gas contracts or spot markets.

Neumann and Hirschhausen (2004) discuss the duration of take-or-pay natural gas agreements into Europe with an econometric inquiry of economic, technological, institutional shifts and suggest that length is decreasing prominently and affected by the commodity origin.

Hirschhausen and Neumann (2008) find an opposite relationship of the length of contracts and the deliveries to the reconstituted markets of the UK and the US natural gas markets.

Ruester (2009) analyzes the effect of the market organization on the choice of optimal governance by concentrating on the long-term LNG contracts and suggests that the length of contracts is adjusted to minimizing of bargaining costs and the risk of uncertainty and inflexibility. She also finds that there is a contrary effect of contract negotiation number, contract year length, prolongation of the previous contracts on the length of contracts.

Ruester (2015) in her study executes both a quantitative and qualitative examination of the debt ratio of financing in LNG projects which is in a relationship with the length of the contracts.

2.3.2 Industrial Economics and Long-term Contracts

Another area of economics concerning long-term contracts is the industrial economics. There are many studies based on industrial economics related to the natural gas sector. Long-term contracts have been studied in the conventional literature on industrial economics as one of the several time prospects on which a resource supplier is able to adjust his or her portfolio of contracts. In many studies in this area, it is examined that whether competition or collusion is favored by long-term contracts. Unfortunately, some of them assumed the market as competitive and some did not. In this section, the literature on industrial economics concerning long-term contracts are examined.

Newbery (1984) explains that product trading takes place in an environment characteristic that is not very competitive. And to support this opinion, he lists “eight commodities for which single countries controlled more than 50% of world trade and another thirteen for which single countries controlled between 25% and 50%” (Newbery, 1984, p. 35).

One of the leading quantitative studies on the expense of long-term agreements strategically in markets with considerably extential investment by using an auction model in Norway, Canada and Russia conducted by Parsons (1989). The results of the study show that the disadvantages regarding the monopolistic market decreases with the increasing number of wholesale buyers. Therefore, this would lead to liberalization of the natural gas market.

Allaz and Vila (1993) originate a logical basis on the forward markets’ usage under certainty and perfect foresight and recommend that the spot markets would be more competitive with the existence of forward markets. They put forward that the long-term contracting is benefited by the consumers with the reason at each phase of the contract producers sell extra output and with infinite number of forward trade sessions the result will approach to the competitive outcome and this will affect the contract price.

Le Coq (2004) figures out that with moving to collusive behavior, the market of contract benefits the spot market’s sustaining collusion in a setting of long-term contracting with successive repetitive interactions within the spot market.

Liski and Montero (2006) find the forward trade opportunities allowing firms to maintain collective profits might not be possible apart from that in a game of oligopoly repeated infinitely.

Green and Le Coq (2010) examine how the risk of collusion in a repeated price-setting game affected by the length of forward contracts and discuss that contracts can both aid and prevent collusion by reducing the spot market’s size.

Hartley and Brito (2002) put on a model of which is expected to lessen the long-term LNG contract durations via decreased CAPEX, declined costs of transport, increased rate of discount and higher number of buyers and suppliers.

Neuhoff and Hirschhausen (2006) evaluate the long-term gas contracts and economics of them underneath shifting institutional circumstances like restructuring of

natural gas sector and show that institutional arrangements required by the natural gas suppliers that allow for long-term contracting when the momentary demand elasticity is remarkably lower than the long-run demand elasticity that generates more revenues for the producers in the long-term.

Polo and Scarpa (2013) investigate the complications in retail competition in characteristics of vertically integrated natural gas markets between wholesalers whom are obtaining natural gas from produces in a manner of TOP contracts and retail dealers. They figure out retail competition deteriorates in case of the nonexistence of well performing wholesale trade market.

2.3.3 Natural Gas Pricing and Factors Affecting Natural Gas Price

In this section, a literature review is being carried out with the historical scanning method on the basis of academically conducted important studies on natural gas pricing and the factors affecting natural gas price which are among the important topics of the thesis.

The literature survey about natural gas pricing is conducted as follows:

Smith (2004) underlines the function of further principals of demand and supply especially for the development of short-run price since the variations in fuel density affecting transportation costs, environmental costs and production costs.

Stern (2007) underlines that the demand and supply principals may happen to be extra important for the advancement of the natural gas hub prices which are liberalized via the decreased portion of oil indexation and of options for short-term replacement of oil and natural gas in North-west Europe.

Brown and Yücel (2008) analyze the US natural gas market, which was deregulated and established with a long pipeline system providing regional arbitrage opportunities. They examine relationship between the oil prices and natural gas prices with a different perspective because of the spotted price upheaval in oil markets and natural gas markets and the deviation in their prices. They implement an Error Correction Model and figured out that the oil price changes notably cointegrate with natural gas prices in the long-term where they are substitutes but they don’t cointegrate in the short-term because of factors like weather conditions, storage levels, supply disruptions. Additionally, they indicate that the causality

between oil prices and natural gas prices in the US market is from WTI oil prices to Henry Hub natural gas prices. Moreover, they use the industry rules-of-thumb that are 10-to-1 rule and 6-to-1 rule which are also named the five-finger rule between oil prices and natural gas prices in their study. 10-to-1 rule and 6-to-1 rule are the constant ratios between oil price and natural gas price of which the 10-to-1 rule provides a comparatively more suitable to historical data and preferred by the industry. Also, the 6-to-1 rule forecasts natural gas prices to be higher and the 10-to-1 rule forecasts natural gas prices to be lower. It is more suitable to use 6-to-1 rule when the oil prices and the natural gas prices are decreasing; more suitable to use 10-to-1 when the oil prices and the natural gas prices are increasing.

The literature survey about factors affecting the natural gas prices in markets are conducted as follows:

Stern (1986) claims that pricing of gas has grown into a truly debated topic in international trade for importers and exporters. Pricing of gas has turned into a highly political issue in western parts of Europe that governments should offset how much importer country is willing to pay against the understanding of how much end-user is willing to pay in both the short-term and long-term perspective. Across different markets, there is a major difference in the price of natural gas that end-users are willing to pay. In discordance with the oil market, within the natural gas market there are no price-setting (OPEC type) cartels. In particular, the prices of natural gas imports are based on the relationship and economics of trade between importing and exporting countries. According to him, by indexing natural gas prices to crude oil prices and long-term fluctuations in crude oil prices, the exporters of both commodities are exposed to cyclical movements in crude oil prices.

According to Egenhofer et al. (1998), European natural gas prices have been established particularly by fuel oil prices. The natural gas market is not priced with cost-plus pricing method like electricity market and in many countries the governments have a powerful effect on end-user prices.

Serletis and Herbert (1999) survey the relationship between North American fuel oil prices, natural gas prices and electricity prices. It is concluded as a result of Engle-Granger cointegration test that all three commodity prices are cointegrated and one variable that affects one's price has an indirect effect on others.

The relationship between both electricity and natural gas futures prices is examined in the study of Emery and Liu (2002). They find that natural gas prices are considered as important input for electricity production and they are integrated with electricity prices.

Serletis and Rangel-Ruiz (2004) observe the cycles and collective trends between natural gas and oil price series using Henry Hub and WTI price data. According to the results of the correlation test, it is found that there was a common trend and cycle in prices following the liberalization of oil and gas markets in the USA. It was also concluded that the same trend was observed between Henry Hub natural gas prices and Canadian Alberta natural gas prices and North American natural gas prices were predominantly determined under the benchmark of Henry Hub market.

Kliesen (2006) discusses the rising prices of natural gas after the Katrina and Rita hurricanes in the USA will slow down the economy by causing a decrease in industrial production. It is concluded that natural gas as an important input in heavy industrial production influences production but the increase in oil prices caused significant changes in macroeconomic measures while the significant effect of the increase in natural gas prices couldn't be mentioned.

Mu (2007) examines the volatility of future returns in the US natural gas market and figures out that the natural gas prices are relatively high on Monday This is called Monday effect, when natural gas storage is reported because of weather aspect that is indicating the significance of market essentials.

Diebold and Yılmaz (2009, 2014) examine dynamics that possibly affecting natural gas price and apply the time-series method they developed which principally based on the Variance Decomposition Method and VAR Model, for the first time.

Honarvar (2009) studies the asymmetries between oil and oil derivatives and states that a positive crude oil price shock is temporary. Moreover, a long-run asymmetry that associate with consumer reactions to technological transformations is put forth.

Malik and Ewing (2009) study out that volatility of oil price has many adherences with other market sectors and most financial tools based upon indices which might be useful for hedging and optimum portfolio allocation.

Honoré (2010) underlines the idea that LNG prices with pricing formula. This formula should be determined in accordance to compete with pipeline natural gas prices, typically indexed to oil prices or its derivatives' prices in Europe. However, the LNG prices in Europe are straightforwardly related to Brent oil prices in the contracts proposed with Algeria, Egypt and Middle East. He relates the presence of oil product prices in the oil indexation mechanism, especially consists of gas oil price and heavy fuel oil price to three main causes given in the study. The first cause is that the natural gas prices can't diverge much from the rival energy sources. The second cause is that the oil market is worked as a liquid commodity market for many years. The third cause is that natural gas has been realized as an undesirable problem during oil production process.

Whistance and Thompson (2010) examine the effect of the increase in biological fuel ethanol production produced from maize and used as, on natural gas prices. Natural gas is a substitute product for ethanol which is among the main inputs used for its production. The two-stage Least Squares Estimation is conducted and noted that natural gas prices would be expected to be higher by 0.25% if the supportive policies for state-owned biofuel production are abolished. However, contrary to gasoline pump prices, it is stated that the increase in ethanol production has no effect on consumption of natural gas for the end consumer, but it increases the cost of the use of natural gas because of the use of natural gas in the ethanol production process.

Yardımcı and Ediger (2010) compared- the Henry Hub natural gas prices with WTI crude oil prices by implementing the Variance Decomposition and Granger Causality Test and figure out that there is a cointegration through oil prices to natural gas prices during 1996-2003 however oil prices aren't affected by natural gas prices. Moreover, they emphasize that the effect of oil prices on natural gas prices diminishes after 2003.

Mohammadi (2011) examines the long-term relationship and short-term dynamics between oil, natural gas and coal prices. As a result, it is found that oil prices are not affected by developments in natural gas and coal market Natural gas prices are affected by developments in oil market, there is a causality through oil prices to natural gas prices and coal prices are not influenced by variances in oil markets and natural gas markets. The findings advocate that coal prices are determined by long-term contracts; oil prices are determined in the global market and natural gas prices are determined in the regional perspective.

Asche et al. (2012) observe the relation between the natural gas production among natural gas and oil prices. They emphasize the production enhancing and cost decreasing impact of the advance in technology of shale gas production and effect of the financial crisis in 2008 to the US market that decreased the prices in the European natural gas market by implementing Johansen Cointegration Test via using prices of the NBP natural gas and prices of Brent oil. In a nutshell, they figure out that prices of natural gas and oil may present high variances in the short-term however in the long-term with the substitution between natural gas and oil of consumers those short-term variances disappear towards equilibrium.

Holland and Ashley (2012) state that there are differences in opinion on whether the price review clauses in long-term natural gas supply contracts will continue to exist in the next decade and that there are different expectations about the price of natural gas. It is stated that each contract article develops a different writing regarding the price review, so that the content of the article should be evaluated individually rather than a general rule is put in place during the evaluation. Additionally, the function of contracting clauses envisages the revision of prices. They will end and there will be no variance between market and contract price if the long-term contract prices are associated with the prices emerging in regional natural gas trade centers with the development of global free natural gas markets. In this regard it is noted that the function of the articles subject to the review of prices will decrease.

Stern (2012) mentions that natural gas is an energy commodity with high infrastructure and investment costs. Furthermore, it is stated that even now the big part of the natural gas trade on international basis is going on with long-term natural gas contracts while the structure of contracts and markets change as the natural gas infrastructure evolves. The natural gas price approaches seem to be endogenous to the progression scheme of the whole market and with a response to natural gas price formation mechanism to evolve.

Conforto (2013) investigates whether the 10:1 rule and 6:1 rule, referred to by Brown and Yücel (2008) as the five-finger rule between prices of oil and natural gas. They are argued to be valid in the US, but they are already valid in the British energy market. In the study, he concludes that the five-finger rule showing the oil price and natural gas price ratio of the US market does not apply to the British market by examining the relation between prices of Brent oil and NBP natural gas.

Creti et al. (2013) investigate the correlation among energy sources and stock market. They conclude that the correlation varies by the time with highly volatile manner and financial markets influences natural gas prices remarkably after global financial crisis in 2008 This is also depending on the structure of the stock market if it is bullish or bearish.

Financial markets effected natural gas prices especially after 2008 crisis and Cheng and Xiong (2013) examine the analyzes of energy markets affected by the financialization in this concept. They figure out that energy markets can be affected by the financialization through information discovery and risk sharing.

Hayashi and Hughes (2013a) and Hayashi and Hughes (2013b) underline that the LNG import levels of Japan increase after nuclear accident in Fukushima, so the LNG project investments show an increment in the world.

Lin and Wesseh (2013) indicate that volatility of natural gas prices is not foreseeable because it is not permanent and regime switching exists in the market of natural gas.

Wakamatsu and Aruga (2013) examine effect of shale gas revolution in the US on the Japanese natural gas market. Bai and Perron Structural Intermediate Test, ADF Stationarity Test, VAR Model, Johansen Cointegration Method are used in the analysis and they conclude that the Japanese natural gas market was affected by the US markets even before 2005, but the effect disappeared afterwards. In their study, the reason for the disappearance of the interaction after 2005 is explained as the possibility of meeting the domestic demand of the country with its own production after the shale gas revolution in the USA. Additionally, they put forward the inelasticity between natural gas consumption, comprehended as necessary good, and income.

Li et al. (2014) discover that other market prices are obviously different from the prices in the North America market prices. Moreover, the study offers that Asian market prices and European market prices integrate because of the oil indexation mechanism.

Nick and Thoenes (2014) investigate the short and long-term factors influencing natural gas prices in the German natural gas market and the consequence of market shocks by implementing SVAR Model in their study. The prices of NetConnect in Germany for natural gas, Brent for crude oil and Northwest Europe market for coal are considered in this study. They figure out short-lasting impacts on the natural gas price are storage, temperature

and supply shocks with more permanent impacts on the natural gas price. These are oil price and coal price shocks. In addition, German natural gas market is affected significantly by the supply shocks even these shocks are driven by concurrent and unexpected demand shifts. In other words, as a result, they claim that natural gas prices are influenced by factors such as temperature, storage capacity and lack of supply in the short term while it is dependent on crude oil and coal prices in the long-run.

Neumann and Hirschhausen (2015), as followers of oil indexation mechanism on behalf of pricing of natural gas discuss that the Asian premium is on account of distinctive market principals.

Creti and Nguyen (2015), emphasize that the energy prices are still solely affected by demand and supply essentials of the market even after the global financial crisis in 2018 where the natural gas prices influenced by financial markets more.

Giziene and Zalgiryte (2015) analyze the pricing of natural gas in the Lithuania and the EU and moreover indicate that both internal factors such as fuel and other energy sources and external factors such as production price, storage price, transportation price, purchase price and factors of substructure costs may affect the prices of natural gas.

Pal and Mitra (2015) examine the possible asymmetries arising between oil prices and its derivative prices by implementing a Multiple Threshold NARDL Model. They conclude that there are variances with the oil derivative prices because of the crude oil price changes both from the perspective of magnitude or direction of the relationship. Moreover, they discuss that intense crude oil decreases do not entirely diffuse to oil derivative prices.

Geng et al. (2016b) investigates the effect of the shale gas revolution among the relationship between natural gas and oil prices besides the natural gas pricing dynamics. Demand and supply mechanism is the major factor in the US market while the oil prices are the major factors in European and Japanese markets.

Geng et al. (2016c) discovered that US Henry Hub gas prices have been largely affected by the shale gas revolution. However, same effect has not been observed in NBP gas prices following the study on the impact of shale gas on the gas price movement systems focusing on the relation between oil and gas prices both in the US and Europe.

Hulshof et al. (2016) study the effect of coal price, oil price, demand and supply essentials on TTF spot prices. They figure out that TTF spot prices are determined among gas-on-gas competition because the prices are affected solely by factors like weather conditions, economic transactions, natural gas consumption level especially affect beyond the oil price and coal price.

Jadidzadeh and Serletis (2017) suggest that natural gas price reaction varies significantly to the oil price shocks. Furthermore, they conclude that aggregate demand and aggregate supply shocks cause the 45% of the variations of the natural gas price with empirical methods implemented. They also find out that oil price and natural price decoupled from each other.

Wiggins and Etienne (2017) show that natural gas prices are variously affected by demand shocks and supply shocks. These aggregate demand and aggregate supply shocks justify post-regulation price volatility with a ratio of 20%. Moreover, in the study it is resolved that aggregate demand and aggregate supply shocks have a higher effect than preventive stock shocks. They also conclude that elasticity of demand increases as consumers substitute more easily to other energy sources.

Zhang (2017) indicates that the international financial market affects the prices of oil from the time when the global financial crisis occurred in 2018. This also influences the prices of natural gas.

2.3.4 Integration and Linkage Between Other Energy Sources and Natural Gas Prices

The trend in today's natural gas markets is now aimed at finding shorter term solutions rather than long term contracts. The main factors in this development can be listed as increase in LNG infrastructure, shale gas revolution and the more complex commercial and political relations in the globalizing world. In addition, as observed in all markets, the level of integration among regions increases gradually in the natural gas market, while the number of independent markets is also increasing. In this section, related academic studies about the integration and linkage between other energy sources and natural gas prices are reviewed in historical manner.

De Vany and Walls (1993, 1995) try to assess natural gas market integration from a regional perspective for natural gas markets in the US. They examine the degree of integration of the North American natural gas markets and how the access of all service providers to pipelines affects the price level. As a result of the Engle-Granger Cointegration Test, they state that the competition is increasing, and prices are approaching to each other with the open access to the pipelines. In other words, they point out that the natural gas markets have been increasingly integrated at the regional level.

In the study by Asche et al. (2002), it is examined whether the German natural gas market is integrated. They try to assess the market integration of natural gas and have focused on market integration from regional perspective for European markets. The Johansen Multivariate Cointegration Method found that the imported border price of natural gas from Norway, Holland and Russia showed an equal change and this result showed that there was cointegration between the markets.

In their study, Wiser and Bolinger (2005) examine whether renewable energy usage and energy efficiency may have a declining effect on natural gas prices. As a result, it is stated that there are many uncertainties in clearly demonstrating this impact and the decline prices of natural gas will not mean an increase in total economic wealth. However, it is proposed that a 1% drop in natural gas demand will result in a 0.8% to 2% decrease in prices. Moreover, they found out that each megawatt hour of electricity generation and energy efficiency from renewable energy will save natural gas consumers at least $ 7.5 to $ 20.

Serletis and Shahmoradi (2005) notice that natural gas prices are more volatile than oil prices because gas prices were linked to oil prices and they gradually decoupled recently. Later, following works have emerged questioning the relation between natural gas prices and crude oil prices in case of long-term equilibrium. They try to figure out empirically if there is a decoupling between natural gas prices and oil prices with the motive of deviation in the prices of these commodities and they observed price upheaval in natural gas and oil markets.

Siliverstovs et al. (2005) examine the cointegration level among the natural gas markets of North America, Europe and Japan between the beginning of 1990s and 2004 with the enhancement in LNG trade. The relationship between the oil prices and international natural gas markets is analyzed with the help of Johansen Cointegration Test and Principal

Component Analysis conducted They figure out that the European natural gas market and North American natural gas market are integrated on a large scale but they also find that the integration between European natural gas market and Japanese natural gas market do not appear till the end of the studied period. In addition, it is concluded that natural gas markets in Europe and Japan are not integrated with North American markets.

Bachmeir and Griffin (2006), survey that whether there is an integration between coal price, oil price and natural gas price. According to the analysis of the data of oil prices in five different regions, it can be concluded that world oil prices are highly cointegrated. Moreover, they state that a very weak cointegration between coal price, oil price and natural gas price which can be revealed so the existence of one energy market for major resources around the world can't be accepted but it can be proclaimed in the very long-term. Also, they emphasize that there are two essentials about prices in different energy sectors tend to be linked. The first of those two essentials is the evidence of energy markets integration and price spillover effect, and the second one is the volatility spillover effect.

Asche et al. (2006) analyze the integration between crude oil, electricity and natural gas markets by applying VEC Model to the UK market. They conclude that there is a cointegration between crude oil price, electricity price and natural gas price. The study also mentions that there is a single market for major energy sources in the UK and that the prices in this market are determined by global oil prices to a huge extent. It stresses over time that, variances in the capacity constrictions and structure of regulations might reduce the cointegration between energy prices. Additionally, it is determined that the crude oil price is the propelling force.

Cuddington and Wang (2006) and Neumann et al. (2006) concentrate on market integration for the US natural gas markets from a regional perception and they figure out that natural gas markets are regionally integrated.

Ghouri (2006) examines the long-term correlation between natural gas prices and oil prices with conducting Johansen and Juselius Cointegration Tests. It is concluded that Henry Hub price, Japanese LNG import prices and European natural gas market prices are cointegrated with the crude oil prices they refer to. In addition, the crucial motive for the emergence of this case is to continue to take the oil price a reference in determining the price of natural gas in the contracts for trade of natural gas.

Villar and Joutz (2006) observe the relation amongst the prices of WTI oil and the Henry Hub natural gas by using VAR Model and they determined the cointegration between them. According to this, it is claimed that the temporary shock of 20% in WTI prices will affect natural gas prices by 5% however the effect decreases to 2% in two months, and 20% change in WTI price in one year will cause 16% change in Henry Hub prices. The long-term relationship between commodity prices is empirically indicated when the natural gas storage level, seasonality, transient shocks are excluded They are considered as external factors, using the error correction model while in some time periods they appeared to decouple. Additionally, they pointed that natural gas prices follow the variations in oil prices with a lag.

Malik and Hammoudeh (2007) discuss the Multivariate Generalized Autoregressive Conditional Heteroscedasticity method (see Bollerslev et al., 1988) that is widely used to analyze the correlation spillover effects and volatility in cross-sectors in many studies.

Panagiotidis and Rutledge (2007) examine the relation of natural gas prices in the wholesale market of UK and Brent oil price. As the orthodox natural gas market liberalization theory argues, whether the oil prices and natural gas prices decouple by using VAR Cointegration Tests, it is stated that there is a long-term correlation between price of oil and price of natural gas in the UK. Additionally, they claim that the short-term relationship is to be linear and oil price shocks influence natural gas prices too. In other words, they figure out a perpetual cointegration both in the long-term and the short-term, so these outcomes don't support the decoupling of price of natural gas with prices of oil assumption.

Hartley et al. (2008) observe the long-term relationship between WTI crude oil, residual fuel oil, natural gas prices with extended time series data. In addition, the effect of various external factors on the long-term relationship is investigated using the error correction model. It is determined that there is an indirect relation of natural gas, over residual fuel oil. Natural gas is in competition, with crude oil so there is cointegration between prices. But the effect of changes in oil prices on natural gas prices can't be mentioned as inversely. It is stated that short term shock changes have lost their effect in the long-term, and consequently sudden changes in crude oil prices as a result of various developments are reflected in natural gas same as residual fuel oil prices in the long-run.

They figure out that the weather conditions, inventories and other seasonal factors solely affect disequilibrium in the short-run.

Neumann (2009) deliberates the increase in the trade of LNG and the integration by observing the European natural gas market and North American natural gas market prices. She concludes an increasing convergence of spot prices. She stresses that of the three major regional natural gas markets. Europe, North America and Asia have integrating faster by implementing the Principal Components Analysis and integration process. Additionally, she concludes that European and North American natural gas markets within their own region are highly integrated; European and Japanese natural gas markets are highly integrated; North American natural gas markets are not integrated with European and Japanese natural gas markets.

Masih et al. (2010) aim to define the relationship between dynamics of pricing of natural gas and the factors determining the prices of methanol. According to them, it is important to determine the price of methanol because it is formed by the price of natural gas or by demand. According to the results obtained with the simple Error Correction Model, prices of natural gas determine methanol prices in the USA and Europe, but this situation is not valid in the Far East.

Brown et al. (2010) and Pettersson et al. (2012) review the linkage between crude oil and natural gas prices in the perspective of policy implications. According to them, changes to this relationship should be assessed for revising those policy implications.

Manzoor and Seiflou (2011) examine the relationship between natural gas prices, crude oil prices and coal prices in the long-term by using ARDL Model for analysis of cointegration. They find a relationship in the long-term between these three commodities in energy market of the US however natural gas prices do not have a significant effect on oil prices in the short term.

Regnard and Zakoïan (2011) determine the cointegration in the long-term between Zeebrugge market natural gas prices and Brent oil prices for the European gas market and approve that prices of natural gas can be predicted by the prices of oil.

Erdős (2012) operates VEC model for investigating the price spillover between oil prices and natural gas prices in the US market, Asian market and European market. He used

the model also with questioning if the decoupling from oil indexation mechanism is perpetual or not. He reviews the relationship between oil and natural gas prices by means of WTI oil price, Henry Hub natural gas price and NBP natural gas price. He proposes the co-movement between natural gas and oil is effective between 1997 and 2008. He realized that when exports of the US from Europe occur because the US natural gas prices were higher in the short-run They are related until 2009, when there is a surplus in the US market and inadequacy of supply variation in Europe, in the long-run. Additionally, he states that after 2009, natural gas prices in the UK continued to depend on oil prices, while the US relationship ended. Furthermore, the lack of supply of shale gas to the Atlantic basin gas market due to the lack of liquefaction and export capacity also has an impact on the divergence of US and UK natural gas prices.

Ewing et. al. (2012) highlight that prices in variant energy markets tend to get associated. Moreover, they emphasize that between different markets, volatilities of the prices are transferred to each other consequently.

Ramberg and Parsons (2012) criticize the numerical analyzes conducted in the studies in the literature. They questioned whether there is a cointegration between oil prices and natural gas prices. The argue that the VEC models implemented in the cointegration. They show that the VEC models typically applied in the cointegration basis do not execute well in describing short-term natural gas price establishments. It is stated that the cointegration determined between oil and natural gas prices is in short-term and it is not possible to reach a clear result because of the high volatility in short-term prices. In addition, the recent increase in shale gas production in the US, the expansion of free markets developing gas-to-gas competition in Europe and the decline in the interest in oil price indexed natural gas contracts are expected to differentiate among the oil prices and natural gas prices.

Akgül and Burucu (2013) try to determine whether a relationship between oil prices and natural gas in Turkey exists with Granger causality test. With the cointegration test, it is concluded that the variables are cointegrated and therefore there is a long-term relationship between them. A causal relationship has not been established between natural gas prices and oil prices for Turkey as a result of Granger causality test application.

Asche et al. (2013) examine the level of integration of European natural gas markets, German contract price and oil prices. After the liberalization of the European natural gas market, spot markets were established in the UK, Belgium and the Netherlands while the long-term contracts in Europe continued to dominate. As a result of Johansen Cointegration Test conducted, there is an integrated natural gas sector in Europe independent of long-term contracts or free market prices and these contract prices are determined by oil prices.

Atil et al. (2014) assess the effect of oil prices on gasoline prices and natural gas prices with NARDL Model using Henry Hub natural gas price data. They point out that natural gas and gasoline prices are adjusted to variations of oil price, but natural gas prices are adjusted to variations of oil price with a slower pace than gasoline prices while attributing this fact to regional character of natural gas. In other words, gasoline and natural gas prices are affected by prices of oil via a nonlinear and asymmetric fashion. Additionally, it is evaluated that the findings obtained as a result of empirical studies examining the price relationship should be considered in the decision-making processes.

Brigida (2014) reclaims with modelling explicitly the time varying cointegration between oil prices and natural gas by implementing a Regime Switching Model and accepting multiple regimes by allowing cointegrating vector shift. He determines that in the beginning of 2000s while oil prices and natural gas prices cointegrating, a state-dependent regime switching mechanism and an impermanent shift occurs rather than an enduring decoupling.

Ji et al. (2014), study the pricing and relationship between natural gas prices and oil prices in the North American market, European market, and Asian market. These markets are remarkably influenced by the shale gas phenomenon and Fukushima nuclear power plant accident from the regional perspective. They find that natural gas prices are solely affected by oil prices in European natural gas market and solely affected by global economic factors in American natural gas market. Additionally, they infer that the region of the market is important on the variance of the effect of volatility of oil prices on import prices of natural gas. Moreover, find that decrease in oil prices is influences natural gas prices more than it increases.

Lin and Li (2015) assert the spillover effect concerning Japanese, European and American natural gas and oil markets by means of moments of mean value and volatility.

They endorse the cointegration in Japanese and European markets while asserting the decoupling in the American market. Additionally, they explain this fact with the oil-indexed natural gas contracts in Japanese market and European markets while American market has specific market essentials for the formulation of price. This spillover effect is through oil price to natural gas price.

Geng et al. (2016a) mention that Brent oil prices and WTI oil prices has a noteworthy effect on Henry Hub natural gas prices and NBP natural gas prices correspondingly. After the US shale gas revolution this relation is altered as WTI affecting less whereas European natural gas market still affected by the volatility of oil price. They bring up that the comparative prices of natural gas and crude oil prices track a "state-dependent regime-switching model" and they decoupled in the medium-term and long-term with empirical evidences. Moreover, there are two directional ancillary spillovers of volatility between oil prices and natural gas prices. They add that European natural gas pricing mechanism may draw away from getting affected by the oil prices if European countries differentiate the supply sources and formulas of pricing.

Asche et al. (2017) provide the information that there is a cointegration on Brent oil prices and the UK natural gas prices within a regime switching framework. In addition, they emphasize that during fall and beginning of winter months, there is a tendency to decouple in natural gas prices, when the gas specific pricing becomes major because of the demand increase for heating.

Batten et al. (2017) emphasis the dynamic relation between natural gas market prices and oil market prices. Additionally, they indicate that even before there is a causality from natural gas markets to oil markets, after 2007 the two markets are decoupled from each other. These markets can't be used for hedging as substitutes because of the gas on gas price mechanism in the US market and the shale gas revolution.

Caporin and Fontini (2017) indicate that there is a structural break in the relation between oil prices and natural gas prices by the shale gas revolution. They affirm that after the global financial crisis in 2008 the relation among oil and natural gas prices in the long-term start to exhaust and thus in general it surpasses the effect of the shale gas.

Zhang et al. (2017) figure out that the low oil prices corresponding to shifting essentials are also a reason causing structural breakdown in the oil and natural gas price relationship beyond the global financial crisis in 2018.

Ramberg et al. (2017) try to figure out if there is a decoupling between oil and natural gas prices with empirical tests. The motive behind the analysis is the detected price upheaval in oil markets and natural gas markets with the obvious deviation in the price of them.

Liu and Li (2018) examine the popular opinion that prices of natural gas are driven by prices of crude oil, shale gas has considerably suppressed the prices of crude oil.

Zhang and Ji (2018) examine the dynamic relations of prices of natural gas in three different markets with the price of Brent oil by implementing a method named long-memory approach. They figure out the decoupling in prices of European and Japanese markets are nonpermanent.

2.3.5 Oil-Indexed vs. Hub-Based Natural Gas Contracts

As mentioned before, markets and countries have frequently used oil-indexed methods for natural gas supply for decades and this method continue to be used in many regions. On the one hand, there is an intense effort to switch to the hub-based pricing method in regions that take serious steps to ensure favorable conditions. The most decisive factor in this regard is that especially the demand side contractors are now in search of short-term systems. It is important to mention that even systems determined instantly depending on the supply-demand balance. In the following part, some important academic literature on the subject is reviewed in historical manner.

Stern (2014) questions as an opposition to the oil-indexation in natural gas pricing that whether oil indexation is appropriate because it does not neglect the essential features in the natural gas. Additionally, he suggests forming the East Asian hubs to create benchmark prices which would bring forth the natural gas market essentials of East Asia as a substitute to oil indexation.

Tong et al. (2014) claim that the Asian premium is caused by the oil indexation mechanism and they suggest local benchmark price developments through hubs for substituting oil indexation mechanism and lessen the Asian premium power. Moreover, they

state that the natural gas pricing system based on oil indexation is started to be criticized which was very applicable until 1990s.

According to Shi and Variam (2016), price of natural gas is adjusted by supply and demand in the natural gas market by the natural gas hub price. Moreover, they verify that Asian premium is not affected by the destination constraints that are aimed to maintain the LNG supplies.

Stern (2016) suggests collaboration within the Asian consumers to support the hub-pricing mechanism progression for substituting oil-indexation mechanism and he offers generating benchmark prices to express regional market of East Asia essentials by forming East Asian natural gas trading hubs.

Shi and Variam (2017) explain that some East Asian countries such as China, Japan and Singapore have been working on establishing their own standard gas prices for hub pricing. These three countries are exchanging natural gas among each other and Singapore has its own LNG price indexes with the emergence of the new markets. Although there is criticism about hub-based pricing system, they also support for such gas hubs in East Asia. In order to replace oil indexation, they propose gas trading hubs in East Asia that would reflect the fundamentals of the regions own market dynamics. Oil prices in European and Japanese markets have increased significantly despite historically low prices in American market. This creates concerns for the governments and producers in the applicability of transitioning from oil indexation to pricing hubs.

Shen et al. (2018) come up with the idea that even in the mechanism of hub-based pricing, market risks that are very high so that it can diffuse to the natural gas prices.

Zhang et al. (2018) point out that because of the natural gas hub price is disposed by demand and supply in the market, it should better reveal the essential natural gas prices. They assert that European and Japanese natural gas prices still rely greatly on the oil price, but they began to decouple potentially especially after Global financial crisis in 2008.

3 METHODOLOGY

In this chapter, it is provided that the research methods followed in the study and detailed information on the data and the econometric techniques that have been used. Also, the research design that was chosen for the purpose of this study is explained and the reasons for this choice are given in this chapter of the thesis. The instruments that were used for data collection is explained and the procedures that were followed to carry out this study are included with the methods used to analyze the data after fore.

3.1 Variable Determination and Data Explanation

In this thesis, time series data for nominal energy prices and macroeconomic variables are used for the empirical analysis and they are presented in Table 3.1 including their sources. The energy commodity variables used in this thesis are Fuel Oil 3.5% Sulphur Price, Brent Oil Price, Fuel Oil 1% Sulphur Price, Gasoil Price, National Balancing Point Price, Henry Hub Price, TTF Price, LNG Price, Turkey LNG Landed Price, Russian Natural Gas Border Price in Germany. These variables are initially selected for Turkey in particular by examining many variables that could affect the natural gas contract price between importer and exporter countries. Firstly, the actual natural gas contract formulas used in Turkey and the world are taken into consideration while determining those variables. Besides, the path Turkey should follow when negotiating the natural gas contracts with other countries and alternative pricing formulas are intended to be suggested for the coming period. A comparison was made between the current contract formula and the proposed alternative contract formulas and a proposal was projected accordingly. For this reason, the energy commodity variables used in the analysis are designated from the current contract, the determinant variables that will affect pricing in Europe and in the world. Also, upon examination of the relationship between production and natural gas prices in Turkey, alternative natural gas pricing formulization has been put forward. In addition, the relevant macroeconomic data which can be stated as Industrial Production Index of Turkey, Consumer Price Index of Turkey, USD/TRY Exchange Rate, EUR/TRY Exchange Rate, CBRT Interest Rate were included in the model in terms of other factors affecting production and finally the analysis was performed.

The sources used to gather data are Refinitiv EIKON for Fuel Oil 3.5% Sulphur Price, Brent Oil Price, Fuel Oil 1% Sulphur Price, Gasoil Price, National Balancing Point Price,

Henry Hub Price, TTF Price, LNG Price, Turkey LNG Landed Price; IMF Cross Country Macroeconomic Statistics for Russian Natural Gas Border Price in Germany; Federal Reserve Economic Data (FRED) for Consumer Price Index of Turkey; TURKSTAT for Industrial Production Index of Turkey; The US Energy Information Administration (EIA) for Brent Oil Price; CBRT Electronic Data Delivery System (EVDS) for USD/TRY Exchange Rate, EUR/TRY Exchange Rate, CBRT Interest Rate. The time span of whole quarterly data are between first quarter of 1999 and fourth quarter of 2018; the time span of whole monthly data are between January of 1960 and December of 2018. The quarterly Consumer Price Index of Turkey data series is obtained as taking the average of each three months data series. The energy prices were taken quarterly because the price formula is being reviewed in every three months periods by the authorities. Also, all the price data used in the analysis are in USD.

Table 3.1. Variables of time series used in the analysis with the source of data obtained

Variable	Abbreviation	Variable	Abbreviation
Refinitiv EIKON:		Federal Reserve Economic Data (FRED):	
Fuel Oil 3.5% Sulphur Price	**FOHIGHP**	Consumer Price Index of Turkey	**CPI**
Brent Oil Price	**BRENTP**		
Fuel Oil 1% Sulphur Price	**FOLOWP**		
Gasoil Price	**GASOILP**	US Energy Information Administration (EIA):	
National Balancing Point Price	**NBPP**		
Henry Hub Price	**NGOP**	Brent Oil Price	**BRENTM**
TTF Price	**TTFP**		
LNG Price	**LNGP**	TURKSTAT:	
Turkey LNG Landed Price	**TURLNGP**	Industrial Production Index of Turkey	**IP**
IMF Cross Country Macroeconomic Statistics:		CBRT Electronic Data Delivery System (EVDS):	
Russian Natural Gas Border Price in Germany	**GERNGP**	Basket of USD/TRY and EUR/TRY	**BASKET**
		CBRT Interest Rate	**INTEREST**

3.2 Method

In this part, the relevance of the data and the econometric techniques used in empirical part of the study are explained in detail.

3.2.1 Unit Root and Stationarity Tests

In this thesis, Unit Root Tests are implemented for testing the stationarity of the time series data used for determining the alternative Natural Gas Contract Prices with Factor

Analysis and making analysis with those variables. Investigating the stationarity of a series is essential as a first step when standard test procedures and estimates in the dynamic time series model are used because most econometric techniques for time series are developed on the consideration of that time series' variables are stationary. The time series indicate a regular pattern that is unpredictable if a time series has a unit root and a unit root is a stochastic trend in a time series. Moreover, it's called a unit root is because of the mathematical procedure behind the method. Primarily, a course can be transcribed as a series of monomials and each monomial resembles to a root what if one of these roots is equal to one then it is called a unit root. A stationary series may be expressed as one with a constant mean, constant variance and constant autocovariance for each given lag. For testing, the most common ones are Augmented Dickey-Fuller (ADF) Test, Phillips-Perron (PP) Test and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Test. In this thesis; ADF Test, PP Test and KPSS Test are applied to verify the property of the data. One can refer to Enders (2015, p. 206-243), Gujarati (2015, p. 250-266), Brooks (2014, p. 361-364) for more details beyond the original studies about the mentioned tests.

3.2.1.1 Augmented Dickey-Fuller (ADF) Test

ADF Test that is primary and innovative effort for investigating the existence of a unit root in a time series data was developed by Dickey and Fuller (1979) and substantially branches into three types which are:

(i) with none

$$\Delta y_t = \phi^* y_{t-1} + \sum_{i=1}^{p-1} \phi_i y_{t-i} + u_t \quad (1)$$

(ii) with constant

$$\Delta y_t = \beta_0 + \phi^* y_{t-1} + \sum_{i=1}^{p-1} \phi_i y_{t-i} + u_t \quad (2)$$

(iii) with constant and deterministic time trend

$$\Delta y_t = \beta_0 + \beta_1 t + \phi^* y_{t-1} + \sum_{i=1}^{p-1} \phi_i y_{t-i} + u_t \quad (3)$$

where y_t denoted as the value of a variable where t is a linear time trend; Δy_t denotes the difference between y_t and y_{t-1} ; β_0 denotes the constant term; u_t denotes an error term.

The main idea of this test is to investigate the null and alternative hypotheses in above equations (i)-(iii) that the time series contains a unit root in other words non-stationary if the null hypothesis is accepted (H_0: $\phi^* = 0$) or does not contain unit root in other words stationary if the null hypothesis is rejected (H_1: $\phi^* < 0$).

The t-statistic $\tau = \frac{\widehat{\phi^*}}{\sqrt{var(\widehat{\phi^*})}}$ should be calculated in order to test for the occurrence of a unit root where $\widehat{\phi^*}$ is the estimate of ϕ^* and $\sqrt{var(\widehat{\phi^*})}$ is the coefficient standard error and compare it with the related critical value at various significance levels.

3.2.1.2 Phillips-Perron (PP) Test

The PP Test is a Unit Root Test developed by Phillips and Perron (1988) which is used in time series analysis to test the null hypothesis by $\phi^* = 1$ in $\Delta y_t = (\phi^*)y_{t-1} + u_t$ which is based on the DF Test and investigates whether a time series is integrated of order 1 or not. The PP Test indicate that the originating data progression for y_t may possibly have a higher degree of autocorrelation whence is stated in the equation of the test making y_{t-1} endogenous likewise the ADF Test and therefore disconfirming the t-test of DF Test. Since the ADF Test conveys this matter with lags of Δy_t regressors in the equation of the test, a non-parametric correction for the t-test statistic is made by the PP Test via adjusting the ϕ* coefficient's t-ratio so as to serial correlation does not influence the test statistic's asymptotic distribution pattern. Therefore, the PP modified t-ratio's asymptotic distribution is a like of the ADF statistic. When there is an autocorrelation and heteroscedasticity problem in the error terms as mentioned by Guidolin and Pedio (2018) it is robust. Any heteroskedasticity and serial correlation in the error terms of u_t of the test regression is adjusted by the PP Test via revising the test statistics $t_{\phi^*=0}$ and $\widehat{\phi^*}$. Aforementioned modified statistics, denoted as Z_t and Z_{ϕ^*}, are given by following equations;

$$Z_t = \sqrt{\frac{\hat{\sigma}^2}{\hat{\lambda}^2}}\, t_{\widehat{\phi^*}} - \frac{1}{2}\left(\frac{\hat{\lambda}^2 - \hat{\sigma}^2}{\hat{\lambda}^2}\right)\left(\frac{\sqrt{var(\widehat{\phi^*})}}{\hat{\sigma}^2}\right) \quad (4)$$

$$Z_{\phi^*} = n\widehat{\phi^*} - \frac{1}{2}\left(\frac{n^2\sqrt{var(\widehat{\phi^*})}}{\hat{\sigma}^2}\right)(\hat{\lambda}^2 - \hat{\sigma}^2) \quad (5)$$

where $\hat{\sigma}^2$ and $\hat{\lambda}^2$ are variance parameters' consistent estimates that are;

$$\sigma^2 = \lim_{n\leftarrow\infty}(n)^{-1}\sum_{t=1}^{n}E({u_t}^2) \quad \lambda^2 = \lim_{n\to\infty}E(\frac{1}{n}\sum_{t=1}^{n}{a_t}^2)$$

3.2.1.3 Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Test

Kwiatkowski, Phillips, Schmidt, and Shin (1992) proposed an alternative test which is a stationarity test differing from the ADF and PP Unit Root Tests with the distinctive factor that KPSS Test's null hypothesis is operated by the time series is stationary against the alternative hypothesis of a unit root to avoid the limitation that ADF test always has a low power. This stationarity test is derived by using the Lagrange Multiplier test statistic. The test statistic can be calculated for the conditions that are with constant or with constant and deterministic time trend as follows:

i) with constant

$$y_t = \alpha + u_t \tag{6}$$

ii) with constant and deterministic time trend

$$y_t = \alpha + \beta t + u_t \tag{7}$$

The dependent variable y_t should be regressed on a constant or a constant and a time trend t firstly. After that the partial sums which is $s_t = \sum_{s=1}^{t} u_s$ should be calculated for all t with the OLS residuals u_t. Moreover, the test statistic for the regression above is:

$$\text{KPSS LM} = T^{-2}\sum_{t=1}^{T}\frac{s_t^2}{\hat{\sigma}_u^2} \tag{8}$$

where $\hat{\sigma}_u^2$ is the estimated error variance which is a weighted average of the sample autocovariances obtained from the regression (Verbeek (2017)).

3.2.2 Factor Analysis

In this thesis, by using Factor Analysis we define the variables, among many, which have the most importance on the alternative Natural Gas Contract Price Formulas and the

Natural Gas Contract Price between Turkey and Russia that we generate for analysis. The overall idea behind the Factor Analysis method is to summarize the gathered data for to interpret and investigate the patterns and the relationships. According to Bartholomew, Knott and Moustaki (2011), Factor Analysis utilizes with the concept that empirically observed variables may be reduced to lesser latent variables or so called reducing the dimensionality which are unobservable and assign a mutual variance. Cattell (2012) states that the said unobservable factors are fundamentally hypothetical concepts that are used to signify variables, but they are not measured directly. Here, we will give attention on the necessary mathematical approach among several ways of articulating the theoretical concepts of Factor Analysis method. The mathematical approach is as follows;

In the model mentioned by equation (9), there are m factors. The variables are X_1, X_2, …, X_p where we assume there are p number of variables. Also, there are m number of latent factors denoted by F_1, F_2, …, F_m and X_j denotes the variable represented in latent factors and aims to replicate the maximum correlations. Moreover, a_{j1}, a_{j2}, …, a_{jm} denote the factor loadings where the first one a_{j1} is the factor loading of the jth variable. The unique factor is denoted by the variable e_j.

$$X_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jm}F_m + e_j \quad \text{where j= 1, 2, …, p.} \tag{9}$$

Harman (1976) states that the factor loadings suggest about the contribution level of the variable's contribution to the factor that the greater the loading factor means the greater contribution of the variable to that factor. For multiple regression analysis, factor loadings and weights are similar according to Kline (1994), which both describe the degree of association between the factor and the variable. Jöreskog and Sörbom (1979) suggest that, in order to understand how the method of factor analysis functions, it is intended to evaluate the factors for each X_i and X_j pair that the partial correlation between the tests is insufficient when obtained, which implies that the partial correlations are zero for all pairs. Therefore, it aims to investigate for factors that when collected, no intercorrelations are left between whatever the couples X_i and X_j as the factors themselves will be counted among the intercorrelations and this causes X_i, X_j, …, X_p, pairs assumed to be conditionally independent. The factor loadings were evaluated to investigate which variables load on which factors after the matrix of correlation is calculated. According to McDonald (1985), Factor Analysis may be stated via the equation of $R = PCP' + U^2$ that R denotes the matrix of correlation coefficients; P denotes loading matrix; P′ denotes the transpose of the loading

matrix; C denotes the matrix of correlations among common factors; U^2 denotes the unique variances or diagonal matrix. Rummel (1970) points out that the common variance is obtained by subtracting U^2 from R. F_{mxp} is resolved by specifying the matrix's eigenvalues and eigenvectors and principally this equation explains linear combination of which common factors is of which of the variables.

3.2.3 Vector Autoregression Model and Near-Vector Autoregression Model

Vector Autoregression (VAR) Model approach was originated by Cristopher Sims in the study Sims (1980) by characterizing an alternate to the commonly used econometric techniques during that period of time and moreover stated that VAR is a very useful instrument for analyzing patterns in economic or financial time series to forecast the future values, policy analysis, structural inference and it is superior compared to the model of single equation [see Berument, Togay and Şahin (2010) for an application of VAR to monetary policy for instance] because the VAR Model lets dynamic relations amongst variables and the VAR Model has more analytical supremacy.

VAR Model consists of several equations which are based on Ordinary Least Square (OLS) regression models. Within this model, all the variables are correlated with their lags and the other variables, so all the variables are assumed to be endogenous. The VAR Model can be stated analytically by equation (10):

$$Y_t = A_0 + A_1 Y_t + \cdots + A_i Y_{t-i} + BZ_t + u_t \qquad \text{(where t = 1, …, N)} \qquad (10)$$

where Y_t denotes an endogenous variables vector; Z_t denotes an exogenous variables matrix; A_i and B denote coefficient matrices that i denotes lag length; u_t denotes zero-mean and constant variance for error terms. Hamilton (1994, p. 291 and 323) explains the VAR Model deeply by considering its theoretical roots.

In a VAR Model, ordering the variables and considering their endogeneity properties are essential and Cholesky Ordering is widely benefitted for this purpose. Consequently, the level of the exogeneity of the variables in comparison with other variables in the model is revealed by the ordering. In another saying, the first ranked variable should be the one that is not affected by the progression of others whereas the lower ranked variables should be vice versa. One of the important issues that should be emphasized is only in the Cholesky

ordering a theoretical information is used via VAR Model and another is that the steadiness of VAR Model is enhanced by supplementary lags consequential to variances in the Cholesky ordering. Furthermore, Lütkepohl (2007, p. 135 and 153) explains VAR order selection methods in detail and compares them.

Furthermore, in this thesis, VAR Model with block exogeneity is used since in conventional VAR Model that dependent variables are affected by the related variables including lag values. This issue is resolved with the help of block exogeneity. VAR Model with a restriction of block causality is an austere generalized restriction of Granger causality where a variable does not Granger cause to another variable if the lagged values of the former do not considerably influence the latter's current values and the restrictions also enables the former variable to influence the latter at the same time. Likewise, block causality imposes in a VAR Model system that past values of a group of variables do not influence another group's current values. Alternatively, block exogeneity in a VAR Model infers that current and past values of a group of variables do not influence another group's current values. Therefore, the first group's variables are block exogenous to the second group's variables. The concept of block exogeneity in terms of VAR Model context is examined by Hamilton (1994, p. 309 and 312) in detail.

A Near-Vector Autoregression (Near-VAR) Model is used for analyzing the effect of macroeconomic shocks in this thesis. Near-VAR Model runs an extension of standard VAR approach is employed because it does not enforce the same lag lengths in all the equations in the system. In other words, for letting the lag lengths differ across the equations, the Near-Var Model is used for estimation. The Near-VAR Model, which is analogous to the Structural Vector Autoregressive (SVAR) Model initially offered by Cushman and Zha (1997), is operated in this thesis and it offers the possibility to integrate economic constraints which affect the parameter of lagged regressors and with this avoiding double-counting the effect of interaction effects between the variables when compared to Standard VAR Model introduced by Sims (1980). This issue becomes very important if the model relies on data at different levels. In the Near-VAR Model, there are two blocks parted as an exogenous block whose variables may influence the other variables of the model and a second block of endogenous variables which do not enter the equations of the first block while in the Standard VAR Model all the estimated variables are endogenous and treated as functions of lagged values of all the endogenous variables. According to Lütkepohl (2007), Ordinary

Least Square (OLS) Method gives consistent estimates while operating a Near-VAR Model system. However, specific potential gain comes from Seemingly Unrelated Regressions (SUR) estimator proposed by Zellner (1962) and that is the purpose why SUR is used rather than OLS in this thesis as explained in the following part.

According to the seminal work by Zellner (1962) and from a comprehensive perspective by Srivastava and Giles (1987), a SUR system involves many distinctive relationships connected with the fact that their residuals are correlated in various applications whereas the correlation between residuals that come from several sources. However, additional constraints lead to constraints on the parameters of different equations. SUR is used for two main reasons. The first is to achieve estimation effectiveness by integrating information on various equations or in other words the SUR system allows us to increase the efficiency during the phase of parameter estimation. And, the second one is to examine the constraints in various equations that parameters are included.

Cushman and Zha (1997)'s identified VAR model can be specified generally with an implicit representation of equation (10) as;

$$A(L)Y(t) = \mathrm{u}(t) \tag{11}$$

Where in equation (11); $A(L)$ denotes a $n\ x\ n$ matrix polynomial by a given lag operator L; $Y(t)$ and $\mathrm{u}(t)$ are the $n\ x\ 1$ vectors of observations and structural disturbances respectively. Equation (12) given below shows the identification of the model with two variables.

$$Y(t) = \begin{bmatrix} Y_1(t) \\ Y_2(t) \end{bmatrix}, A(L) = \begin{bmatrix} A_{11}(L) & A_{21}(L) \\ A_{21}(L) & 0 \end{bmatrix}, \ \mathrm{u}(t) = \begin{bmatrix} \mathrm{u}_1(t) \\ \mathrm{u}_2(t) \end{bmatrix} \tag{12}$$

In the equation, it is assumed for j > 0 that u(t) is uncorrelated with $Y(t-j)$ and the coefficient matrix $A(0)$ is non-singular. $A_{22}(L)$ represents the Block exogeneity in the matrix that is zero. The dimensions of the matrices which for $A_{11}(L)\ is\ n_1\ x\ n_1$, $A_{21}(L)$ is $n_2\ x\ n_1$, $A_{22}(L)$ is $n_2\ x\ n_2$, $Y_1(t)$ is $n_1\ x\ 1$, $Y_2(t)$ is $n_2\ x\ 1$, $\mathrm{u}_1(t)$ is $n_1\ x\ 1$, $\mathrm{u}_2(t)$ is $n_2\ x\ 1$ and $n_1 + n_2 = n$ and indicate that $Y_1(t)$ is exogenous mutually for concurrent and lagged values to the second block. On behalf of estimating the Near-VAR Model's efficient parameters, the SUR Model is used, which is the generality of a model of linear regression

consisting of numerous equations of regression those respectively with its specific dependent and unalike exogenous explanatory variables.

3.2.4 Historical Decomposition and Impulse Response Functions

The Near-VAR Model is utilized to develop Historical Decompositions (HD) and Impulse Response Functions (IRF) to observe and interpret the related data in this thesis. Even the Historical Decomposition Method is employed less frequently than IRF and Variance Decompositions which are all constructed on the model's moving average representation, the Historical Decomposition is an extensively explanatory output (Wheeler and Chowdhury, 1993). The main notion of the issue is that in the VAR Model all variables may be broken up fully into the impact of the different shocks and an exogenous component which is referred to as the baseline projection. In other words, the original time series at time t would be recovered when the contribution of all the shocks at any time t summed up together with the baseline projection. The Historical Decomposition is a contrary to fact where one examines how differently would variables have evolved if particular histories of shocks have instead occurred. Examples of prominent empirical applications using the Historical Decomposition as the primary tool to figure out the significance of specific shocks during certain historical periods are Burbidge and Harrison (1985) and Kilian (2009). Moreover, Burbidge and Harrison (1985) and McMillin (1988) indicate that the concern amongst the base projection and the actual data as that to what degree the shocks for a particular variable close the gap between the base projection and the actual data is a measure of the significance of this variable.

IRFs demonstrate the predictable response of each variable in the system to a shock at one of the variables in the system and used to establish the direction of the association between two variables. To guarantee enough degrees of freedom in small samples only the appropriate lags of the dependent variables in each equation have been kept, which is known as a Near-VAR Model. In this thesis, Monte Carlo simulation is used for computing confidence bands or standard errors for impulse responses.

On behalf of constructing the orthogonal residuals for orthogonalizing the residuals in the Near-Var model for computing HDs and IRFs. It is required that Near-VAR Model's variables ought to be ordered in a certain fashion in the Cholesky Decomposition. Accordingly, when a higher ranked variable in the ordering varies then all lower ranked

variables in the ordering are acquired to vary owing to residual correlation of cross-equation where the level of the variation depends on the level of the correlation of residual.

The Near-VAR Model's moving average demonstration may be given as in the following:

$$Y_t = \sum_{i=0}^{\infty} Z_i \, u_{t-i} \tag{13}$$

where Y_t denotes a of endogenous variables vector; u_{t-i} denotes a serially uncorrelated residuals vector alongside a diagonal covariance matrix; Z_i denotes an impulse response weights matrix appropriate for Y and u.

And the matrix Z_i in equation (13) has the interpretation as:

$$Z_i = \frac{\partial Y_t}{\partial u'_{t-j}} \quad \text{or} \quad Z_i = \frac{\partial Y_{t+j}}{\partial u'_t}$$

For Historical Decomposition, the value of Y in after *t* period by considering a base period projection that operates from observation one to *t* may be written as follows:

$$Y_{t+j} = \sum_{i=j}^{\infty} Z_i \, u_{t-j-i} + \sum_{i=0}^{j-1} Z_i \, u_{t+j-i} \tag{14}$$

The first part of the equation (14) that is $\sum_{i=j}^{\infty} Z_i \, u_{t-j-i}$ denotes the base projection or in other words forecast of Y_{t+j} based upon shocks to the system's variables up to time t. The second part of the equation (14) that is denoted by $\sum_{i=0}^{j-1} Z_i \, u_{t+j-i}$ justifies the shocks after time *t* and it is benefited to define that how much the gap amongst Y_{t+j} and the first part is closed by the shocks to a specific variable. The significance of a variable is investigated by the degree to which residuals in this variable after *t*, close the gap amongst the actual series and base projection. HD technique is usually illustrated with graphs to visualize for observations of time series.

For Impulse Response Analysis with using equation (13) for the moving average representation of the Near-VAR, IRF with the reaction of Y_{it+j} to a one-time impulse in Y_{t+j} ceteris paribus with all other variables dated t or earlier can be written as:

$$Y_{t+j} = \sum_{i=0}^{\infty} Z_i \, u_{t+j-i}$$

$$Z_{i,k} = \frac{\partial Y_{it+j}}{\partial u'_{kt}} \tag{15}$$

The reaction of variable *i* to a unit shock or in other words forecast error in variable *k* is sometimes represented graphically for developing a visual insight of the dynamic interrelation within the model as benefited in this thesis. The estimation of parameters is executed with SUR Model by Zellner (1962).

4 EMPIRICAL RESULTS AND DISCUSSION

In this chapter, the empirical results obtained from the econometric techniques described in the methodology chapter are examined. Moreover, these results are assessed in order to get an insight via the findings upon the hypothesis of the thesis.

Table 4.1 reports the results for ADF Test, PP Test and KPSS unit root tests and shows level of significance at 1%, 5% and 10% but results interpreted for only 1% significance level in the text. They are all implemented for the variables: The quarterly contract price data of several time series (see Table 3.1) as Fuel Oil 3.5% Sulphur, Brent, Fuel Oil 1% Sulphur, Gasoil, National Balancing Point, Henry Hub, TTF (Title Transfer Facility), LNG (Liquefied Natural Gas), Russian Natural Gas Border Price in Germany, Turkey LNG Landed. The lag length for ADF determined by Schwarz Info Criterion and the bandwidths for PP and KPSS lag length determined by Newey-West Bandwidth techniques. The prices are used in nominal levels and the Unit Root Tests implemented for nominal energy prices. As seen from Table 4.1, we reject the null hypothesis that the process has unit root in level with intercept for none of the variables with ADF Test and PP Test; Fuel Oil 3,5% Sulphur, Fuel Oil 1% Sulphur, Russian Natural Gas Border Price in Germany with KPSS Test at 1% level. Also, we reject the null hypothesis in level with intercept and trend for none of the variables with ADF Test and PP Test; Brent Oil, Gasoil, Henry Hub for KPSS Test at 1% level. Moreover, we reject the null hypothesis in the first difference with the intercept for all the variables with ADF Test and PP Test; Brent Oil, Gasoil, Russian Natural Gas Border Price in Germany with KPSS Test at 1% level. We can conclude that the null hypothesis is rejected at 1% level for ADF and PP Tests in first difference with intercept that interprets the first difference of all variables are stationary.

Table 4.1. Unit root and stationarity tests for nominal energy prices

Variable	ADF TEST			PP TEST			KPSS TEST		
	level (intercept)	level (intercept and trend)	first difference (intercept)	level (intercept)	level (intercept and trend)	first difference (intercept)	level (intercept)	level (intercept and trend)	first difference (intercept)
Brent Oil	-2.1642	-2.1892	-7.8807***	-2.0887	-2.1533	-8.2363***	0.6678**	0.2194***	0.1334***
Fuel Oil 1% Sulphur	-1.7925	-2.7534	-9.5045***	-1.7920	-2.9021	-10.4490***	1.0029***	0.1222*	0.0482**
Fuel Oil 3.5% Sulphur	-1.7130	-2.7409	-10.0647***	-1.6167	-2.6982	-11.0880***	1.0054***	0.1241*	0.0374
Gasoil	-2.1624	-2.2544	-7.4334***	-2.1504	-2.2995	-7.9329***	0.6813**	0.2198***	0.1130***
Henry Hub	-3.2752**	-3.2810*	-9.9832***	-3.1170**	-3.0944	-12.5546***	0.2758	0.2714***	0.1724
LNG	-2.4593	-2.6351	-6.3343***	-2.8925*	-2.8530	-6.3343***	0.1833	0.0619	0.0686
National Balancing Point	-1.8556	-1.2795	-3.9197***	-1.8614	-2.3792	-5.7832***	0.3083	0.1817**	0.4287*
Russian Natural Gas Border Price in Germany	-2.1848	-3.2150*	-7.2177***	-1.5260	-2.1502	-5.5049***	0.9476***	0.1402*	0.1073***
TTF	-1.8104	-1.8704	-5.1357***	-1.8129	-1.8704	-5.1357***	0.1823	0.1685**	0.1908
Turkey LNG Landed	-1.9878	-4.2335**	-2.3038***	-2.5281	-2.4810	-7.7700***	0.1501	0.1500**	0.0963

Note: 1) ***Indicates the level of significance at 1%. **Indicates the level of significance at 5%. *Indicates the level of significance at 10%. 2) Eviews 10 Software Package is used for generating the Unit Root Tests.

In this thesis, to forecast the Natural Gas Contract Price of Turkey, especially the contract price between Turkey and Russia, a Near-VAR Model is implemented. The variables for the Near-Var Model used in this thesis are taken in order as Natural Gas Price (NGP), Basket of USD/TRY and EURO/TRY Exchange Rates (BASKET), CBRT Interest Rate (INTEREST), Industrial Production Index of Turkey (IP), Consumer Price Index of Turkey (CPI) and the constant variable as Brent price (BRENTM). For the model, number of lags is two, the number of iterations is 10 000 and the parameters of the model obtained with Seemingly Unrelated Regressions (SUR) Model.

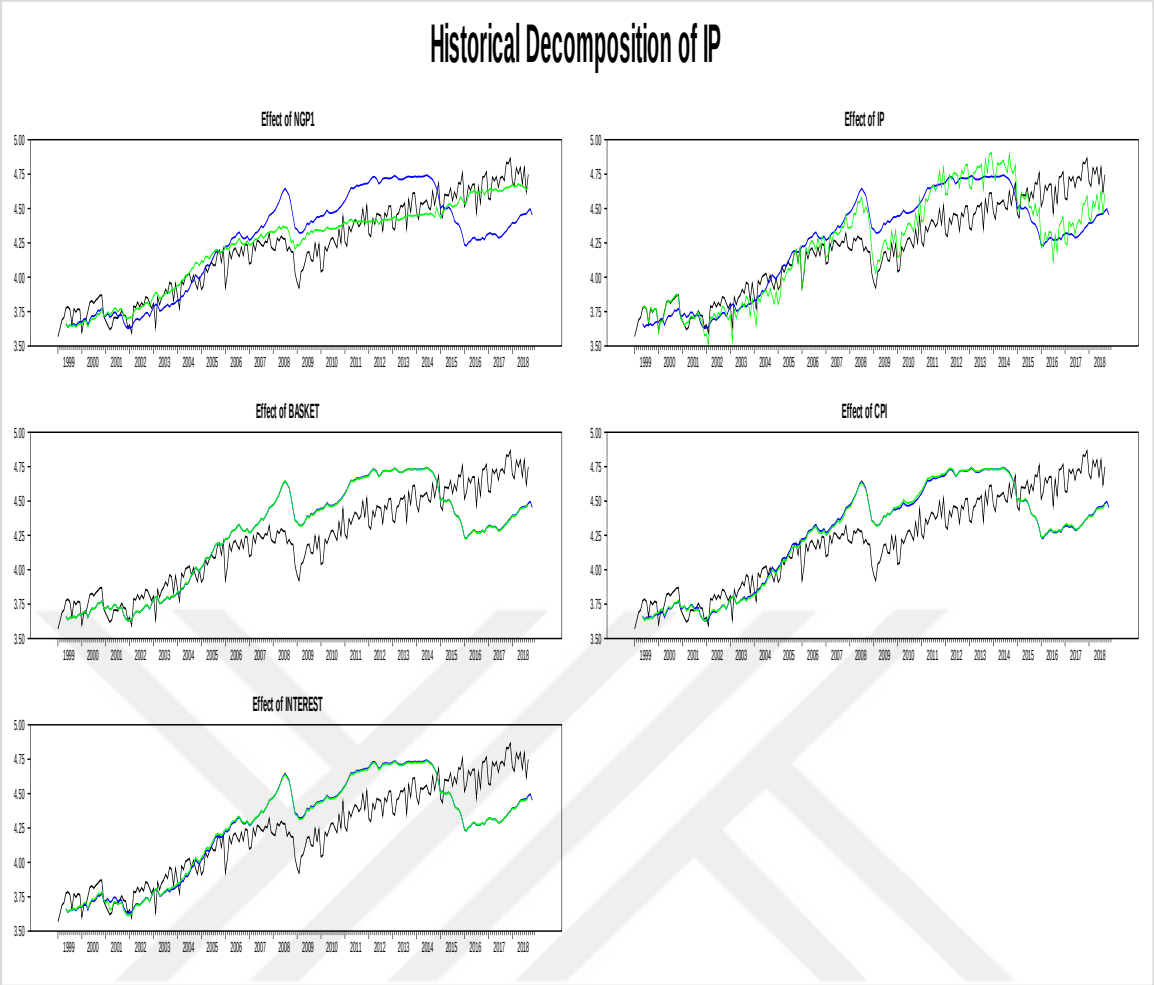
Factor Analysis Method is used in the thesis for determining the most important sets of variables from the several prices affecting the Natural Gas Contract Price, and the determined factor as Natural Gas Contract Price with those chosen commodity prices are used in the Near-Var Model. Different combinations of the various commodity prices are to be used for analysis in different scenarios.

The First Natural Gas Price (NGP1) is obtained with Fuel Oil 3.5% Sulphur Price and Brent Oil Price because the current Natural Gas Contract Price formula is relying on these variables according to the information given by the authorities. As it can be seen from Table 4.2, one factor is obtained with the help of the Factor Analysis. Also, NGP1 obtained is used for the Impulse Responses and the Historical Decomposition Analysis.

Table 4.2. Factor analysis of fuel oil 3.5% sulphur and Brent prices

	FACTOR		LOADINGS	
FACTOR	VARIANCE	PROPORTION	FOHIGHP	BRENTP
F1	1.7987	1.0000	**0.9483**	**0.9483**

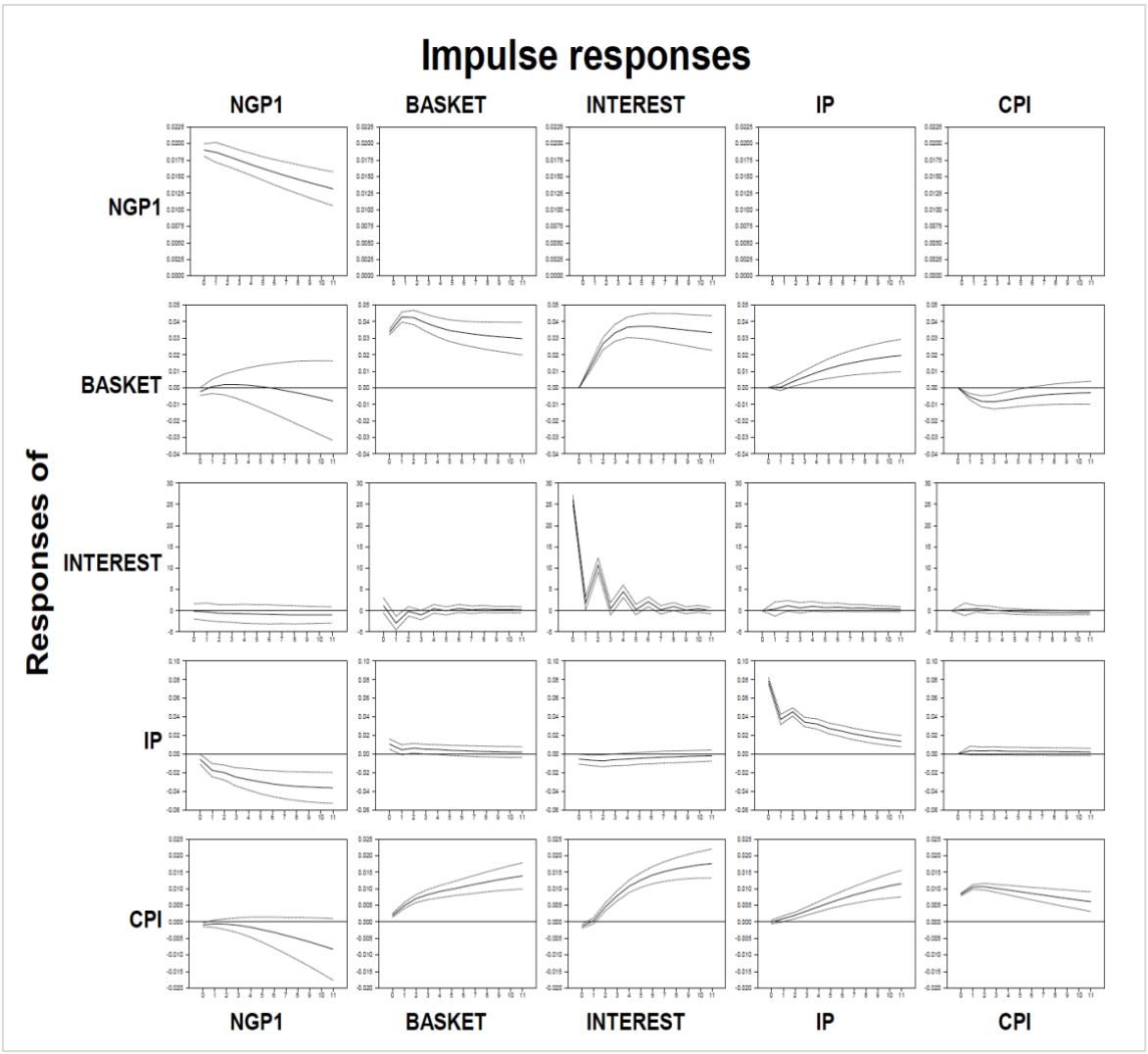
***** Eviews 10 Software Package is used for generating the Factor Analysis.



*RATS Software Package is used for generating the Historical Decomposition analysis.

Figure 4.1. Historical decomposition of industrial production for the first natural gas contract price

The color of the lines used in the Historical Decomposition graphs indicates that the black line is the actual data, the blue line is the base forecast and the green line is the base forecast plus the effects of the shock. The gaps between the blue and green lines summed across all five series add up to the gap between the blue and black lines. The gaps between the lines can take either positive or negative sign. In Figure 4.1, the cumulative effects of past and current shocks on the IP are expressed by Historical Decomposition. It turns out to be necessary for constructing a Historical Decomposition of the effect of each of the shocks on the variable to comprehend the cumulative effect of such a series of shocks. It is depicted from the figures that the historical fluctuations between the actual IP data and the base forecast of IP solely caused by the effects of NGP1 and IP itself. The gap in gas price is more noticeable after 2006. Especially in the period between 2006-2015, the gas price contribution increases IP while after 2015 decreases.



* RATS Software Package is used for generating the Impulse Responses.

Figure 4.2. Impulse Responses of First Natural Gas Contract Price, Basket, Interest Rate, Industrial Production and Consumer Price Index shocks

Impulse Response Functions trace out the responses of the dependent variable in the VAR system to the shocks given. And the dependent variable is a function of its lagged values of other variables in the model. In Figure 4.2, impulse and responses of First Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, CBRT Interest Rate, Industrial Production Index, Consumer Price Index to the shock given to each variable are illustrated. The solid line in the middle of the graphs shows the Impulse Response Functions and the other dashed ones are the confidence intervals. The shock given to the NGP1 increases the NGP1 itself in a decreasing manner. From the IP perspective the NGP1 shock decreases the IP increasingly up to tenth period and then continues to decrease in a constant manner and all periods are statistically significant. Furthermore, it can be seen from

Figure 4.2 that the other variables are statistically insignificant with the shock given to NGP1. When the other variables' responses to the shock investigated, BASKET firstly decreases until second period, increases until the sixth period and decreases again to end of the period. On the other hand, INTEREST decreases slightly and CPI decreases. It can be seen from the economic perspective; the response of IP is meaningful as it decreases steadily with the increase in NGP1.

Beyond the effect of NGP1 on IP, also the other reasons affecting IP should be investigated. In Figure 4.2 the response of IP to the impulses of BASKET, INTEREST, IP itself and CPI with one standard deviation shock can be investigated. It can be interpreted that a shock given to the BASKET increases IP until tenth period but it is statistically significant only from initial period to one; a shock on INTEREST decreases IP until eleventh period but it is statistically significant only from initial period to three; a shock on IP itself increases IP for all the periods and it is statistically significant; a shock on CPI slightly increases IP until eleventh period but it is statistically insignificant except the initial point.

The Second Natural Gas Price (NGP2) is obtained with National Balancing Point Price, Henry Hub Price, TTF Price and Russian Natural Gas Border Price in Germany because the natural gas prices in Europe and America are important benchmarks. Also, the natural gas prices in Europe is used for forming the spot prices. So, the related prices used for the Factor Analysis and one factor is obtained as it can be seen from Table 4.3. Moreover, NGP2 obtained is used for the Impulse Responses and the Historical Decomposition Analysis.

Table 4.3. Factor analysis of National Balancing Point, Henry Hub, TTF and Russian Natural Gas Border Price in Germany prices

	FACTOR		LOADINGS			
FACTOR	VARIANCE	PROPORTION	NBPP	NGOP	TTFP	GERNGP
F1	2.3716	1.0000	**0.9883**	**0.4983**	**0.9728**	**0.4474**

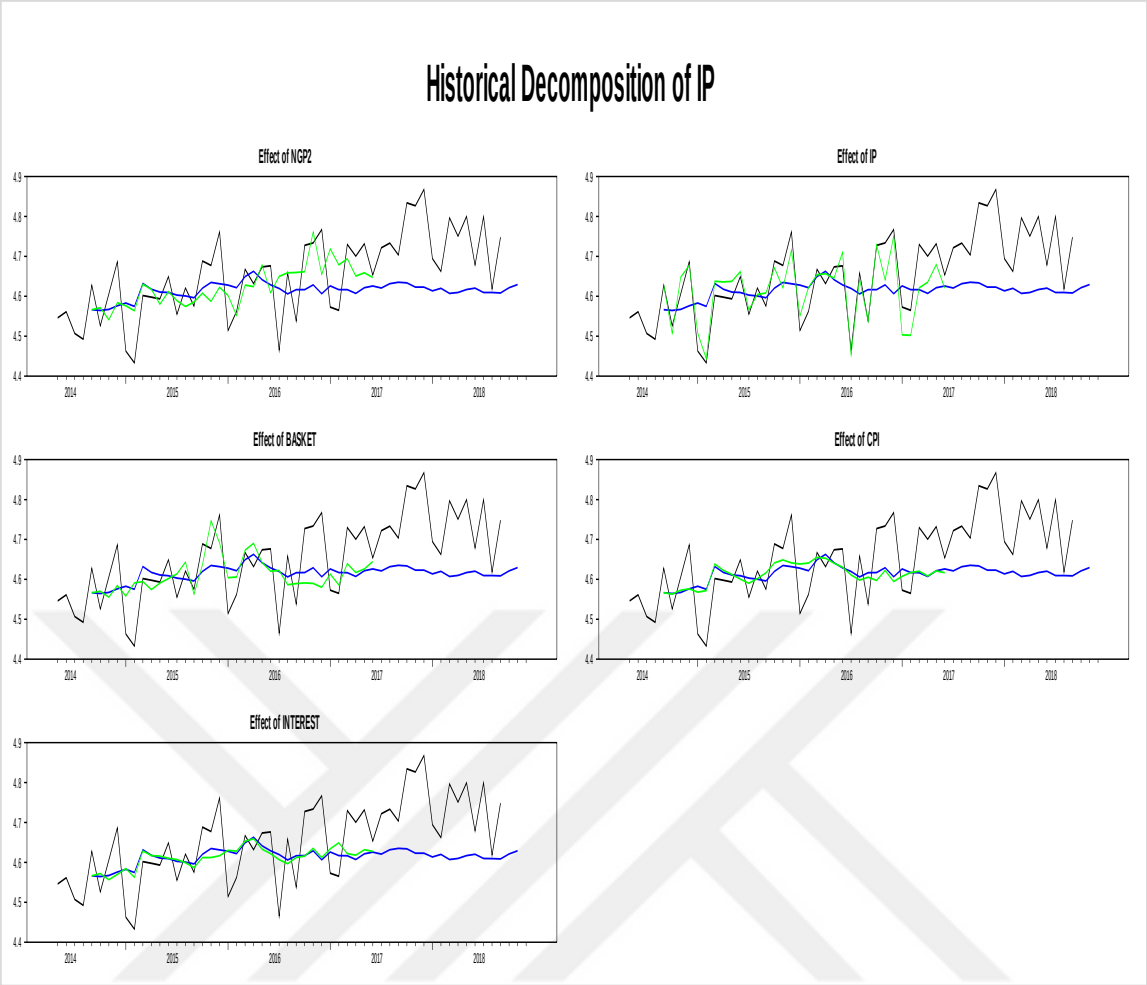


Figure 4.3. Historical Decomposition of Industrial Production for the Second Natural Gas Contract Price

In Figure 4.3, the cumulative effects of past and current shocks on the IP are expressed by Historical Decomposition. It is seen from the figure that the historical fluctuations between the actual IP data and the base forecast of IP solely caused by the effects of NGP2, BASKET and IP itself. The gap in gas price is more noticeable after the first quarter of 2015. For all periods, the natural gas price contribution to the IP is stable.

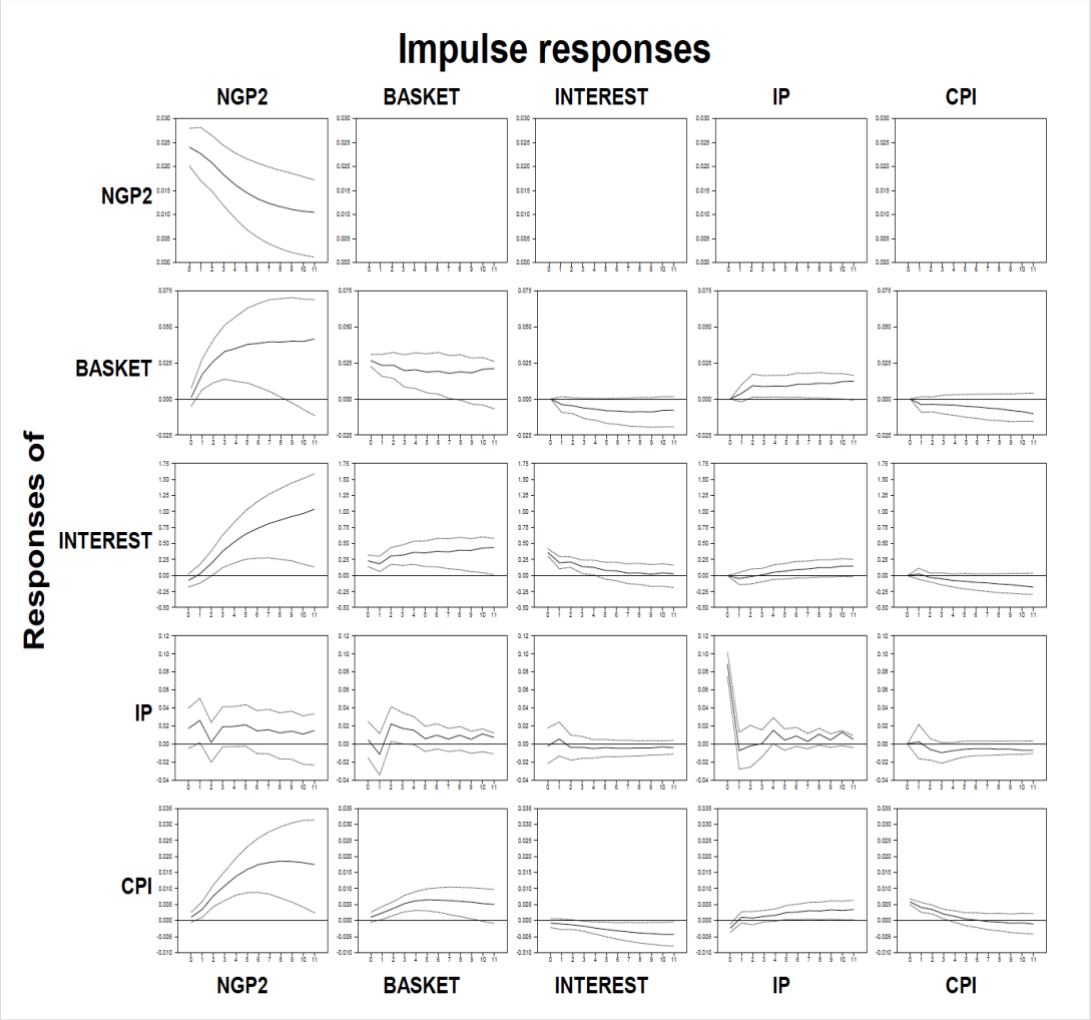


Figure 4.4. Impulse Responses of Second Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, Interest Rate, Industrial Production Index and Consumer Price Index shocks

In Figure 4.4, impulse and responses of Second Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, CBRT Interest Rate, Industrial Production Index, Consumer Price Index to the shock given to each variable are illustrated. The shock given to the NGP2 increases the NGP2 itself in a decreasing manner and it is statistically significant in all periods. From the IP perspective the NGP2 shock increases the IP increasingly and then decreasingly around first period where it is statistically significant. When the other variables' responses to the shock investigated, BASKET increases from the end of the second quarter of the initial period to beginning of third quarter of the eighth period where it is statistically significant. On the other hand, INTEREST increases increasingly up to the third period and then increases decreasingly up to period eleven in the interval it is statistically significant. Also, CPI shows a similar pattern with INTEREST, but it is statistically significant after period one.

Beyond the effect of NGP2 on IP, also the other reasons affecting IP should be investigated. It can be interpreted again from Figure 4.4 that a shock given to the BASKET increases IP decreasingly until the half of first period and between period two and period three where it is statistically significant; a shock on INTEREST increases IP first increasingly then decreasingly between the halves of the initial level and the first period until eleventh period where statistically significant; a shock on IP itself increases IP decreasingly up to period one where it is statistically significant; a shock on CPI slightly increases IP until the half of period one where it is significant.

The Third Natural Gas Price (NGP3), the Fourth Natural Gas Price (NGP4) and the Fifth Natural Gas Price (NGP5) are obtained with Fuel Oil 3.5% Sulphur Price, Brent Oil Price, Fuel Oil %1 Sulphur Price, Gasoil Price, National Balancing Point Price, Henry Hub Price, TTF Price, LNG Price and Russian Natural Gas Border Price in Germany because the different energy prices from the world intended to be used to form a Natural Gas Price with the worldwide energy commodities. The related prices are used for the Factor Analysis and three factors obtained as it can be seen from Table 4.4. Furthermore, NGP3, NGP4 and NGP5 obtained are used for the Impulse Responses and the Historical Decomposition Analysis of each price examined in the following pages.

Table 4.4. Factor Analysis of Fuel Oil 3.5% Sulphur, Brent, Fuel Oil %1 Sulphur, Gasoil, National Balancing Point, Henry Hub, TTF, LNG and Russian Natural Gas Border Price in Germany prices

	FACTOR		LOADINGS								
FACTOR	VARIANCE	PROPORTION	FOHIGHP	BRENTP	FOLOWP	GASOILP	NBPP	NGOP	TTFP	LNGP	GERNGP
F1	4.1316	0.6058	**0.9428**	**0.9307**	**0.9216**	**0.9293**	**0.4933**	0.3510	**0.5398**	-0.0272	0.0691
F2	2.0968	0.3075	-0.2687	-0.2774	-0.3104	-0.2500	**0.8554**	0.3820	**0.8109**	-0.0535	**0.5007**
F3	0.5912	0.0867	-0.0601	0.0523	0.0004	0.1180	-0.0357	-0.0317	-0.1678	**0.5630**	**0.4728**

The first factor named as NGP3 is consisted of Fuel Oil 3.5% Sulphur Price, Brent Oil Price, Fuel Oil %1 Sulphur Price, Gasoil Price, Henry Hub Price and TTF Price.

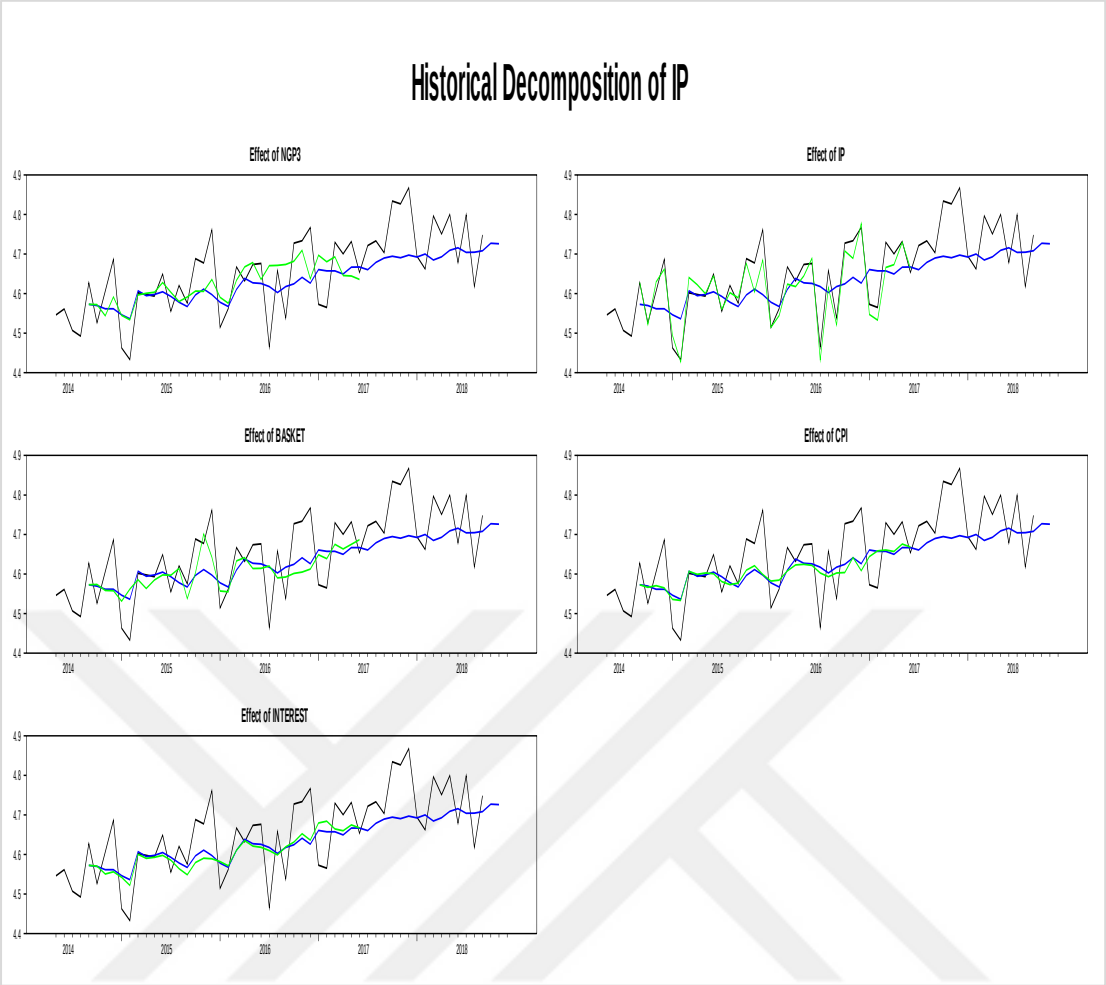


Figure 4.5. Historical Decomposition of Industrial Production for the Third Natural Gas Contract Price

In Figure 4.5, the cumulative effects of past and current shocks on the IP are expressed by Historical Decomposition. It is seen from the figure that the historical fluctuations between the actual IP data and the base forecast of IP solely caused by the effects of NGP3, BASKET and IP itself. The gap in gas price is more noticeable after the last quarter of 2015. For all periods, the natural gas price contribution to the IP is slightly increasing.

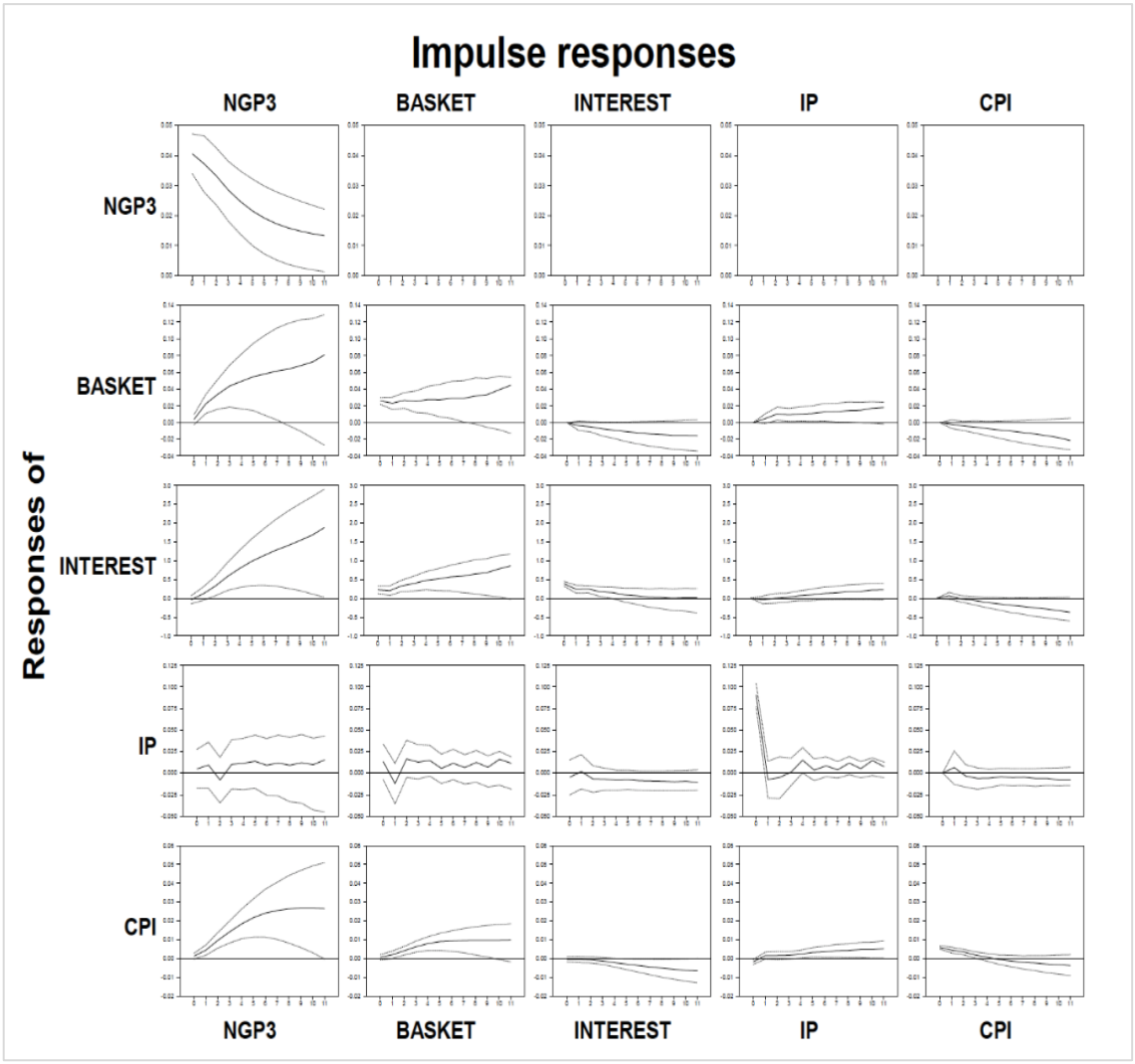


Figure 4.6. Impulse Responses of Third Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, CBRT Interest Rate, Industrial Production Index and Consumer Price Index shocks

In Figure 4.6, impulse and responses of Third Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, CBRT Interest Rate, Industrial Production Index, Consumer Price Index to the shock given to each variable are illustrated. The shock given to the NGP3 increases the NGP3 itself in a decreasing manner and it is statistically significant in all periods. From the IP side, it is statistically insignificant in all periods to the NGP3 shock. When the other variables' responses to the NGP3 shock investigated, BASKET decreasingly increases from the initial period to middle of the seventh period where it is statistically significant. On the other hand, INTEREST increases constantly from the middle of the first period up to period eleven where it is statistically significant. CPI shows a decreasingly increasing pattern where it is statistically significant after period the middle of the initial period.

Other than the effect of NGP3 on IP, other reasons affecting IP should be investigated, too. It can be interpreted again from Figure 4.6 that a shock given to a shock on IP itself increases IP decreasingly up to period one where it is statistically significant. The other shocks are statistically insignificant in all periods.

The second factor named as NGP4 is consisted of National Balancing Point Price, TTF Price and Russian Natural Gas Border Price in Germany.

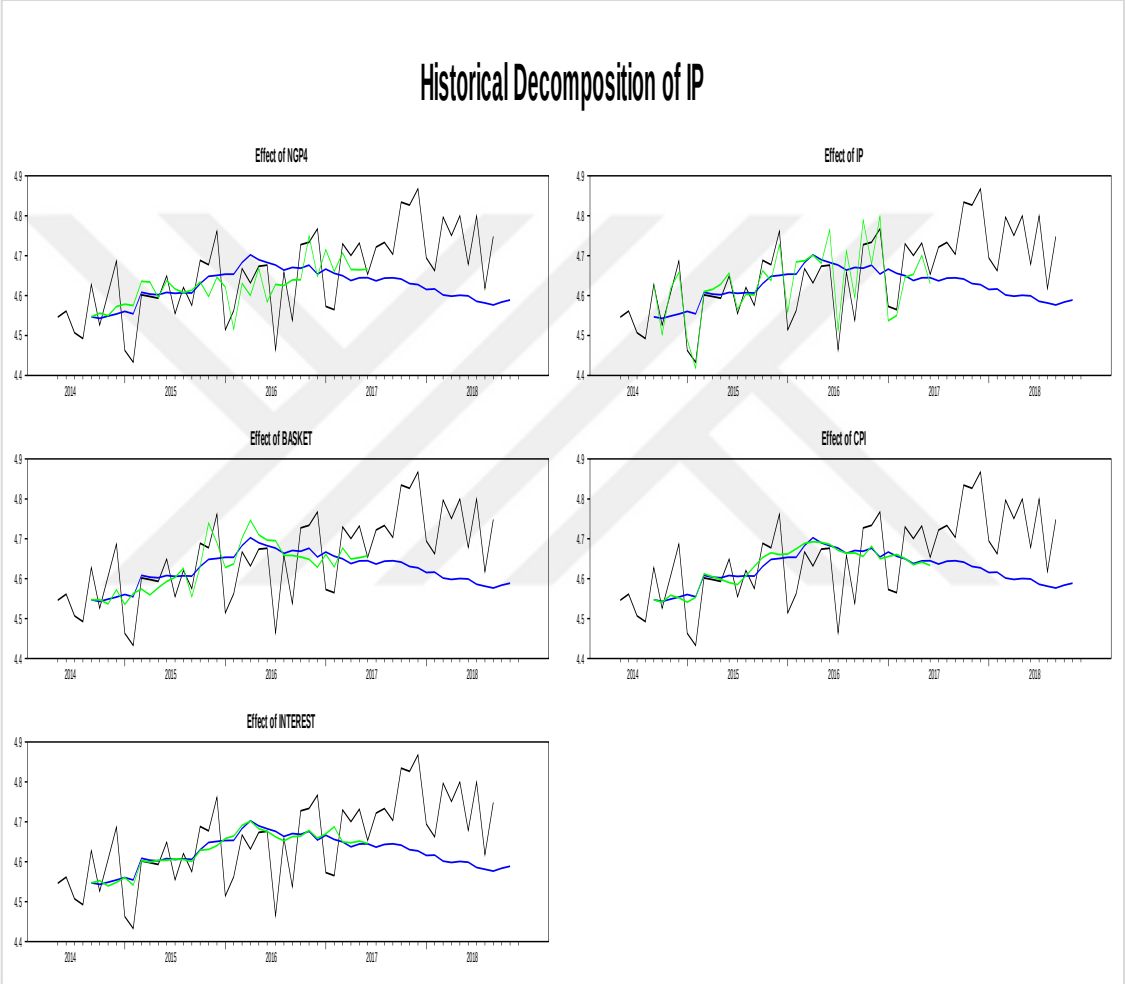


Figure 4.7. Historical Decomposition of Industrial Production for the Fourth Natural Gas Contract Price

In Figure 4.7, the cumulative effects of past and current shocks on the IP are expressed by Historical Decomposition. It is seen from the figure that the historical fluctuations between the actual IP data and the base forecast of IP solely caused by the effects of NGP4, BASKET and IP itself. The gap in gas price is more noticeable after the last quarter of 2015. For all the periods, the natural gas price contribution to the IP is stable.

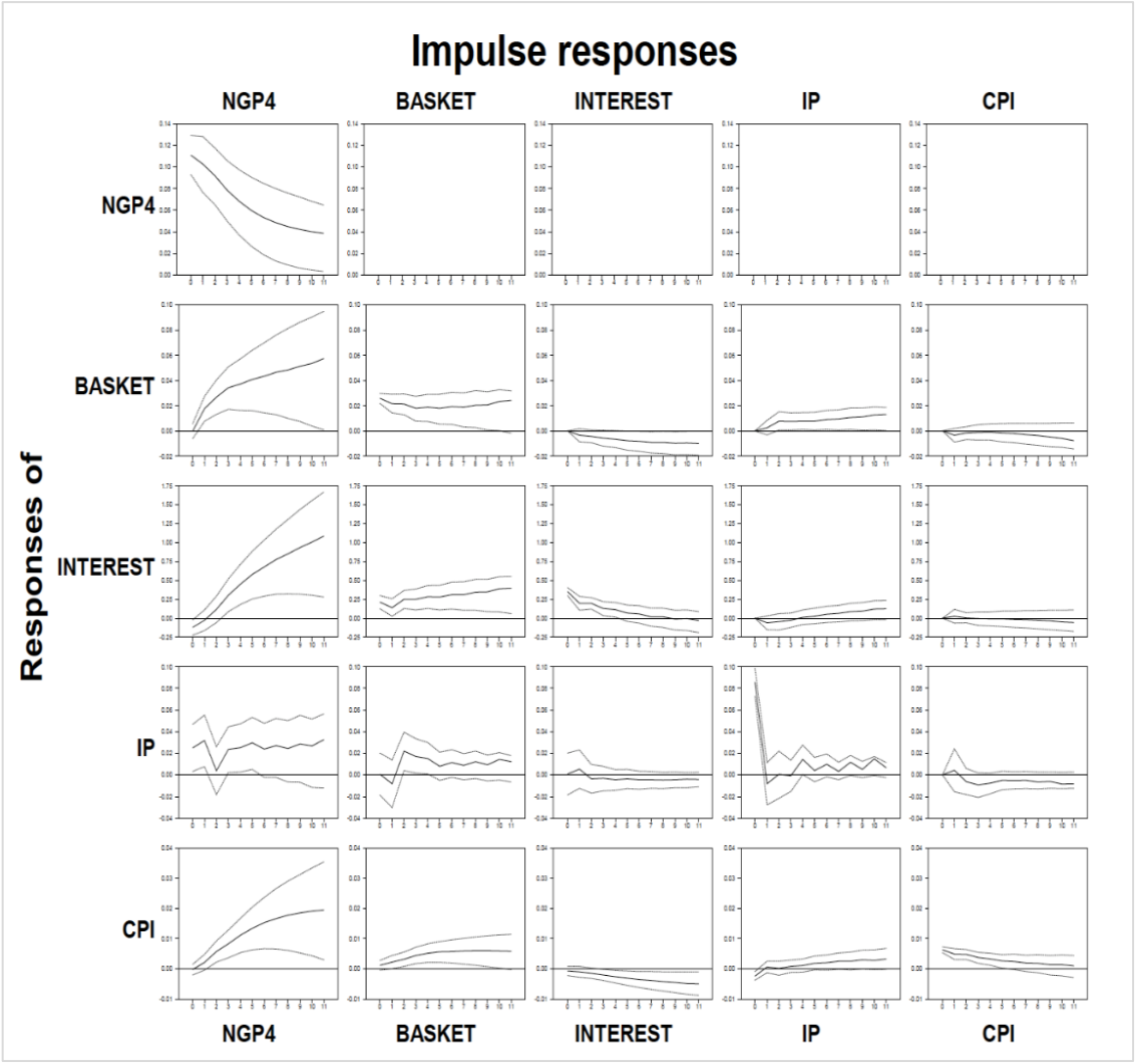


Figure 4.8. Impulse Responses of Fourth Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, CBRT Interest Rate, Industrial Production Index and Consumer Price Index shocks

In Figure 4.8, impulse and responses of Fourth Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, CBRT Interest Rate, Industrial Production Index, Consumer Price Index to the shock given to each variable are illustrated. The shock given to the NGP4 increases the NGP4 itself in a decreasing manner and it is statistically significant in all periods. From the IP perspective the NGP4 shock increases the IP increasingly and then decreasingly around first period and, also, increasing increasingly and then decreasingly between periods three and middle of five where it is statistically significant. When the other variables' responses to the price shock investigated, BASKET increases from the middle of the initial period to eleventh period where it is statistically significant. On the other hand, INTEREST increases decreasingly between the middle of the

second period and the eleventh period where it is statistically significant. Also, CPI shows a similar pattern with INTEREST where it is statistically significant after period one.

Other than the effect of NGP4 on IP, it can be interpreted from Figure 4.8 that a shock given to the BASKET increases IP first increasingly then decreasingly between periods two and three where it is significant; a shock on INTEREST increases IP first increasingly then decreasingly from the initial period to the middle of the first period where statistically significant; a shock on IP itself increases IP decreasingly up to period one where it is statistically significant.

The third factor named as NGP5 is consisted of LNG Price and Russian Natural Gas Border Price in Germany.

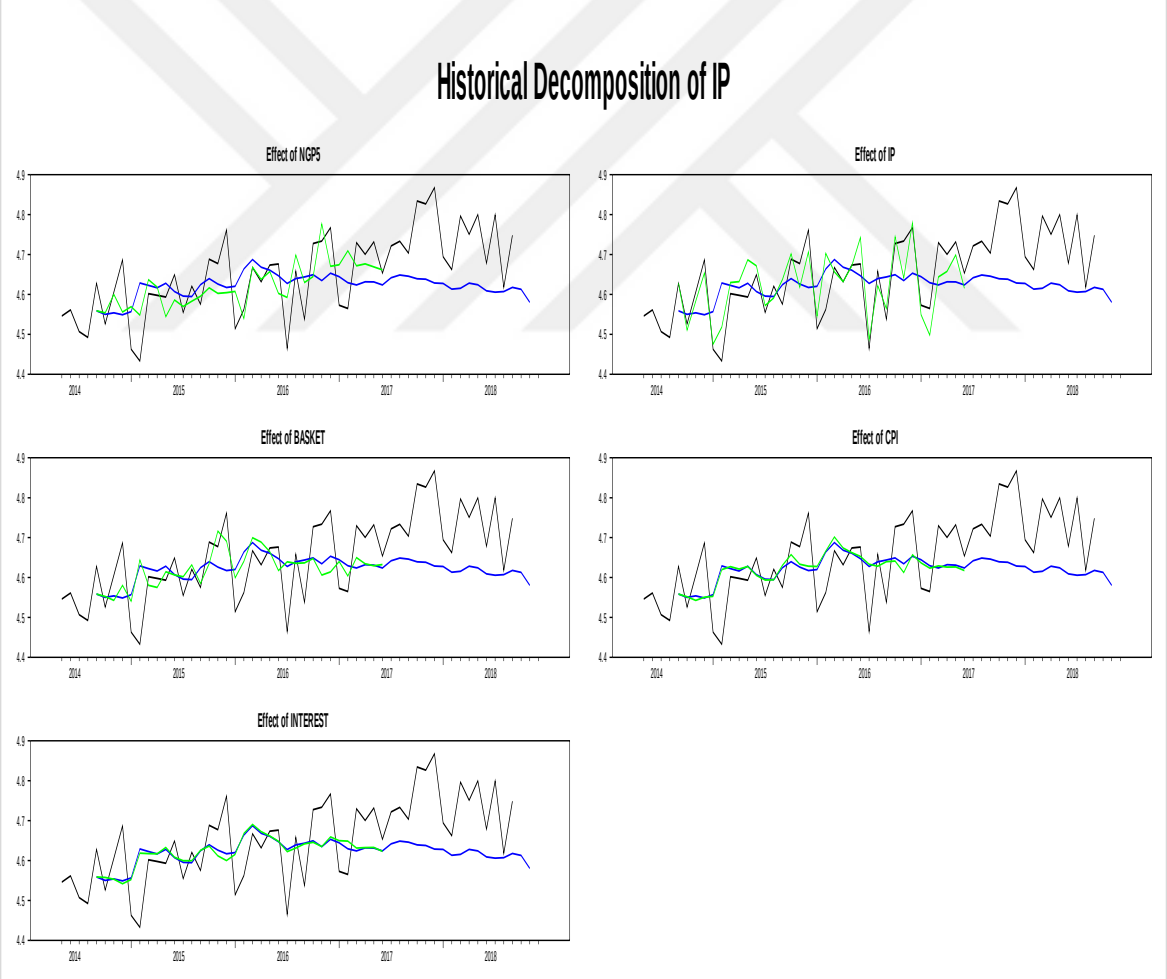


Figure 4.9. Historical Decomposition of Industrial Production for the Fifth Natural Gas Contract Price

In Figure 4.9, the cumulative effects of past and current shocks on the IP are expressed by Historical Decomposition. It can be seen from the figure that the historical

fluctuations between the actual IP data and the base forecast of IP solely caused by the effects of NGP5, BASKET and IP itself. The gap in gas price is more noticeable after the second quarter of 2014. For all the periods, the natural gas price contribution to the IP is stable.

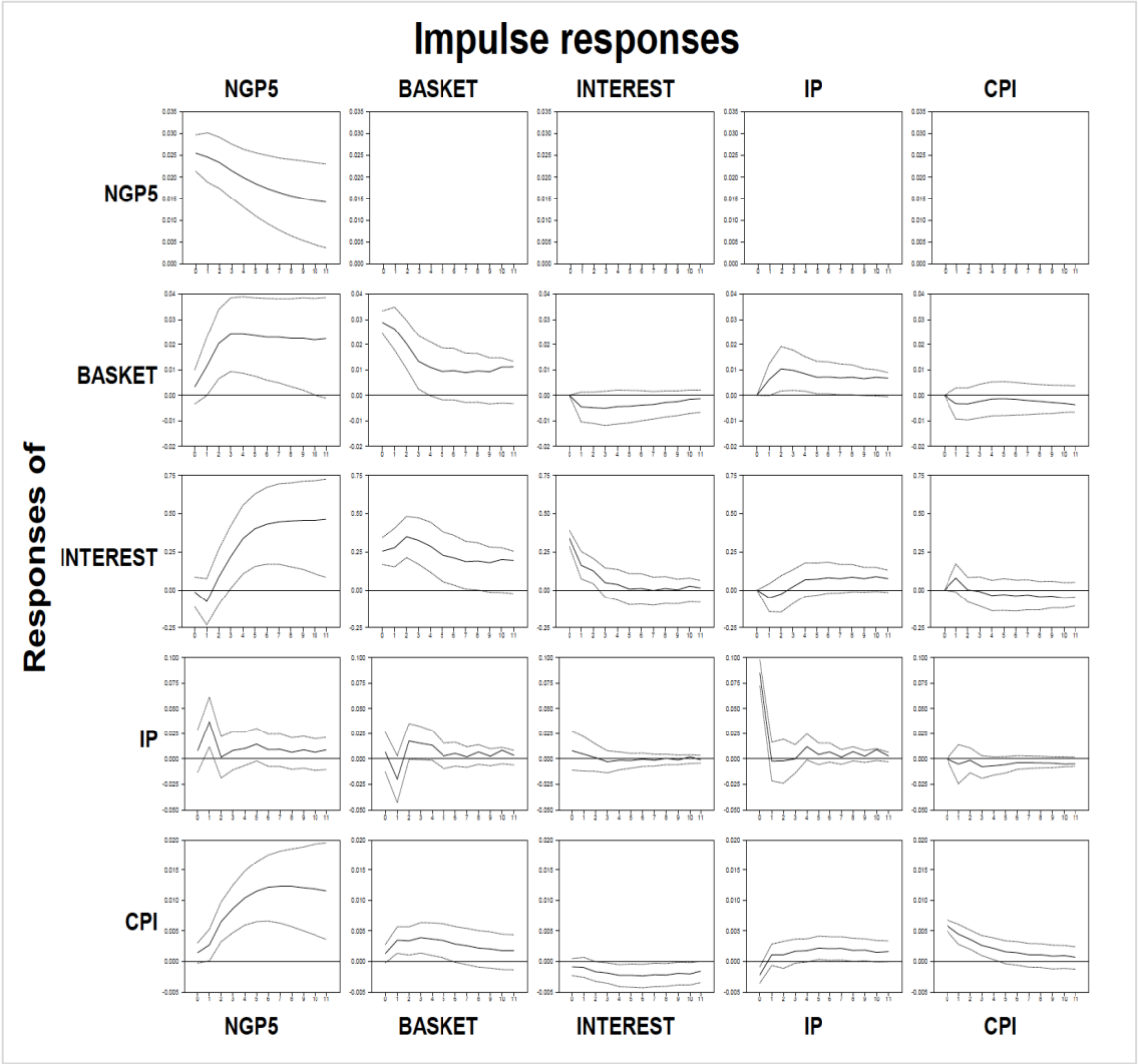


Figure 4.10. Impulse Responses of Fifth Natural Gas Contract Price, Basket, Interest Rate, Industrial Production and Consumer Price Index shocks

In Figure 4.10, impulse and responses of Fifth Natural Gas Contract Price, Basket of USD/TRY and EURO/TRY Exchange Rates, CBRT Interest Rate, Industrial Production Index, Consumer Price Index to the shock given to each variable are illustrated. The shock given to the NGP5 increases the NGP5 itself in a decreasing manner and it is statistically significant in all periods. From the IP perspective the NGP5 shock increases the IP increasingly and then decreasingly between the middle of initial period and the middle of the first period where it is statistically significant. When the other variables' responses to the price shock investigated, BASKET increases increasingly from the first period to the third

period and then increases in a constant fashion up to period ten where it is statistically significant. On the other hand, INTEREST increases increasingly from the middle of the first period to the eleventh period where it is statistically significant. CPI increases increasingly between period one and period six but after that it continues in a constant fashion where it is statistically significant.

When the other reasons affecting IP investigated, it can be interpreted from Figure 4.10 that a shock given to IP increases IP itself decreasingly up to period one where it is statistically significant, and it is statistically insignificant to the shock on other variables.

Finally, Figure 4.11 and Table 4.5 (see APPENDIX B) state the effects of present and the other four alternative Natural Gas Contracts with actual prices on IP while Figure 4.12 and Table 4.6 (see APPENDIX C) state the effects of present and the other four Natural Gas Contracts with forecasted prices on IP within the model. The actual and alternative prices are benefitted to give a price shock for especially analyzing the effect on Industrial Production Index of Turkey and we compare the results. These two pairs of tables and figures give us an opportunity to compare the investigated situations and test the hypothesis.

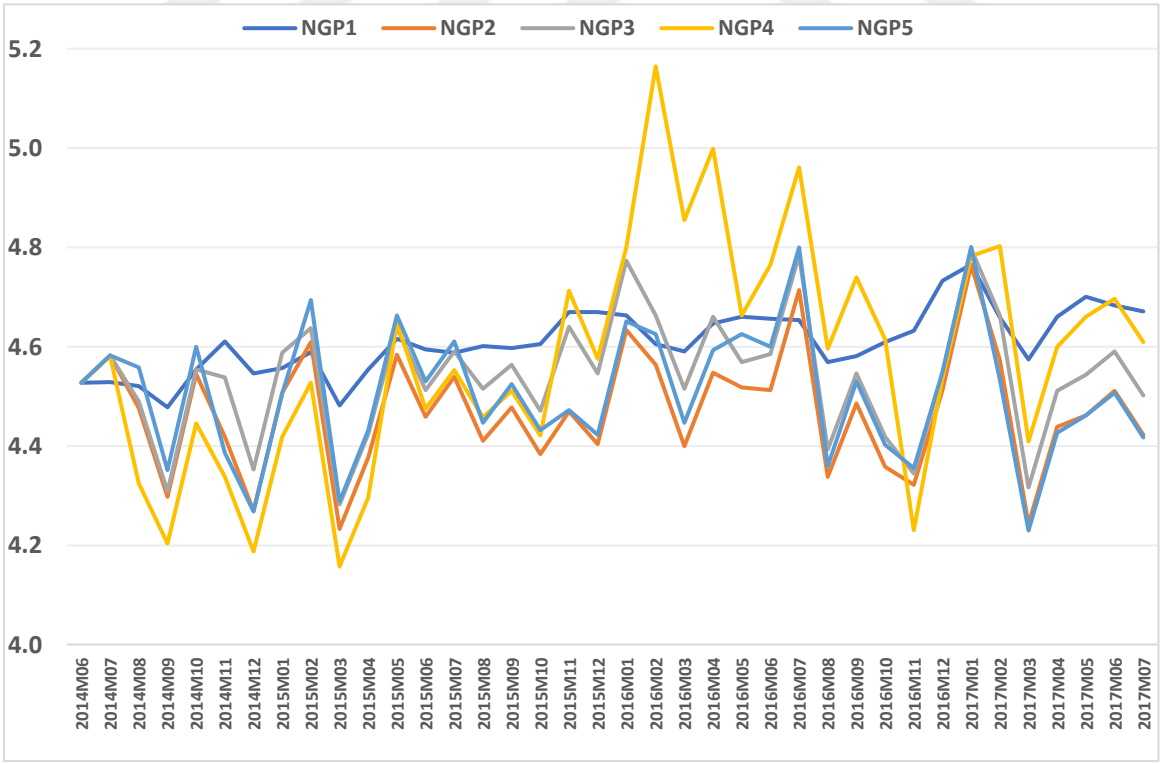


Figure 4.11. Effects of actual alternative natural gas contract prices on IP

It can be seen from Figure 4.11 and Table 4.5 (see APPENDIX B) that when compared to the other four Alternative Natural Gas Contract Prices, the actual price formula NGP1 (dark blue line) is the most preferred one because it is the least volatile and it starts and ends above. NGP4 (yellow line) is the most volatile one and NGP5 (light blue line) is the least preferred one among alternatives.

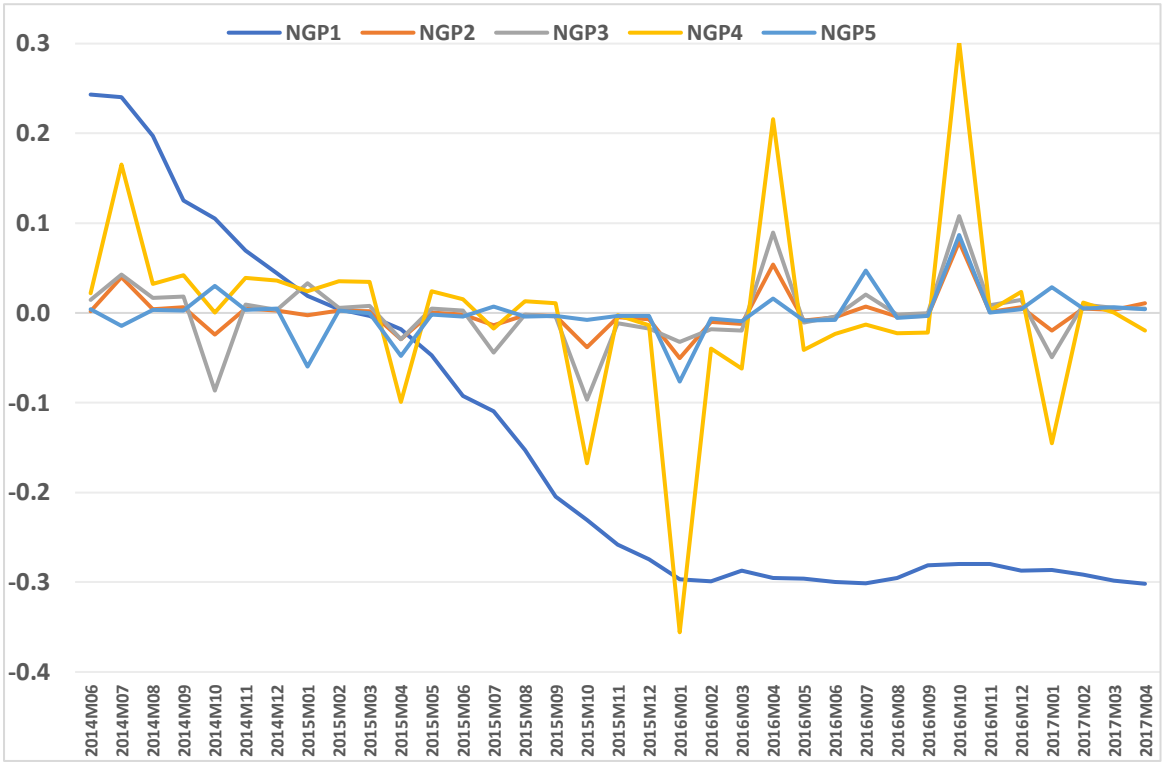


Figure 4.12. Effects of modelled alternative natural gas contract prices on IP

It can be seen from Figure 4.12 and Table 4.6 (see APPENDIX C) that the fitted values of the actual Natural Gas Contract Price NGP1 (dark blue line) is not so impressive. The model suggests NGP2 (orange line) the most because it has low volatility and it is above the actual one. Also, NGP5 (light blue line) seems impressive compared the others except NGP2. The least preferred one is NGP4 (yellow line) because it is the most volatile and lowest one compared to the others even it is better than the actual contract.

5 CONCLUSION AND RECOMMENDATIONS

In this thesis, it was intended to capture a better functioning relationship between the chosen macroeconomic variables and natural gas prices via the long-term natural gas contracts of Turkey with the help of several econometric techniques, due to the upcoming expiry dates for some of the long-term natural gas contracts that Turkey signed before. Especially, the long-term contracts and their criteria between Turkey and Russia are examined because Turkey mostly imports natural gas as well as crude oil and products from Russia, and the nearest long-term natural gas contract expiry date is the one with them. The main underlying cause of such a study is based on Turkey's need of ensuring energy supply security for its ever-growing population and economy as well as accessing clean and cheaper energy sources like natural gas, as a net energy importer country via alternative long-term natural gas contracts more suitable for both sides. Also, the subject is examined with remembering the perspective that "Pipelines can, in a way, be a tool to build relationships between countries." (Karbuz, 2016, p. 66).

The long-term contract details and formulas are mostly a commercial secret between the agreed companies and countries. And based on this fact, in Chapter 2, we especially examined the concept and history of energy and natural gas, natural gas markets both in Turkey and in the world, natural gas pricing and contracting methods, and long-term oil-indexed natural gas contracts of Turkey. Moreover, a literature review on natural gas pricing, contracts, and market structures was conducted to give information about the subject and find the missing parts by reviewing several studies. It was noticed that there was a big missing gap among studies about pricing and long-term contracting in Turkey's natural gas market especially from the quantitative perspective. Solely with the help of the Historical Decomposition Method, the missing part about the quantitative examination of long-term natural gas contracts of Turkey was attempted to be executed by applying econometric techniques explained in the methodology part of the thesis in Chapter 3. These econometric techniques implemented in three different scenarios and, besides, five different natural gas price formulas are offered for Turkey's long-term natural gas contracts to be discussed in detail in Chapter 4. The scenarios are based on concerning different energy commodities and different regional benchmarks. The first scenario is by using the current pricing formula according to the information obtained from the authorities, the second scenario is an alternative one by using natural gas prices in Europe and America as important benchmarks,

the third scenario is by using the different energy prices from the world to form a natural gas price via the contribution of worldwide energy commodities. Since the industrial production shows more successful and meaningful results in the analyzes performed, it has been focused on. As a result, we have figured out a slightly better alternative formula compared to the actual one which results in a greater boost on Turkey's industrial production. This alternative formula was based on the second scenario and called NGP2 which is less volatile and results in higher industrial production for Turkey. Although one of the alternatively generated formulas performed better, in terms of industrial production as a result of this study, the investigation of alternative recommendations should be further expanded with including the variables such as renewable energy sources, coal, nuclear energy, spot hub natural gas prices, LNG prices, political and geopolitical factors to the pricing formula and considering the effects on many more macroeconomic variables or vice versa.

Moreover, one of the worthwhile issues is whether Turkey could find a better alternative due to Turkey's unique political, geopolitical, geological, and economic rationales. Even the subjects like Turkey's dependency on Russian natural gas and price of this imported Russian natural gas have often been highly discussed, they should be examined more thoroughly with these facts. The authorities and academics should investigate the rationales and concrete criteria behind why Turkey's natural gas import price is claimed to be high and, even if this is true, how this issue would be resolved with down to earth studies and practical recommendations. Additionally, Turkey, as a country, that can be considered inadequate in terms of energy resources, should be supported by realistic proposals to reduce dependency on energy imports. It is necessary to present and implement long-term projections that will be put forward with the relevant steps by accepting and reading the facts rather than delusions. For the time being, Russia might be considered as the leading option in terms of long-term natural gas contracts due to the special circumstances of our country. However, it is important to keep the importance of supply diversification needs in mind to come up with a conclusion for the best option. Turkey should create a competitive environment for its natural gas import contracts in order to benefit the alternative supply options to use against Russian gas. In case, Turkey can secure a long-term and beneficial contract with Russia that can provide a reliable, secure and affordable natural gas, from the technical point, Russian gas can be the leading option. When the conjunctures of other alternative countries are examined, the natural gas capacity that Azerbaijan can offer to Turkey is enough to meet a small portion of the country's needs. Turkmenistan has made

over-commitments to many other countries which most of them cannot be fulfilled. Iran has been struggling in keeping its supply and export commitments with limited natural gas upstream development capacity due to long-lasting international sanctions that prevent them to increase output and export capacities. Although it is too far from meeting the vast demand for natural gas that cannot be met by other domestic resources, it is also seen that LNG import is the only alternative for the imported natural gas transported by the pipelines which are the subject of intense long-term contracts. However, LNG is not a commodity itself but a logistic option for the transmission of natural gas so it cannot be a direct competitor for natural gas alone. The most important factor in LNG trade is the transportation costs and the resulting price competition so it is not only about the total supply of LNG globally, but also Turkey's long-term demand and price competition against other large LNG buyers. Besides, Turkey cannot replace the amount of pipelined natural gas due to the lack of LNG term contracts, storage capacity, transmission methods, and geographical factors.

During our study, current petroleum products used in the existing contracts have been observed not to meet the current demand structure of Turkey. High sulfur fuel oil, low sulfur fuel oil, and gasoil are not direct substitutes for natural gas in Turkey anymore. This essentially creates a problem for the products used in the oil product indexed natural gas pricing mechanism for Turkey's imported pipeline natural gas. With the existing price methodology, one might also challenge that the demand pattern of the petroleum products used in the formula has been diverging from the demand pattern of Turkey's natural gas market. This contradicts the basic assumption of the oil price indexed pricing formula which is expected to provide a reasonable ground for Turkey to prefer pipeline natural gas rather than other energy sources to meet its demands while the cost of imported natural gas will not bring additional budget pressure. However, according to our observations, the unparalleled connection between Turkey's natural gas market and the products used in the price formula creates another problem for Turkey's energy import requirements.

Based on today's realities, despite the challenges behind Turkey's LNG import strategy, the only reliable substitute against Russian pipelined natural gas is imported LNG. Hence, one strategy that Turkey can follow is to force Russian counterparts to add spot LNG prices in the long-term pipelined natural gas pricing formula. This new price index might help Turkey to have a more realistic price for its imported pipelined natural gas that reflects the market trend of its direct substitute. In this way, Turkey might also dilute seeking

alternative sources against Russian natural gas which can be a mutual benefit both for Turkey and Russia. It is important to mention that as Russia's second-biggest natural gas customer, Turkey has a vital role in Russia's overall energy export policy so this can be used as a useful tool by Turkey.

Turkey has commenced expanding share of LNG in total imports, as well as, using Azeri gas via TANAP pipeline. These options give Turkey a chance to leverage its options in choosing the most reliable and sustainable natural gas source(s). Although, current market conditions suggest that the share of LNG in global natural gas consumption will increase, Turkey needs to calculate the cost of transportation and any risks associated with such cost. As LNG is not a commodity itself, but just an alternative mean of transportation for natural gas, it is heavily dependent on the LNG carrying vessels capacity globally. Turkey needs to secure long-term LNG contracts, as well, as the shrinking vessel capacity could create a freight cost risk in the following years. This would have negative impact on spot LNG market, in which Turkey solely relies on its LNG imports strategy, in the time being.

For the last words, as a result, it has been observed that the best solution for the long-term natural gas contracts of Turkey with other countries, which includes a contract amount of natural gas purchase of about 50 Bcm that will expire by 2020s and the ones which will expire later on, is to remake new long-term natural gas agreements under mutually better conditions for the sake of energy security and to establish long-term cooperation for the future of each counterparty. Furthermore, Turkey should make an effort for being a natural gas hub instead of just a corridor in the region and bravely take the necessary steps to become a player with significant influence in the world natural gas market.

6 REFERENCES

11th Development Plan. (2019). Retrieved September 12, 2019, from Presidency of The Republic of Turkey Strategy and Budget Presidency: http://www.sbb.gov.tr/wp-content/uploads/2019/07/OnbirinciKalkinmaPlani.pdf

2B1st Consulting. (n.d.). Associated gas. Retrieved (n.d.), from 2B1st Consulting One Day - One Word: https://www.2b1stconsulting.com/associated-gas

Akgül S, Burucu H. (2013). Petrol ve doğal gaz fiyatları arasındaki ilişki. *Sosyal ve Beşeri Bilimler Dergisi*, 5(1), 453-468.

Allaz B, Vila JL. (1993). Cournot competition, forward markets and efficiency. *Journal of Economic Theory*, 59(1), 1-16.

Allegret JP, Couharde C, Guillaumin C. (2012). The impact of external shocks in East Asia: Lessons from a structural VAR model with block exogeneity. *Economie Internationale*, (4), 35-89.

American Gas Association. (n.d.). What is natural gas? Retrieved from American Gas Association: https://www.aga.org/natural-gas/energy-education

Asche F, Misund B, Sikveland M. (2013). The relationship between spot and contract gas prices in Europe. *Energy Economics*, 38, 212-217.

Asche F, Oglend A, Osmundsen P. (2012). Gas versus oil prices the impact of shale gas. *Energy Policy*, 47, 117-124.

Asche F, Oglend A, Osmundsen P. (2017). Modeling UK natural gas prices when gas prices periodically decouple from the oil price. *The Energy Journal*, 38(2).

Asche F, Osmundsen P, Sandsmark M. (2006). The UK market for natural gas, oil and electricity: Are the prices decoupled? *The Energy Journal*, p. 27-40.

Asche F, Osmundsen P, Tveterås R. (2002). European market integration for gas? Volume flexibility and political risk. *Energy Economics*, 24(3), 249-265.

Atil A, Lahiani A, Nguyen DK. (2014). Asymmetric and nonlinear pass-through of crude oil prices to gasoline and natural gas prices. *Energy Policy*, 65, p. 567-573.

Bachmeir LJ, Griffin JM. (2006). Testing for market integration: Crude oil, coal, and natural gas. *The Energy Journal*, p. 55-72.

Balat M. (2010). Security of energy supply in Turkey: Challenges and solutions. *Energy Conversion and Management*, 51(10), 1998-2011.

Bartholomew DJ, Knott M, Moustaki I. (2011). *Latent variable models and factor analysis: A unified approach* (Vol. 904). John Wiley & Sons.

Batten JA, Ciner C, Lucey BM. (2017). The dynamic linkages between crude oil and natural gas markets. *Energy Economics*, 62, p. 155-170.

BBC. (2019). Nord Stream 2: Trump approves sanctions on Russia gas pipeline. Retrieved December 21, 2019, from BBC News: https://www.bbc.com/news/world-europe-50875935

Berk I, Schulte S. (2017). Turkey's role in natural gas: Becoming a transit country? (No. 17/01). EWI Working Paper.

Berument H, Şahin A, Togay S. (2011). An Identification of monetary policy disturbances using non-borrowed reserves for a small-open economy: *Turkey. Open Economies Review*, 22, p. 649-667.

Bolle F. (1989). Take-or-pay contracts and vertical integration in natural gas trade. Take or Pay-Vertraege und vertikale Integration im Erdgashandel.

BOTAŞ. (n.d.). Completed projects. Retrieved (n.d.), from Petroleum Pipeline Company: https://www.botas.gov.tr/pages/completed-projects/418

BOTAŞ. (n.d.). Corporate. Retrieved (n.d.), from Petroleum Pipeline Company: https://www.botas.gov.tr/pages/corporate/258

Bowden J. (2019). SE Europe gas markets: Towards integration. *OIES Paper* NG150.

BP. (2018). BP statistical review of world energy 2018. 67th edition.

BP. (2019). BP statistical review of world energy 2019. 68th edition.

Brigida M. (2014). The switching relationship between natural gas and crude oil prices. *Energy Economics*, 43, p. 48-55.

Brito DL, Hartley PR. (2002). New energy technologies in the natural gas sectors. Houston, Texas, James A. Baker III Institute for Public Policy.

Brito DL, Hartley PR. (2007). Expectations and the evolving world gas market. *Energy Journal*-Cambridge Ma then Cleveland OH-, 28(1), 1.

Brooks C. (2014). *Introductory econometrics for finance*, 3rd Edition, Cambridge University Press, USA.

Brown SP, Gabriel SA, Egging R. (2010). Abundant shale gas resources: some implications for energy policy. *Resources for the Future*, p. 1-46.

Brown SP, Yücel MK. (2008). What drives natural gas prices?. *Energy Journal*, 29(2), p. 45-60.

Brown SP, Yücel MK. (2013). Shale gas and tight oil boom: US' economic gains and vulnerabilities. New York: Council on Foreign Relations.

Burbidge J, Harrison A. (1985). An historical decomposition of the great depression to determine the role of money. *Journal of Monetary Economics*, 16(1), p. 45-54.

Cağaptay S, Evans T. (2013). Turkey's energy policy and the future of natural gas. Houston, Texas, James A. Baker III Institute for Public Policy.

Caporin M, Fontini F. (2017). The long-run oil–natural gas price relationship and the shale gas revolution. *Energy Economics*, 64, p. 511-519.

Cattell R. (Ed.). (2012). *The scientific use of factor analysis in behavioral and life sciences*. Springer Science & Business Media.

CBRT. (2019). Balance of payments statistics. Retrieved April 10, 2019, from Central Bank of the Republic of Turkey: https://www.tcmb.gov.tr/wps/wcm/connect/TR/TCMB+TR/Main+Menu/Istatistikler/Odemeler+Dengesi+ve+Ilgili+Istatistikler/Odemeler+Dengesi+Istatistikleri

CEC. (1988). The internal energy market, COM (1988) 238 final, 2 May 1988, Brussels: Commission of the European Communities. Retrieved May 02, 1988, from EUR-Lex: https://eur-lex.europa.eu/procedure/EN/107212

CEGH. (n.d.). Austrian gas market model 2013. Retrieved (n.d.), from CEGH: https://www.cegh.at/en/vtp-market/market-information

Chen J. (2019). Henry Hub. Retrieved January 07, 2019, from Investopedia: https://www.investopedia.com/terms/h/henry_hub.asp

Cheng IH, Xiong W. (2014). Financialization of commodity markets. *Annual Rev. Finance. Econ.*, 6(1), p. 419-441.

Child D. (2006). *The essentials of factor analysis*. (3rd ed.). New York, NY: Continuum International Publishing Group.

CME Group. (n.d.). Japan crude cocktail. Retrieved (n.d.), from CME Institute: https://www.cmegroup.com/education/frequently-asked-questions-japan-crude-cocktail.html

Coase RH. (1937). The nature of the firm. *Economica*, 4(16), p. 386-405.

Conforto G. (2013). What drives natural gas prices in British market. CEPMLP Annual Review.

Conserve Energy Future. (n.d.). Solar energy facts. Retrieved (n.d.), from Conserve Energy Future: https://www.conserve-energy-future.com/various-solar-energy-facts.php

Corbeau AS, Hasan S, Dsouza S. (2018). The challenges facing India on its road to a gas-based economy (No. ks-2018-dp41).

Correljé A, van der Linde C, Westerwoudt T. (2003). Natural gas in the Netherlands: From cooperation to competition? Amsterdam: Oranje-Nassau Groep.

Correljé A. (2016). The European natural gas market. Current Sustainable/Renewable Energy Reports, 3(1-2), 28-34.

Cranmore RG, Stanton E. (2000). Natural gas. *Modern Petroleum Technology*, 2, 337-382.

Creti A, Joëts M, Mignon V. (2013). On the links between stock and commodity markets' volatility. *Energy Economics*, 37, p. 16-28.

Creti A, Nguyen DK. (2015). Energy markets′ financialization, risk spillovers, and pricing models (No. hal-01517413).

Creti A, Villeneuve B. (2004). Long-term contracts and take-or-pay clauses in natural gas markets. *Energy Studies Review*, 13(1), p. 75-94.

Crocker KJ, Masten SE. (1988). Mitigating contractual hazards: Unilateral options and contract length. *The RAND Journal of Economics*, p. 327-343.

Crocker KJ, Masten SE. (1991). Pretia ex machina? Prices and process in long-term contracts. *The Journal of Law and Economics*, 34(1), p. 69-99.

Cuddington JT, Wang Z. (2006). Assessing the degree of spot market integration for US natural gas: evidence from daily price data. *Journal of Regulatory Economics*, 29(2), p. 195-210.

Cushman DO, Zha T. (1997). Identifying monetary policy in a small open economy under flexible exchange rates. *Journal of Monetary Economics*, 39(3), p. 433-448.

Dailami M, Hauswald R. (2000). Risk shifting and long-term contracts: evidence from the Ras Gas Project. The World Bank.

De Vany AS, Walls WD. (1993). Pipeline access and market integration in the natural gas industry: Evidence from cointegration tests. *The Energy Journal*, p. 1-19.

De Vany AS, Walls WD. (1995). *The emerging new order in natural gas: Markets versus regulation*. Greenwood Publishing Group.

Dediu D, Czajkowski M, Janiszewska-Kiewra E. (2019). How did the European natural gas market evolve in 2018? Retrieved April 15, 2019, from McKinsey&Company: https://www.mckinsey.com/industries/oil-and-gas/our-insights/petroleum-blog/how-did-the-european-natural-gas-market-evolve-in-2018

DEK. (2018). Türkiye enerji piyasaları araştırma raporu. Retrieved 2018, from Dünya Enerji Konseyi: https://www.dunyaenerji.org.tr/wp-content/uploads/2018/07/TEPG1.pdf

Deloitte Türkiye. (2016). Turkish energy market outlook: Achievements, overview and opportunities. İstanbul: World Energy Council, p. 47.

Deloitte Türkiye. (2018). Energy investment and financing report. İstanbul: Deloitte Türkiye, p. 5.

Dickey DA, Fuller WA. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74, p. 427-431.

Diebold FX, Yılmaz K. (2009). Measuring financial asset return and volatility spillovers, with application to global equity markets. *The Economic Journal*, 119(534), p. 158-171.

Diebold FX, Yılmaz K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, 182(1), p. 119-134.

Doane MJ, Spulber DF. (1994). Open access and the evolution of the US spot market for natural gas. *The Journal of Law and Economics*, 37(2), p. 477-517.

Earthworks. (n.d.). Fracking-related earthquakes. Retrieved (n.d.), from Earthworks: https://earthworks.org/issues/fracking_earthquakes

Egenhofer C, Chevalier JM, Labory S. (1998). *The development of competition in European Gas Markets*. Centre for European Policy Studies.

EIA. (2017). Turkey overview. Retrieved February 2, 2017, from U.S. Energy Information Administration: https://www.eia.gov/beta/international/analysis.php?iso=TUR

EIA. (2019a). Natural gas explained. Retrieved July 4, 2019, from U.S. Energy Information Administration: https://www.eia.gov/energyexplained/natural-gas/liquefied-natural-gas.php

EIA. (2019b). Natural gas explained. Retrieved July 4, 2019, from U.S. Energy Information Administration: https://www.eia.gov/energyexplained/natural-gas

EIA. (2019c). Natural gas explained. Retrieved July 4, 2019, from U.S. Energy Information Administration: https://www.eia.gov/energyexplained/natural-gas/delivery-and-storage.php

EIA. (2019d). The U.S. leads global petroleum and natural gas production with record growth in 2018. Retrieved August 20, 2019, from U.S. Energy Information Administration: https://www.eia.gov/todayinenergy/detail.php?id=40973

EIA. (2019e). Drilling productivity report. Retrieved September 16, 2019, from U.S. Energy Information Administration: https://www.eia.gov/petroleum/drilling/archive/2019/09

EIA. (2019f). EIA projects that natural gas consumption in Asia will continue to outpace supply. Retrieved October 28, 2019, from U.S. Energy Information Administration: https://www.eia.gov/todayinenergy/detail.php?id=41795

EIA. (n.d.). Natural gas glossary. Retrieved (n.d.), from U.S. Energy Information Administration: https://www.eia.gov/tools/glossary/index.php?id=natural%20gas

Emery GW, Liu Q. (2002). An analysis of the relationship between electricity and natural-gas futures prices. *Journal of Futures Markets: Futures, Options, and Other Derivative Products*, 22(2), p. 95-122.

EMRA. (2012). Doğal gaz piyasası 2011 yılı sektör raporu. Ankara, Retrieved 2012, from Energy Market Regulatory Authority: http://epdk.gov.tr

EMRA. (2014). Doğal gaz piyasası 2013 yılı sektör raporu. Ankara, Retrieved 2014, from Energy Market Regulatory Authority: http://epdk.gov.tr

EMRA. (2017). Doğal gaz piyasası 2016 yılı sektör raporu. Ankara, Retrieved 2017, from Energy Market Regulatory Authority: http://epdk.gov.tr

EMRA. (2018). Doğal gaz piyasası 2017 yılı sektör raporu. Ankara, Retrieved 2018, from Energy Market Regulatory Authority: http://epdk.gov.tr

EMRA. (2019). Doğal gaz piyasası 2018 yılı sektör raporu. Ankara, Retrieved 2019, from Energy Market Regulatory Authority: http://epdk.gov.tr

EMRA. (n.d.). Tarihçe. Retrieved from Enerji Piyasası Düzenleme Kurumu: http://epdk.org.tr/Detay/Icerik/1-1051/kurumsaltarihce

Enders W. (2015). *Applied econometric time series*, Fourth Edition, Wiley Publications, USA.

Energy Charter Secretariat. (2007). *Putting a price on energy: International pricing mechanisms for oil and gas*. Brussels: Energy Charter Secretariat.

Energy UK. (n.d.). The energy market explained. Retrieved (n.d.), from Energy UK: https://www.energy-uk.org.uk/energy-industry/the-energy-market.html

Erdős P. (2012). Have oil and gas prices got separated? *Energy Policy*, 49, p. 707-718.

ERGEG. (2007). The hub used as a balancing point (in the South-South East Region). Milan: ERGEG Gas Regional Initiative.

Ewing BT, Malik F, Özfidan O. (2002). Volatility transmission in the oil and natural gas markets. Energy Economics, 24(6), 525-538.

EXIST. (n.d.). About us. Retrieved (n.d.), from Energy Exchange İstanbul: https://www.epias.com.tr/en/corporate/about-us

ExxonMobil. (n.d.). 6 Charts that explain why natural gas will be a critical fuel for the future. Retrieved (n.d.), from Energy Factor: https://energyfactor.exxonmobil.eu/news/6-charts-explain-natural-gas-will-fuel-future

Fore River Residents Against the Compressor Station. (n.d.). The "rotten egg" smell of natural gas. Retrieved (n.d.), from No Compressor: https://www.nocompressor.com/smell-methane-rotten-eggs-more

Fuellers. (n.d.). History. Retrieved (n.d.), from The Worshipful Company of Fuellers: https://www.fuellers.co.uk/about/history

Fuller WA. (1976). *Introduction to statistical time series*, New York: John Wiley. Fuller Introduction to Statistical Time Series.

GAZBİR. (2018). 2017 yılı doğal gaz dağıtım sektörü raporu. Retrieved 2018, from Türkiye Doğal Gaz Dağıtıcıları Birliği: http://www.gazbir.org.tr

GAZBİR. (2019). 2018 yılı doğal gaz dağıtım sektörü raporu. Retrieved 2019, from Türkiye Doğal Gaz Dağıtıcıları Birliği: http://www.gazbir.org.tr

GAZİD. (n.d.). Domestic natural gas market - imports. Retrieved (n.d.), from Doğal Gaz İthalatçıları Derneği: http://gazid.org.tr/domestic-natural-gas-market-imports/?lang=en

Geng JB, Ji Q, Fan Y. (2016c). The impact of the North American shale gas revolution on regional natural gas markets: Evidence from the regime-switching model. *Energy Policy*, 96, p. 167-178.

Geng, JB, Ji Q, Fan Y. (2016a). How regional natural gas markets have reacted to oil price shocks before and since the shale gas revolution: A multi-scale perspective. *Journal of Natural Gas Science and Engineering*, 36, p. 734-746, 2016.

Geng, JB, Ji Q, Fan Y. (2016b). The behaviour mechanism analysis of regional natural gas prices: A multi-scale perspective. *Energy*, 101, p. 266-277.

Ghouri SS. (2006). Forecasting natural gas prices using cointegration technique. *OPEC Review*, 30(4), p. 249-269.

Giziene V, Zalgiryte L. (2015). The assessment of natural gas pricing. *Procedia-Social and Behavioral Sciences*, 213, p. 111-116.

Glachant JM, Hallack M, Vazquez M. (2013). *Building competitive gas markets in the EU*. Edward Elgar Publishing.

Green R, Le Coq C. (2010). The length of contracts and collusion. *International Journal of Industrial Organization*, 28(1), p. 21-29.

Greentumble. (2017). Why is natural gas a non-renewable resource?. Retrieved March 10, 2017, from Greentumble: https://greentumble.com/why-is-natural-gas-a-non-renewable-resource

Gudmundsson JS. (2017). *Flow assurance solids in oil and gas production*. CRC Press.

Guidolin M, Pedio M. (2018). *Essentials of time series for financial applications*. Academic Press.

Gujarati D. (2015). *Econometrics by example*, Palgrave Publications, Second Edition, USA.

Hallack M, Vazquez M. (2013). European Union regulation of gas transmission services: Challenges in the allocation of network resources through entry/exit schemes. *Utilities Policy*, 25, p. 23-32.

Hamhaber J. (2015). Energy, geography of. In: *International Encyclopedia of the Social and Behavioral Sciences*. 2nd ed., Vol 7. New York: Elsevier, p. 633-640.

Hamilton JD. (1994). *Time series analysis* (Vol. 2). New Jersey: Princeton.

Harman HH. (1976). *Modern factor analysis* (3rd ed. revised). University of Chicago Press.

Hartley PR, Medlock III KB, Rosthal JE. (2008). The relationship of natural gas to oil prices. *The Energy Journal*, 29(3), p. 47-65.

Hartley PR. (2015). The future of long-term LNG contracts. *The Energy Journal*, p. 209-233.

Hayashi M, Hughes L. (2013a). The Fukushima nuclear accident and its effect on global energy security. *Energy policy*, 59, p. 102-111.

Hayashi M, Hughes L. (2013b). The policy responses to the Fukushima nuclear accident and their effect on Japanese energy security. *Energy Policy*, 59, p. 86-101.

Heather P. (2015). The evolution of European traded gas hubs. *OIES Paper* NG104.

Heather P. (2019). European traded gas hubs: a decade of change. *OIES Energy Insight*, 55.

Henderson J. (2019). Pipeline gas versus LNG - increasing competition in Europe and Asia. *The Oxford Institute for Energy Studies*, Forum 119, September, p. 12-15.

Holland B, Ashley PS. (2012). Natural gas price reviews: Past, present and future. *Journal of Energy & Natural Resources Law*, p. 29-44.

Honarvar A. (2009). Asymmetry in retail gasoline and crude oil price movements in the United States: An application of hidden cointegration technique. *Energy Economics*, 31(3), p. 395-402.

Honoré A. (2011). European natural gas demand, supply, and pricing: Cycles, seasons, and the impact of LNG price arbitrage. OUP Catalogue.

Hubbard RG, Weiner RJ. (1986). Regulation and long-term contracting in US natural gas markets. *The Journal of Industrial Economics*, p. 71-79.

Hulshof D, Van der Maat JP, Mulder M. (2016). Market fundamentals, competition and natural-gas prices. *Energy Policy*, 94, p. 480-491.

IBS Research & Consultancy. (2019). Developments in Turkish Gas Sector. Regional Oil & Gas Conference. İstanbul: Balkan and Black Sea Petroleum Association.

ICE. (n.d.). Webinar: 8 factors driving natural gas markets. Retrieved (n.d.), from Intercontinental Exchange: https://www.theice.com/article/8-factors-driving-nat-gas-markets

IEA. (2019). LNG market trends and their implications, IEA, Paris. Retrieved 2019, from International Energy Agency: https://www.iea.org/reports/lng-market-trends-and-their-implications, p. 66.

IGU. (2019). World LNG report. Shanghai, 2019. Retrieved 2019, from International Gas Union: https://www.igu.org/news/igu-releases-2019-world-lng-report

IGU. (n.d.). Global natural gas trade. Retrieved (n.d.), from International Gas Union: https://www.igu.org/resources-data#natural-gas

IGU. (n.d.). Natural gas contracts. Retrieved (n.d.), from International Gas Union: https://www.igu.org/resources-data#natural-gas

IGU. (n.d.). Natural gas facts & figures. Retrieved (n.d.), from International Gas Union: https://www.igu.org/resources-data#natural-gas

IGU. (n.d.). Natural gas price formation. Retrieved (n.d.), from International Gas Union: https://www.igu.org/dialog-sidebar/price-formation-mechanisms?minimal

IGU. (n.d.). Natural gas unit conversion. Retrieved (n.d.), from International Gas Union: https://www.igu.org/dialog-sidebar/unit-conversion?minimal

Jadidzadeh A, Serletis A. (2017). How does the US natural gas market react to demand and supply shocks in the crude oil market?. *Energy Economics*, 63, p. 66-74.

Jaganathan J. (2019). Global LNG-Asian prices near $6 per mmBtu on higher European gas, oil prices. Retrieved September 20, 2019, from CNBC: https://www.cnbc.com/2019/09/20/reuters-america-global-lng-asian-prices-near-6-per-mmbtu-on-higher-european-gas-oil-prices.html

Jensen JT. (2004). The development of a global LNG market: is it likely? If so, when?. Oxford Institute for Energy Studies.

Ji Q, Geng JB, Fan Y. (2014). Separated influence of crude oil prices on regional natural gas import prices. *Energy Policy*, 70, p. 96-105.

Karbuz S. (2016). The legal status of the Caspian Sea: Implications on Caspian resources development and transport. *Energy Policy Turkey*, (2), p. 62-69.

Khan Academy. (n.d.). What is conservation of energy? Retrieved (n.d.), from Khan Academy: https://www.khanacademy.org/science/physics/work-and-energy/work-and-energy-tutorial/a/what-is-conservation-of-energy

Kilian L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review*, 99(3), 1053-69.

Kim Y. (2017). Asian LNG market changes under low oil prices: prospects for trading hubs and a new price index. *Geosystem Engineering*, 20(3), p. 129-141.

Klein B, Crawford RG, Alchian AA. (1978). Vertical integration, appropriable rents, and the competitive contracting process. *The journal of Law and Economics*, 21(2), p. 297-326.

Kliesen KL. (2006). Rising natural gas prices and real economic activity. Federal Reserve Bank of St. Louis Review, p. 511-526.

KPMG. (2019). Sektörel bakış: Enerji. İstanbul, Retrieved 2019, from KPMG: https://assets.kpmg/content/dam/kpmg/tr/pdf/2019/03/sektorel-bakis-2019-enerji.pdf

Kwiatkowski D, Phillips PC, Schmidt P, Shin Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics*, 54(1-3), 159-178.

Le Coq C. (2004). Long-term supply contracts and collusion in the electricity market (No. 552). SSE/EFI Working Paper Series in Economics and Finance.

Levine S, Carpenter P, Thapa A. (2014). Understanding natural gas markets. American Petroleum Institute.

Li R, Joyeux R, Ripple RD. (2014). International natural gas market integration. *The Energy Journal*, p. 159-179.

Liang C, Abreu A, Fan SY. (2019). Russia pipe gas supplies may further slow China's LNG import growth. Retrieved October 18, 2019 from S&P Global: https://www.spglobal.com/platts/en/market-insights/latest-news/natural-gas/101819-russia-pipe-gas-supplies-may-further-slow-chinas-lng-import-growth

Lin B, Li J. (2015). The spillover effects across natural gas and oil markets: Based on the VEC–MGARCH framework. *Applied Energy*, 155, p. 229-241.

Lin B, Wesseh Jr PK. (2013). What causes price volatility and regime shifts in the natural gas market. *Energy*, 55, p. 553-563.

Liski M, Montero JP. (2006). Forward trading and collusion in oligopoly. *Journal of Economic Theory*, 131(1), p. 212-230.

Liu H, Li J. (2018). The US shale gas revolution and its externality on crude oil prices: A counterfactual analysis. *Sustainability*, 10(3), p. 697.

LiveMint. (2017). Undersea Iran-India gas pipeline can bring cheaper LNG to India. Retrieved September 5, 2017, from LiveMint: https://www.livemint.com/Industry/wj8PfRvGGyAfh1p8aoPX9K/Undersea-IranIndia-gas-pipeline-can-bring-cheaper-LNG-to-I.html

Lütkepohl H. (2007). *New introduction to multiple time series analysis* (p. 211). Berlin: Springer Verlag.

Malik F, Ewing BT. (2009). Volatility transmission between oil prices and equity sector returns. *International Review of Financial Analysis*, 3(18), p. 95-100.

Malik F, Hammoudeh S. (2007). Shock and volatility transmission in the oil, US and Gulf equity markets. *International Review of Economics & Finance*, 16(3), 357-368.

Manzoor D, Seiflou S. (2011). Are crude oil, gas and coal prices co-integrated?. *Iranian Economic Review*, 15(28), 29-51.

Masih AMM, Albinali K, DeMello L. (2010). Price dynamics of natural gas and the regional methanol markets. *Energy Policy*, 38(3), 1372-1378.

Masten SE, Crocker KJ. (1985). Efficient adaptation in long-term contracts: Take-or-pay provisions for natural gas. *The American Economic Review*, 75(5), p. 1083-1093.

Matlary JH. (1997). *Energy policy in the European Union*. Basingstoke: Macmillan.

McMillin WD. (1988). Money growth volatility and the macroeconomy. *Journal of Money, Credit and Banking*, 20(3), p. 319-335.

Medium Term Programme for 2018-2020. Retrieved September 12, 2019, from Presidency of The Republic of Turkey Strategy and Budget Presidency: http://www.sbb.gov.tr/wp-content/uploads/2018/11/Medium_Term_Programme_2018-2020.pdf

MENR Strategic Plan for 2015-2019. Retrieved September 12, 2019, from Republic of Turkey Ministry of Energy and Natural Resources: https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FStrategic%20Plan%2FStrategicPlan2015-2019.pdf

MENR. (2017). Dünya ve Türkiye enerji ve tabii kaynaklar görünümü. Sayı, 15, 8, 2017.

MENR. (2018). Turkey launches Spot Natural Gas Trade System. Retrieved September 1, 2018, from Republic of Turkey Ministry of Energy and Natural Resources: https://www.enerji.gov.tr/en-US/News/Turkey-Launches-Spot-Natural-Gas-Trade-System

MENR. (n.d.). MENR. Retrieved (n.d.), from Ministry of Energy and Natural Resources: http://www.enerji.gov.tr

MENR. (n.d.). MENR. Retrieved (n.d.), from Ministry of Energy and Natural Resources: https://www.enerji.gov.tr/en-US/Pages/Electricity (Accessed on 04.03.2019).

MENR. (n.d.). Natural gas pipelines and projects. Retrieved (n.d.). from Republic of Turkey Ministry of Energy and Natural Resources: https://www.enerji.gov.tr/en-US/Pages/Natural-Gas-Pipelines-and-Projects

MENR. (n.d.). Natural gas. Retrieved (n.d.), from Republic of Turkey Ministry of Energy and Natural Resources: https://www.enerji.gov.tr/en-US/Pages/Natural-Gas

Ministry of Foreign Affairs. (n.d.). Turkey's energy profile and strategy. Retrieved (n.d.), from mfa.gov.tr: http://www.mfa.gov.tr/turkeys-energy-strategy.en.mfa

Miyamoto A. (2009). A new paradigm for natural gas pricing in Asia: A perspective on market value. *Oxford Institute for Energy Studies*.

Mohammadi H. (2011). Long-run relations and short-run dynamics among coal, natural gas and oil prices. *Applied Economics*, 43(2), p. 129-137.

Mokhatab S, Poe WA, Mak JY. (2018). *Handbook of natural gas transmission and processing: principles and practices*. Gulf professional publishing.

Mokyr J. (1977). Demand vs. supply in the industrial revolution. *The Journal of Economic History*, 37(4), 981-1008.

Mu X. (2007). Weather, storage, and natural gas price dynamics: Fundamentals and volatility. *Energy Economics*, 29(1), 46-63.

Mulherin JH. (1986). Complexity in long-term contracts: An analysis of natural gas contractual provisions. *JL Econ. & Org.*, 2, 105.

Müller J, Hirsch G, Müller A. (2015). Modelling the price of natural gas with temperature and oil price as exogenous factors. In *Innovations in Quantitative Risk Management* (p. 109-128). Springer, Cham.

Natgas. (n.d.). Gas pipelines. Retrieved (n.d.), from The Independent Natural Gas Information Site: http://natgas.info/gas-information/what-is-natural-gas/gas-pipelines

Natgas. (n.d.). Gas pricing. Retrieved (n.d.), from The Independent Natural Gas Information Site: http://natgas.info/gas-information/what-is-natural-gas/gas-pricing-contracts

Natgas. (n.d.). Unconventional gas. Retrieved (n.d.), from The Independent Natural Gas Information Site: http://natgas.info/gas-information/what-is-natural-gas/unconventional-gas

Neuhoff K, Von Hirschhausen C. (2006). Long-term vs. short-term contracts; A European perspective on natural gas. Faculty of Economics.

Neumann A, Siliverstovs B, Hirschhausen CV. (2006). Convergence of European spot market prices for natural gas? A real-time analysis of market integration using the Kalman Filter. *Applied Economics Letters*, 13(11), 727-732.

Neumann A, Von Hirschhausen C. (2004). Less long-term gas to Europe? A quantitative analysis of European long-term gas supply contracts. *Zeitschrift für Energiewirtschaft*, 28(3), p. 175-182.

Neumann A, Von Hirschhausen C. (2015). Natural gas: an overview of a lower-carbon transformation fuel.

Neumann A. (2009). Linking natural gas markets–is LNG doing its job?. *The Energy Journal*, p. 187-199.

New York State. (2020). Governor Cuomo announces legislation to make the fracking ban permanent included in FY 2021 executive budget. Retrieved January 22, 2020, from New York State: https://www.governor.ny.gov/news/governor-cuomo-announces-legislation-make-fracking-ban-permanent-included-fy-2021-executive

Newbery D. (1984). Manipulation of futures markets by a dominant producer, in *The Industrial Organization of Futures Markets* (R. Anderson, Ed.).

Nexant. (2017). Global LNG outlook quarter 1, 2017. Retrieved 2017, from: https://eneken.ieej.or.jp/data/7283.pdf

NGML. (2001). Natural Gas Market Law, Law No: 4646, Adoption Date: 18/04/2001, Published in the Turkish Official Gazette No. 24390 on May 2001. Retrieved 2001, from Turkish Official Gazette: https://www.resmigazete.gov.tr/eskiler/2001/05/20010502.htm#1

NGML. (2018). Law on the Amendment to NGML 4646, Law No: 7103, Adoption Date: 21/03/2018, Published in the Turkish Official Gazette No. 30373 on March 2018. Retrieved 2018, from Turkish Official Gazette: https://www.resmigazete.gov.tr/eskiler/2018/03/20180327M2-1.htm

Nick S, Thoenes S. (2014). What drives natural gas prices? -A structural VAR approach. *Energy Economics*, 45, p. 517-527.

Nord Stream 2. (n.d.). Rationale. Retrieved (n.d.), from Nord Stream 2: https://www.nord-stream2.com/company/rationale

Oxford Learner's Dictionaries. (n.d.). Energy. Retrieved (n.d.), from Oxford Learner's Dictionaries: https://www.oxfordlearnersdictionaries.com/definition/english/energy

Pal D, Mitra SK. (2015). Asymmetric impact of crude price on oil product pricing in the United States: An application of multiple threshold nonlinear autoregressive distributed lag model. *Economic Modelling*, 51, p. 436-443.

Panagiotidis T, Rutledge E. (2007). Oil and gas markets in the UK: Evidence from a cointegrating approach. *Energy Economics*, 29(2), p. 329-347.

Parsons JE. (1989). Estimating the strategic value of long-term forward purchase contracts using auction models. *The Journal of Finance*, 44(4), p. 981-1010.

PETFORM. (n.d.). Türkiye doğal gaz piyasası. Retrieved (n.d.), from Petrol ve Doğal Gaz Platformu Derneği: https://www.petform.org.tr/dogal-gaz-piyasasi/turkiye-dogal-gaz-piyasasi

Pettersson F, Söderholm P, Lundmark R. (2012). Fuel switching and climate and energy policies in the European power generation sector: A generalized Leontief model. *Energy Economics*, 34(4), p. 1064-1073.

Phillips PC, Perron P. (1988). Testing for a unit root in time series regression. *Biometrika*, 75(2), p. 335-346.

Polo M, Scarpa C. (2013). Liberalizing the gas industry: Take-or-pay contracts, retail competition and wholesale trade. *International Journal of Industrial Organization*, 31(1), p. 64-82.

Presidency of the Republic of Turkey Investment Office. (n.d.). Energy. Retrieved (n.d.), from Why Invest in Turkish Energy Sector?: https://www.invest.gov.tr/en/Sectors/Pages/energy.aspx

PWC. (2014). Liberalizing natural gas in Turkey. İstanbul, Retrieved February 2014. from PricewaterhouseCoopers: https://www.pwc.com.tr/tr/publications/industrial/energy/assets/turkiyede-dogalgaz-piyasasinin-liberallesmesi-raporu.pdf

QatarGas. (n.d.). Corporate structure. Retrieved (n.d.), from QatarGas: http://www.qatargas.com/english/aboutus/corporate-structure

Ramberg D, Parsons J. (2012). The weak tie between natural gas and oil prices. *The Energy Journal*, p. 13-35.

Ramberg DJ, Chen YH, Paltsev S, Parsons JE. (2017). The economic viability of gas-to-liquids technology and the crude oil–natural gas price relationship. *Energy Economics*, 63, p. 13-21.

Regnard N, Zakoian JM. (2011). A conditionally heteroskedastic model with time-varying coefficients for daily gas spot prices. *Energy Economics*, 33(6), p. 1240-1251.

Rogers HV. (2012). The Impact of a globalising market on future European gas supply and pricing: The importance of Asian demand and North American supply. *The Oxford Institute for Energy Studies*, NG 59, January 2012.

Ruester S. (2009). Changing contract structures in the international LNG markets-An empirical analysis.

Ruester S. (2015). Financing LNG projects and the role of long-term sales-and-purchase agreements.

SAGE. (2016). India's energy security & transnational gas pipelines. New Delhi, 2016: Confederation of Indian Industry (CII). Retrieved 2016, from SAGE: www. http://www.sage-india.com

Schmalensee R, Armstrong M, Willig RD, Porter RH. (Eds.). (1989). *Handbook of industrial organization* (Vol. 3). Elsevier.

SciDevNet. (2014). Should hydropower truly be described as renewable?. Retrieved June 2, 2014, from SciDevNet: https://www.scidev.net/global/water/editorials/hydropower-described-as-renewable.html

Serletis A, Herbert J. (1999). The message in North American energy prices. *Energy Economics*, 21(5), p. 471-483.

Serletis A, Rangel-Ruiz R. (2004). Testing for common features in North American energy markets. *Energy Economics*, 26(3), p. 401-414.

Serletis A, Shahmoradi A. (2005). Business cycles and natural gas prices. *OPEC Review*, 29(1), p. 75-84.

Shen Y, Shi X, Variam HMP. (2018). Risk transmission mechanism between energy markets: A VAR for VaR approach. *Energy Economics*, 75, p. 377-388.

Shi X, Variam HMP. (2016). Gas and LNG trading hubs, hub indexation and destination flexibility in East Asia. *Energy Policy*, 96, p. 587-596.

Shi X, Variam HMP. (2017). East Asia’s gas-market failure and distinctive economics: A case study of low oil prices. *Applied Energy*, 195, p. 800-809.

Siliverstovs B, L'Hégaret G, Neumann A, Von Hirschhausen C. (2005). International market integration for natural gas? A cointegration analysis of prices in Europe, North America and Japan. *Energy Economics*, 27(4), p. 603-615.

Sims CA, Zha T. (1999). Error bands for impulse responses. *Econometrica*, 67(5), p. 1113-1155.

Sims CA. (1980). Macroeconomics and reality. *Econometrica*, 1-48.

Sims CA. (1986). Are forecasting models usable for policy analysis?. *Quarterly Review*, (Win), p. 2-16.

Sims CA. (1992). Interpreting the macroeconomic time series facts: The effects of monetary policy. *European Economic Review*, 36(5), p. 975-1000.

Skalamera M. (2016). The Russian reality check on Turkey's gas hub hopes. Belfer Center Policy Brief.

Srivastava VK, Giles DE. (1987). Seemingly unrelated regression equations models: Estimation and inference (Vol. 80). CRC Press.

Stern J. (2012). The pricing of internationally traded gas. (p. 40-85). New York: Oxford University Press.

Stern J. (2014). International gas pricing in Europe and Asia: A crisis of fundamentals. *Energy Policy*, 64, 43-48.

Stern J. (2016). The new Japanese LNG strategy: A major step towards hub-based gas pricing in Asia. London: *Oxford Institute of Energy Studies*, Oxford Energy Comment.

Stern JP. (1984). *International gas trade in Europe: The policies of exporting and importing countries*. Heinemann Educational Books.

Stern JP. (2007). Is there a rationale for the continuing link to oil product prices in continental European long-term gas contracts?. *International Journal of Energy Sector Management*, 1(3), 221-239.

Sung J. (2015). Impact of new waves of LNG in the Asia Pacific gas market: Future of LNG market in Asia. The Dynamic Energy Landscape. Pittsburgh: 33rd USAEE/IAEE North American Conference.

TANAP. (n.d.). Anlaşmalarımız. Retrieved (n.d.), from Trans-Anadolu Doğal Gaz Boru Hattı: https://www.tanap.com/kurumsal/anlasmalarimiz

Taylor JB. (1999). A historical analysis of monetary policy rules. *Monetary Policy Rules* (p. 319-348). University of Chicago Press.

Techopedia. (n.d.). What is a Joule? Retrieved (n.d.), from Techopedia: https://www.techopedia.com/definition/1742/joule

The Baker Institute. (2007). Research: The fundamental relationship between natural gas and crude oil prices in North America. Retrieved November 16, 2017, from Rice University's Baker Institute for Public Policy: https://www.bakerinstitute.org/center-for-energy-studies/research-fundamental-relationship-between-natural-gas-and-crude-oil-price

The World Bank. (2019a). Country overview: Turkey. Retrieved October 18, 2019, from The World Bank: https://www.worldbank.org/en/country/turkey/overview

The World Bank. (2019b). Turkey. Retrieved October 20, 2019, from The World Bank Data: https://data.worldbank.org/country/turkey

The World Bank. (n.d.). Foreign trade data of Turkey. Retrieved (n.d.), from The World Bank Data: https://data.worldbank.org/country/turkey

The World Bank. (n.d.). Population of Turkey. Retrieved (n.d.), from The World Bank Data: https://data.worldbank.org/country/turkey

The World Bank. (n.d.). The World Bank databank: World development indicators. Retrieved (n.d.), from The World Bank Databank: https://databank.worldbank.org/source/world-development-indicators

Tong X, Zheng J, Fang B. (2014). Strategic analysis on establishing a natural gas trading hub in China. *Natural Gas Industry B*, 1(2), 210-220.

Topuz K. (2019). The missing piece in the Turkey's gas hub ambitions. IICEC.

Turkey and Russia International Treaty. (1984). T.C. Official Gazette, 18598, December 7, 1984.

Turkish Competition Authority. (2012). Natural gas sectoral survey, 56, July 2012.

Türkiye Petrolleri. (2018). 2017 yılı ham petrol ve doğal gaz sektör raporu. Retrieved 2018, from Türkiye Petrolleri: http://www.tpao.gov.tr/tp5/docs/rapor/sektor_rapor_2017.pdf

Türkiye Petrolleri. (2019). 2018 yılı ham petrol ve doğal gaz sektör raporu. Retrieved 2019, from Türkiye Petrolleri: http://www.tpao.gov.tr/tp5/docs/rapor/sektor_rapor_2018.pdf

TURKSTAT. (2017). Foreign trade statistics, December 2017. Retrieved February 9, 2018, from Turkish Statistical Institute: http://www.turkstat.gov.tr/PreHaberBultenleri.do;jsessionid=tJjSh9JbvVcXVsP75LPy8B7j72G9PYpVkXypZBX0J25n9DfGtFcn!128339323?id=27806

TURKSTAT. (2018). Foreign trade statistics, December 2018. Retrieved January 31, 2019, from Turkish Statistical Institute: http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=30652

TURKSTAT. (2019). Statistics by theme. Retrieved October 20, 2019, from Turkish Statistical Institute: http://www.turkstat.gov.tr/UstMenu.do?metod=kategorist

U.S. Department of Energy. (n.d.). Energy sources. Retrieved (n.d.), from energy.gov: https://www.energy.gov/science-innovation/energy-sources

Vaidyanathan G. (2016). Fracking can contaminate drinking water. Retrieved April 4, 2016, from Scientific American: https://www.scientificamerican.com/article/fracking-can-contaminate-drinking-water

Verbeek M. (2017). *A Guide to modern econometrics* (Fifth Edition). Rotterdam: John Wiley & Sons Ltd.

Villar JA, Joutz FL. (2006). The relationship between crude oil and natural gas prices. Energy Information Administration, Office of Oil and Gas, p. 1-43.

Vivoda V. (2014). Natural gas in Asia: Trade, markets and regional institutions. *Energy Policy*, 74, 80-90, p. 5.

Von Hirschhausen C, Neumann A. (2008). Long-term contracts and asset specificity revisited: An empirical analysis of producer–importer relations in the natural gas industry. *Review of Industrial Organization*, 32(2), p. 131-143.

Wakamatsu H, Aruga K. (2013). The impact of the shale gas revolution on the US and Japanese natural gas markets. *Energy Policy*, 62, p. 1002-1009.

Wheeler M, Chowdhury AR. (1993). The housing market, macroeconomic activity and financial innovation: an empirical analysis of US data. *Applied Economics*, 25(11), p. 1385-1392.

Whistance J, Thompson W. (2010). How does increased corn-ethanol production affect US natural gas prices?. *Energy Policy*, 38(5), p. 2315-2325.

Wiggins S, Etienne XL. (2017). Turbulent times: Uncovering the origins of US natural gas price fluctuations since deregulation. *Energy Economics*, 64, p. 196-205.

Wikipedia. (n.d.). Liquefied Natural Gas. Retrieved (n.d.), from Wikipedia: https://en.wikipedia.org/wiki/Liquefied_natural_gas

Winstel S. (2020). Fracking ban could hamstring important energy producing states. Retrieved March 2, 2020, from Energy API: https://www.api.org/news-policy-and-issues/blog/2020/03/02/fracking-ban-could-hamstring-energy-producing-states

Wiser R, Bolinger M. (2005). Can deployment of renewable energy and energy efficiency put downward pressure on natural gas prices. Berkeley: Lawrence Berkeley National Laboratory.

World Bank/ESMAP. (1993). Long-term gas contracts: Principles and applications, Washington, DC: The World Bank, Report No. 152/93.

World's Top Exports. (2019). Turkey's top 10 imports. Retrieved June 3, 2019, from World's Top Exports: http://www.worldstopexports.com/turkeys-top-10-imports

Xin Z. (2019). China-Russia gas pipeline construction begins new phase. Retrieved July 4, 2019, from China Daily: http://www.chinadaily.com.cn/a/201907/04/WS5d1db85ea3105895c2e7bb87.html

Yardımcı O, Ediger V. (2010). Petrol fiyatlarının doğal gaz fiyatları üzerindeki etkisi: Türkiye için fırsatlar ve tehditler. *16. Uluslararası Enerji ve Çevre Fuarı ve Konferansı Bildiriler Kitabı*.

Yardımcı O. (2011). Türkiye doğal gaz piyasası: Geçmiş 25 yıl, gelecek 25 yıl. *Ekonomi Bilimleri Dergisi*, 3(2), 157-166.

Zawadzki S. (2019). European gas prices exceed Asian spot LNG, shuts arbitrage. Retrieved July 15, 2019, from Reuters: https://www.reuters.com/article/us-global-lng-europe/european-gas-prices-exceed-asian-spot-lng-shuts-arbitrage-idUSKCN1UA1L6

Zellner A, Ando T. (2010). A direct Monte Carlo approach for Bayesian analysis of the seemingly unrelated regression model. *Journal of Econometrics*, 159(1), 33-45.

Zellner A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association*, 57(298), 348-368.

Zhang D, Ji Q. (2018). Further evidence on the debate of oil-gas price decoupling: A long memory approach. *Energy Policy*, 113, 68-75.

Zhang D, Shi M, Shi X. (2018). Oil indexation, market fundamentals, and natural gas prices: An investigation of the Asian premium in natural gas trade. *Energy Economics*, 69, 33-41.

Zhang D. (2017). Oil shocks and stock markets revisited: measuring connectedness from a global perspective. *Energy Economics*, 62, 323-333.

Zhang YJ, Chevallier J, Guesmi K. (2017). "De-financialization" of commodities? Evidence from stock, crude oil and natural gas markets. *Energy Economics*, 68, 228-239.

Zlámal D. (2009). *Option embedded in natural gas sales' contracts*. Praha, 2009. Rigorous thesis. Charles University, Faculty of Social Sciences, Institute of Economic Studies. Thesis supervisor: Mejstřík, Michal.

7 APPENDICES

APPENDIX A



T. C.
Resmî Gazete

Kuruluş Tarihi: (7 Teşrinievvel 1336) - 7 Ekim 1920

Yönetim ve Yazı İşleri için Başbakanlık Neşriyat Daire Başkanlığına başvurulur	7 Aralık 1984 CUMA	Sayı: 18598

YÜRÜTME VE İDARE BÖLÜMÜ

Milletlerarası Andlaşma

Karar Sayısı: 84/8806

18 Eylül 1984 tarihinde imzalanan ekli «Sovyet Sosyalist Cumhuriyetleri Birliği'nden Türkiye Cumhuriyetine Doğal Gaz Sevkiyatına Dair, Türkiye Cumhuriyeti Hükümeti ile Sovyet Sosyalist Cumhuriyetleri Birliği Hükümeti Arasında Anlaşma»nın ve bu Anlaşmanın ekini teşkil eden Protokolün ve Mektupların onaylanması; Dışişleri Bakanlığı'nın 20/11/1984 tarihli ve E2BD: I-470-702-1-84-5816-157/84 sayılı yazısı üzerine, 31/5/1963 tarihli ve 244 sayılı Kanun'un 3 üncü ve 5 inci maddelerine göre, Bakanlar Kurulu'nca 22/11/1984 tarihinde kararlaştırılmıştır.

Kenan EVREN
Cumhurbaşkanı

T. ÖZAL
Başbakan

İ. K. ERDEM — Devlet Bak. - Başbakan Yrd.
K. OKSAY — Devlet Bakanı
A. M. YILMAZ — Devlet Bakanı
S. N. TÜREL — Devlet Bakanı
A. TENEKECİ — Devlet Bakanı
İ. ÖZDAĞLAR — Devlet Bakanı
A. KARAEVLİ — Devlet Bakanı
M. N. ELDEM — Adalet Bakanı
K. OKSAY — Milli Savunma Bakanı V.
Y. AKBULUT — İçişleri Bakanı
A. M. YILMAZ — Dışişleri Bakanı V.
A. K. ALPTEMOÇİN — Maliye ve Gümrük Bakanı
M. V. DİNÇERLER — Milli Eğitim Gençlik ve Spor Bakanı
S. N. TÜREL — Bayındırlık ve İskân Bakanı V.
M. AYDIN — Sağlık ve Sosyal Yardım Bakanı

Yürütme ve İdare Bölümü Sayfa: 1

Resmî Gazete Kodu: 071284 — Resmî Gazete Fihristi 64. Sayfadadır.

7 Aralık 1984 — Sayı: 18598 REGMI GAZETE Sayfa: 3

MADDE — 4

İki taraf, Anlaşma'ya uygun olarak, malların sevkiyatının düzenli bir şekilde yürütülmesi için gerekli bütün tedbirleri her iki ülkede yürürlükte bulunan mevzuat çerçevesinde alacaklardır. Bu amaçla iki taraf yetkili mercileri özellikle gerekli lisans ve müsaadeleri engelleme olmadan vereceklerdir.

MADDE — 5

Taraflar, Türk topraklarında gaz boru hattı dizaynı ve inşası için işbirliği imkanlarını iyi niyetle gözönünde bulunduracaklardır.

MADDE — 6

Anlaşma, doğal gaz sevkiyatının başlangıç tarihinden itibaren 25 yıl süreyle yürürlükte kalacaktır. Bu Anlaşma ile yapılacak gaz sevkiyatı, Romanya Sosyalist Cumhuriyeti ve Bulgaristan Halk Cumhuriyeti topraklarındaki ilgili boru hattının faaliyete geçmesinden sonra başlıyacaktır. Taraflardan herhangi birinin Anlaşmanın sona erişi tarihinden 6 ay önce geçerlilik süresinin sona erdirilmesine ilişkin arzusunu yazılı biçimde bildirmemesi halinde, Anlaşmanın geçerlilik süresi 5 yıllık bir dönem için kendiliğinden uzayacaktır.

Her iki nüsha da aynı derecede geçerli olmak üzere, Türkçe ve Rusça iki orijinal kopya olarak 18/9/1984 tarihinde Ankara'da imzalanmıştır.

Türkiye Cumhuriyeti Hükümeti Adına

Sovyet Sosyalist Cumhuriyetleri Birliği Hükümeti Adına

Sayfa: 2 RESMÎ GAZETE 7 Aralık 1984 — Sayı: 18598

A. TENEKECİ — Ulaştırma Bakanı V.
H. H. DOĞAN — Tarım Orman ve Köyişleri Bakanı
M. KALEMLİ — Çalışma ve Sosyal Güvenlik Bakanı
H. C. ARAL — Sanayi ve Ticaret Bakanı
C. SÜYÜKBAŞ — Enerji ve Tabii Kaynaklar Bakanı
M. M. TAŞÇIOĞLU — Kültür ve Turizm Bakanı

Sovyet Sosyalist Cumhuriyetleri Birliği'nden Türkiye Cumhuriyetine Doğal Gaz Sevkiyatına Dair, Türkiye Cumhuriyeti Hükümeti ile Sovyet Sosyalist Cumhuriyetleri Birliği Hükümeti Arasında Anlaşma

Türkiye Cumhuriyeti Hükümeti ve Sovyet Sosyalist Cumhuriyetleri Birliği Hükümeti karşılıklı yarar ve eşitlik esasına dayanarak iki ülke arasındaki ticareti daha da geliştirmeye katkıda bulunmak gayesi ile aşağıdaki şekilde anlaşmışlardır.

MADDE — 1

Türk tarafı Sovyet Sosyalist Cumhuriyetleri Birliği'nden aşağıdaki miktarlarda ve tarihlerde doğal gaz almayı, Sovyet tarafı ise 1987 yılından başlıyarak 25 yıl süreyle Türkiye Cumhuriyeti'ne ticari şartlarla doğal gaz sevketmeyi garanti edecektir.

1987	— 1.5 Milyar M³
1988	— 1.5 » »
1989	— 2.3 » »
1990	— 3.0 » »
1991	— 3.5 » »
1992	— 4.0 » »
1993 - 2011	— 5.0 - 6.0 Milyar M³

Anlaşma gereğince doğal gaz sevkiyatı, karşılıklı olarak Türkiye Cumhuriyeti'nde ve Sovyet Sosyalist Cumhuriyetleri Birliği'nde yürürlükte bulunan kanun ve yönetmelikler ile Türkiye Cumhuriyeti ve Sovyet Sosyalist Cumhuriyetleri Birliği arasındaki 8 Ekim 1937 tarihli Ticaret ve Seyrüsefain Antlaşması, Türkiye Cumhuriyeti ile Sovyet Sosyalist Cumhuriyetleri Birliği arasında tadil edilmiş bulunan 8 Ekim 1937 tarihli Ticaret ve Ödeme Anlaşması, aynı zamanda Türkiye Cumhuriyeti ile Sovyet Sosyalist Cumhuriyetleri Birliği arasında ödemelerde serbest dövize geçişe dair 20 Mayıs 1982 tarihli Protokole uygun olarak gerçekleştirilecektir.

MADDE — 2

Türk Devleti Kuruluşu «Botaş» ve Sovyetler Birliği Kuruluşu «Soyuz gasexport» Sovyetler Birliği'nden Türkiye'ye gaz sevkiyatı için Anlaşma'ya uygun olarak kendi aralarında bir sözleşme yapacaklardır. Sözkonusu sözleşme, doğal gaz sevkiyatının ayrıntılı şartlarını ve fiyatını tesbit edecektir.

MADDE — 3

İşbu Anlaşmaya göre, T. C.'ne ihraç edilecek gazın bedeli, Sovyetler Birliği Dışticaret Kuruluşları tarafından ticari şartlar esasında olmak üzere genelde Türk mallarının alımında kullanılacak ve Türk tarafının imkanları ve Sovyet Dışticaret teşekküllerinin ihtiyaçlarına göre pamuk, tahıl, et, nebati yağlar, demir ve demir dışı metaller, demir dışı cevherler ve diğer sanayi mamulleri ile ödenecektir.

Bu maksatla iki taraf her yıl Sovyet Sosyalist Cumhuriyetleri Birliği'ne ihraç edilecek olan Türk mallarının listelerini müştereken tespit edeceklerdir.

Yürütme ve İdare Bölümü Sayfa: 2

Figure 2.14. The Official Gazette dated on 07.12.1984. Source: Turkey and Russia International Treaty (1984)

APPENDIX B

Table 4.5. Effects of actual alternative natural gas contract prices on IP

Date	NGP1	NGP2	NGP3	NGP4	NGP5
2014M06	4.5270	4.5270	4.5270	4.5270	4.5270
2014M07	4.5284	4.5828	4.5823	4.5813	4.5827
2014M08	4.5200	4.4754	4.4889	4.3238	4.5584
2014M09	4.4777	4.2971	4.3078	4.2031	4.3516
2014M10	4.5539	4.5452	4.5535	4.4447	4.5994
2014M11	4.6103	4.4183	4.5376	4.3374	4.3866
2014M12	4.5462	4.2697	4.3524	4.1870	4.2679
2015M01	4.5561	4.5073	4.5878	4.4184	4.5052
2015M02	4.5888	4.6089	4.6367	4.5265	4.6943
2015M03	4.4819	4.2326	4.2819	4.1569	4.2881
2015M04	4.5534	4.3762	4.4241	4.2967	4.4315
2015M05	4.6151	4.5841	4.6388	4.6475	4.6634
2015M06	4.5936	4.4589	4.5118	4.4743	4.5300
2015M07	4.5873	4.5387	4.5909	4.5520	4.6097
2015M08	4.6012	4.4106	4.5148	4.4571	4.4461
2015M09	4.5964	4.4771	4.5631	4.5115	4.5249
2015M10	4.6051	4.3837	4.4705	4.4205	4.4316
2015M11	4.6697	4.4697	4.6400	4.7118	4.4718
2015M12	4.6691	4.4041	4.5458	4.5761	4.4220
2016M01	4.6631	4.6333	4.7728	4.7994	4.6510
2016M02	4.6052	4.5637	4.6623	5.1643	4.6256
2016M03	4.5896	4.3999	4.5144	4.8551	4.4467
2016M04	4.6471	4.5466	4.6597	4.9980	4.5932
2016M05	4.6601	4.5177	4.5682	4.6633	4.6247
2016M06	4.6565	4.5128	4.5851	4.7645	4.5990
2016M07	4.6538	4.7139	4.7843	4.9604	4.7999
2016M08	4.5686	4.3375	4.3929	4.5961	4.3595
2016M09	4.5803	4.4856	4.5460	4.7396	4.5298
2016M10	4.6094	4.3573	4.4189	4.6145	4.4015
2016M11	4.6316	4.3214	4.3450	4.2299	4.3546
2016M12	4.7332	4.5123	4.5473	4.5367	4.5491
2017M01	4.7652	4.7640	4.7966	4.7819	4.8006
2017M02	4.6593	4.5730	4.6626	4.8019	4.5335
2017M03	4.5735	4.2423	4.3159	4.4085	4.2295
2017M04	4.6596	4.4388	4.5106	4.5999	4.4258
2017M05	4.7004	4.4610	4.5438	4.6600	4.4614
2017M06	4.6823	4.5115	4.5900	4.6959	4.5072
2017M07	4.6706	4.4218	4.5011	4.6085	4.4176

*RATS Software Package is used for generating the data.

APPENDIX C

Table 4.6. Effects of modelled alternative natural gas contract prices on IP

Date	NGP1	NGP2	NGP3	NGP4	NGP5
2014M06	0.2432	0.0019	0.0141	0.0217	0.0039
2014M07	0.2402	0.0397	0.0430	0.1650	-0.0141
2014M08	0.1972	0.0040	0.0165	0.0323	0.0033
2014M09	0.1255	0.0064	0.0182	0.0418	0.0025
2014M10	0.1053	-0.0241	-0.0868	0.0001	0.0299
2014M11	0.0693	0.0047	0.0096	0.0387	0.0035
2014M12	0.0442	0.0028	0.0034	0.0359	0.0047
2015M01	0.0188	-0.0030	0.0328	0.0239	-0.0599
2015M02	0.0039	0.0025	0.0058	0.0350	0.0024
2015M03	-0.0035	0.0021	0.0075	0.0343	-0.0005
2015M04	-0.0180	-0.0290	-0.0295	-0.0992	-0.0478
2015M05	-0.0469	0.0004	0.0045	0.0243	-0.0021
2015M06	-0.0927	-0.0016	0.0023	0.0155	-0.0042
2015M07	-0.1094	-0.0139	-0.0445	-0.0174	0.0074
2015M08	-0.1524	-0.0023	-0.0015	0.0131	-0.0038
2015M09	-0.2048	-0.0031	-0.0043	0.0109	-0.0033
2015M10	-0.2307	-0.0383	-0.0967	-0.1675	-0.0078
2015M11	-0.2581	-0.0050	-0.0118	-0.0023	-0.0035
2015M12	-0.2748	-0.0073	-0.0173	-0.0141	-0.0037
2016M01	-0.2969	-0.0504	-0.0322	-0.3558	-0.0765
2016M02	-0.2990	-0.0097	-0.0185	-0.0395	-0.0062
2016M03	-0.2874	-0.0124	-0.0194	-0.0620	-0.0095
2016M04	-0.2952	0.0537	0.0894	0.2156	0.0160
2016M05	-0.2957	-0.0087	-0.0105	-0.0414	-0.0086
2016M06	-0.2998	-0.0045	-0.0041	-0.0231	-0.0074
2016M07	-0.3016	0.0070	0.0201	-0.0131	0.0474
2016M08	-0.2954	-0.0039	-0.0021	-0.0223	-0.0055
2016M09	-0.2813	-0.0031	-0.0007	-0.0217	-0.0031
2016M10	-0.2798	0.0793	0.1078	0.3021	0.0868
2016M11	-0.2798	0.0015	0.0082	0.0024	0.0001
2016M12	-0.2871	0.0067	0.0146	0.0237	0.0041
2017M01	-0.2863	-0.0198	-0.0493	-0.1449	0.0289
2017M02	-0.2918	0.0052	0.0094	0.0112	0.0050
2017M03	-0.2986	0.0035	0.0056	0.0001	0.0061
2017M04	-0.3018	0.0104	0.0049	-0.0195	0.0040

*RATS Software Package is used for generating the data.

CURRICULUM VITAE

GÖKTUĞ ŞAHİN

EDUCATIONAL BACKGROUND

Middle School : American Collegiate Institute / Math and Science, İzmir, Turkey

High School : İzmir Science High School / Math and Science, İzmir, Turkey

B.A. : Middle East Technical University / Economics, Ankara, Turkey

M.A. : Ufuk University / International Trade and Finance, Ankara, Turkey

Ph.D. : Ankara Yıldırım Beyazıt University / Economics, Ankara, Turkey

ACADEMIC PROFESSIONAL EXPERIENCE

2018 – … Ankara Hacı Bayram Veli University / Lecturer – Ankara/Turkey

2012 – 2018 Gazi University / Lecturer – Ankara/Turkey

2012 – 2012 Budapest Business School / Visiting Lecturer – Budapest/Hungary

2010 – 2012 Abant İzzet Baysal University / Lecturer – Bolu/Turkey

FOREIGN LANGUAGES

English (Score: 92.5)

ACADEMIC PUBLICATIONS

Book and Book Chapters:

Impact and Paradox of Information Technology: A Review Essay on the Financial Institutions – 2013. (Book Chapter in Impact of IT Applications in Finance and Accounting, (Ed.) Chimun Kumar Nath) (Prof. Dr. Afşin Şahin, Lec. Göktuğ Şahin)

Macroeconomics: Principles, Applications, and Tools - 2014. (Book Chapters translation)

Peer-Reviewed Congresses/Symposiums:

Ioannina Meeting on Applied Economics & Finance – 2010, Ioannina/Greece. "The Role of the Short-Run Interest Rate for Managing Expectations - Time Series Evidence from Turkey, 2001-2009" (Lec. Göktuğ Şahin, Prof. Dr. Afşin Şahin, Prof. Dr. Serdar Altınok)

IV. Anadolu International Conference in Economics (ECON ANADOLU 2015), Eskişehir/Turkey – 2015. "Effects of Economic Development on Energy Ladder: Case of Turkey between 2000–2014" (Assist.Prof.Dr. H. Sencer Peker, Lec. Göktuğ Şahin, Burak Yitgin)

IV. International Congress on Economics, Finance & Energy (EFE 2020), Niğde/Turkey – 2020. "Effects of the European Green Deal on Turkish electricity Market" (Lec. Göktuğ Şahin, M. Ali Taksim, Burak Yitgin)

IV. International Congress on Economics, Finance & Energy (EFE 2020), Niğde/Turkey – 2020. "Integration of EV's to the Turkish Electricity Markets" (Burak Yitgin, Lec. Göktuğ Şahin)

International Conference Speaker and Organization Committee Membership:

International Conference on Energy, Economy, Ecology (E3): Renewable Energy Resources, Ankara/Turkey – 2013. "Logistics Security" (Lec. Göktuğ Şahin)

Articles:

The International Journal of Applied Economics and Finance – 2014. "An Overview on the Exchange Rate and Liability Dollarization in Turkey" (Prof. Dr. Afşin Şahin, Lec. Göktuğ Şahin)

Scientific Journal Refreeings:

African Journal of Marketing Management (AJMM) – 2011

Projects:

Doğu Marmara Development Agency (MARKA) Technical Support Project – Fall 2010. "AİBÜ Technical Support Project"