TC
YILDIZ TECHNICAL UNIVERSITY
THE INSTITUTE OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
ECONOMICS PhD PROGRAM

PhD THESIS

THREE ESSAYS ON ENERGY ECONOMICS

DİNÇER DEDEOĞLU
09710206

THESIS ADVISOR
Prof. Dr. TURAN YAY

ISTANBUL
2014

TC
YILDIZ TECHNICAL UNIVERSITY
THE INSTITUTE OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
ECONOMICS PhD PROGRAM

PhD THESIS

THREE ESSAYS ON ENERGY ECONOMICS

DİNÇER DEDEOĞLU
09710206

THESIS ADVISOR
Prof. Dr. TURAN YAY

ISTANBUL
2014

TC
YILDIZ TEKNİK ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
İKTİSAT ANABİLİM DALI
İKTİSAT DOKTORA PROGRAMI

DOKTORA TEZİ

ENERJİ EKONOMİSİ ÜZERİNE ÜÇ DENEME

DİNÇER DEDEOĞLU
09710206

Tezin Enstitüye Verildiği Tarih:…………..
Tezin Savunulduğu Tarih:…………

Tez Oy birliği / Oy çokluğu ile başarılı bulunmuştur.

	Unvan Ad Soyad	İmza
Tez Danışmanı :	Prof. Dr. Turan Yay	
Jüri Üyeleri :	Prof. Dr. Necip Çakır	
	Doç. Dr. Hüseyin Taştan	

İSTANBUL
SEPTEMBER, 2014

ÖZ

ENERJİ EKONOMİSİ ÜZERİNE ÜÇ DENEME

DİNÇER DEDEOĞLU

EYLÜL, 2014

Bu çalışma Türkiye ekonomisi açısından önem arz eden enerji ile ilgili bir takım konuları incelemektedir. Tez farklı metodolojiler kullanılan üç bölümden oluşmaktadır. Birinci bölüm Türkiye'de ekonomik büyümeyi engellemeden enerji etkin politikalar uygulanabileceğini göstermektedir. İkinci bölüm petrol fiyatlarının enflasyona geçişkenliğinin düzeyini ve zaman içindeki seyrini incelemektedir. Bulgular Türkiye'de petrol fiyatlarının enflasyona geçişkenliğinin zaman içinde arttığını işaret etmektedir. Üçüncü bölüm enerji politikası ile ilgili meseleler açısından önemli olan emtia gelecek sözleşme fiyatları arasındaki bağlantılar üzerinde, biyoyakıtların etkisini incelemektedir. Bulgular biyoyakıtlar üzerinden ortaya çıkan bir kanalın aralarındaki korelasyonu arttırmak suretiyle muhtemelen enerji ve tarımsal emtialar arasında ilişkilere neden olduğunu göstermektedir.

Anahtar Kelimeler: Granger Nedensellik, Bootstrap, Türkiye, Petrol Fiyatları, Yurtiçi Fiyatlar, Geçişkenlik, Dalgacık Analizi, Eşhareketlilik, Enerji Gelecek sözleşmeleri, Tarımsal Emtia Gelecek Sözleşmeleri

ABSTRACT

THREE ESSAYS ON ENERGY ECONOMICS

DİNÇER DEDEOĞLU

SEPTEMBER, 2014

This study examines a number of energy related issues which are important with respect to the Turkish economy. It is comprised of three chapters, each utilizing a different methodology. Chapter One shows that Turkey has room for implementing energy efficiency policies without hampering economic growth. Chapter Two examines the level and the evolution of oil price pass-through over time. The findings indicate that oil price pass-through to domestic prices in Turkey increases over time. Chapter Three investigates the role of biofuels in commodity futures price linkages, which is relevant to energy policy issues in Turkey. The findings shows that a channel through biofuels has probably caused links between energy and agricultural commodities by increasing the correlation between them.

Keywords: Granger Causality, Bootstrap, Turkey, Oil Prices, Domestic Prices, Pass-Through, Wavelet analysis, Comovement, Energy futures, Agricultural Commodity Futures, Biofuels

ACKNOWLEDGEMENTS

Without the support and help of many people this thesis could not be completed. I will gratefully acknowledge them here.

I'm grateful to my advisor Prof. Dr. Turan Yay and my committee members Prof. Dr. Necip Çakır, Assoc. Prof. Dr. Hüseyin Taştan with whose able guidiance I have finished this thesis.

I'm indebted to Asst. Prof. Dr. Emin Köksal at the Department of Economics at Bahcesehir University who introduced me the interestig world of Energy Economics.

I'm also grateful to Asst. Prof. Dr. Hüseyin Kaya Department of Economics at Bahcesehir University who has provided valuable comments as well as critiques. He is also willing to provide patient guidiance anytime he is available.

What's more I appreciate academicians and researchers for their suggessions, participative manner and for making their software and codes available.

I appreciate countless others in both the Economics Departments at Yıldız Technical University and Bahcesehir University for their understanding and help at various stages of my research.

I appreciate my PhD canditate friends Ali Piskin and Bekir Aşık for their support and encouragement. I want to express my grattitude to the wonderful wife of Ali Pişkin for her endurance and support.

I'm grateful to the members of my music group especially my companion Demet Tekin for their understanding, intangible support and encouragement at various stages of my research.

This thesis is dedicated to my mother Semra Dedeoğlu and to my father Cengiz Dedeoğlu without whose support, understanding, encouragement and devotion I would not have been able to complete this work. Thus, I want to gratefully acknowledge them here in particular.

To My Parents…

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

GDP **:** Real grossdomestic product

EU **:** Energy Use

BTU **:** British Thermal unit.

EIA **:** Energy Information Administration

MENR **:** The Ministry of Energy and Natural Resources

Mtoe **:** Million tonnes of oil equivalent

IEA **:** International Energy Agency

FAO **:** Food and Agriculture Organization

NASS **:** National Agricultural Statistics Service

1. INTRODUCTION

This dissertation aims to explore energy issues in Turkey with respect to energy-growth nexus, oil price pass-through and commodity comovement. The three essays comprising the thesis aim at contributing to the development of the understanding of energy issues in Turkey.

Energy issues are interdisciplinary concerns that influence economies as a whole. As a country with limited energy sources, Turkey is exposed to various influences from the outside world arising from energy related issues. Inevitably this means energy is a matter of serious concern. The world's rising energy needs are expected to be met by the Middle-East, Europe, Russia and Central-Asia which are home to approximately 75% of the world's oil and natural gas reserves. Indeed due to its geographical and geopolitical location, Turkey is becoming an important energy player by acting as a bridge between large importers of energy resources, particularly in Western Europe, and major energy producers. In addition, Turkey is in the process of growth and development. Over the last decade it has experienced significant economic expansion that has resulted in an increasing need for energy sources. These issues highlight the importance of energy for Turkey.

Chapter One investigates the potential relationship between energy consumption and growth in Turkey at the macroeconomic level for the period 1972-2011 by taking into consideration the proposed arguments in the literature. The results from different models are documented in order to illuminate the energy use-growth nexus for Turkey and try to account for the potential cause of the difference in Granger causality results in the literature. Granger causality results that reveal no Granger causality between energy consumption and economic growth for Turkey expose two alternatives, namely, decreasing energy consumption directly and increasing efficiency in energy consumption. The first alternative is not preferable for a rapidly developing country. The second, energy efficiency, enables mitigating energy use, contributes to economic development and becomes an integral part of sustainable development in an environment in which energy security and energy costs are major constraints. Accordingly, greater energy security and energy efficiency play a crucial role in loosening the underlying constraints.

Chapter Two explores the oil price pass-through issue. Turkey is a heavily oil dependent country and imports high amounts of oil based products. A considerable part of its substantial current account deficit is comprised of energy imports leaving Turkey vulnerable to both oil price and exchange rate shocks. Besides, Turkey is following an increasing growth path with increasing energy needs. Last but not least, Turkey has adopted inflation targeting monetary policy. When considering these issues together conducting proper monetary and energy policies becomes challenging. In this setting, oil price pass-through becomes a prominent area of concern for Turkey regarding energy, monetary and fiscal policy.

Chapter Three examines the role of biofuels in commodity futures price linkages. As a potential link between energy markets and agricultural commodities, biofuels are receiving increased attention. Many researchers identify the biofuel industry as a potential channel that affects the oil-food linkage. The channels between oil and biofuel commodity prices can lead to energy and agriculture commodity comovement. This is a matter of concern for a country like Turkey It is evident that comovement, which is not country specific, becomes a greater issue for Turkey due to country specific issues. Accordingly, comovement should be considered in creating energy, fiscal and monetary policies.

Each chapter, with its own introduction, literature review, data-methodology and conclusion, contributes to the constitution of the whole thesis which aims to investigate energy issues in Turkey.

2. A COMPHERENSIVE STUDY OF ENERGY USE-GROWTH NEXUS:

2.1. Introduction

There is a vast literature that investigates the causality relationship between energy consumption and real gross domestic product (henceforth GDP). These studies aim at presenting the potential relationship between the two variables and conclude with recommendations for energy policies based on their findings.

In the literature there is no consensus regarding the direction of the causality between energy consumption and GDP. Therefore, possible causes for this disagreement are documented by researchers. Ozturk (2010) and Payne (2010) point out that the causality relationship is investigated for different individual countries or for different groups of countries by using different data and proxy variables for different time periods. Due to these discrepancies, the empirical results vary and some contradictions have emerged.

Brendt (1978) and Cleveland et al. (2000) criticize the conventional approach which relies on aggregating different energy flows based on thermal equivalents (thermal aggregation) such as British thermal units (henceforth BTU) and joules. According to Brendt (1978), thermal aggregation does not consider quality among different fuels. In other words, varying levels of performance among different fuels in terms of performing economic functions is in question. In addition, Berndt (1978) and Cleveland et al. (2000) argue that different energy types are not perfect substitutes for each other due to differences in properties such as the capacity for useful work, weight, cleanness, suitability for storage, safety, physical scarcity, flexibility of use, cost of conversion, and energy density. Therefore marginal productivities and appropriate uses of different energy sources differ causing their prices to change. Correspondingly, consideration of quality differences may alter the causality results.[1]

[1] Stern (1993, 2000) considered a discrete time divisia aggregation of energy use and showed that consideration of quality differences among fuels cause the causality results to change.

Karanfil (2009) and Ozturk (2010) argue that future research should focus on econometric techniques rather than employing the conventional methods for different countries and time periods. Lütkepohl (1982) argues that a common problem of a bivariate analysis is the possibility of omitted variable bias. Consistent with this, the current widely held view in the energy consumption-growth literature is that studies using bivariate models may be biased due to the omission of relevant variables (Narayan and Smyth, 2005; Stern, 2000). Since omitted variable bias may alter the results, many studies now examine the relationship between energy consumption and economic growth within a multivariate framework.[2]

This chapter aims to investigate the potential relationship between energy consumption and real GDP per capita for Turkey during the period 1972-2011 by taking into consideration the aforementioned arguments. The results in different models are documented and compared in order to illuminate the energy use-growth causality for Turkey and try to account for the potential cause of the difference in causality results.

Before presenting empirical findings, it is worthwhile to briefly discuss Turkey's energy outlook. Turkey was ranked 17th in 2012 with its 794.468 billion dollars of Gross Domestic Product based on the IMF's World's Economic Outlook.[3] The world's energy consumption is expected to grow 53% by 2035, according to the International Energy Outlook 2011 by the US Energy Information Administration (EIA). Demand will be met by the Middle-East, Europe, Russia and Central-Asia. These areas contain approximately 75% of the world's oil and natural gas reserves. In particular Central Asia seems to be an alternative source for meeting the world's energy demand in the future. Due to its geographical and geopolitical location, Turkey can act as a bridge and an outlet for transporting energy from Central Asia to world markets. Turkey has the potential to become a major transit hub and the supplies from Russia, the Caspian Sea region and the Middle East can be transferred to Europe via Turkey. Although Turkey is not one of the major oil and natural gas producers, its potential role as a transit country makes it vital to world markets, particularly Europe. Apart from its importance to the world, Turkey's continuing

[2] Clarke (2005) argues that the inclusion of additional control variables is not a remedy for omitted variable bias. He demonstrates that the mathematical framework of regression analysis supports this conclusion.

[3] Report for Selected Countries and Subjects. World Economic Outlook Database, April 2013. Washington, D.C.: International Monetary Fund. Retrieved 16 April 2013.

economic development and growth induces an increasing need for energy. Figure 1 documents total primary energy consumption and GDP (1998 prices) figures which reflect remarkable similar movements.

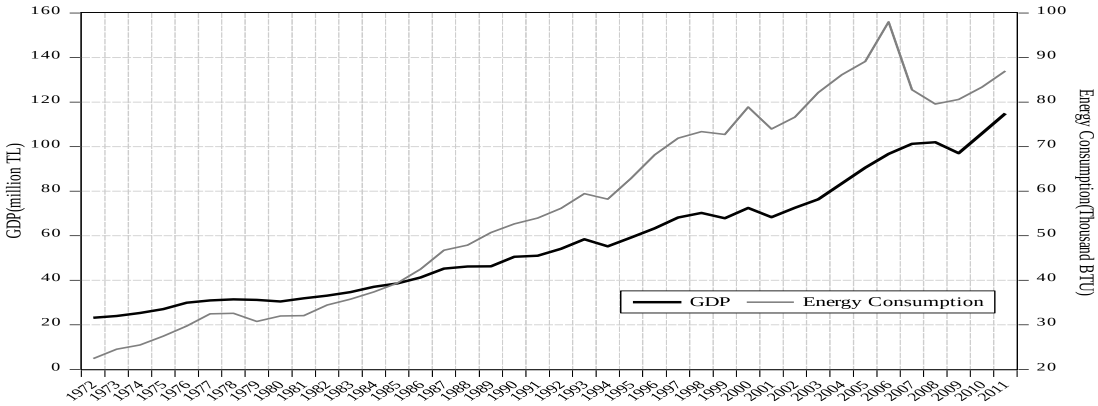


Figure 1 : GDP and Energy Consumption between 1972-2011
(Source: GDP and EC data are obtained from Turkey data monitor and World Development indicators respectively. The figure is created using aforementioned data.)

Nevertheless, Turkey's energy needs are primarily met by imports rendering it vulnerable to increases in energy costs. As of 2011, Turkey's total imports amounted to 240.8 billion US dollars while energy imports accounted for 54.1 billion of this, constituting 22% of total imports (MENR, 2011). Moreover, petroleum production and consumption are 2.285.103 tonnes and 27.722.652 tonnes respectively. Natural gas production and consumption are 0.79 billion and 343.9 billion m^3 respectively. The amount of petrol production and natural gas production accounted for only 8.2% of petrol consumption and 1.8% of natural gas consumption respectively. Figure 2 illustrates the annual figures of energy imports as a percentage share of energy use revealing an increase in dependence on foreign energy sources.

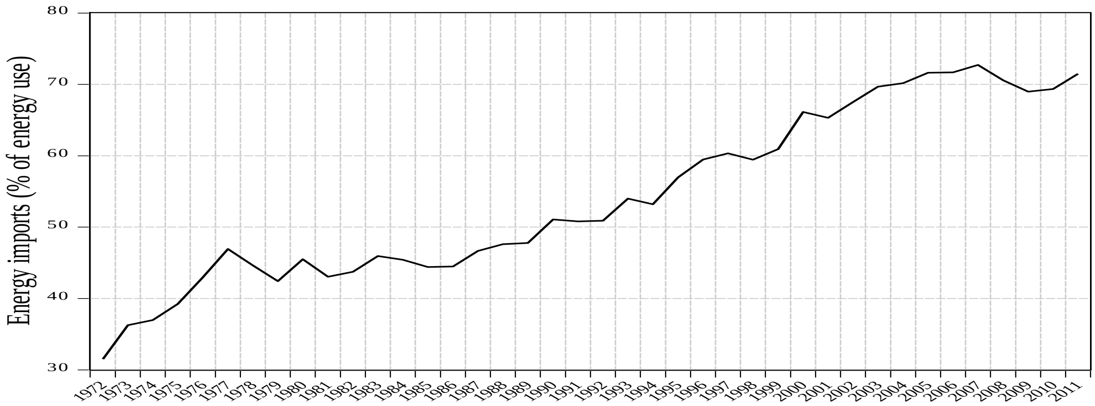


Figure 2 : Energy imports (% of energy use)
(Source: Energy imports as a share of energy use is obtained from World Development Indicators)

Turkey's primary energy supply amounted to 114.480 mtoe in 2011. Among energy sources domestic energy sources accounted for 28.15% of the total of the primary energy supply while the share of imports was 78.87%. The biggest share of the energy supply belongs to natural gas (32.24%) followed by oil (26.64%), hard coal (14.56%) and lignite (14.34%). In addition the biggest share of final energy consumption belongs to oil (32.61%) followed by natural gas (21.11%), electric (18.41%) hard coal (7.60%) and lignite (6.49%). As it can be seen, the highest shares of total energy imports belong to natural gas (40.11%) and oil (39.98%) respectively. (See Table 1)

Table 1 : Primary Energy Balance of Turkey 2011

	Production	% of Total	Imports	% of Total	Primary Energy Supply	% of Total	Total Final Energy Consumption	% of Total	Electric Energy Production (GWh)	% of Total
Oil	2555.10	7.93	36099.40	39.98	30498.80	26.64	28355.40	32.61	903.60	0.39
Natural Gas	652.40	2.02	36219.20	40.11	36909.10	32.24	18358.50	21.11	104047.60	45.36
Hard Coal	1307.80	4.06	15351.40	17.00	16665.90	14.56	6609.20	7.60	26530.60	11.57
Lignite	16138.40	50.07	0.00	0.00	16420.00	14.34	5639.50	6.49	38870.40	16.94
Animal and vegetable wastes	1091.40	3.39	0.00	0.00	1091.40	0.95	1056.20	1.21	469.20	0.20
Hydrolic	4501.20	13.97	0.00	0.00	4501.20	3.93	0.00	0.00	52338.60	22.82
Jeothermal	596.80	1.85	0.00	0.00	596.80	0.52	0.00	0.00	694.00	0.30
Wind	406.30	1.26	0.00	0.00	406.30	0.35	0.00	0.00	4724.00	2.06
Jeo Heat Other Heat	1463.00	4.54	0.00	0.00	1463.00	1.28	2679.00	3.08	0.00	0.00
Solar	630.00	1.95	0.00	0.00	630.00	0.55	630.00	0.72	0.00	0.00
Electric	0.00	0.00	391.80	0.43	78.40	0.07	16004.60	18.41	0.00	0.00
Wood	2446.20	7.59	0.00	0.00	2446.20	2.14	2442.30	2.81	0.00	0.00
Asphaltit	422.80	1.31	0.00	0.00	403.50	0.35	186.30	0.21	816.90	0.36
Coke	0.00	0.00	214.80	0.24	389.40	0.34	3010.90	3.46	0.00	0.00
Petro Coke	0.00	0.00	2015.50	2.23	1962.60	1.71	1962.60	2.26	0.00	0.00
Biofuel	17.70	0.05	0.00	0.00	17.70	0.02	17.70	0.02	0.00	0.00
TOTAL	32228.90	100.00	90292.00	100.00	114480.20	100.00	86952.20	100.00	229395.00	100.00

Source: MENR 2011, own calculation

Furthermore, the period covered in the study includes many alterations, regulations and reforms in terms of the energy sector and the economy as a whole. Investigating the causality relationship between output and energy consumption by taking into consideration the aforesaid changes can yield new useful energy policy recommendations for Turkey. In order to provide a more clear-cut picture of the energy sector in Turkey, the events that have taken place in Turkey’s energy sector are summarized in Table 2.

Table 2 : Events in Turkish Energy Sector

Date	Event	Date	Event
19th century	Oil exploration activities began in Turkey	**1995**	The Constitutional Court of Turkey issued a series of rulings, which made the privatization almost impossible to implement
1902	The first electric generator was introduced in Tarsus, Turkey	**1996**	The first LPG use in cogeneration plants
1913	The first power plant was installed in Silahtaraga, Istanbul	**1997**	The Build Operate Own (BOO) Law (No. 4283) was enacted to enable private sector participation in the construction and operation of new power plants
1923	The Republic of Turkey was founded and started to try a liberal economy	**1999**	The parliament passed a constitutional amendment permitting the privatization of public utility services and allowing international arbitration for resolving disputes
1938	Nationalization of Turkish electricity industry started	**2000**	Law on transit pass of petroleum through pipelines (No:4586)
1944	Nationalization was completed	**2001**	Electricity Market Law (EML, No. 4628) came into force
1960s	LPG started to be used as an alternative to kerosene (and later to gas) in Turkey		Natural Gas Market Law (NGML, No. 4646) came into force
1962	The First 5-Year Development Plan was introduced, and thereby "development plans era" star1ted	**2003**	Petroleum Market Law (PML, No. 5015) came into force
1963	The Ministry of Energy and Natural Resources (MENR) was established	**2004**	Turkish government issued the Strategy Paper Concerning Electricity Market Reform and Privatisation, which outlines the major steps to be taken up to 2012
1970	The Turkish Electricity Administration (TEK) was created	**2005**	Liquefied Petroleum Gas Market Law (LPGML, No.5307) came into force
1974	The BOTAS was founded for the transport of Iraqi crude oil		Law on Utilization of Renewables in Electricity Generation(No. 5346)
1982	Distribution assets were transferred to TEK, thus making TEK a national vertically integrated monopoly fully owned by the state		Energy Efficiency Law (No:5627) Amendments to the Law on Utilization of Renewables in Electricity Generation
1982	The monopoly of public sector on generation was abolished and the private sector was allowed to build power plants and sell its electricity to TEK	**2006**	Geothermal Law No. 5496
1982	Natural gas was introduced for the first time in Turkey	**2007**	Energy Efficiency Law No. 5627 Nuclear Investments Law (No:5710) Law on geothermal resources and mıneral waters (No:5686)
1984	TEK was restructured and gained the status of state-owned enterprise	**2008**	Significant Amendments to the Electricity Market Law (No:5784)
	Law No. 3096, which forms the legal basis for BOT, TOOR and autoproducer system, was enacted	**2009**	Strategy Paper on Electricity Market Reform, & Security of Supply
	The BOTAS started to diversify into the natural gas sector		Law on the endorsement of Turkey’s Ratification of Kyoto Parotocol to the United Nations Framework Convention on Climate Change (No:5836)
1993	TEK was incorporated into privatization plan and split into two separate state- owned enterprises as TEAS and TEDAS	**2010**	Law on the amendments to the Law on Utilization of Renewables in Electricity Generation (No:6093)
1994	The Constitutional Court of Turkey issued a series of rulings, which made the privatization almost impossible to implement Law No. 3996 and Implementing Decree 5907 were enacted to enhance the attractiveness of BOT projects by authorizing the granting of guarantees by the Undersecretariat of Treasury and providing some tax exemptions		

Source: MENR 2011 http://www.epdk.gov.tr/index.php/elektrik-piyasasi/mevzuat

In order to understand Turkey's outlook it is necessary to examine environmental issues. The opportunity cost of increase in energy consumption is environmental problems, which arise for many reasons such as population growth, acceleration of urbanization and industrialization. The EU and the international community demand Turkey make commitments in the post-2012 climate regime. Turkey ratified the Kyoto Protocol recently in 2009. As in other developing countries, Turkey faces a trade-off between a clean environment and industrial development. Therefore Turkey's sustainable development goal seems unable to be reached by ignoring the increase in emissions.

This study contributes to the existent literature on the energy consumption-economic growth nexus in several ways. First, this is the pioneering study aspiring to account for the cause of the disagreement on the energy consumption-economic growth nexus for Turkey. Second, this study uses energy consumption as a whole rather than just using electric or any other type of consumption. Third, recent parametric methods including the bounds test approach to cointegration (ARDL) and the Toda and Yamomoto procedure are used. Forth, this study uses a multivariate framework rather than a bivariate framework. Fifth, the thermal aggregation issue is considered through the constitution of a divisia index for Turkey. Sixth, this study employs a nonparametric approach, namely the maximum entropy bootstrap method of Vinod (1993, 2004, 2008) Vinod and de Lacalle (2009), in order to investigate the nexus.

The rest of the study is as follows. Section 2 provides an overview of the literature, the four hypotheses in the literature and the energy consumption and growth literature pertaining to Turkey. Section 3 describes the data and methodology and shows the results obtained. Section 4 includes policy analysis. Section 5 offers a conclusion.

2.2. Literature Review

The causal relationship between energy consumption and economic growth has been widely studied but there is no consensus on the direction of the causality. According to Ozturk (2010), the direction of a causal relationship between energy consumption and economic growth can be put into four hypotheses, namely the neutrality hypothesis, the conservation hypothesis, the growth hypothesis and the feedback hypothesis.

The neutrality hypothesis posits that energy consumption may have negligible or no impact on economic growth. This means that there is no causality relationship between energy consumption and gross domestic product. The conservation hypothesis postulates that the causal relationship runs from economic growth to energy consumption, hence, there is a unidirectional causality running from economic growth to energy consumption. The growth hypothesis claims that energy consumption stimulates economic growth but curtailment in energy supply can affect economic growth negatively. Thus energy conservation policies are not recommended. The feedback hypothesis considers a bi-directional causality relationship between energy consumption and economic growth.

Dating from the initial work of Kraft and Kraft (1978), different researchers studied the energy use growth nexus and documented contradicting results for different countries as well as for different time periods within the same country. Lee and Chang (2007) and Wolde-Rufael (2009) can be referred to for studies aiming at analyzing a particular country, and Akinlo (2008), Chiou-Wei et al. (2008), Apargis and Payne (2009a-b-c) and Narayan and Smith (2009) can be referred to for studies aiming at analyzing a group of countries. [4] Although the literature on the energy consumption growth nexus concerning developing countries is vast, the empirical literature on Turkey is rather limited.

However, Turkey has recently been subject to several studies. Soytas and Sari (2003) found that causality runs from EC to GDP in Turkey during the 1960-1995 period using a vector error correction model (VECM). Altinay and Karagol (2004) used Hsiao's version of the Granger method in order to analyze the period spanning from 1950 to 2000 for Turkey and found no evidence of causality between EC and GDP. Altinay and Karagol (2005) tested causality in a VAR framework and obtained evidence in favor of causality running from electricity consumption to GDP. Jobert and Karanfil (2007), by employing a cointegration and Granger causality analysis, concluded that no causal relationship is prevalent between GNP and EC for Turkey during the 1960-2003 time period. Halicioglu (2007) examined the period from 1968 to 2005 for Turkey in a VECM framework and found a unidirectional causality running from GNP to electricity consumption. Lise and Montfort (2007) concluded

[4] I try to gather the majority of the studies on the related literature in Table A1 in the appendix section.

that there is a unidirectional causality running from GDP to EC during the 1970-2003 period in Turkey by undertaking an error correction model (ECM). Narayan and Prasad (2008) used a basic parametric IID bootstrap approach in order to analyze the causality for the OECD countries and found no evidence of any causal relationship between GDP and EC between 1960 and 2002 for Turkey. Karanfil (2008) found that there is no causal relationship between EC and GDP for the 1970-2006 period in Turkey. Erdal et al. (2008) used a pair-wise Granger causality approach in order to examine the causality between EC and GNP for the 1970-2006 period in Turkey and revealed a bi-directional causality between the variable pair. Halicioglu (2009) examined the related nexus in an autoregressive distributed lag (ARDL) model framework for the 1960-2005 period revealing no causal relationship between EC and GNP in Turkey. Recently, Yalta (2012) employed a maximum entropy bootstrap based framework to analyze the energy consumption and real GDP nexus between 1950 and 2006 in Turkey and found no evidence in favor of the related nexus.

2.3. Data And Methodology

The time series data consists of annual state level data regarding real GDP, energy consumption, capital stock, labor and quality adjusted divisia index between 1972 and 2011. Energy consumption is measured by energy use (henceforth EU) in kilo ton of oil equivalent. Output is measured by real GDP (henceforth Y) in constant 1000 TL. Capital stock is measured in 1998 prices 1000 YTL (henceforth K). Labor is measured in employed people according to kind of economic activity (1000 person) (henceforth L). Quality adjusted divisia index is in units (Henceforth DI). All variables are in in their natural logarithms.[5]

2.3.1. Neo Classical Production Function

Apart from the traditional version of the neo-classical production function in the alternative view energy is considered as an important input in output determination. Following Ghali and Sakka, 2004, Soytaş and Sarı, 2006, 2007, Yuan et al., 2008, and Yalta (2012) among others who have attempted to incorporate energy as a separate input along with capital and labor, I investigate the causality for Turkey

[5] Data for this study was compiled from various sources as outlined in appendix A1.

using the above-mentioned aggregate production function where energy is treated as a separate factor of production along as well as capital and labor.

$$Y_t = f(K_t, L_t, E_t) \tag{1}$$

The log-linear version of the model is as follows:

$$\ln Y_t = \alpha_0 + \beta_1 \ln K_t + \beta_2 \ln L_t + \beta_3 \ln E_t \tag{2}$$

β_1, β_2 and β_3 stand for the elasticities of real GDP with respect to capital, labor and energy use, respectively.

Both parametric and non-parametric approaches in a multivariate framework were adopted by further substituting DI for EU in order to ensure the robustness of the results and account for the probable reasons for the differences in causality results among empirical studies.

2.3.2. Parametric Approach

First, the time series properties of the data were examined and the integration order of EU, Y, DI, K and L was tested by employing different unit root tests following the works of Dickey and Fuller(1979) (henceforth ADF), Phillips and Perron (1988) (henceforth PP), Narayan and Popps (henceforth NP).[6]

After obtaining evidence in favor of nonstationarity, the cointegration relationship was analyzed to determine the long-run relationship between EU and Y, DI and Y in a multivariate framework by employing the bounds test to cointegration (Pesaran and Shin, 1995) (Henceforth ARDL) and Hatemi J.(2008) cointegration tests (Henceforth HJ). Based on the evidence in favor of cointegration[7] causality is checked for by employing Engle and Granger (1968) and Toda and Yamamoto (1995) (Henceforth TY) procedures.

2.3.2.1. Unit Root

The existence of unit roots is essential for identifying some features of the existent data-generating process of a macroeconomic series. If a series has no unit roots, it can be defined as stationary or integrated of order zero (I(0)). In such a case, the

[6] Some procedures can be applied regardless of whether the integration order of the series is the same or not such as Toda and Yamomoto (1995).

[7] It is worth noting that results seem to be conflicting.

series fluctuates around a constant long-run mean and has a variance which is independent of time and so is finite. On the other hand, if a series has a unit root, then it is non-stationary or integrated of order one (I(1)). In such a case, the series does not go back to its long-run deterministic path. Also, the mean and the variance of the series are time dependent and as time goes to infinity, the variance tends to go to infinity. Therefore, if a series has a unit root, it tends to follow a random walk. In this case, neither the sampling distribution of the least squares estimates nor the sampling distribution of t-ratios is normal. Besides, critical values are different from the conventional ones. Thus, spurious regression problems and crucial complications in forecasting can be encountered. When there is a unit root, the difference of the series should be taken and differenced series should be used in the investigation for a precise analysis.

Hendry and Juselius (2000) note that if the level of any variable with a stochastic trend is related to another variable, this related variable will inherit nonstationarity from the variable with the stochastic trend and will transmit it to other variables in turn. Hence, links between variables lead to the propagation of nonstationarity throughout the economy. When the effects of structural changes in oil markets on macroeconomic variables is taken into consideration, the stationarity properties of energy consumption have important implications in terms of economic policies. (Narayan and Smyth, 2007) Accordingly if energy consumption/GDP is nonstationary when it is exposed to a shock such as a sudden increase in energy prices/technological shocks, it will transmit this nonstationarity to other key macroeconomic variables. For instance, a disturbance in the world oil market will affect energy consumption permanently or an increase in total factor productivity will affect GDP permanently. In other words, the failure in the rejection of the null of the unit root for the energy consumption/GDP series implies that the effects of shocks or innovations are permanent. On the other hand, the rejection of the null of the unit root means that shocks to the energy consumption/GDP series have transitory effects and both of the series will return to their long run equilibrium path after a short period of time. Findings from the panel unit root test suggest that shocks to per capita energy consumption and GDP are permanent. This result implies that, following major structural changes, the energy consumption and GDP series will not return to its original equilibrium. Other variables linked to energy consumption and GDP will inherit key economic variables.

Sensitivity of Granger causality tests to the stationarity of the series is a common fact, therefore, the stationarity properties of the series are studied first in order to further analyze causality. Same integration orders of the series enable proceeding with the cointegration tests and vector error correction VEC analysis. Since there are a variety of unit root tests that can yield conflicting results for robustness more than one type of unit root test is used. Two unit root tests were conducted without considering structural breaks, namely ADF and PP, and one unit root test was conducted considering structural breaks, namely NP.

Due to their low power properties, ADF and PP tests are exposed to criticism (Hubrich, Lutkepohl and Saikkonen, 2001). But these tests are employed, as in many studies, in order to check the existence of a unit root roughly at the beginning. Sensitivity to lag structure is another issue that necessitates a guide for lag selection such as Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). ADF and PP have the null of nonstationarity. The results for the aforementioned unit root tests are presented in Table 3. According to Table 3 the time series seems to be integrated of order one(I(1)).

Table 3 : Unit Roots Without Structural Break

	ADF		PP	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
lnY	-0.252	-3.098	-0.158	-3.263*
△lnY	-6.149***	-6.059***	-6.230***	-6.122***
lnK	-0.935	-4.370***	-1.966	-3.626**
△lnK	-2.681*	-2.678	-2.657*	-2.731
lnL	-0.724	-1.988	-0.732	-2.109
△lnL	-5.501***	-5.392***	-5.501***	-5.391***
lnEU	-0.757	-3.181	-0.79	-3.181
△lnEU	-6.277***	-6.159***	-6.537***	-6.374***
lnDI	-0.637	-2.305	-0.559	-2.308
△lnDI	-6.897***	-6.857***	-6.899***	-6.938***

Note: ***, ** and * denote the significant at the 1, 5 and 10 per cent level, respectively. The optimal lag order for ADF test is determined by SIC, while the bandwidths for PP test is determined by using the Newey-West Bartlett kernel.
For optimal lag length determination $T^{1/3}$ formula is used as suggested by Lüketpohl(1993).

Perron (1989) points out that many time series are in fact stationary when structural brakes are taken into account by allowing intercept and slope to change. Hence, a unit root test is employed that is appropriate for testing the stationarity of the series in the presence of structural breaks in order to obtain more robust evidence about stationarity. For this purpose NP is employed. Table 4 presents the results of the unit root test with structural breaks for the series. According to the results, the null of the unit root can not be rejected in the presence of structural breaks.

Table 4 : Narayan and Popp unit root test with two structural breaks

	M1			M2		
k=4	t-stat	TB1	TB2	t-stat	TB1	TB2
lnY	-3.126	1979	2000	-5.454**	1986	2000
△lnY	-5.87***	1993	1998	-5.25**	1993	1998
lnK	-6.559***	1979	2000	-3.219	1979	2000
△lnK	-3.77	1998	2000	-1.738	1979	2000
lnL	-4.486***	1993	2002	-4.136	1987	1992
△lnL	-4.315*	1987	1993	-3.739	1987	1993
lnEU	-3.423	1978	2000	-4.427	1986	2000
△lnEU	-5.716***	1990	2000	-6.21***	1979	2000
lnDI	-3.788	1989	1995	-4.168	1989	2000
△lnDI	-5.424***	1989	2000	-6.023***	1989	2000

	M1			M2		
T	1%	5%	10%	1%	5%	10%
50	−5.259	−4.514	−4.143	−5.949	−5.181	−4.789

Note:***, ** and * denote the significant at the 1, 5 and 10 per cent level, respectively.

Based on the majority of the results displayed in Table 3 and Table 4, the null of the unit root for the series could not be rejected.

2.3.2.2. Cointegration

In the literature there are a variety of tests used for testing cointegration. In order to be certain of the existence of cointegration between variables, two different cointegration tests were conducted, namely ARDL bounds testing approach to Cointegration (Pesaran), and HJ cointegration test with structural breaks.

The bounds testing approach to cointegration in an auto regressive distributed lag framework that outpaces other popular methods in terms of small sample properties, and has become a popular method for obtaining evidence with regard to the causal relationship (Narayan and Smyth, 2005). In other words, bounds testing can produce robust results in a short time span. Besides, the method is useful irrespective of whether the series have the same or different integration orders.[8]

The ARDL approach to cointegration tests the existence of a long-run relation using an error correction framework. Dynamic specification of ARDL includes the lags of the dependent variable and contemporaneous lags of the independent variables.

$$\Delta \ln Y_t = \alpha_C + \alpha_T T + \sum_{i=1}^{p} \alpha_i \Delta \ln Y_{t-i} + \sum_{k=0}^{r} \alpha_k \Delta \ln K_{t-i} + \sum_{l=0}^{s} \alpha_l \Delta \ln L_{t-i} + \sum_{j=0}^{q} \alpha_j \Delta \ln EU_{t-i}$$
$$+\sigma_Y \ln Y_{t-1} + \sigma_K \ln K_{t-1} + \sigma_L \ln L_{t-1} + \sigma_{EU} \ln EU_{t-1} + \mu_{1t} \qquad (3)$$
$$\Delta \ln EU_t = \beta_C + \beta_T T + \sum_{j=0}^{q} \beta_j \Delta \ln Y_{t-i} + \sum_{k=0}^{r} \beta_k \Delta \ln K_{t-i} + \sum_{l=0}^{s} \beta_l \Delta \ln L_{t-i} + \sum_{i=1}^{p} \beta_i \Delta \ln EU_{t-i}$$
$$+\beta_Y \ln Y_{t-1} + \beta_K \ln K_{t-1} + \beta_L \ln L_{t-1} + \beta_{EU} \ln EU_{t-1} + \mu_{2t} \qquad (4)$$
$$\Delta \ln K_t = \theta_C + \theta_T T + \sum_{j=0}^{q} \theta_j \Delta \ln Y_{t-i} + \sum_{i=1}^{p} \theta_i \Delta \ln K_{t-i} + \sum_{l=0}^{s} \theta_l \Delta \ln L_{t-i} + \sum_{k=0}^{r} \theta_k \Delta \ln EU_{t-i}$$
$$+\theta_Y \ln Y_{t-1} + \theta_K \ln K_{t-1} + \theta_L \ln L_{t-1} + \theta_{EU} \ln EU_{t-1} + \mu_{3t} \qquad (5)$$
$$\Delta \ln L_t = \delta_C + \delta_T T + \sum_{j=0}^{q} \delta_j \Delta \ln Y_{t-i} + \sum_{l=0}^{s} \delta_l \Delta \ln K_{t-i} + \sum_{i=1}^{p} \delta_i \Delta \ln L_{t-i} + \sum_{k=0}^{r} \delta_k \Delta \ln EU_{t-i}$$
$$+\delta_Y \ln Y_{t-1} + \delta_K \ln K_{t-1} + \delta_L \ln L_{t-1} + \delta_{EU} \ln EU_{t-1} \mu_{4t} \qquad (6)$$

Where Δ is the difference operator, $\ln Y, \ln EU, \ln K, \ln L$ stand for the natural logarithms of real gdp, energy consumption[9], capital stock and employment respectively, $\mu's$ are white noise error terms. $\alpha, \beta, \theta, \delta$ coefficients of the differenced terms are short run coefficients and $\alpha, \beta, \theta, \delta$ coefficients of the lagged terms are long-run multipliers of the ARDL model. The existence of a cointegrating relationship among variables is tested by examining the joint significance of the lagged terms using an F-test. For equation (1) the null of no cointegration between variables is $H_0: \alpha_Y = \alpha_K = \alpha_L = \alpha_{EU} = 0$ while the alternative is $H_0: \alpha_Y \neq \sigma_K \neq \sigma_L \neq \sigma_{EU} \neq 0$. The F-statistics under the aforementioned null hypothesis are $F_Y(Y|K,L,.EU)$, $F_Y(EU|Y,K,L)$, $F_Y(K|Y,L,EU)$ and $F_Y(L|Y,K,EU)$ respectively.

Gosh (2009b) and Narayan(2005) argue that the integration order of the variables, regressor number, inclusion of intercept and/or trend and the sample size affect the

[8] It is still necessary to ensure that none of the series have an integration order of I(2) or higher.

[9] Further lnDI is substituted for lnEU but the specification is not displayed in order to conserve space.

distribution of an F-test. In order to find a remedy for this Pesaran et al.(2001) and Narayan(2005) have provided asymptotic critical F values for different sample sizes. Since the sample in this study is between 30 to 80 the use of Narayan (2005) critical F values for cointegration testing seem to be more appropriate than the ones provided by Pesaran et al.(2001). If $F_{computed} < F^{lower}_{critical}$ we fail to reject the null of no cointegration. If $F_{computed} > F^{upper}_{critical}$ we can regard the result as evidence in favor of cointegration. If lower $F^{lower}_{critical} < F_{computed} < F^{upper}_{critical}$ the test is said to be inconclusive.

The results are displayed in Table 5. According to the results, there is evidence in favor of cointegration for both specifications including thermal aggregation of energy and divisia index. [10]

Table 5 : The results for ARDL Bounds testing to cointegration

			Diagnostic tests			
Thermal Aggregation	Optimal lag length	F-statistics	χ^2_{SERIAL}	χ^2_{RESET}	χ^2_{NORMAL}	χ^2_{ARCH}
$F_Y\left(Y\middle\|K,L,EU\right)$	(2,4,4,0)	2.694	0.861 [0.353]	2.516[0.113]	11.455[0.003]	0.341[0.559]
$F_K\left(K\middle\|Y,L,EU\right)$	(1,1,0,0)	4.344	2.5376[0.111]	.83320[.361]	0.5460[0.761]	0.22192[.638]
$F_L\left(L\middle\|Y,K,EU\right)$	(0,0,0,0)	5.198*	1.0916[0.296]	5.0331[.025]	0.00905[.995]	0.34923[.555]
$F_{EU}\left(EU\middle\|Y,K,L\right)$	(4,2,4,4)	10.694***	5.0769[0.024]	.12993[.719]	0.66395[.718]	1.1793[.277]
Divisia Index						
$F_Y\left(Y\middle\|K,L,DI\right)$	(4,4,0,0)	7.0478**	0.72549[.394]	0.18964[.663]	55.7208[0.000]	0.68220[0.409]
$F_K\left(K\middle\|Y,L,DI\right)$	(0,0,1,0)	12.3615***	0.0038128[.951]	1.1130[.291]	2.9005[0.235]	0.54704[0.460]
$F_L\left(L\middle\|Y,K,DI\right)$	(0,0,0,0	3.2666	0.94750[0.330]	3.1411[0.076]	1.9336[0.380]	1.8092[0.179]
$F_{EU}\left(DI\middle\|Y,K,L\right)$	(2,4,4,3)	13.2053***	7.1633[.007]	2.5210[0.112]	2.0571[0.358]	0.98432[0.321]

Significant level	Critical values (T=40)#	
	Lower bounds $I(0)$	Upper bounds $I(1)$
1 per cent level	6.053	7.458
5 per cent level	4.450	5.560
10 per cent level	3.740	4.780

Note: The asterisks ***, ** and * denote the significant at 1, 5 and 10 per cent levels, respectively. The optimal lag length is determined by SC which performs slightly beter than AIC as Pesaran and Shin(1995). [ ] is the probability of the values. # Critical values are collected from Narayan (2005). k=max lag number d= the number of independent variable reg number =(4+1)^3+1=625. Max lag ischosen as 4.

[10] The diagnostic test results show that the model for thermal aggregation specification pass the tests for functional form, serial correlation, heteroskedasticity and normality however for, divisia index specification the model fails to pass the normality test among the four.

For robustness of the results, the possibility of a change in the cointegrating vector over time is considered. Economic crises, technological shocks, changes in the economic actors' preferences and behavior, policy and regime changes, and organizational or institutional evolution structural changes can take place causing regime shifts in the series, and hence the cointegrating vector (Hatemi J. 2008, Maslyuk and Smyth, 2009). In these circumstances tests that do not take into account the regime shifts can lead to wrong inferences about the existence of long run relationships. Gregory and Hansen (1996) show that if a regime shift is not taken into account, tests for cointegration have low power, similar to tests for the unit root in the presence of structural changes as shown by Perron (1987).

Gregory and Hansen (1996) modify two tests known as Za and Zt (as suggested by Phillips 1987) and ADF test (as suggested by Engle and Granger 1987). Their procedure takes into account one unknown regime shift (a change in both the intercept and the slope parameters) by allowing its timing to be chosen endogenously (based on the data). In addition they provide new critical values for the underlying tests. Hatemi J.(2008) builds on Gregory and Hansen (1996) by allowing for two structural breaks. He furthermore provides new critical values for the three tests in the presence of two regime shifts. In the same manner as Gregory and Hansen (1996), timing of the breaks can be chosen based upon data.

The null of no cointegration is tested in three specifications in which a structural shift (Model C) in either intercept (Model C/T) or trend or intercept and slope Model C/S) is allowed.

$$y_{1t} = \alpha_0 + \alpha_1 D_{1t} + \alpha_2 D_{2t} + \beta_0^{'} x_t + \beta_1^{'} D_{1t} x_t + \beta_2^{'} D_{2t} x_t + u_t \qquad (7)$$

D_{1t} and D_{2t} are binary variables

$$D_{1t} = \begin{cases} 0\, if\ t \leq [\mathrm{n}\tau_1] \\ 1\, if\ \ > [\mathrm{n}\tau_1] \end{cases}$$

and

$$D_{2t} = \begin{cases} 0\, if\ t \leq [\mathrm{n}\tau_2] \\ 1\, if\ \ > [\mathrm{n}\tau_2] \end{cases}$$

$\tau_1 \in (0,1)$ and $\tau_2 \in (0,1)$ are unknown parameters denoting the relative timing of the regime shift point. $\tau_1 \in T_1 = (0.15, 0.70)$ and $\tau_2 \in T_2 = (0.15 + \tau_1, 0.85)$

The test statistics are based on the calculation of the bias-corrected first-order serial correlation coefficient estimate. The test statistics are the smallest values of the three tests across all values for τ_1 and τ_2, with $\tau_1 \in T_1 = (0.15, 0.70)$ and $\tau_2 \in T_2 = (0.15 + \tau_1, 0.85)$.

Three test statistics are as follows[11]:

$$ADF^* = \inf_{(\tau_1,\tau_2)\in T} ADF(\tau_1, \tau_2)$$

$$Z_t^* = \inf_{(\tau_1,\tau_2)\in T} Z_t(\tau_1, \tau_2)$$

$$Z_\alpha^* = \inf_{(\tau_1,\tau_2)\in T} Z_\alpha(\tau_1, \tau_2)$$

I tested for a multivariate cointegration relationship using the Hatemi J. (2008) test for both specifications including thermal aggregation of energy and divisia index. For the thermal aggregation case the test results are conflicting. However, the conclusions were based on the Z_t* statistic following Maslyuk and Smyth (2009). The authors indicate that, according to Gregory and Hansen (1996), the Z_t* statistic is the most powerful test statistic among of all three statistics. Table 6 displays the results of the underlying cointegration test. The estimated Z_t* value is higher than the critical value at the one percent significance level in absolute terms. Thus, we reject the null of no cointegration for the specification including thermal aggregation while we cannot for the latter specification including the divisia index.

[11] For detail please refer to o Gregory and Hansen (1996) and Hatemi, J. (2008)

Table 6 : Hatemi J. Cointegration Results

	Test Statistic					
Thermal Aggregation						
	ADF*		Z_t*		Z_α*	
C	-6.569		-8.404***		-50.549	
C/T	-5.887		-8.012***		-49.420	
C/S	-7.533**		-9.426***		-53.386	
Divisia Index						
C	-5.269		-5.201		-33.992	
C/T	-5.694		-5.124		-33.416	
C/S	-6.122		-5.468		-35.360	
	1 % Critical Value	5 % Critical Value	10 % Critical Value	Break1	Break 2	
ADF*, Z_t*	−7.833	−7.352	−7.118	0.3	0.6	
$Z\alpha$*	−118.577	−104.860	−97.749	0.3	0.6	

Notes: The asterisks ***, ** and * denote the significant at 1, 5 and 10 per cent levels, respectively. The critical values are collected from Table 1. Note that m(the number of independent variables) = 3 in this application(Hatemi, 2008)

2.3.2.3. Causality

Granger(1969) aims at identifying how much of a variable can be explained by its past values and then questions whether is it possible to improve the explanation power by adding the lagged values of other variables. A variable is said to be Granger-caused by another variable if the other variable improves the prediction of the associated variable. The crucial point is that Granger-causality provides precedence content rather than causality. In other words, the evidence in favor of Granger-causality does not imply that a variable is the result of the other variable.

Based upon the results, a causality check is conducted in order to obtain the direction of the causal relationship among the variables[12]. Both short-run and long–run causality within an error correction mechanism(henceforth ECM) were examined. For short-run causality the statistical significance of the coefficients of the lagged explanatory variables was checked using an F-test. For long run causality the statistical significance of the lagged error correction term(henceforth ECT) was checked using a t-test, in the ECM framework. Results are displayed in Table 7.

[12] The conclusions on the existence of the cointegration relationship are mixed. The ARDL bounds test indicates the existence of a cointegration relationship; however, the HJ cointegration test seems to confirm the existence of cointegration relationship only for the specification which includes thermal aggregation.

Table 7 : Granger Causality Results

Dependent variable	Wald-statistics [p-value]				t-statistics [p-value]
	$\Delta \ln Y_{t-1}$	$\Delta \ln K_{t-1}$	$\Delta \ln L_{t-1}$	$\Delta \ln EU_{t-1}$	ECT_{t-1}
Thermal Aggregation					
△lnY$_t$	-	0.046[0.921]	0.551[0.038]	-0.137[0.652]	-0.793[0.086]
△lnK$_t$	-0.008[0.935]	-	0.111[0.163]	0.046[0.613]	-0.224[0.000]
△lnL$_t$	0.025[0.923]	0.412[0.268]	-	-0.010[0.966]	0.104[0.3708]
△lnEU$_t$	-0.07[0.840]	-0.726 [0.151]	0.514[0.071]	-	0.476[0.0032]
Divisia Index					
	$\Delta \ln Y_{t-1}$	$\Delta \ln K_{t-1}$	$\Delta \ln L_{t-1}$	$\Delta \ln DI_{t-1}$	ECT_{t-1}
△lnY$_t$	-	0.833[0.239]	0.340[0.222]	-2.102[0.46]	-0.484[0.03]
△lnK$_t$	0.109[0.121]	-	0.161[0.097]	-1.083[0.276]	0.099[0.197]
△lnL$_t$	0.011[0.937]	0.776[0.115]	-	0.651[0.742]	-0.145[0.345]
△lnDI$_t$	0.009[0.540]	0.057[0.240]	0.022[0.247]	-	-0.0229[0.058]

Notes: The asterisks *, ** and * denote the significant at 1, 5 and 10 per cent levels, respectively. The values given in te table are calculated wald statistics. [] indicate p-values.**
The null hypothesis is that there is no causal relationship between variables. Values inparentheses are p-values for Wald tests with a χ distribution. Δ is the first difference operator.

For the thermal aggregation specification the significance of the coefficients of the lagged explanatory variables of the error correction mechanism terms indicates that there is a bidirectional long-run causality between lnY and lnEU. However there is no evidence for the existence of short-run causality. For the second specification, in which lnDI was substituted for lnEU, the significance of the negative error correction terms (ECT) is evidence in favor of long-run causality and tested via conducting a t-test for each associated coefficient. There is no evidence in favor of short-run for this specification.

In order to check for the robustness of causality results a TY procedure was conducted to avoid the impact of pretesting bias on the causality conclusions. The modified Wald (MWald) procedure of Toda and Yamamoto (1995) can be used when there is uncertainty about stationarity and cointegration. The major advantage of this procedure is that it can be applied regardless of whether the series have same integration orders and/or they are cointegrated or not. In order to apply a TY procedure the lag length of the level VAR (k) is first determined according to different information criteria. The maximum order of integration (dmax) is determined by employing unit root tests. The optimal lag length of the augmented VAR model is based on the sum of the aforementioned lag length(k) and order of integration(dmax). According to Kuzozumi and Yamomoto (2000), the model is valid until k ≥ d.

TY model can be specified as follows:

$$\ln Y_t = \alpha_{0y} + \sum_{i=1}^{k} \gamma_{1i} \Delta \ln Y_t + \sum_{j=k+1}^{d_{\max}} \gamma_{2i} \Delta \ln Y_{t-j} + \sum_{i=1}^{k} \varphi_{1i} \Delta \ln K_t + \sum_{j=k+1}^{d_{\max}} \varphi_{2i} \Delta \ln K_{t-j} \quad (8)$$
$$+ \sum_{i=1}^{k} \psi_{1i} \Delta \ln L_t + \sum_{j=k+1}^{d_{\max}} \psi_{2i} \Delta \ln L_{t-j} + \sum_{i=1}^{k} \varpi_{1i} \Delta \ln E_t + \sum_{j=k+1}^{d_{\max}} \varpi_{2i} \Delta \ln E_{t-j} + \omega_{it}$$

$$\ln K_t = \alpha_{0k} + \sum_{i=1}^{k} \varphi_{1i} \Delta \ln K_t + \sum_{j=k+1}^{d_{\max}} \varphi_{2i} \Delta \ln K_{t-j} + \sum_{i=1}^{k} \gamma_{1i} \Delta \ln Y_t + \sum_{j=k+1}^{d_{\max}} \gamma_{2i} \Delta \ln Y_{t-j} \quad (9)$$
$$+ \sum_{i=1}^{k} \psi_{1i} \Delta \ln L_t + \sum_{j=k+1}^{d_{\max}} \psi_{2i} \Delta \ln L_{t-j} + \sum_{i=1}^{k} \varpi_{1i} \Delta \ln E_t + \sum_{j=k+1}^{d_{\max}} \varpi_{2i} \Delta \ln E_{t-j} + \omega_{it}$$

$$\ln L_t = \alpha_{0k} + \sum_{i=1}^{k} \psi_{1i} \Delta \ln L_t + \sum_{j=k+1}^{d_{\max}} \psi_{2i} \Delta \ln L_{t-j} + \sum_{i=1}^{k} \varphi_{1i} \Delta \ln K_t + \sum_{j=k+1}^{d_{\max}} \varphi_{2i} \Delta \ln K_{t-j} \quad (10)$$
$$+ \sum_{i=1}^{k} \gamma_{1i} \Delta \ln Y_t + \sum_{j=k+1}^{d_{\max}} \gamma_{2i} \Delta \ln Y_{t-j} + \sum_{i=1}^{k} \varpi_{1i} \Delta \ln E_t + \sum_{j=k+1}^{d_{\max}} \varpi_{2i} \Delta \ln E_{t-j} + \omega_{it}$$

$$\ln E_t = \alpha_{0k} + \sum_{i=1}^{k} \psi_{1i} \Delta \ln L_t + \sum_{j=k+1}^{d_{\max}} \psi_{2i} \Delta \ln L_{t-j} + \sum_{i=1}^{k} \varphi_{1i} \Delta \ln K_t + \sum_{j=k+1}^{d_{\max}} \varphi_{2i} \Delta \ln K_{t-j} \quad (11)$$
$$+ \sum_{i=1}^{k} \gamma_{1i} \Delta \ln Y_t + \sum_{j=k+1}^{d_{\max}} \gamma_{2i} \Delta \ln Y_{t-j} + \sum_{i=1}^{k} \varpi_{1i} \Delta \ln E_t + \sum_{j=k+1}^{d_{\max}} \varpi_{2i} \Delta \ln E_{t-j} + \omega_{it}$$

In equation (6) the null of E does not Granger cause Y, K does not Granger cause Y, L does not Granger cause Y via checking $\varpi_{1i} = 0$, $\varphi_{1i} = 0, \psi_{1i} = 0$ for $\forall \boldsymbol{i}$. A Granger-causality test for the remaining equations from (8) to (11) can be performed in a similar way. Toda and Yamamoto (1995) showed that Wald tests based on the estimation of the aforementioned model will follow a chi-square distribution. TY models are commonly estimated using the seemingly unrelated regressions (SUR) technique.

Clarke and Mirza (2006) emphasize that determining the order of integration of the series and the optimal lag length are essential for causality testing. The sensitivity of the Granger non-causality test is sensitive to the selection of lag length which can cause spurious causality results. As can be seen from Table 2 and Table 3 the series seems to be integrated of order one (I(1)). For the lag length determination issue various lag length criteria was used. According to lag length criteria the order of the VAR is determined as 1 and is displayed in Table 8.

Table 8 : Lag length criteria for selecting the order of the VAR model

Lag	LogL	LR	AIC	SC	HQ
Thermal Aggregation					
0	186.9402	NA	-10.16334	-9.987397	-10.1019
1	353.3424	286.5816*	-18.51902	-17.63929*	-18.21197*
2	369.4219	24.11922	-18.52344*	-16.93992	-17.9708
3	373.6534	5.406911	-17.86963	-15.58233	-17.0713
4	392.225	19.60345	-18.0125	-15.02141	-16.9685
Divisia Index					
0	246.2777	NA	-13.45987	-13.28393	-13.3985
1	434.3297	323.8673*	-23.01831*	-22.13858*	-22.71126*
2	443.9773	14.4715	-22.66541	-21.08189	-22.1127
3	457.0955	16.76215	-22.50531	-20.218	-21.707
4	469.7742	13.383	-22.32079	-19.3297	-21.2768

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

Since k=1 and d_{max}=1 the VAR order for the TY procedure is 2. The TY Granger non-causality test is undertaken by estimating the following system of equations.[13]

$$\begin{bmatrix} \ln Y_t \\ \ln K_t \\ \ln L_t \\ \ln EU_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} \ln Y_{t-1} \\ \ln K_{t-1} \\ \ln L_{t-1} \\ \ln EU_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} \ln Y_{t-2} \\ \ln K_{t-2} \\ \ln L_{t-2} \\ \ln EU_{t-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_{\ln Y_{t-1}} \\ \varepsilon_{\ln K_{t-1}} \\ \varepsilon_{\ln L_{t-1}} \\ \varepsilon_{\ln EU_{t-1}} \end{bmatrix}$$

Results for TY Granger non-causality tests are presented in Table 9. [14]

[13] Further lnDI is substituted for lnEU but the specification for brevity is not displayed.

[14] We can reasonably accept classical regression assumptions are satisfied. The diagnostic test results on VAR (2) are reasonable. *R*-square values are pretty high. The Jarque Bera test results reveal that there is no serious violations of normality assumption.(Only in the equation in which lnL is the dependent variable normality assumpion is violated). The results for serial correlation indicate reasonable results for all equations. According to the White test underlying equations are robust to heteroskedasticity. ARCH-LM test reveals that autoregressive conditional hetroscedasticity is not revalent. Finally all AR roots for the estimated VAR lie inside the unit circle providing that the VAR is stable.

Table 9: Toda and Yamamoto Granger Non-Causality Results

Null hypothesis	MWALD χ^2	p-value
LnY granger not cause LnEU	3.871	0.049**
LnEU granger not cause Lny	0.432	0.511
LnY granger not cause LnDI	0.738	0.390
LnDI granger not cause Lny	0.297	0.585

** denotes the significance at 5 percent level

According to Table 9 I reject the null of output granger not cause energy consumption, whereas, I do not reject the null of energy consumption granger not cause output for the thermal aggregation specification. The results provide evidence in favor of causality running from output to energy consumption. On the other hand, no evidence is obtained indicating that causality exists for the specification including the divisia index.

2.3.3. Non-Parametric Approach

Since the sample is relatively small it is worthwhile to check the robustness of the results by using a method different than the conventional methods. Yalta(2011) points out that when the sample size is relatively small the results obtained by employing conventional, asymptotic theory based hypothesis tests and confidence intervals can be misleading. In short, this concludes with rejecting the true null hypothesis of no causality and inferring a fictitious relationship.

This study used a maximum entrophy bootstrap technique (henceforth meboot) by Vinod (2004) followed by Yalta (2011).

2.3.3.1. Entropy Bootstrap

The originality of meboot is that it can preserve the dependence and heterogeneity of information in the data by not reordering it. Instead of reordering the data meboot follows the seven step procedure of Vinod(2004) below (2004):[15]

i. Sort the original data in increasing order to create order statistics x(t) and store the ordering index vector.

[15] For details please refer to Vinod (2004),(2008),(2009).

ii. Compute intermediate points $z_t = (x_t + x_{t+1})/2$ for t = 1, . . . , T-1 from the order statistics.

iii. Compute the trimmed mean mtrm of deviations x_t-x_{t-1} among all consecutive observations. Compute the lower limit for left tail as z0 = x(1) − mtrm and upper limit for right tail as zT = x(T) + mtrm. These limits become the limiting intermediate points.

iv. Compute the mean of the maximum entropy density within each interval such that the 'mean-preserving constraint' (designed to eventually satisfy the ergodic theorem) is satisfied. Interval means are denoted as mt. The means for the first and the last interval have simpler formulas.

v. Generate random numbers from the [0, 1] uniform interval, compute sample quantiles of the ME density at those points and sort them.

vi. Reorder the sorted sample quantiles by using the ordering index of step 1. This recovers the time dependence relationships of the originally observed data.

vii. Repeat steps 2 to 6 several times (e.g., 999).

Instead of using uncertain unit root tests on lny, lnk, lnl, lneu and lndi to decide whether differencing is appropriate, this part employs the meboot and creates J = 999 reincarnations of the underlying series, and uses them to construct confidence intervals. By using these confidence intervals the statistical significance of the estimated coefficients is tested.[16]

For the multivariate specification, a neoclassical production function including energy consumption as a seperate input is again considered.[17] [18]

Estimation results are displayed in Table 10 and Table 11. As can be seen in Table 9 and Table 10, (1-α_n)% HDRs for the coefficients αs and βs except α_{11} and β_{21} for VAR(1), VAR(2), β_{21} for VAR(3); α_{31} and β_{41} for VAR(1), VAR(2), VAR(3) include zero. The tables reveal that there is no causality relationship between energy

[16] The R codes provided by Taha Yalta are used.

[17] We follow Ghali and Sakka (2004), Soytaş and Sarı (2006, 2007), Yuan et al. (2008) and Yalta (2012) among others.

[18] Two specifications considering energy consumption in terms of thermal aggregate and divisia index are again considered.

consumption and economic performance. In addition, the lagged capital and labor terms are insignificant as well.

$$\ln Y_t = c_1 + \sum_{i=1}^{n} \alpha_{1i} \ln EU_{t-i} + \sum_{i=1}^{n} \beta_{1i} \ln Y_{t-i} + \sum_{i=1}^{n} \gamma_{1i} \ln K_{t-i} + \sum_{i=1}^{n} \beta_{1i} \ln L_{t-i} + \varepsilon_{y,t} \qquad (12)$$

$$\ln EU_t = c_2 + \sum_{i=1}^{n} \alpha_{2i} \ln EU_{t-i} + \sum_{i=1}^{n} \beta_{2i} \ln Y_{t-i} + \sum_{i=1}^{n} \gamma_{2i} \ln K_{t-i} + \sum_{i=1}^{n} \beta_{2i} \ln L_{t-i} + \varepsilon_{2,t} \qquad (13)$$

$$\ln Y_t = c_3 + \sum_{i=1}^{n} \alpha_{3i} \ln EU_{t-i} + \sum_{i=1}^{n} \beta_{3i} \ln Y_{t-i} + \sum_{i=1}^{n} \gamma_{3i} \ln K_{t-i} + \sum_{i=1}^{n} \beta_{3i} \ln L_{t-i} + \varepsilon_{3t} \qquad (14)$$

$$\ln DI_t = c_4 + \sum_{i=1}^{n} \alpha_{4i} \ln EU_{t-i} + \sum_{i=1}^{n} \beta_{4i} \ln Y_{t-i} + \sum_{i=1}^{n} \gamma_{4i} \ln K_{t-i} + \sum_{i=1}^{n} \beta_{4i} \ln L_{t-i} + \varepsilon_{4t} \qquad (15)$$

Table 10 : Meboot based HDR interval estimations for the multivariate analysis.

Regressor	VAR(1) 95% conf. intervals				VAR(2) 90% conf. intervals				VAR(3) 85% conf. intervals			
	LNY		LNEU		LNY		LNEU		LNY		LNEU	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Constant	-2.822	5.381	-6.872	1.679	-3.370	5.277	-7.310	2.307	-3.480	6.315	-7.279	2.719
LNY(-1)	**0.226**	**1.047**	**0.166**	**0.958**	**0.057**	**0.871**	**0.139**	**0.901**	-0.003	0.832	**0.086**	**0.864**
LNEU(-1)	-0.237	0.465	-0.266	0.532	-0.156	0.628	-0.372	0.374	-0.172	0.591	-0.420	0.321
LNK-1)	-0.073	0.512	-0.090	0.559	-0.191	0.452	-0.402	0.404	-0.290	0.400	-0.220	0.405
LNL(-1)	-0.596	0.629	-0.532	0.737	-0.382	0.234	-0.204	0.586	-0.161	0.430	-0.407	0.400
LNY(-2)					-0.350	0.571	-0.416	0.653	-0.388	0.184	-0.254	0.598
LNEU(-2)					-0.329	0.500	-0.414	0.573	-0.239	0.334	-0.372	0.429
LNK-2)					-0.507	0.797	-0.519	0.932	-0.349	0.569	-0.424	0.646
LNL(-2)					-0.889	0.535	-0.853	0.528	-0.548	0.535	-0.604	0.597
LNY(-3)									-0.320	0.520	-0.371	0.605
LNEU(-3)									-0.517	0.728	-0.547	0.881
LNK-3)									-0.889	0.535	-0.943	0.679
LNL(-3)									-0.640	0.662	-0.718	0.659

Note: Values in bold indicate the estimates where the zero is inside the (1-αn)% confidence interval

Table 11 : Meboot based HDR interval estimations for the multivariate analysis.

Regressor	VAR(1) 95% conf. intervals				VAR(2) 90% conf. intervals				VAR(3) 85% conf. intervals			
	LNY		LNDI		LNY		LNDI		LNY		LNDI	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Constant	-24.634	18.238	0.227	1.612	-21.533	18.358	0.215	1.434	-18.342	22.835	0.234	1.553
LNY(-1)	**0.294**	**1.002**	**0.488**	**0.901**	**0.155**	**0.885**	**0.326**	**0.982**	**0.102**	**0.839**	**0.319**	**1.019**
LNDI(-1)	-5.149	7.785	-0.010	0.017	-0.170	0.521	-0.270	0.398	-0.237	0.496	-0.317	0.361
LNK-1)	-0.048	0.537	-0.012	0.011	-6.669	5.984	-0.014	0.014	-0.229	0.429	-0.253	0.228
LNL(-1)	-0.562	0.639	-0.010	0.028	-4.316	6.776	-0.007	0.021	-6.057	5.502	-0.014	0.014
LNY(-2)					-0.318	0.586	-0.018	0.021	-3.769	8.723	-0.006	0.022
LNDI(-2)					-0.311	0.495	-0.022	0.015	-7.662	2.970	-0.015	0.013
LNK-2)					-0.502	0.844	-0.008	0.045	-0.346	0.620	-0.019	0.021
LNL(-2)					-0.895	0.514	-0.035	0.016	-0.544	0.558	-0.025	0.023
LNY(-3)									-0.310	0.522	-0.021	0.015
LNDI(-3)									-0.529	0.734	-0.005	0.044
LNK-3)									-0.919	0.485	-0.058	0.017
LNL(-3)									-0.638	0.671	-0.013	0.042

Note: Values in bold indicate the estimates where the zero is inside the (1-αn)% confidence interval.

2.4. Policy Analysis

Turkey's development has significantly increased in recent years. With the ongoing development process and high population growth driving Turkey's growing energy needs, energy has become more of an issue over time. While most of Turkey's energy needs are met by oil and natural gas, the reserves of these resources are rather limited. As of 2011 the energy imports to current account deficit ratio was approximately 70%. Accordingly, energy security and energy efficiency play a crucial role in order to lessen the impact of the underlying constraints.[19]

Our Granger causality results revealing no Granger causality between energy consumption and economic growth for Turkey expose two alternatives, namely, decreasing energy consumption directly and increasing the efficiency in energy consumption. The first one is not reasonable for a rapidly developing country leaving the latter one as the only feasible approach. Energy efficiency enables mitigating energy usage, contributes to economic development and becomes an integral part of sustainable development in an environment where energy security and energy costs are major constraints.

As a general rule energy efficiency is measured by energy intensity.[20] If energy intensity is lower, then energy consumption in order to produce a unit of GDP will be relatively lower. Accordingly, a reduction in energy intensity plays a crucial role in energy efficiency. In Turkey the potential to benefit from energy efficiency is high. The major fields that can adopt energy efficiency are industry, building, transportation as well as generation and transmission and distribution systems. Broad policy suggestions in order to increase energy efficiency in these fields are as follows[21]:

[19] Energy security constraints such as the Kyoto Protocol as well as the increase in energy dependency and energy costs the need for energy efficiency increased and it has exposed to play a crucial role in terms of energy issues as a whole.
[20] Energy Intensity is defined as units of energy consumed to produce one unit of GDP (Units of energy per unit of GDP).
[21] For detail please refer to the report "Turkey's energy efficiency map and targets" by KUTEM (Koç University Turpraş Energy Center)

i. Incentives should be created for projects that increase efficiency and for voluntary agreements in industry sectors and existing incentives for these projects should be maintained.

ii. Since the existing building stock of Turkey is considerable, gains from transforming these buildings into energy efficient types will be fairly high. (Thermal insulation may be encouraged, an architectural design avoiding energy loss can be adopted, water heating solar panels may be used, etc.)

iii. Energy inefficient goods can be discouraged and removed from the market by efficient market surveillance and inspection facilities.

iv. Energy efficient illumination can be adopted (energy efficient light bulbs can be substituted for energy inefficient ones.)

v. The usage of energy star electronic devices and durables can be encouraged.

vi. Providing surveillance and inspection facilities for inefficient fuels.

vii. Public transportation can be encouraged and provided in a more energy efficient way.

viii. Instead of road transport, rail and sea transportation can be encouraged.

ix. Coal energy production can be altered since Turkey has ample coal reserves.

x. Power theft should be avoided by increasing surveillance and inspection levels.

xi. Renewable energy sources should be considered as an alternative for energy production facilities.

xii. Generation, transmission and distribution lines should be modernized.

2.5. Conclusion

This study examined the energy consumption growth nexus in Turkey. Although Turkey is not a major oil and natural gas producer its role as a transit and terminal hub makes it vital to world markets, particularly Europe. Despite this, Turkey's energy consumption-economic growth nexus is rarely investigated. This nexus is examined for Turkey by employing the neoclassical production function. This study investigates the major arguments that can account for the conflicting results in the literature such as quality differences among fuels, time periods, data and proxy variables, countries, econometric techniques as well as omitted variable bias. This is the first comprehensive study in the literature on Turkey considering the aforementioned causes that can contribute diversified results. This study employs contemporary parametric and nonparametric techniques in order to make inferences for Turkey for the period between 1972 and 2011. Several tests on different specifications reveal conflicting results on the related nexus. However, inferences are based on the recently developed maximum entrophy bootstrap based causality test which reveals no Granger causality between energy consumption and economic growth for Turkey. The result implies that energy consumption can not be considered as a stimulating factor for economic growth, thus, energy saving or conservation would not be considered as an adversely affecting factor on energy growth. Since Turkey's energy needs are heavily met by foreign resources policies should aim to increase efficiency in energy consumption.

3. PASS-THROUGH OF OIL PRICES TO TURKISH DOMESTIC PRICES

3.1. Introduction

Several studies document that oil price shocks have major effects on the economy. (Hamilton, 1983, 1988; Tatom, 1988; Mork, 1994; Kahn and Hampton, 1990; and Huntington, 1995 among others). Particularly in regard to oil importing countries, oil price shocks have always been important because oil dependence can lead to GDP losses, inflationary effects and trade balance deteriorations via oil prices increases.

A change in oil price level affects the economy through different channels. Kojima and Bacon (2008-2009) point out three channels through which economies can be affected. These channels are direct affects on the terms of trade, indirect effects from real wage price and structural rigidities within the economy and global effects through the impact on world output. An increase in oil price leads to an increase in the price of imports relative to the price of exports. If a country does not have excess reserves or is unable to access external funds the GDP of this country will fall. The second channel works in this way: Oil price increases lead to an increase in input costs, reduction in non-oil demand and decrease investment. In addition, net oil importers' tax revenues can fall and budget deficits can rise. For controlling inflationary effects the money supply can be restricted which in turn leads the interest rates to rise. On the other hand, price of wage increases can put pressure on wages by causing an increase in unemployment.[22] The third channel works through alterations in the world output. The rise in oil price reduces the demand from oil importers, causing oil exporters' GDP to decrease, thus world GDP to fall. This in turn leads to a decline in general demand.

[22] The structure of the economy and the nature of the policy response of the government may alter the magnitude and timing of such effects.

Due to its dependency on oil imports, Turkey's economy is vulnerable to oil price shocks. [23] In order to provide insight into the Turkish economy with respect to oil, several indicators are calculated for Turkey such as net oil import dependency, oil dependency, energy intensity and oil intensity. According to Bhattacharyya (2010), oil import dependence is a measure of the oil supply shock exposure of a country. Oil dependency is an indicator that shows the flexibility of a country in switching to other fuels when high oil prices are prevalent (The World Bank, 2005f). The level of energy intensity for a country can indicate how costly the transformation of energy to GDP is. Thus, it can be one of the fragility measures with respect to oil shocks for an energy importing country. Oil intensity signifies how much oil is used to produce one unit of GDP. In addition, a vulnerability indicator, which measures the required fall in GDP to offset a crude oil price increase, is calculated using these indicators.[24] Above indicators are illustrated in Table 12.

Table 12 : Oil Supply Security Measures As The Determinants Of Oil Price Vulnerability

$$\text{Net Oil Import Dependency} = \frac{\text{Oil Consumption} - \text{Oil Production}}{\text{Oil Consumption}} \quad \frac{(\text{PBTU})}{(\text{PBTU})}$$

$$\text{Oil Dependency} = \frac{\text{Oil Consumption}}{\text{Total Primary Energy Consumption}} \quad \frac{(\text{PBTU})}{(\text{PBTU})}$$

$$\text{Energy Intensity} = \frac{\text{Total Primary Energy Consumption}}{\text{GDP}} \quad \frac{(\text{PBTU})}{(\text{US \$})}$$

$$\text{Oil Intensity} = \frac{\text{Oil Use}}{\text{GDP}} = \text{Oil dependence} \times \text{Energy Intensity}$$

$$\text{Oil Vulnerability} = \text{Price (FOB)of oil import}^{a} \times \text{Net Oil Import Dependency} \times \text{Oil Dependency} \times \text{Energy Intensity}$$

Source: Vulnerability Indicator (The World Bank, 2005f:33)
[a]: Price (FOB) is in US$/PBTU, BTU=British Thermal Units, 1 barrel = 5.8 MBTU =0.0000000058 PBTU, P= Peta = 10^{15}
Data sources: Crude Oil Price was obtained from Global Economic Monitor Commodities of World Bank and it is the average of the FOB spot price of the internationally traded crude oils namely West Texas International, Europe Brent and Dubai Fateh. Oil Consumption and Production (1000 barrels/day), Total Primary Energy Consumption(PBTU) from EIA database. GDP (PPP constant, 2005 international $) from World Bank database.

[23] There are studies carried out by Asia Pacific Energy Research Centre (2007) and the United Nations Development Programme Management Assistance Program (2007) for Asia and Pacific Region Countries, by the Energy Sector Management Assistance Program (ESMAP, 2005) for low income and Sub-Saharan African countries, by the World Energy Council (2008) for European countries among others. According to these studies a high dependence on imported oil leads to an increase in vulnerability of an economy to oil price shocks.(Kojima Bacon, 2009)

[24] For more detailed information please refer to "The World Bank, (2005f), "The Vulnerability of African Countries to Oil Price Shocks: Major Factors and Policy Options, the Case of Oil Importing Countries". ESMAP Report No. 308/05.World Bank, Washington DC."

These indicators were calculated for the period between 1987 and 2011 and are displayed below in Figure 3.[25] According to the figure: The oil import dependency index indicates that Turkey is externally oil dependent and this dependency has increased over time. The International Energy Agency documented that in 2011 more than 90% of the total liquid fuels consumption of Turkey was imported and predicted that this import level will rise over the next decade. In addition, Turkey is a net importer of oil products, with total product imports amounting to about 300,000 bbl/d[26] in 2010[27]. However, oil dependency is falling over time. This can be as sign of substitution of other fuels for oil in the fuel mix. Energy intensity tends to increase steadily over time. Oil intensity tends to decrease over time. This is compatible with the substitution of natural gas for oil. Finally, the oil vulnerability of Turkey begins to increase after the 1990s and the uptrend continues except the crises year of 2008. It is noteworthy that the increase in oil prices, the increase in oil import dependency and increase in energy intensity can be candidates for the vulnerability increase with respect to Turkey. In 2011, the value of vulnerability indicator is approximately 0.021 where the value of the indicator was 0.007 in 1987. This means that 0.7% of Turkey's GDP in 1987 fell due to high oil price whereas in 2011 the requisite fall in GDP was 2.1% of it.

[25] The indicator series periods are determined according to the availability of the data.
[26] One bbl/d also equivalent to 49.8 tonnes per year.
[27] The majority of oil products imports consist of diesel fuel, with smaller volumes of jet fuel and liquefied petroleum gas (LPG).

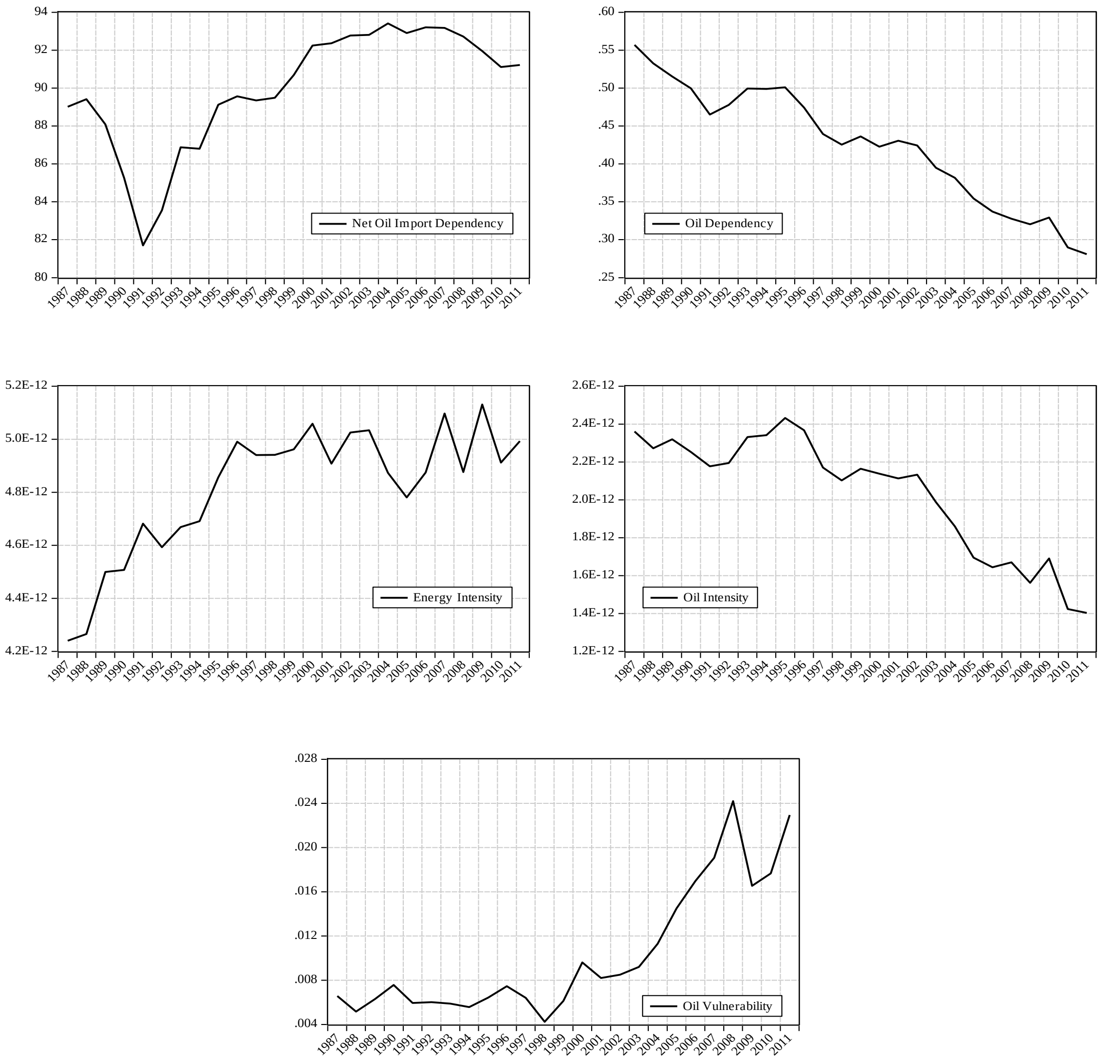


Figure 3 : Net Oil Import Dependency, Oil Dependency, Energy Intensity, Oil Intensity, Oil vulnerability

As mentioned previously, oil price level alterations affect to the economy through different channels. Oil price pass-through features in the background of these channels. Particularly in regard to the Turkish economy, the linkage between oil price and inflation is essential. Historically the Turkish economy has struggled with persistent high levels of inflation. According to Diboğlu and Kibritçioğlu(2004), the Turkish economy has been exposed to chronic inflation problem because of high public sector deficits, monetization of public sector deficits, increases in the prices of the major imported inputs, increases in exchange rates (via increases in imported goods) and persistency in inflationary expectations of economic agents. Since inflation is one of the chronic problems of the Turkish economy it is essential to uncover the driving mechanisms of inflation. Oil price pass through is one of the points worth highlighting for an economy that imports a considerable amount of its oil and oil product requirements as previously discussed. In addition, the import level of intermediate goods and raw materials is considerable in Turkey and a considerable proportion of these items are composed of petroleum based products. [28] Figure 20 displays the proportion of various goods imports to total imports. It is apparent that the proportion of intermediate goods imports to total imports is fairly high. Thus, a change in the price of these items or the exchange rate will affect domestic prices through production cost alterations.

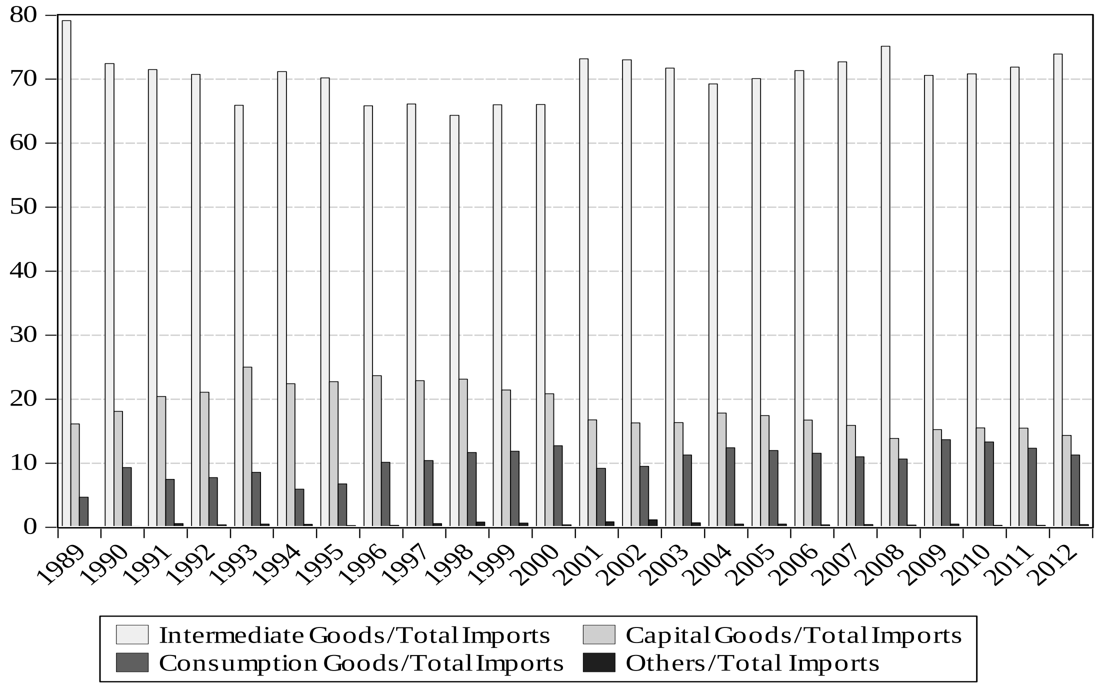


Figure 4 : Goods Imports/Total Imports

To summarize, a considerable portion of the substantial current account deficit of Turkey is comprised of energy related imports. This presents a risk that vulnerability could be high in the event of further oil price and exchange rate shocks. It is evident that Turkey is following a path of increasing development which is accompanied by increasing energy requirements. In addition, Turkey has adopted inflation targeting. Considering all of these together reveals that conducting proper monetary and energy policies becomes challenging.

[28] Intermediate goods include unprocessed materials incidental to industry, processed materials incidental to industry, unprocessed fuels and oils, parts of investment goods, parts of transportation vehicles, unprocessed materials of food and beverages, processed materials of food and beverages, and processed fuels and oils.

This study has several aims. First, this study will contribute to the scarce literature on OPPT for developing economies such as Turkey. Second, Turkey is a net oil importer developing country and, as such has been exposed to high and persistent inflation since the 1970s. In order to sustain economic growth and development a reduction in energy usage may not be favorable with respect to energy saving. Besides, oil price increases can trigger inflation. Consequently, the level and evolution of oil price pass through can be informative for policy making. The magnitude and the evolution of OPPT can be a motive for policy making based upon renewable energy sources and energy efficiency.[29] Third, this study tests the hypothesis of Taylor (2000) that proposes that OPPT is lower in a low inflation environment.[30] Fourth, this study enables an assessment of the validity of the argument proposing OPPT has decreased over time, as reported by a majority of the studies in the literature.

The rest of the study is organized as follows. Section Two introduces the literature review. Section Three includes the data and methodology. Section Four presents the empirical results. Section Five provides a discussion on empirical evidence and Section Six presents the concluding remarks.

3.2. Literature review

During the 1970s, due to the sequent increases in inflation measures following the oil price hikes, the relationship between oil prices and inflation was found to be remarkable by researchers. The relationship deteriorated after the 1980s following the moderation in oil prices. However, oil prices have appeared to follow an increasing trend since the beginning of the 2000s attracting the interest of researchers once again. In particular, the majority of studies in OPPT literature after 2000 report that OPPT has decreased over time.

Hooker (2002) examines OPPT for the U.S. for the period between 1962:Q2 to 2000:Q1 by estimating a Phillips curve and reports that OPPT has decreased substantially since the 1980s. Using a Hooker (2002) type approach De Gregorio et

[29] Dependency on a non-renewable resource, a commodity such as oil, can constrain policy making in an environment where policy authority aspires to optimize growth and development under the constraints including sustainable growth and development, low and nonvolatile inflation and environmental issues.

[30] After the February 2001 banking crisis, the Turkish economy switched to low inflation environment.

al. (2007) assess OPPT for a group of 34 developed and developing countries. They estimate a Phillips curve and for robustness estimate Rolling VARs by using quarterly data spanning from 1965:Q1 to 2005:Q1. Their study reveals that OPPT has decreased. Blanchard and Gali (2007) estimate VARs for the United States, United Kingdom, Germany, Japan and Italy for the period between 1970:Q1 and 2005:Q4. They further estimate bivariate Rolling VARs for the United States for the period between 1960:Q1 and 2005:Q4. The conclusion drawn by their analysis is that the effects of oil price shocks have steadily smaller effects on prices. By estimating a Phillips curve, Chen (2009) obtains a time varying OPPT coefficient for a group of 19 industrial countries over the period 1970:Q1 to 2006:Q4. The results confirm the decline in OPPT. Shioji and Uchino (2010) assess the OPPT for Japan for the period 1975:01 and 2009:05 by employing regular and time-varying parameter VAR models. They find that the OPPT declined for the period between 1980 and 2000 but increased for the period spanning from 2000 to 2007. Valcarcel and Wohar (2013) estimate a time-varying parameter Bayesian structural VAR model with stochastic volatility for the United States for the period between 1948:Q1 and 2011:Q2. Their conclusion is that OPPT has become negligible since the 1980s.

It is evident that the majority of studies focus on developed economies, while the number of studies regarding developing countries is rather limited. Kibritçioğlu and Kibritçioğlu (1999) assess OPPT for Turkey for the period from 1986:01 to 1998:03 by estimating a VAR model. They report that there is no significant OPPT. Berument and Taşçı (2002) conduct input-output analysis by using year 1990's input-output table of Turkey. The conclusion drawn by their analysis is that when wages and the other three factors of income (profit, interest and rent) are adjusted to the general price level that reflects the oil price increases as well, OPPT becomes significant.

3.3. Candidate Causes For the Decline in the OPPT

In the literature proposed causes for the decrease in the OPPT are as follows:[31]

i. The reduction in oil intensity of economies,

ii. Reduction in exchange rate pass-through,

[31] Candidate causes proposed by the authors as follows: i, ii, iii, iv De Gregorio et al. (2007), v, vi, vii Blanchard and Gali (2007), viii, ix, x, Chen(2009) v, vi, vii Blinder and Rudd (2009), xi Kilian (2008), xii Bernanke, Gertler and Watson (1997).

iii. A more favorable inflationary environment (which leads to less frequent price changes by firms by rarifying oil price increases to pass through to domestic prices easily),

iv. The fact that the current oil price increase is largely the result of strong world demand,

v. Credible monetary policy,

vi. Greater wage flexibility,

vii. Change in industrial structure,

viii. The appreciation of domestic currency,

ix. A more active monetary policy in response to inflationary movements

x. A higher degree of trade openness (the study argues that energy intensity may have played a minor role in the evolution of pass-through overtime),

xi. Differences in the underlying causes of episodes of oil prices surges,

xii. Tight monetary policy.

3.4. Methodology

In order to examine the oil price pass-through to domestic prices in Turkey a five variable monthly recursive VAR model is used.[32] The model is similar to the recursive VAR model introduced by McCarthy (1999) which is used to analyze the Exchange rate pass-through.[33] McCarthy (1999) utilizes a model of pricing along a distribution chain, including import, producer and consumer distribution stages. In this approach, inflation at one of these distribution stages in period *t* includes different components:

- Expected rate of inflation for period t at a particular stage based on available information at the end of period *t-1*
- Effects of period t domestic demand and supply shocks on inflation
- Effects of period t exchange rate shocks on inflation

[32] In a recursive VAR, the structure of a model involves constructing the error terms in each regression in a way that the error term in each regression is uncorrelated with the ones in preceding equations.
[33] Leigh and Rossi (2002) and Kara and Ogunc (2008) analyze the exchange rate pass-through in Turkey based on a methodology similar to McCarty (1999).

– Effects of inflation shocks at the previous stages of the distribution

– Effect of inflation at that particular stage

The supply shocks are identified by the dynamics of oil price inflation in local currency, the demand shocks are identified by the dynamics of output gap after considering the contemporaneous effect of supply shocks and the exchange rate shocks are identified by considering contemporaneous supply and demand shocks. The ordering of endogenous variables is oil prices, real output, nominal exchange rate against the US dollar, producer prices and consumer prices. Cholesky decomposition of the variance-covariance matrix is used in order to recover from the VAR residuals. The decomposition assumes that a shock to the last variable in the ordering does not contemporaneously affect the previous variables in the ordering. The representation of the system is as follows:

Supply Shock $\pi_t^{oil} = E_{t-1}\left(\pi_t^{oil}\right) + \varepsilon_t^{oil}$ (1)

Demand Shock $\tilde{y}_t = E_{t-1}\left(\tilde{y}_t^{oil}\right) + \varepsilon_t^{oil} + \varepsilon_t^{\tilde{y}}$ (2)

Exchange Rate Shock $\Delta e_t = E_{t-1}(\Delta e_t) + \varepsilon_t^{oil} + \varepsilon_t^{\tilde{y}} + \varepsilon_t^{\Delta e}$ (3)

Producer Price Inflation $\pi_t^{ppi} = E_{t-1}\left(\pi_t^{ppi}\right) + \varepsilon_t^{oil} + \varepsilon_t^{\tilde{y}} + \varepsilon_t^{\Delta e} + \varepsilon_t^{ppi}$ (4)

Consumer Price Inflation $\pi_t^{cpi} = E_{t-1}\left(\pi_t^{cpi}\right) + \varepsilon_t^{oil} + \varepsilon_t^{\tilde{y}} + \varepsilon_t^{\Delta e} + \varepsilon_t^{ppi} + \varepsilon_t^{cpi}$ (5)

The variables in the system are as follows:

π_t^{oil} : Oil price (in nominal US dollar) inflation

$\tilde{y}_t$: Output gap

Δe_t : Change in the logarithm of the nominal exchange rate relative to the US dollar

π_t^{ppi}: Producer price inflation rate

π_t^{cpi} : Consumer price inflation rate

$\varepsilon_t^{oil}\varepsilon_t^{\tilde{y}}, \varepsilon_t^{\Delta e}, \varepsilon_t^{wpi}, \varepsilon_t^{cpi}$: Oil price inflation, output gap, change in exchange rate, producer price inflation and consumer price inflation rate shocks respectively.

E_{t-1}: The expectation of a variable conditional on information available at period *t-1*.[34]

Following Shioji and Uchio (2010), a gradual change in pass-through is considered instead of allowing for a one-point structural change and the cumulative pass-through coefficient estimates are calculated from the impulse response functions. Based on the estimated response of domestic prices to an oil price shock and the oil price's own response to an oil price shock, the oil price inflation pass-through coefficient is calculated as follows:

$$OPPT_{t,t+s} = \frac{DP_{t,t+s}}{OP_{t,t+s}} \tag{6}$$

$OPPT_{t,t+s}$: Oil price pass through rate at time horizon s, in period t

$DP_{t,t+s}$: Cumulative impulse response of domestic price index (CPI or PPI) inflation to an oil shock at time horizon s, in period t (i.e cumulative impulse response of a variable up to t-th period)

$OP_{t,t+s}$: Cumulative impulse response of oil price inflation to an oil shock at horizon s, in period t.

3.5. Data

Monthly data of average crude oil price (OP), industrial production index (IPI), nominal exchange rate (E), producer price index (PPI) and consumer price index (CPI) for the period between 1986:02 and 2013:01 is used. OP[35] is in terms of nominal US dollars and is obtained from the Global Economic Monitor (GEM)

---

[34] In estimation expectations are introduced to the model by linear projections of the lags of the variables. The system allows for tracing the dynamic effect of an oil price shocks on consumer prices along the supply chain, going from real output, to the exchange rate, and to the producer prices that contains a relatively high proportion of tradable goods and finally to the consumer prices that contains smaller proportion of tradable goods (Leigh and Rossi, 2002).

[35] The average of the FOB spot price of the internationally traded crude oils West Texas International, Europe Brent and Dubai Fateh.

commodities of the World Bank. E ($/TL), CPI, PPI and IPI [36]and seasonally adjusted and obtained from the International Financial Statistics of the International Monetary Fund. All series are differenced and are in their natural logarithms. Output gap is the difference between IPI and its long-run trend value.[37]

3.6. Emprical Results

In order to obtain the empirical results the system is estimated for 204 rolling window periods with each rolling window width set to 120 months. Impulse responses are calculated up to a 24-month horizon. In estimation maximum lag length is set to 12 which is customary to use in the case of monthly data. After obtaining the cumulative impulse responses[38] at each time horizon s in each time period t, the oil price pass through rate is calculated for both CPI and PPI. Figure 21 and Figure 22 show how the rate of estimated pass-through from oil prices to CPI and to PPI evolve over time for up to a 24-month horizon from a 1-month horizon. Along with the evolution of the OPPT rate, I provide a 12-month moving average of the OPPT rate in order to identify the trend.

Table 13 : OPPT Rates

		%
Short Time Horizon	PPI	0.044
	CPI	0.007
Medium Time Horizon	PPI	0.097
	CPI	0.023
Long Time Horizon	PPI	0.107
	CPI	0.025

Table 13 summarizes the findings. [39] I find that the maximum values of the OPPT to CPI and PPI are approximately 0.7% and 4.4% for the short time horizon. For the medium time horizon the corresponding values are 2.3% and 9.7%. For the long time

[36] CPI and PPI are seasonally adjusted by using Census X12 method.
[37] The Hodrick-Prescott (HP) filter is applied to the IPI series in order to obtain long-run trend (potential IPI).
[38] Since all impulse responses are all cumulative responses, they are the responses of the log level of CPI and PPI to one standard deviation oil price shocks.
[39] Although for some estimation windows OPPT is negative, for the majority of the windows it is positive.

horizon the values are 2.5% and 10.7% respectively. The results can be interpreted as the corresponding percentage change in CPI or PPI in response to a 1% increase in oil price (i.e. CPI and PPI increase at most 2.5% and 10.7% in response to a 1% increase in oil price). Figures 21 and 22 show the evolution of pass through rate to CPI and PPI. Each minor graph in both figures stands for different number of periods after the shock (i.e. 1 month, 2months,…,24 months) whereas the x-axis and y-axis of these graphs signify the magnitude of pass through rate and at which point in time is evaluated, respectively. Despite the ups and downs, both OPPT to CPI and PPI are trending up.

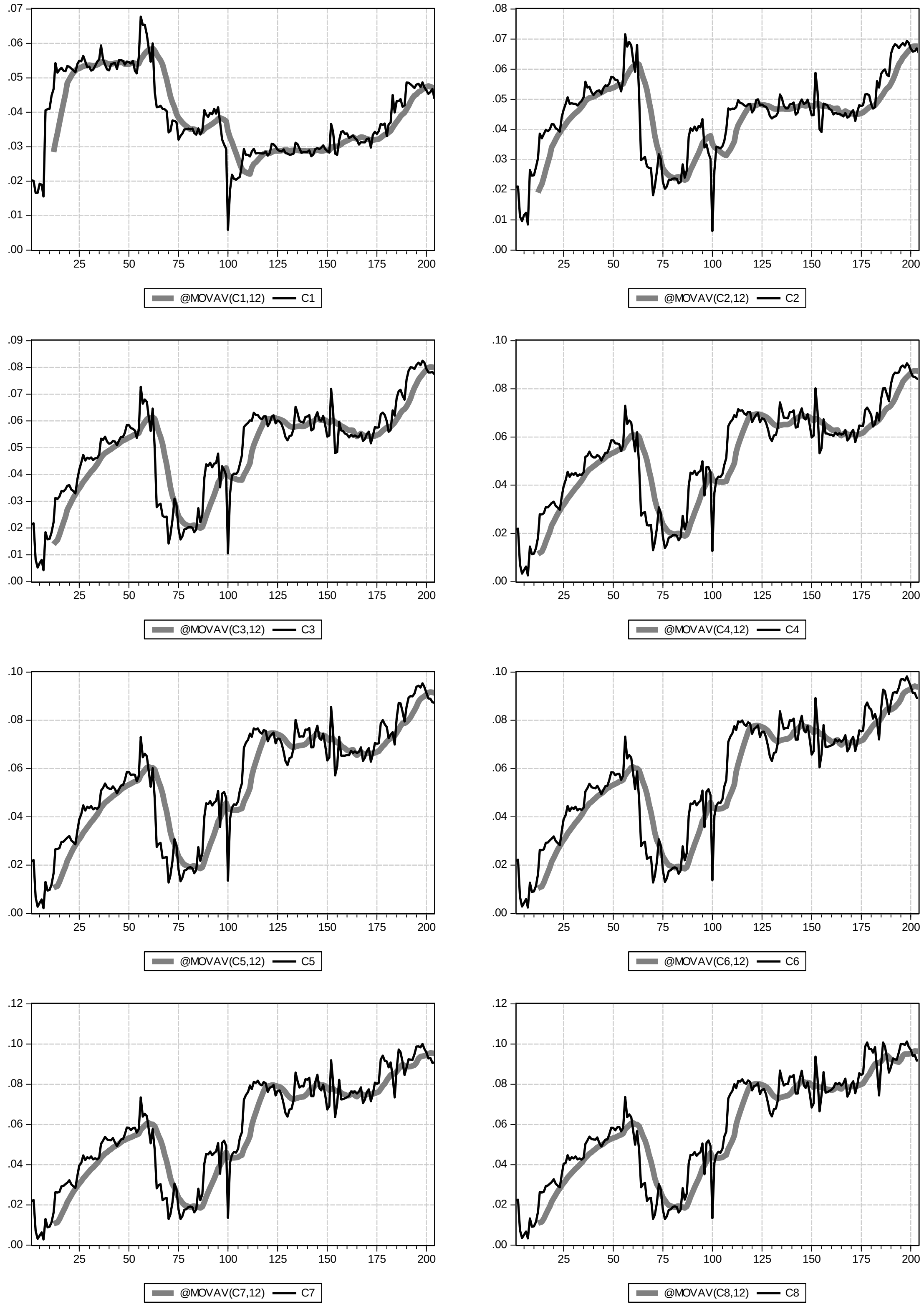


Figure 5 : Oil price pass through to PPI

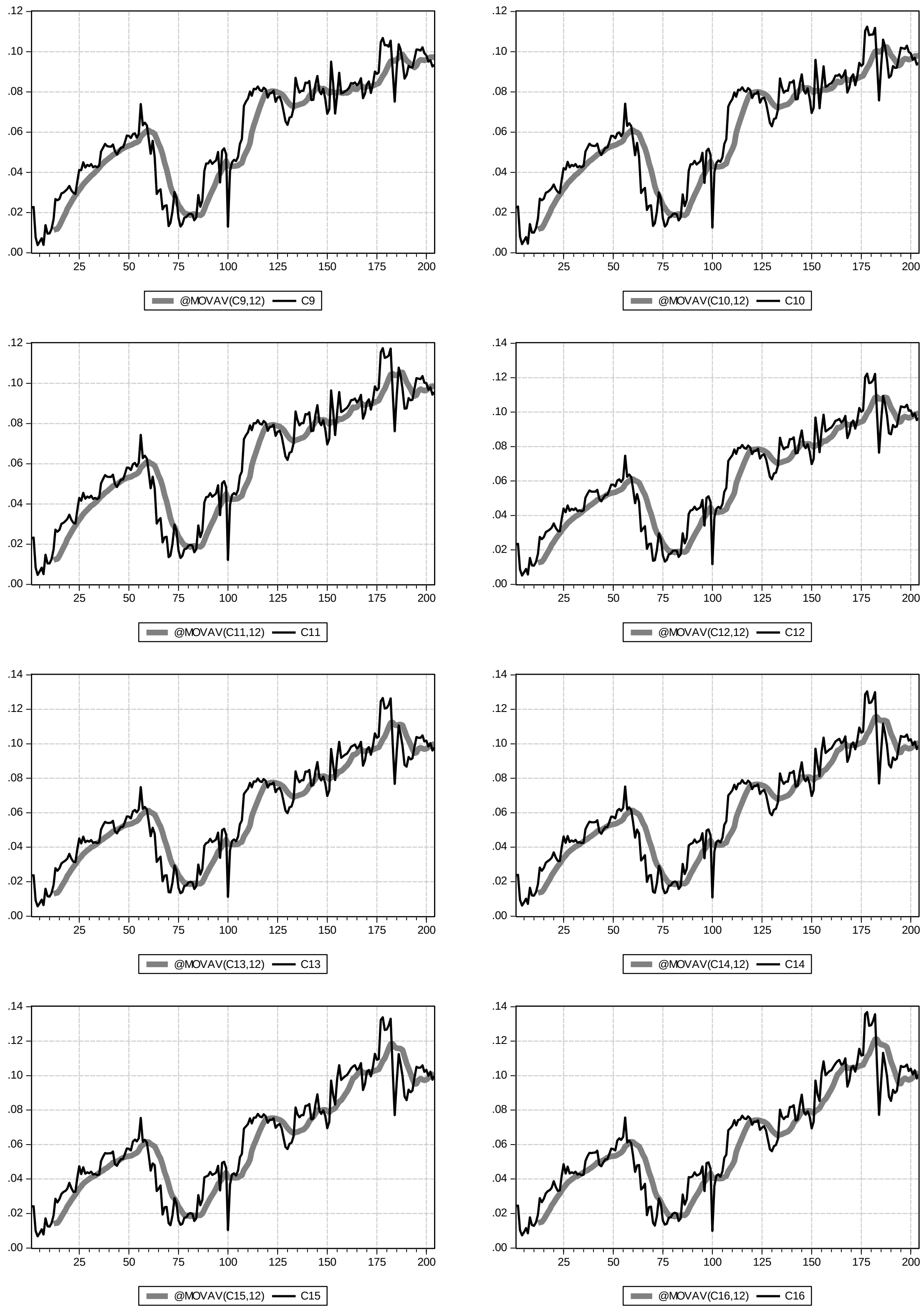


Figure 5: Oil price pass through to PPI (Cont.)

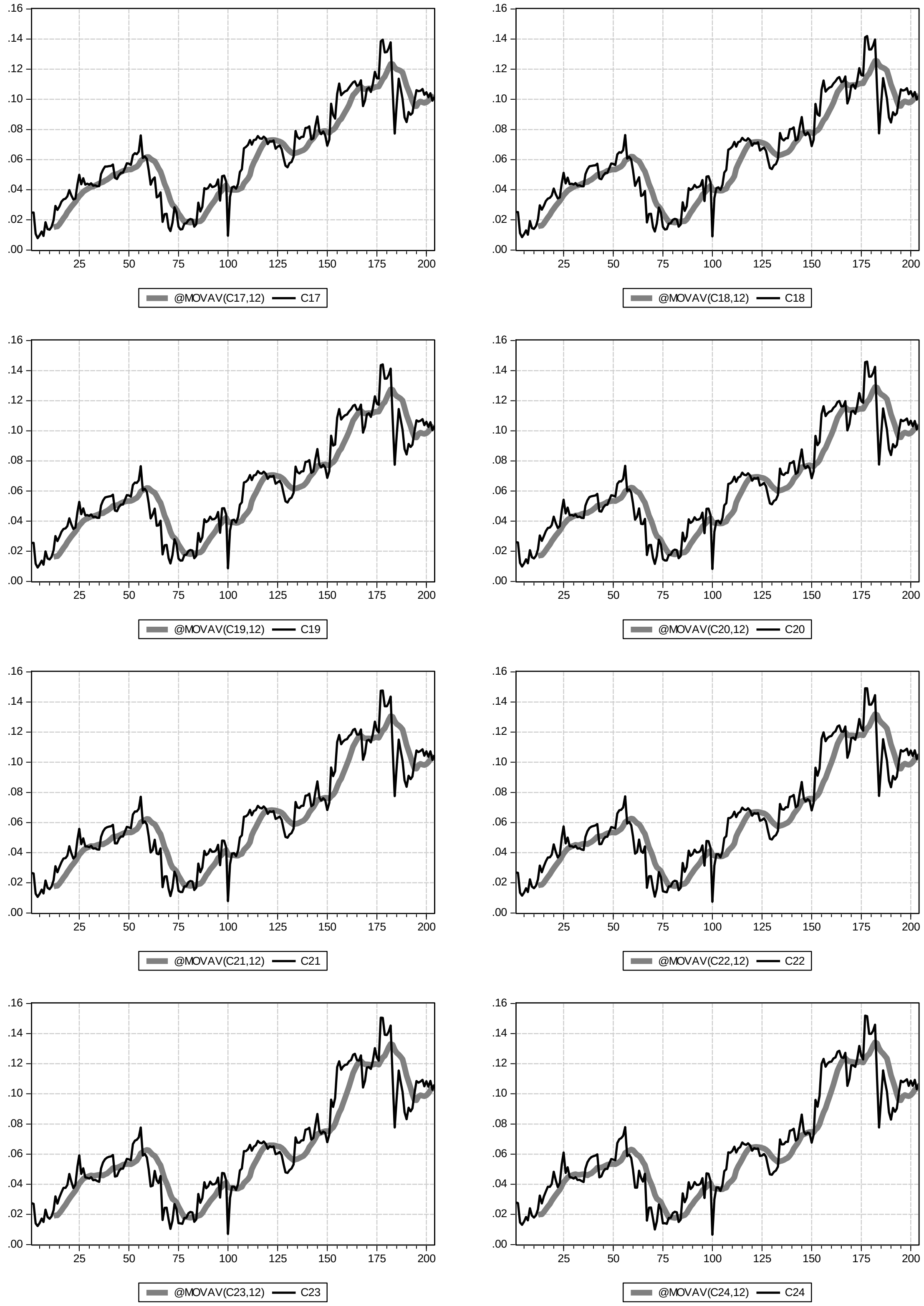


Figure 5: Oil price pass through to PPI (Cont.)

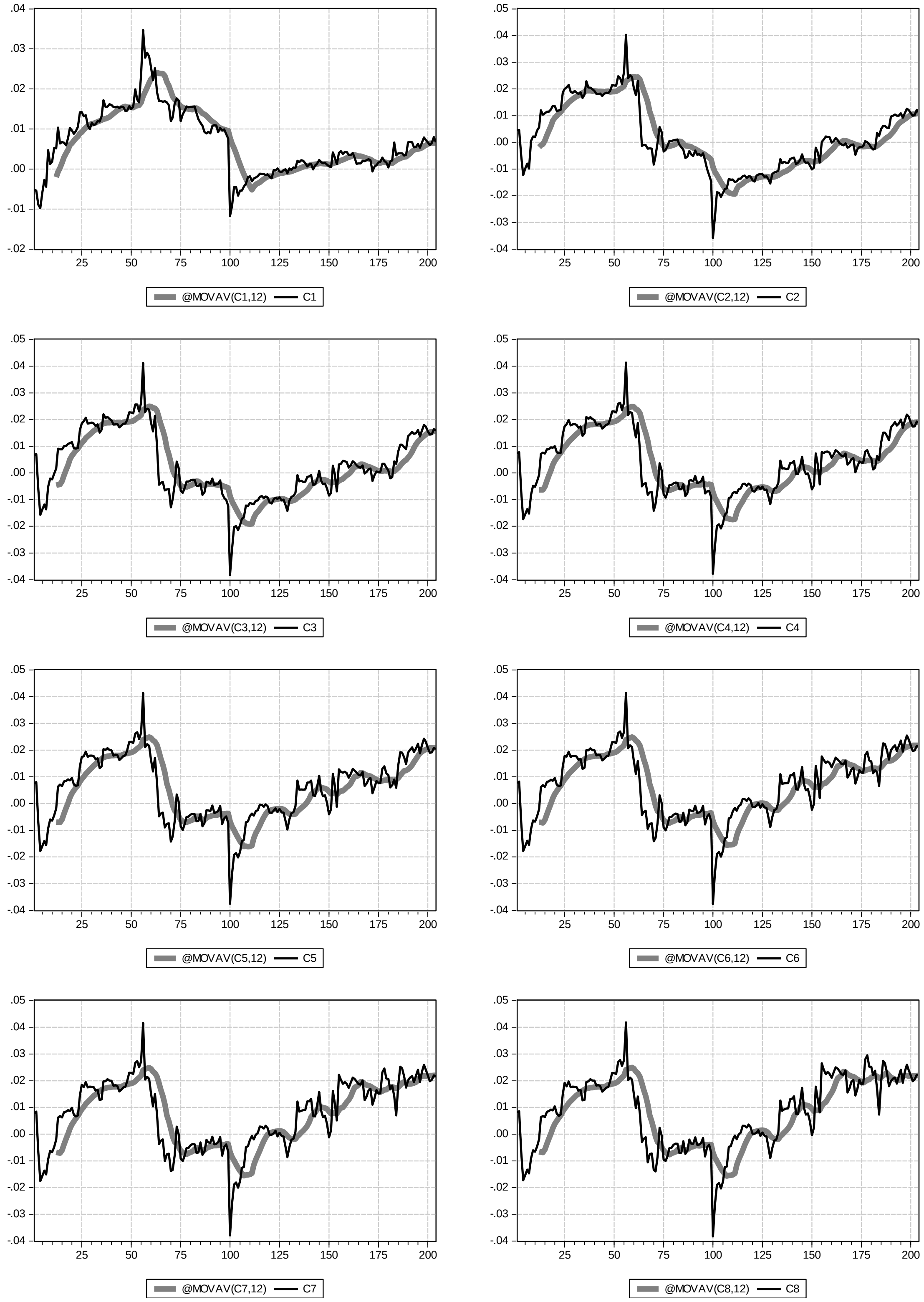


Figure 6: Oil price pass through to CPI

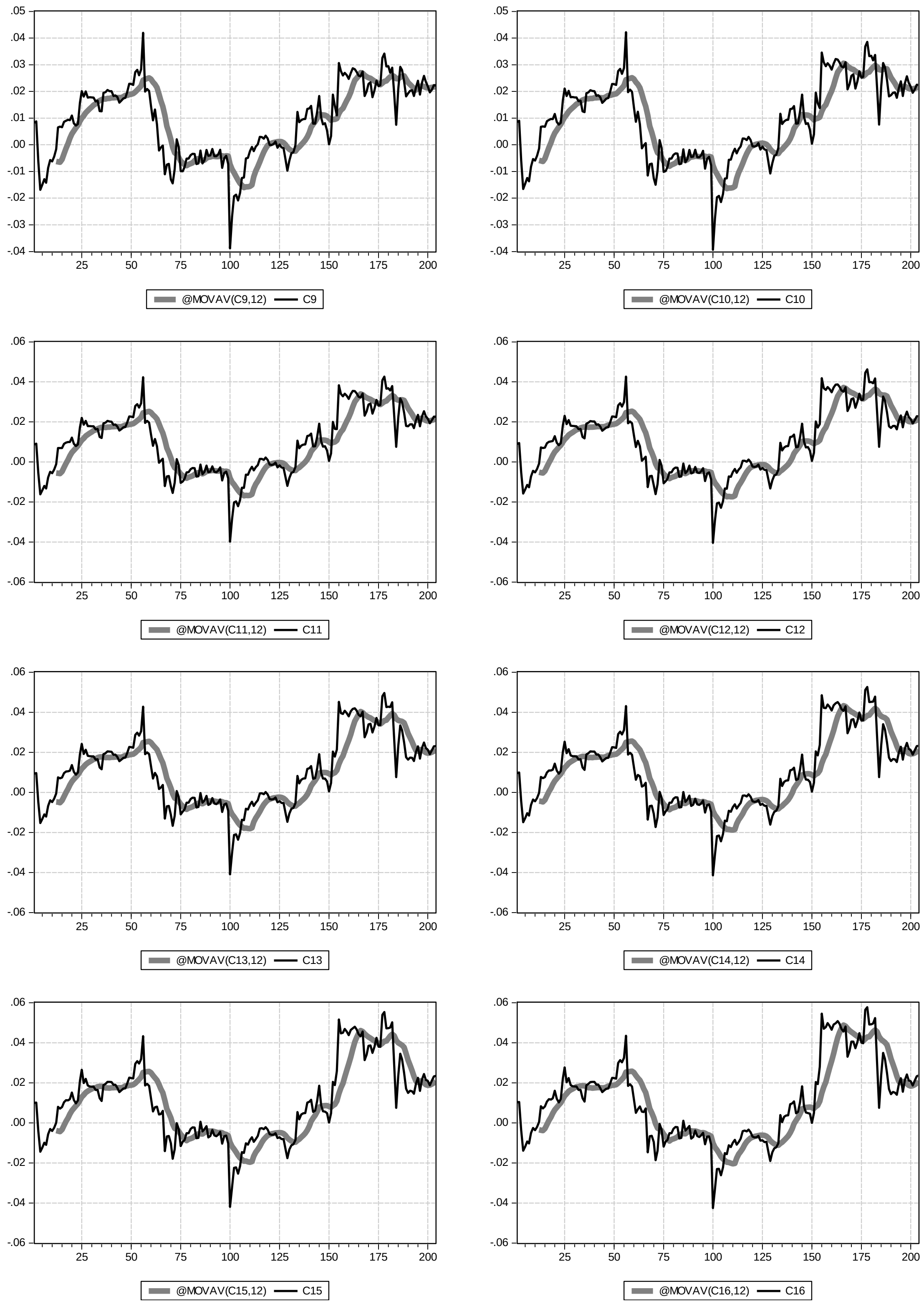


Figure 6: Oil price pass through to CPI (Cont.)

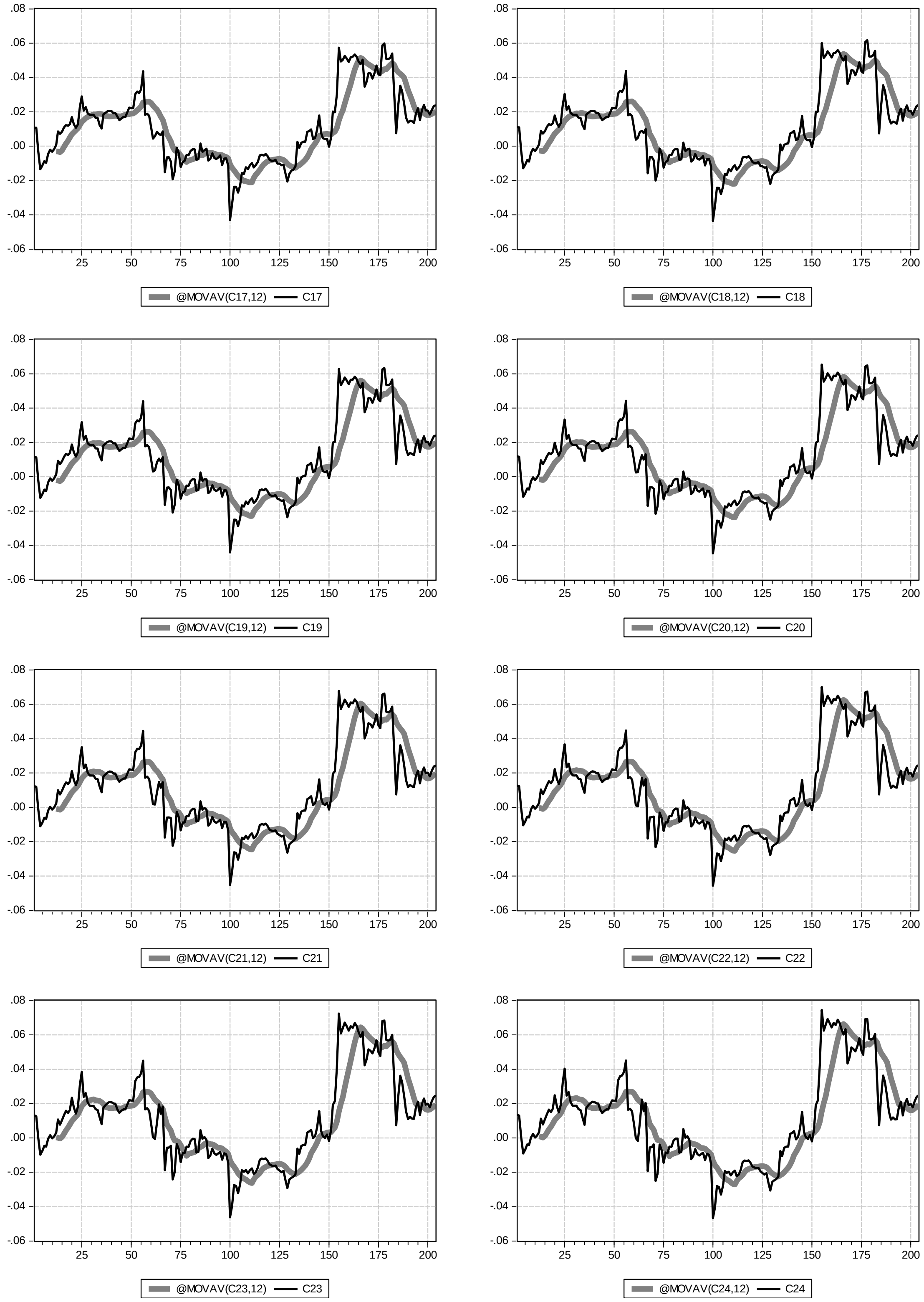


Figure 6: Oil price pass through to CPI (Cont.)

Shioji and Uchio (2010) argue that as oil becomes cheaper it becomes a less important cost item for firms and thus, they naturally decide to respond less to its price changes. In line with this argument, they find declining pass-through rates for the period 1980-2000 in which oil prices trended down. In other words, the main driving force of the decline in pass-through rate is argued to be the oil price itself. Conversely, they obtain increasing pass-through rates for the period 2000-2007 when oil prices were on the rise. This evidence is also consistent with their argument. The same argument can be valid for Turkey and provide an explanation for the increasing pass-through rate. In order to investigate whether oil becomes a less important cost item for firms, it is necessary to utilize an input output table for Turkey. However, in Turkey the last input output table was constructed in 2002. Thus, different indicators are investigated to determine whether or not the argument is valid for Turkey.

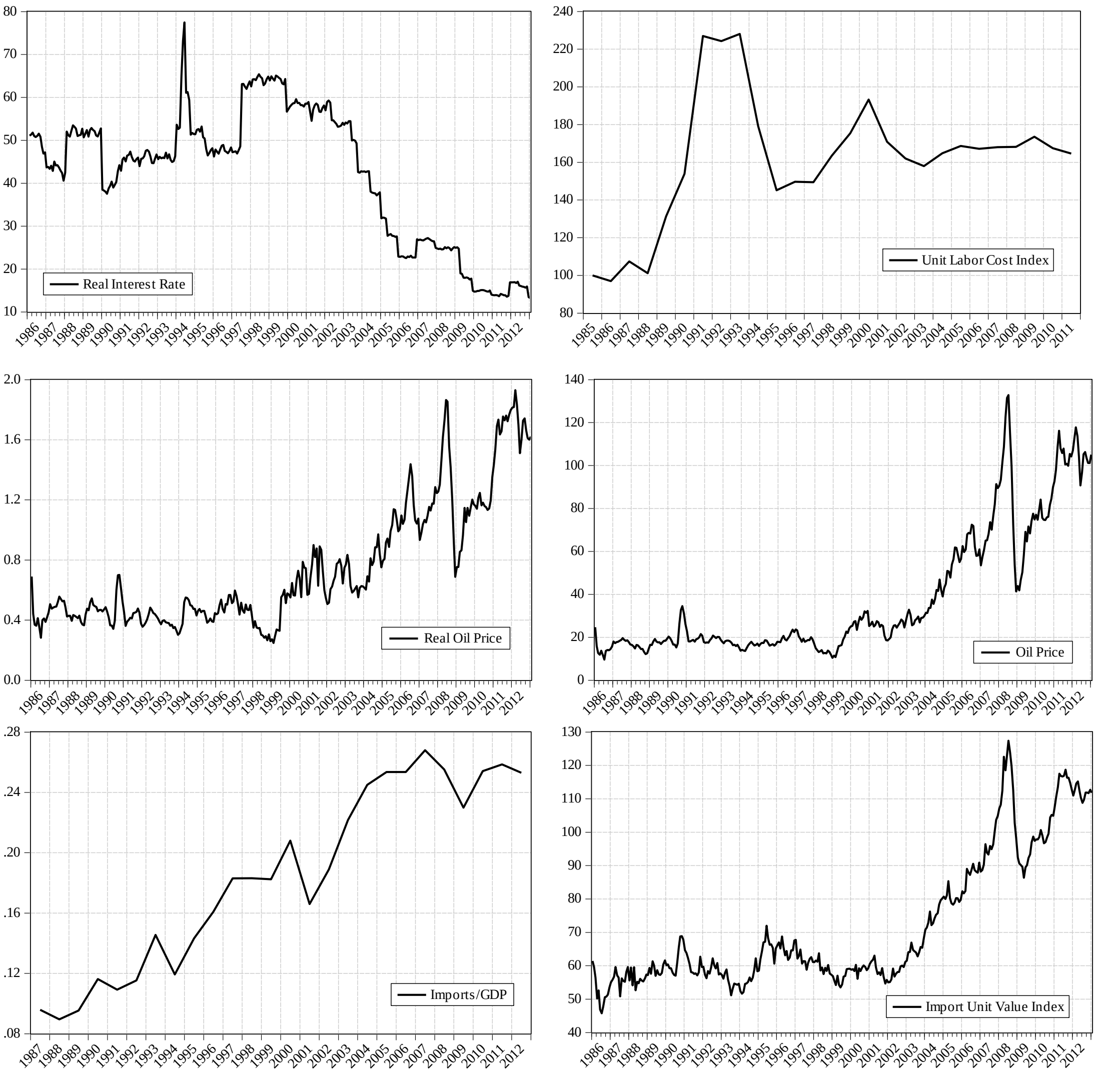


Figure 7: Selected Macroeconomic Indicators

Source: Imports of Goods and Services(Constant 2005 prices) and GDP(Constant 2005 prices) is obtained from the World Bank, nominal interest rate series IMF, crude oil price was obtained from Global Economic Monitor Commodities of World Bank and it is the average of the FOB spot price of the internationally traded crude oils namely West Texas International, Europe Brent and Dubai Fateh, Unit Labor Cost Index(1985=100) Tisk. Real interest rates is own calculation using fisher equation[40]. Real oil price is own calculation.[41]Import value index is obtained from Turkstat.

Figure 7 shows that the movements in import value index and oil prices are compatible with each other. The import/GDP ratio is trending up, the unit labor cost in manufacturing reflects no significant changes especially after 2002, the real interest rate is trending down and real oil prices are trending up. These indicate that the weight of imported goods in GDP production has been increasing over time.

[40] Real interest rate = [(1+money market rate)/(1+inflation)]-1. Since the expected inflation is not available current inflation rate is used as a proxy.

[41] $\text{Real Oil Price} = \text{Nominal Oil Price} \times \text{Nominal Exchange rate} \times (\text{CPI}_{\text{US}}/\text{CPI}_{\text{TR}})$. CPI for United States is obtained from OECD.

There is no significant increase in the cost of labor and capital. At the same time, oil prices are trending up. From the results it can be inferred that oil becomes a more important cost item over time for firms in Turkey.

Furthermore, the rate of OPPT to PPI is higher than to CPI for all time horizons and time periods. As a consequence, the gap between these OPPT rates can be a sign of the ability of producers to pass higher costs onto consumers (Jongwanich and Park, 2011). They argue that due to intense competition producers may cut profit margins instead of immediately passing higher prices on to consumers. A low inflationary environment may decrease the level of the producer prices pass-through to consumer prices.

In Turkey consumer prices include taxes whereas producer prices do not, and the weight of the service sector is higher with respect to consumer prices. Besides, under inflation targeting the central inflation target is set on consumer prices and, if the target is considered credible by the public, expected and actual inflation coincides with each other and sensitivity to oil price changes decreases. Consequently, sensitivity of consumer prices to oil price increases is lower than the sensitivity of producer prices.

Figure 23 shows the gap between the OPPT rates. It can be clearly seen that it is positive for all time horizons and time periods and is trending up.

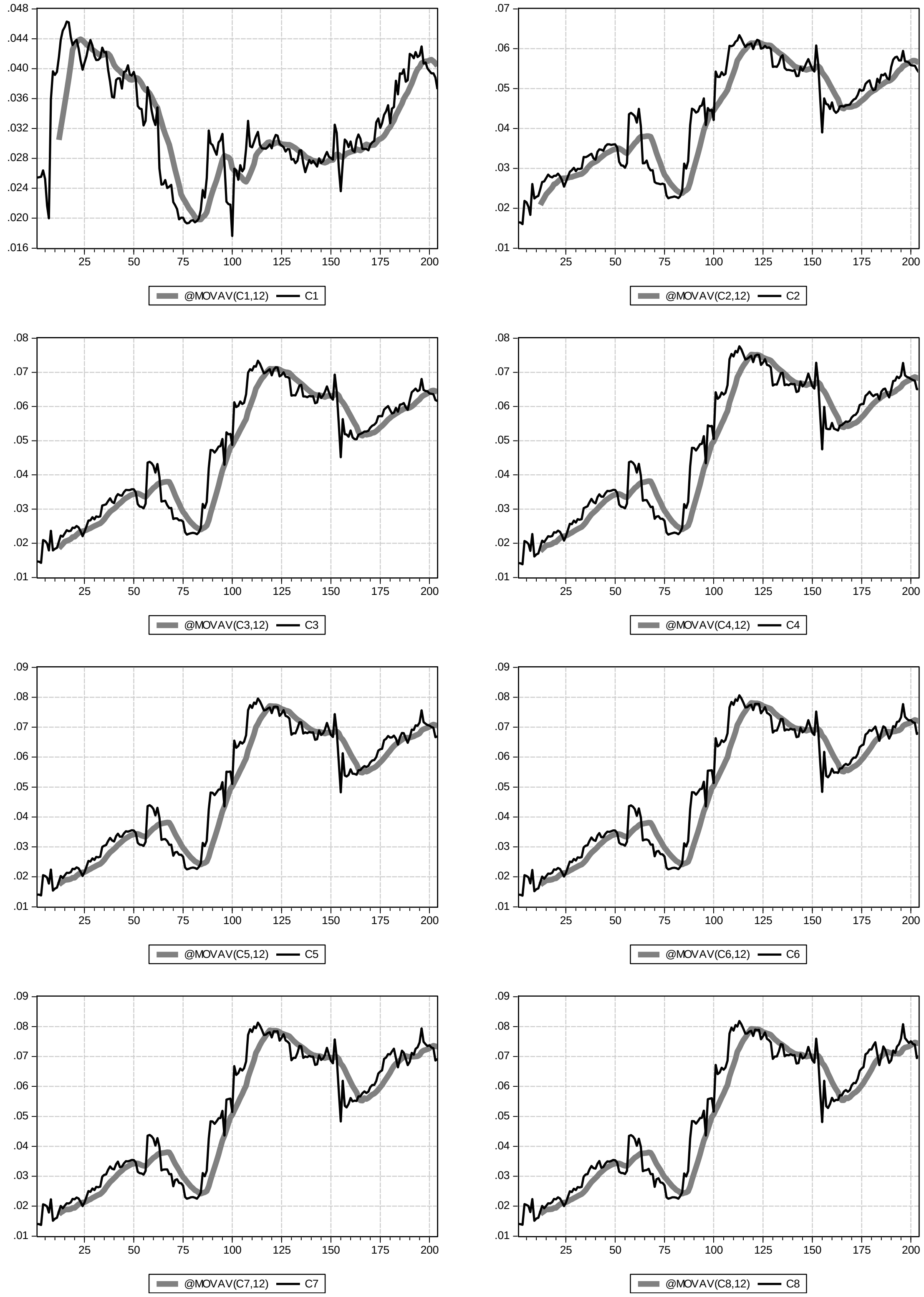


Figure 8: GAP between oil price pass through to PPI and oil price pass through to CPI

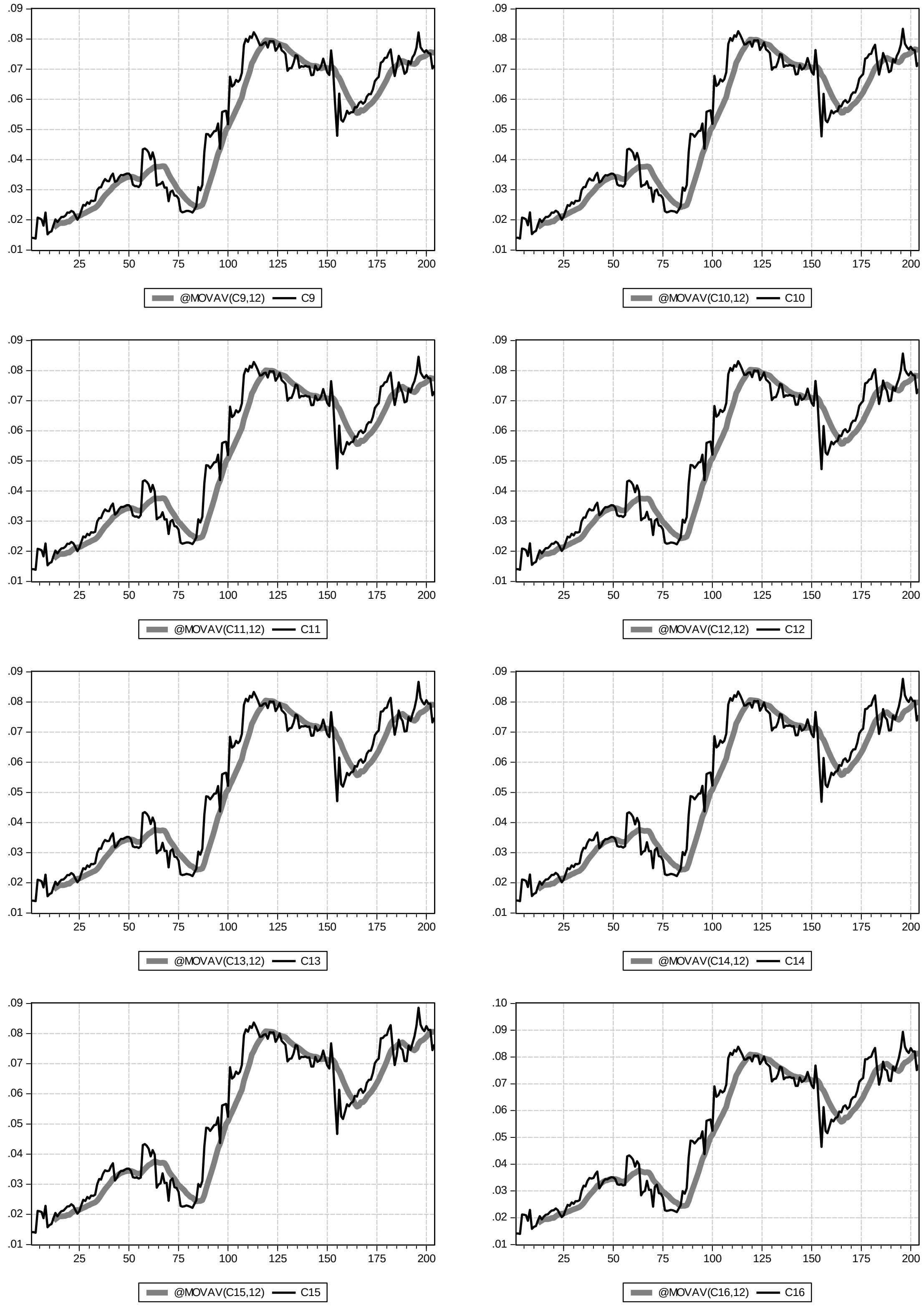


Figure 8: GAP between oil price pass through to PPI and oil price pass through to CPI (Cont.)

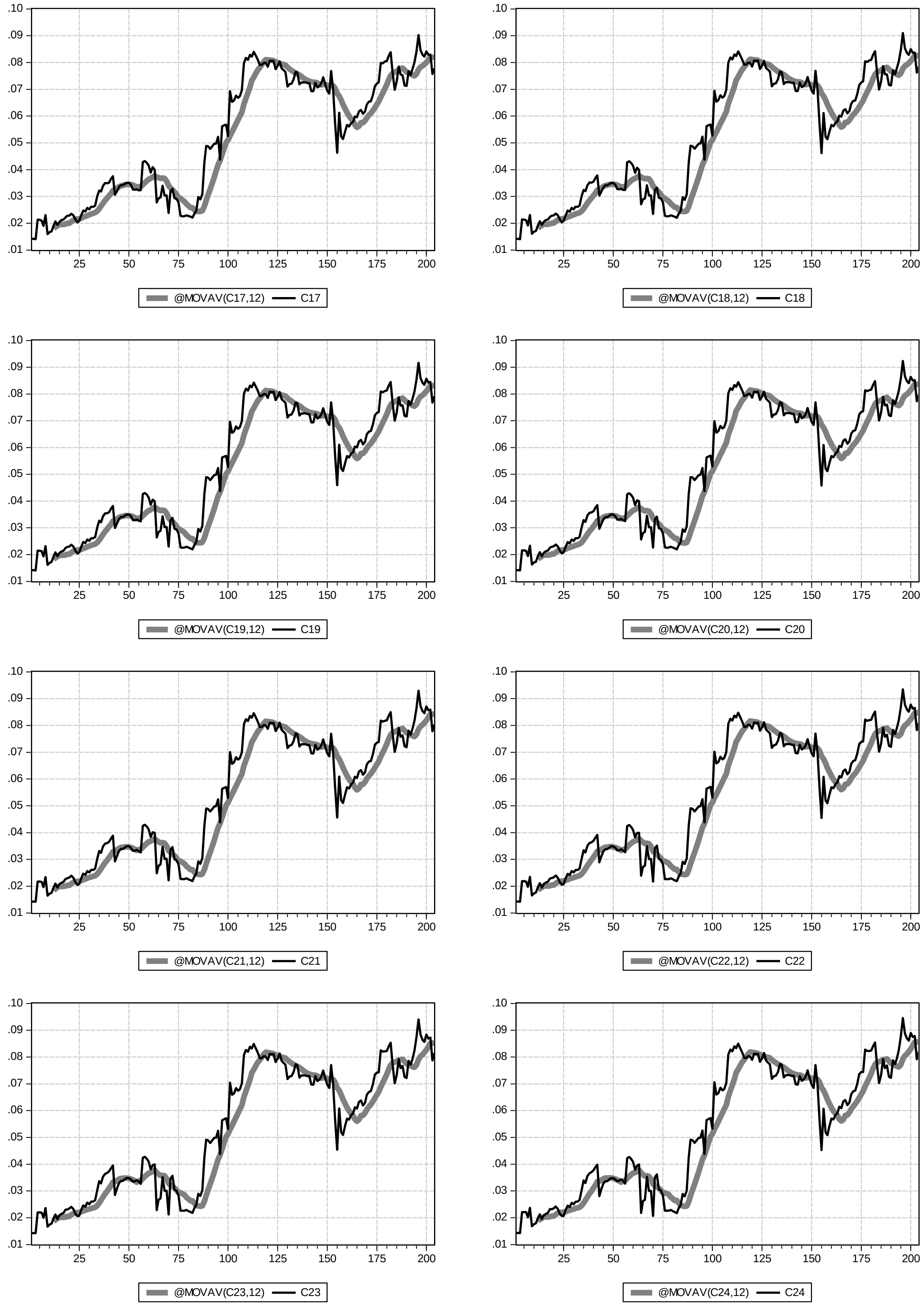


Figure 8: GAP between oil price pass through to PPI and oil price pass through to CPI (Cont.)

6. Conclusion and Policy Implications

This study examines the OPPT with regards to Turkey. It is found that the OPPT rate has increased over time. Additionally, there is a gap between oil price pass-through to CPI and PPI and this gap has increased over time.

Turkey is a heavily oil dependent country and imports high amounts of oil based products. A considerable part of its substantial current account deficit is comprised of energy imports which leaves Turkey vulnerable to both oil price and exchange rate shocks. For a developing country like Turkey with increasing energy needs, implementation of energy saving policies becomes a constraint. Inflation targeting monetary policy is also an significant factor. Due to these things, OPPT is important for Turkey in regard to energy, fiscal and monetary policy making.

In this environment appropriate policy recommendations for Turkey should include the following: (1) the proportion of oil in the cost structure of firms should be reduced, (2) to decrease the OPPT without hampering economic growth energy efficiency policies rather than energy saving policies should be employed along with policies encouraging renewable energy usage. Since the Kyoto Protocol has become binding for Turkey, energy efficiency and renewable energy usage issues have become more important. Although it is not a major energy producer, due to its geographical and geopolitical location Turkey acts as a bridge and an outlet for transporting energy from Russia, the Caspian Sea region and the Middle East to world markets. This strategic position can be translated into energy cost cutbacks in return for Turkey’s contributions to energy security issues.

4. EVOLUTION OF COMOVEMENT BETWEEN COMMODITY FUTURES

4.1. Introduction

Energy is not only a primary cost item for firms but also it enters to household heating and transportation expenditures. Food prices can affect firm costs through wages. Food expenditures as a share of total expenditures, particularly in low-income households, are high. It is evident that both energy and agricultural commodity prices are among inflationary factors. As a result of this, policy authorities are required to consider both commodity price movements and comovements. The existence of comovement between the prices in agricultural and energy markets is one of the issues that should be considered in policy making. In a different vein, Runge and Senauer (2007) warn that “biofuels have tied oil and food prices together in ways that could profoundly upset the relationships between food producers, consumers, and nations in the years ahead, with potentially devastating implications for both global poverty and food security.” It is evident that the existence of price comovement in commodity markets has important implications for different parties including consumers, producers, investors and policy makers.

As a potential link between energy markets and agricultural commodities, biofuels are receiving increased attention. According to Peñaranda and Micola (2011) there is a plausible economic logic for an oil-food connection through biofuels. Many researchers point out the biofuel industry as a potential channel that affects the linkage (Banse et al., 2008; Ren21, 2007; Campiche et al., 2007; Francisco and Augusto, 2009; Harri et al., 2009; Hertel and Beckman, 2011; Tyner, 2009; Yu et al., 2006; Peñaranda and Micola, 2011). Even though authors present evidence in favor of the existence of such a link, the evidence is not clear-cut.

If we assume that there is such a linkage the three possible sources of correlation between oil and biofuels are inter-fuel substitution, costs and financialization (Peñaranda and Micola, 2011). Oil and biofuels are often considered substitutes. If interfuel substitution is prevalent, changes in oil prices will affect the demand for biofuels by leading changes in their prices. This in turn will affect the demand and the price of feedstock commodities. Agricultural production includes energy intensive activities such as the use of fertilizers, transportation and agricultural field machinery usage. According to NASS (2011), the total of all energy intensive activities account for a high share of the non-feedstock biofuel production cost. Accordingly, energy price alterations lead to agricultural commodity price changes. In futures markets oil is a reference commodity and accounts for a high share in most of the commodity indexes. Therefore, comovement would influence all index components, regardless of whether they are used in the manufacturing of biofuels. The above three channels between oil and biofuel commodity prices can lead to energy and agriculture commodity comovement.

The subject is a matter of concern for Turkey due to oil and oil product dependency, substantial current account deficit; high energy need, inflation targeting.[42]

4.2. Literature Review

The literature on commodity prices can be separated into three strands. The first strand examines the excess comovement, the second examines the effects of changes in energy prices on world markets and the third examines the effects of crude oil and other energy prices on other commodities.

The idea of excess comovement between commodity prices is introduced by Pindyck and Rotemberg (1990). According to them, the correlation of the prices of the commodities with different fundamentals which cannot be explained by macroeconomic effects is called excess comovement. They argue that, due to herd behavior, prices tend to move together. By herd behavior they mean the bullish or bearish manner of traders on all commodities for no plausible reason. Deb et al. (1996) suggest the use of a GARCH framework due to the prevalence of nonnormality and heteroskedasticity of the commodity price changes. These models find weak evidence of comovement for the same commodities and same time period in Pindyck and Rotemberg (1990). Ai et al.(2006) re-examined comovement between agricultural commodities. By using a structural model they are able to explain a

[42] Since the economic profile of Turkey was mentioned several times hence the details are not given here again in order to conserve space

substantial part of the correlation between commodities. However, their structural model falls short in explaining the comovement between the prices of the commodities with different fundamentals.

Another strand of the literature examines the direct and indirect effects of changing energy prices through macroeconomic effects on world markets. (Gohin and Chantret, 2010; Uri, 1996; Lardic and Mignon, 2008; He et al., 2010 among others). Crude oil markets even seem to affect the stock markets (Ciner, 2001; Ghouri, 2006; Miller and Ratti, 2009; Papapetrou, 2001 among others). Various other studies suggest that crude oil prices have a statistically significant effect on economic activity (Adrangi et al., 2001; Berument et al., 2010; Brown and Yucel, 2001; Costantini and Martini, 2010; Hamilton, 2009a; Hamilton, 2009b; Huang et al., 1996; Jones et al., 2004; Oladosu, 2009; Papapetrou, 2001; Reynolds and Kolodziej, 2007; Zagaglia, 2010 among others).

Furthermore, a third strand in the literature includes studies examining the effects of crude oil and other energy prices on commodity futures. Gohin and Chantret (2010) find a significant relationship between world energy and food prices by employing a general equilibrium model. Baffes (2007) suggests that if crude oil prices remain high for a certain time period then the recent commodity price boom is likely to last much longer than earlier booms, at least for food commodities. However, other commodities are likely to follow diverging paths. Plourde and Watkins (1998) document that that short-term price volatility of various commodities is lower than that of oil.

Reviewing the literature enables reconciling the existence of a possible impact of the crude oil futures on the agricultural commodity futures prices. This study aims to uncover the direct linkages between crude oil and agricultural commodity futures.

Particularly of interest is the comovement between energy and agricultural commodity futures prices rather than the prices of these commodities. Natalenov et al. (2011) argue that if herd behavior in financial markets can be observed, futures markets should reflect this behavior because this behavior is inherent in speculative instruments.

The remainder of this study is as follows: Section 3 describes the data and methodology, Section 4 provides the empirical findings and Section 5 offers a conclusion.

4.3. Data and Methodology

Monthly cocoa, coffee, corn, crude oil, rice, soybean oil, soybean, sugar, and wheat futures prices are used. The sample period covers 1988:M1-2012:M4. All data is obtained from Bloomberg.

This study investigates monthly commodity futures price linkages. This, to some degree, enables extracting some information about the herding behavior of the futures prices. The analysis is conducted within a wavelet framework. The use of wavelet analysis is rare in economics, whereas its use in a wide variety of disciplines has been growing rapidly during the last two decades[43] (Crowley, 2007).

Rua (2010) states that time domain approaches[44] reveal the evolution of the comovement between variables by capturing the time varying features, whereas frequency domain approaches[45] reveal the evolution of comovement across frequencies. Wavelet analysis reconciles both the time domain approach and the frequency domain approach. Eventually this enables assessing the relationship between variables at different frequencies and the evolution of the relationship through time.

The Fourier Transform is the conventional method for studying a signal (time series) in frequency domain. It enables translating a time series into the sum of well-chosen sinusoidal basis functions. Using this method the signal in time domain is transformed into frequency domain. However, this transformation removes the time domain features of the signal which can convey essential information for analyzing a nonstationary time series. For such a signal the time interval in which the spectral components (e.g. transient jumps etc.) occur can be important (Yazgan and Korürek, 1996). In other words, the Fourier Transform provides information about how much of each frequency component is in a signal (time series) but it provides no information about when this frequency exists (Rua, 2011). The Short-Term Fourier

[43] Cowley (2007) provides a guide and survey for economists.
[44] e.g. Rolling window correlation coefficient
[45]e.g. Dynamic correlation

Transform (also known as Gabor or windowed Fourier transform) is introduced as a remedy for this limitation. In this transformation the signal is cut into slices by using a window function (also known as window) with a definite length.[46] After this, the Fourier Transformation is applied to each segment (the window is slid across the data). According to Heisenberg's Uncertainty Principle, existent frequency at a specific time cannot be exactly known so it is only possible to obtain what spectral components exist at a given time interval (Rua, 2011). This means that for a better time resolution some frequency resolution should be sacrificed. In other words, the frequency resolution and time resolution are related with window width positively and negatively respectively (narrow window width good time resolution, poor frequency resolution and vice a versa). An important limitation of the short-term Fourier Transform is the inflexibility of the window length for different frequency components. The wavelet transform becomes a remedy for this. The wavelet transform enables widening and narrowing the window width according to frequency (narrow window for high frequency, wide window for low frequency).

Wavelet, by definition, stands for small waves which begin and die out at different finite points in time. In other words, wavelets are finite length oscillatory small waves. Wavelets are elementary functions. The wavelet transform enables decomposing a time series in terms of these elementary functions (wavelets)[47]. Wavelets can either be stretched or squeezed in order to mimic the original series which enables locally approximating variables in time or space. In other words, any series can be built up as a sum of projections onto wavelets with different scales and time positions (Crowley, 2007).

Wavelets can be distinguished into two main categories, such as father and mother wavelet, according to integration. The father wavelet integrates to one where the mother wavelet integrates to zero. The father wavelet (scaling function) and mother wavelet represent the smooth trend (low-frequency) part and the detailed (high frequency) parts respectively (Crowley, 2007). All wavelets can be generated from mother wavelets. A mother wavelet is a wavelet that should satisfy a number of both regularity and admissibility conditions (see Mallat, 1998).

[46] A window function is a function zero-valued outside of some chosen interval. The product of another function or waveform/data-sequence with a window function is also zero-valued outside the interval.

[47] Wavelets correspond to the sines and cosines in the Fourier Transform (Rua, 2011).

A wavelet with scale, s and time, u is defined as

$$W_{s,u}(t) = \frac{1}{\sqrt{s}} \Psi_{s,u}\left(\frac{t-u}{s}\right) \quad (1)$$

$W_{s,u}(t)$ is a wavelet with scale,s and time, u. $\frac{1}{\sqrt{s}}$ is the normalization factor[48], Ψ is a mother wavelet.

There are various shapes of wavelet such as Morlet, Mexican hat, symmlet and daublets. Figure 9 illustrates the translation and the dilation of a Mexican hat wavelet. On the left-hand side of figure 9 there are three versions of the wavelet with different translation parameters. Gray solid line (u<0), black solid line (u=0), black dashed line (u>0). Respectively right-hand side of figure 9 there are three versions of the wavelet with different scales. Gray solid line(s>1), black solid line(s=1), black dashed line(s<1).

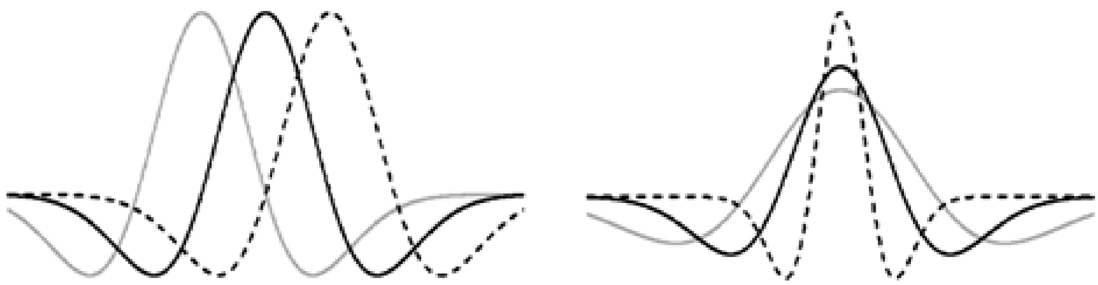


Figure 9 : Translation and dillation of a wavelet (Source: Rua, 2011)

In practice, the most commonly used wavelet is the Morlet wavelet (a kind of mother wavelet). A Morlet wavelet can be defined as

$$\Psi(u) = \pi^{-1/4} e^{iw_0 u} - e^{u^2/2} \quad (2)$$

[48] The wavelet function at each scale s is normalized to have unit energy in order to ensure that the wavelet transforms at each scale are directly comparable to each other and to the transforms of other time series.(see, Torrence and Campo(1998)). In other words the normalization by $1/\sqrt{s}$ equalizes the variance of the scaled mother wavelet and the original one.(Rua, 2011)

A Morlet wavelet is a complex sine wave within a Gaussian envelope. The number of oscillations of the wavelet within the Gaussian envelope is determined by the parameter ω_0 that represents the central frequency (Bigot et al., 2011). In other words, it represents the wave number and the number of oscilliations are determined by this parameter.[49]

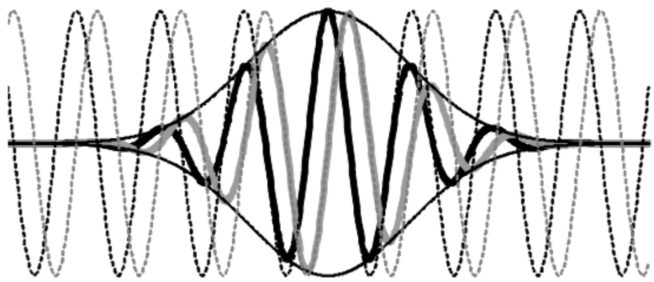


Figure 10 : Morlet Wavelet for $\omega_0 = 6$
(Source:Rua, 2011)

In Figure 10 the black bold solid line and the gray bold solid line are the real part and the imaginary part of the Morlet wavelet, respectively. The black dashed line and the gray dashed line are real and imaginary parts of a complex sine wave, respectively. The bell-shaped line is the Gaussian envelope.

Let $\mathrm{x_t}$ denote a random time series, then a wavelet transform of $\mathrm{x_t}$ at scale s>0 (dilation parameter) and time u (translation parameter) is defined as (Mallat, 1998)

$$\mathrm{W_x(s,u)} = \sum \mathrm{x_t} \overline{\Psi}_{\mathrm{s,u}}(\mathrm{t}) \tag{3}$$

where $\sum x_t \overline{\Psi}_{s,u}(t)$ is the complex conjugate of $\Psi_{s,u}(t)$.

The continuous wavelet transform with respect to Ψ can be explicitly written as

$$W_x(s,u) = \sum_{-\infty}^{+\infty} x_t \overline{\Psi}_{s,u}(t)\,dt = \frac{1}{\sqrt{s}} \sum_{-\infty}^{+\infty} x(t) \overline{\Psi}\left(\frac{t-u}{s}\right) dt \tag{4}$$

[49] In practice this parameter is set to 6 (Torrence and Campo, 1998) and (Rua , 2010).

Also, the time series x_t can be obtained through the inverse wavelet transform which is defined as follows

$$x(t) = \frac{1}{C_\Psi} \int_{-\infty}^{+\infty} \left[\int_{-\infty}^{+\infty} \frac{1}{\sqrt{s}} \Psi \left(\frac{t-u}{s} \right) W_x(s,u) ds \right] \frac{du}{u^2} \tag{5}$$

By using the wavelet transform the wavelet power spectrum of time series x_t, which is defined as $|W_x(s,u)|^2$, can be obtained. The wavelet power spectrum can be used to measure the relative contribution to the variance of x_t at each scale and time. Obviously, the integration of the wavelet power spectrum both across scale and time gives the total variance of the series. If the aim is the comparison of two time series, the wavelet power spectrum can be extended to accomplish this. For two random times series, namely x_t and y_t, the extended wavelet power spectrum, which is called wavelet cross spectrum (WCS), is defined as $WCS_{xy} = W_x(s,u)\bar{W}_y(s,u)$ where $\bar{W}$ stands for complex conjugate. This measure enables obtaining covariance between the series x_t and y_t. In other words, WCS shows the areas where two time series have a high common power (Vacha and Barunik, 2012). WCS in wavelet analysis is analogous to covariance in time series analysis but provides no information about the strength of the relationship because it is not bounded to specific values (not normalized). A remedy for this shortcoming is normalizing the WCS and obtaining wavelet coherency (also known as wavelet squared coherence or WCO) which is similar to normalizing covariance and obtaining correlation coefficient in time series analysis. In other words, WCO is a normalized measure of the linear relationship between two time series by the individual power spectra. WCO enables measuring the coherence of two time series as a function of time and scale (frequency). Analogous to Fourier coherence, WCO is defined as

$$WCO_{xy}^2 = \frac{|WCS_{xy}(s,u)|}{\sqrt{|W_x(s,u)|^2 |W_y(s,u)|^2}} \tag{6}$$

WCO_{xy}^2 takes values between 0 and 1 depending on the strength of the relationship. In the absence of a relationship between series, WCO_{xy}^2 take the value of zero. If there is an exact linear relationship both measures take the value of 1. Hence, a wavelet coherency value which is close to 1 can be interpreted as evidence for significant time-frequency correlation between series.

It is evident that since WCS is a complex function, WCO_{xy}^2 has an imaginary part, besides it disregards the phase differences. Considering this, Rua (2010) proposed a new measure analogous to the dynamic correlation of Crox et al. (2001). The Dynamic correlation is a measure related to squared coherency; similarly, the new measure of Rua (2010) is related to wavelet squared coherency. Rua (2010) proposes the real part of WCS which is normalized by individual spectras of the two time series as the new measure and defined as

$$\rho_{xy} = \frac{\Re(WCS_{xy}(u,s))}{\sqrt{|W_x(s,u)|^2 \left|W_y(s,u)\right|^2}} \tag{7}$$

where $\Re$ denotes the real part of WCS. According to Rua (2010), ρ_{xy} can be seen as a generalization of the dynamic correlation measure of Croux et al. (2001), and it allows assessing the strength of the contemporaneous comovement over both time and frequency. The value of the wavelet based measure, ρ_{xy}, ranges between -1 and 1 in a similar way to the standard correlation coefficient and the dynamic correlation proposed by Croux et al. (2001).

4.4. Emprical Results

The results on comovement of all commodity pairs are illustrated in contour plots. For convenience, comovement results for both futures prices and returns are provided. For each contour plot the vertical axis and horizontal axis show the frequency in terms of years and time respectively. Gray scale represents the topographic features of the surface. The gray scale darkens along with the increase in the height of the surface. In other words, the increase in wavelet based measure corresponds to darkening in the scale. There are ten commodity futures price pairs that consist of cocoa, coffee, corn, crude oil, rice, soybean oil, soybean, sugar and wheat. The pairs are given at the top of each contour plot.

The first set of contour plots in Figure 11 to represents the comovement of commodity futures prices. The examination of comovement between oil and agricultural commodity futures prices reveals that, in general, the pairs seem to have low correlation for the whole sample period. However, in the medium-run after around 2008, the correlation between provided pairs tends to increase. The second set of contour plots in Figure 12 illustrates the comovement of commodity futures returns. The evidence on returns is consistent with the one obtained using commodity futures prices.

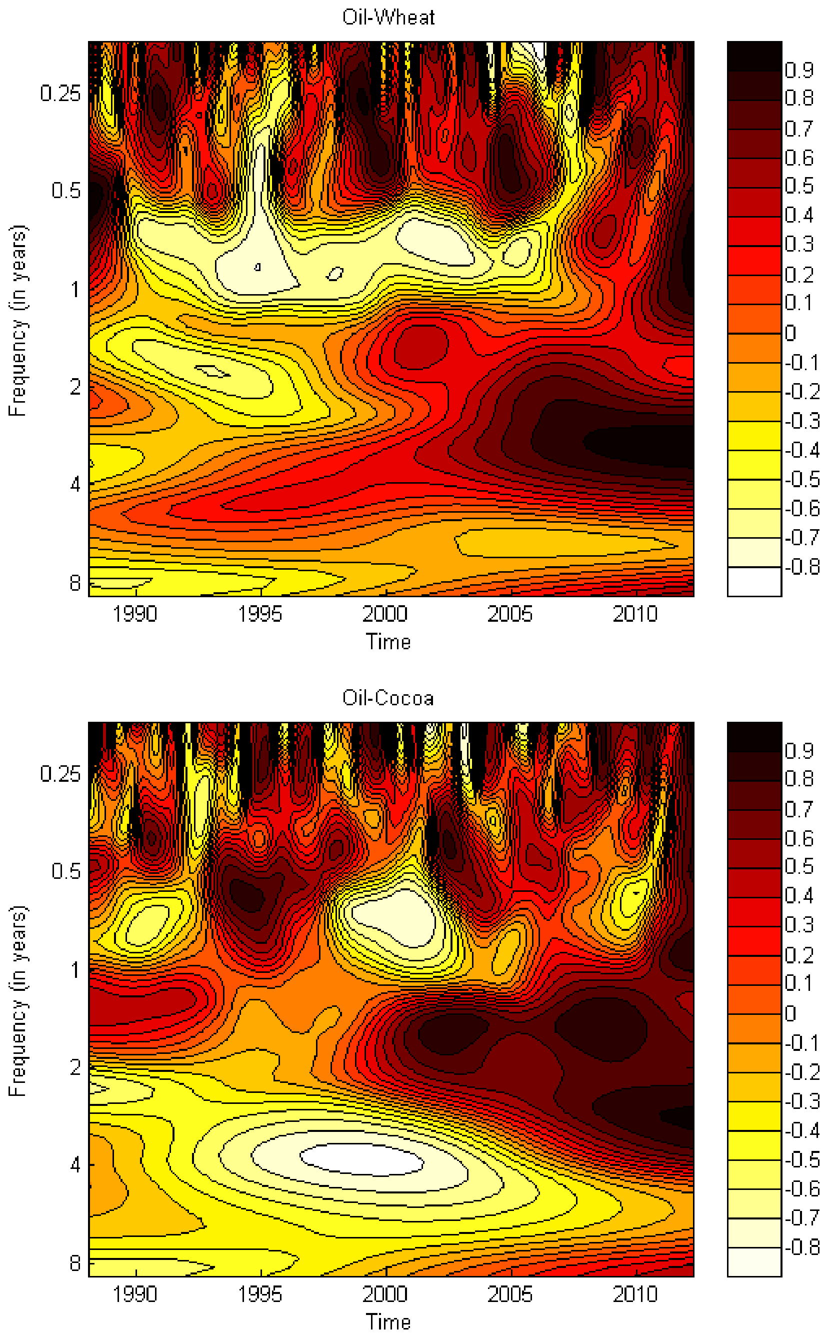


Figure 11: Comovement of Commodity Futures Prices

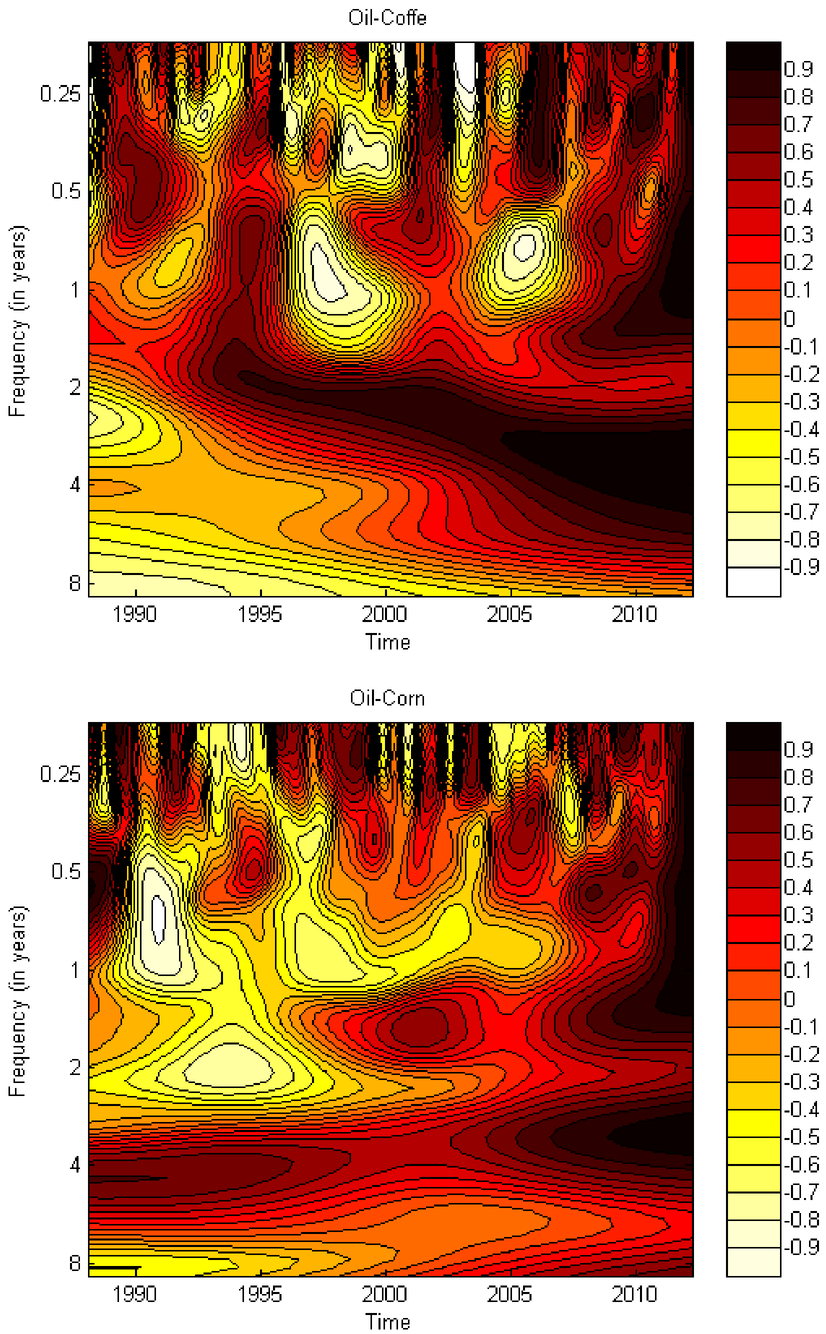


Figure 11: Comovement of Commodity Futures Prices(Cont.)

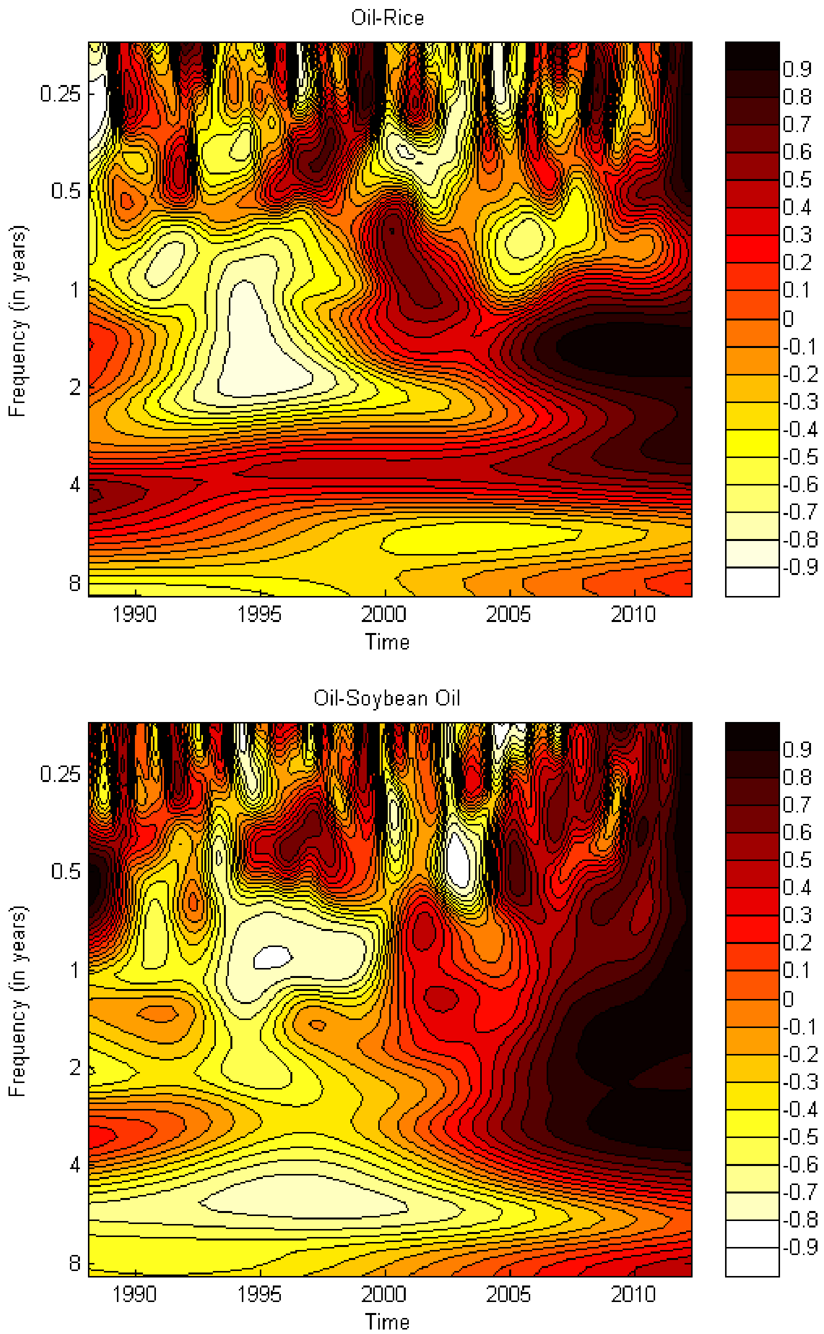


Figure 11: Comovement of Commodity Futures Prices (Cont.)

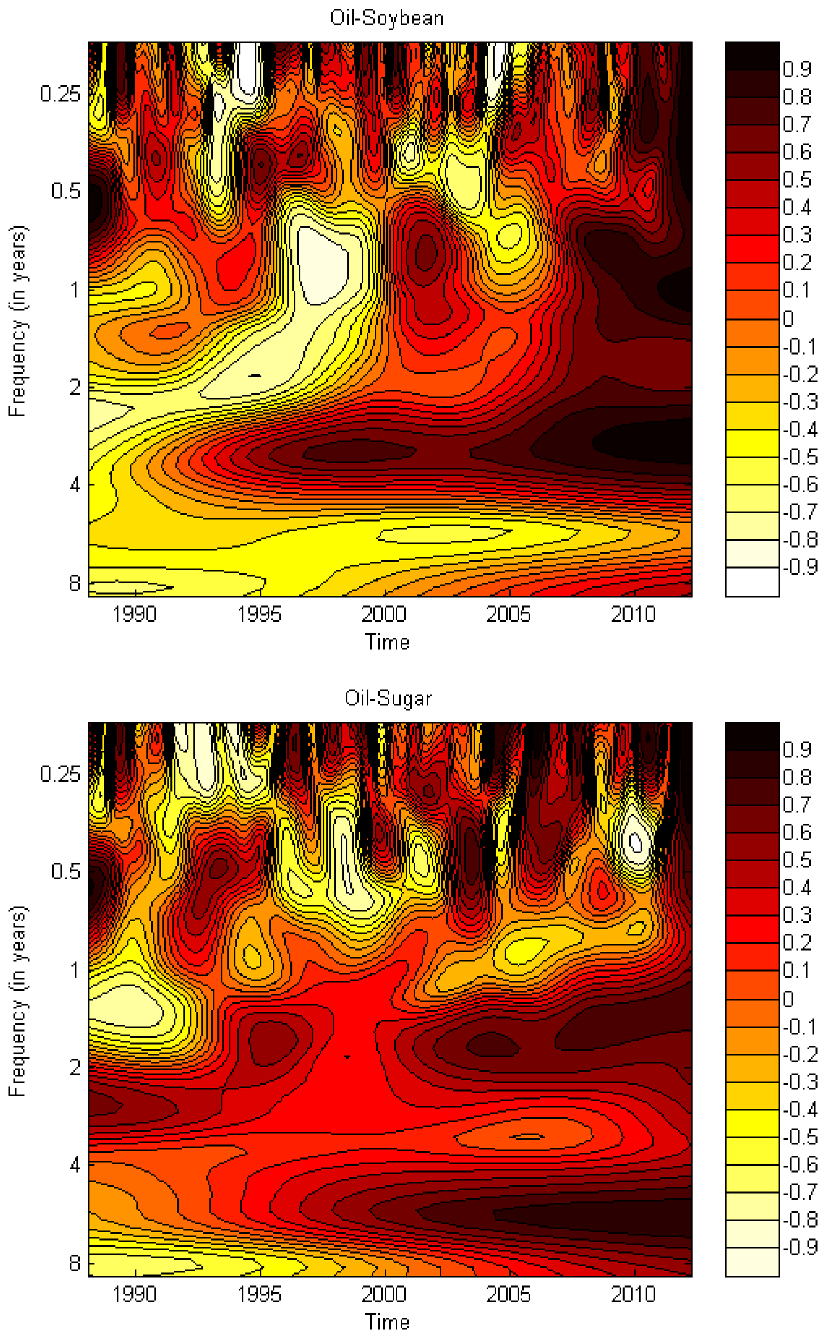


Figure 11: Comovement of Commodity Futures Prices (Cont.)

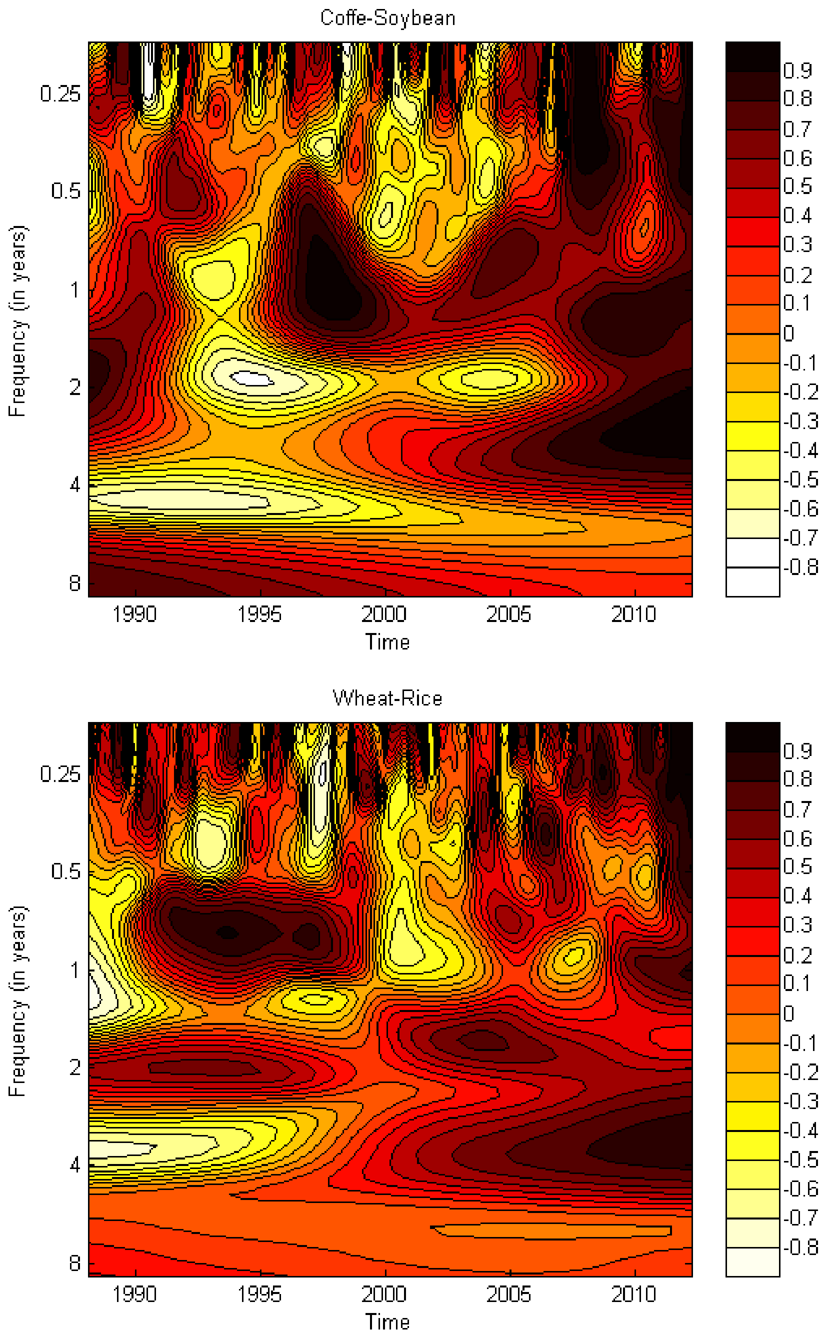


Figure 11: Comovement of Commodity Futures Prices (Cont.)

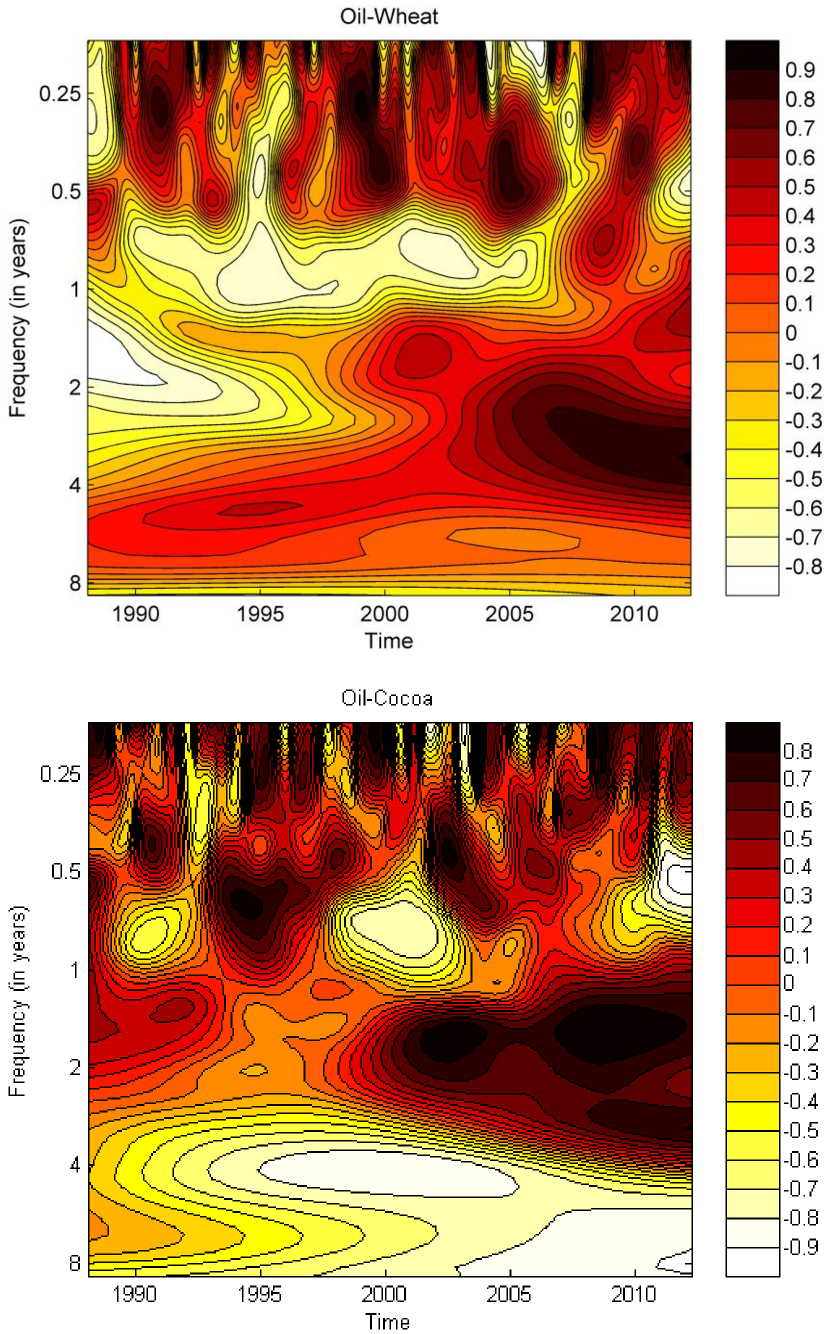
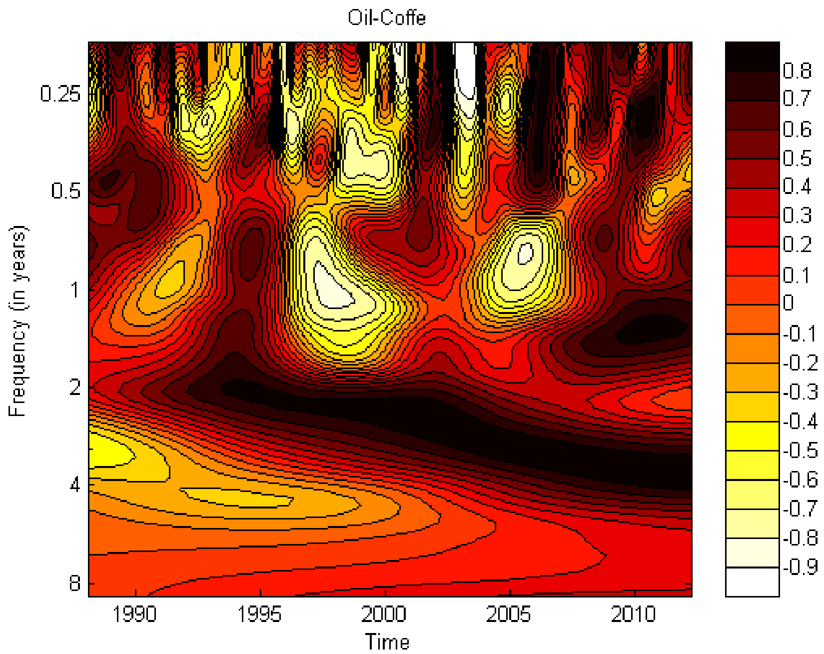


Figure 12: Comovement of Commodity Futures Returns



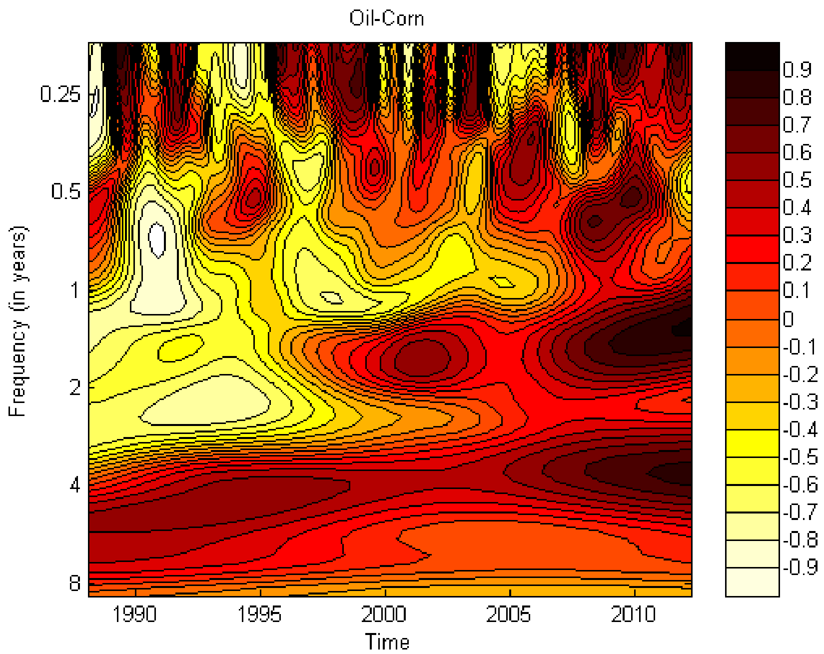
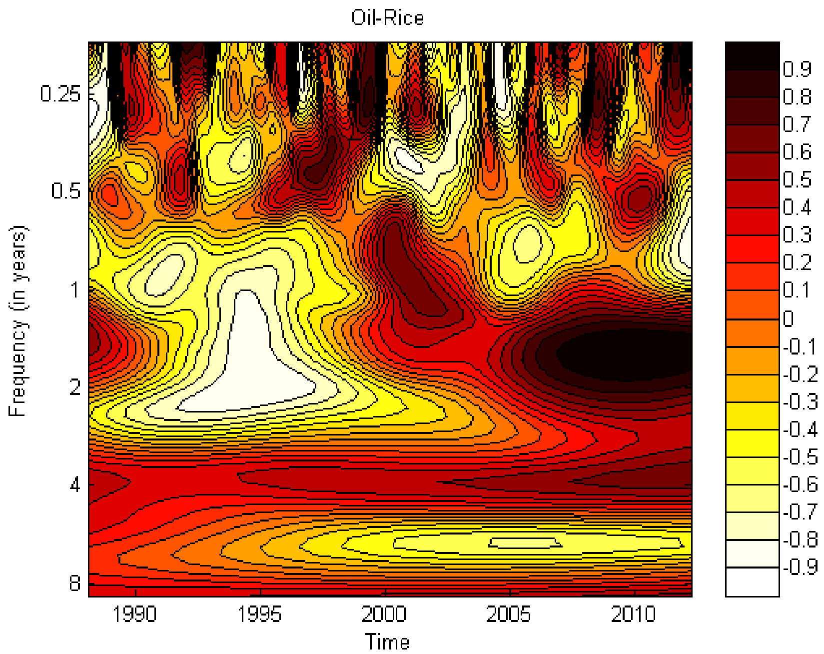


Figure 12: Comovement of Commodity Futures Returns (Cont.)



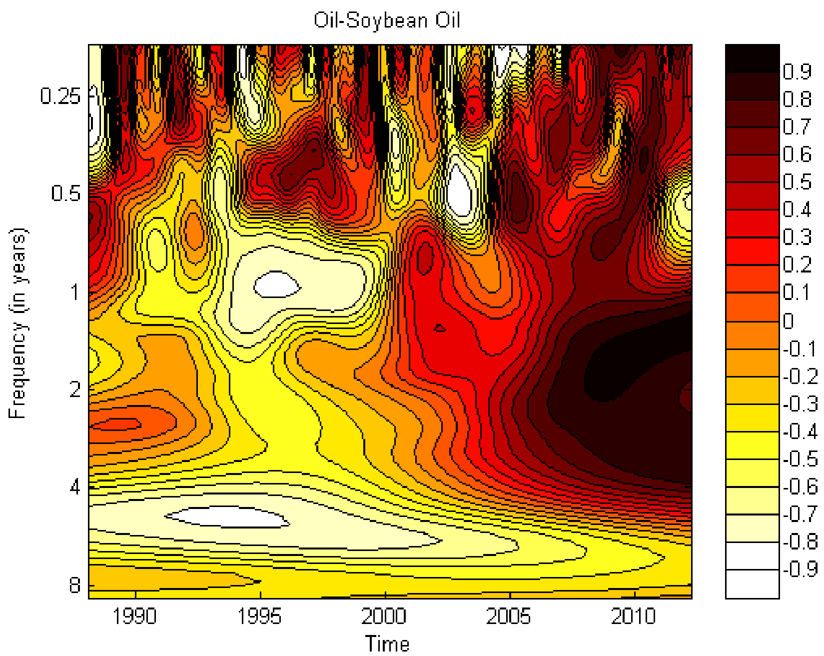


Figure 12: Comovement of Commodity Futures Returns(Cont.)

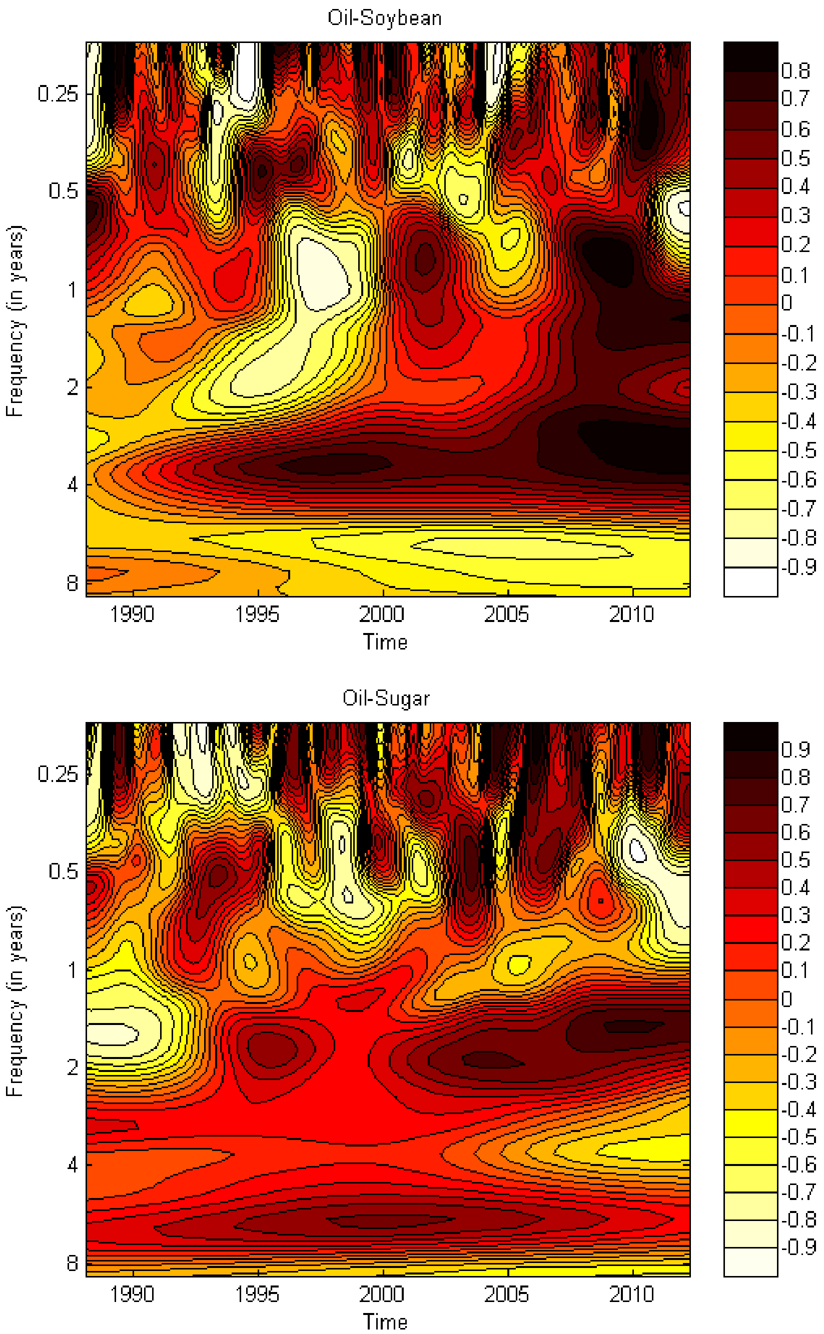


Figure 12 : Comovement of Commodity Futures Returns (Cont.)

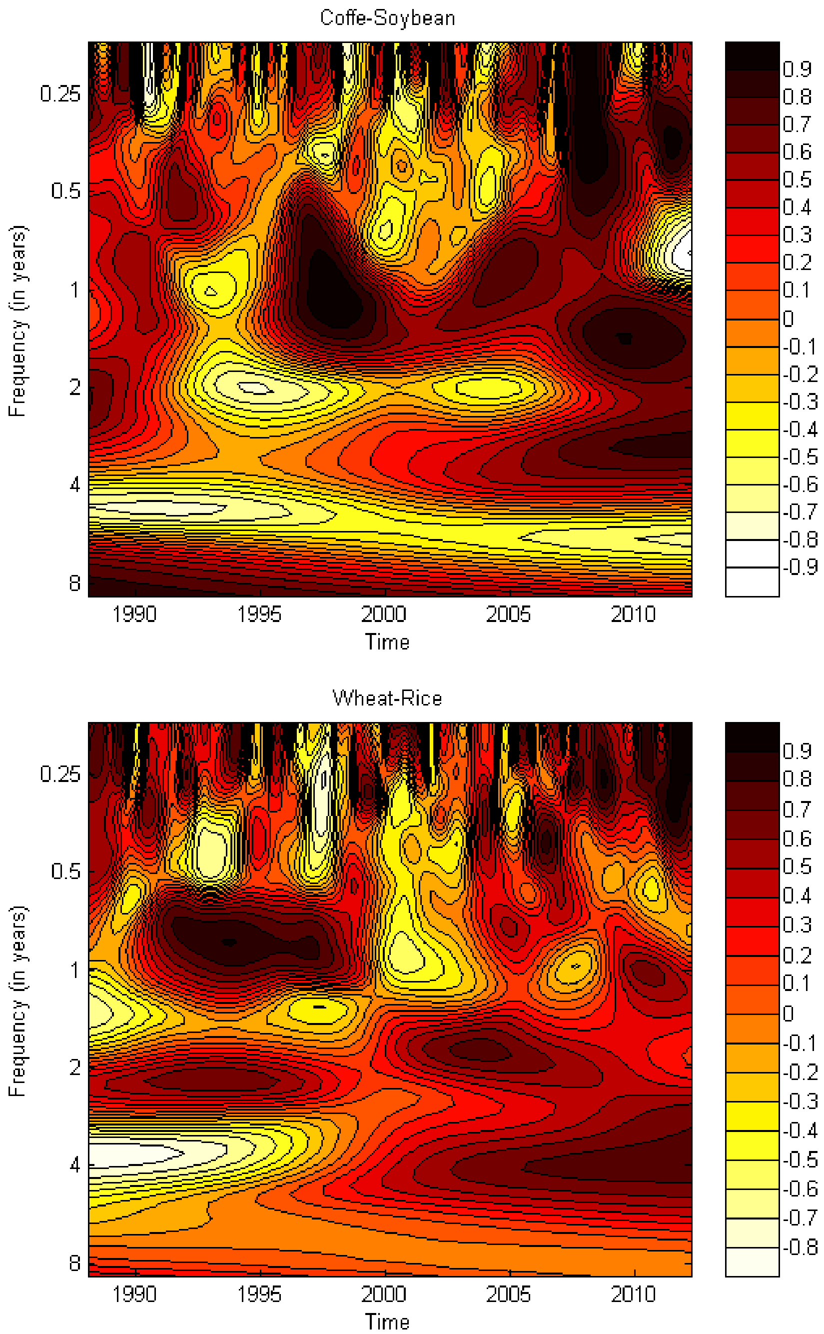


Figure 12: Comovement of Commodity Futures Returns (Cont.)

4.5. Conclusion

This study investigates oil and agricultural commodity linkages. Monthly commodity futures prices are used. I employ wavelet analysis to investigate the comovement of commodity futures prices. The wavelet base measure of correlation enables us to investigate the correlation between commodity futures in both time and frequency domains. The results document that the correlation level is low in the short, medium and long-run. However, it tends to increase after 2008 for the medium-run, particularly for oil-soybean, oil-soybean oil and oil-sugar pairs.

The main production inputs for biofuels are Brazilian sugarcane ethanol, US corn ethanol and soybean oil biodiesel (OECD, 2006). Soybean and corn are feedstock for ethanol production where soybean oil is an input for biodiesel production. Since the biofuel production techniques are standard, feedstock costs, the price of energy inputs, the output prices and the potential to sell byproducts show up as the drivers of biofuels (Peñaranda and Micola, 2011). The 2008 housing crisis could have affected feedstock costs and the price of energy inputs.This may have revealed a channel through biofuels which links energy and agricultural commodities by increasing the correlation between them after 2008.

5. CONCLUSION

This thesis explores the energy issue for Turkey with respect to energy efficiency, oil price pass-through and biofuels. Each independent study, which has its own introduction, literature review, data-methodology and conclusion, contributes to the constitution of the whole thesis which aims at investigating energy issues with respect to Turkey.

Chapter One investigates the potential relationship between energy consumption and growth for Turkey at the macroeconomic level taking into consideration the proposed arguments in the literature. Based on the results indicating the validity of the neutrality hypothesis, this chapter puts forward two policy alternatives, namely, decreasing energy consumption directly and increasing the efficiency in energy consumption. The first one is not practical for a rapidly developing country. Energy efficiency enables mitigating energy use, contributes to economic development and becomes an integral part of sustainable development in an environment in which energy security and energy costs are major constraints. Accordingly, energy security and energy efficiency play a crucial role in mitigating these constraints. As is common, energy efficiency is measured by energy intensity. If energy intensity is lower, then energy consumption in order to produce a unit of GDP will be relatively lower. Accordingly, a reduction in energy intensity plays a crucial role in energy efficiency implementations. The potential for benefitting from energy efficiency is high in Turkey. The major fields that can adopt energy efficiency policies are industry, building, transportation as well as generation and transmission and distribution systems.

Turkey is a heavily oil dependent country and imports high amounts of oil based products. A considerable part of its substantial current account is comprised of energy imports which leaves Turkey vulnerable to both oil price and exchange rate shocks. Besides, Turkey is continually developing and its energy needs are increasing. Additionally, Turkey has adopted inflation targeting monetary policy. In such an environment oil price pass through becomes prominent for Turkey with regards to energy, monetary and fiscal policy.

Chapter Two investigates the oil price pass through for Turkey, and shows that oil price pass through to producer prices and consumer prices is increasing through time. Besides, the gap between the two pass through rates is also increasing. A possible explanation for increasing pass through rates can be the increased importance of oil as a cost item for firms. In other words, the driving force of the increase in pass-through rate can be the oil price itself. In this case, conducting proper monetary and energy policies becomes challenging.

As a potential link between energy markets and agricultural commodities, biofuels are receiving increased attention. Many researchers identify the biofuel industry as a potential channel that affects the oil-food linkage. The channels between oil and biofuel commodity prices can lead to energy and agriculture commodity comovement. The subject is a matter of concern for a country like Turkey. It is evident that comovement, which is not a country specific case, becomes more of an issue for Turkey due to country specific issues. High oil and oil product dependency, a substantial current account deficit with a considerable part coming from energy related items, particularly oil, and increasing oil price pass through leaves Turkey vulnerable to oil price alterations. Accordingly, comovement between oil and agricultural commodity futures prices should be considered in making energy, fiscal and monetary policies.

Chapter Three investigates the comovement between oil and agricultural commodity futures prices and returns. The chapter shows that the 2008 housing crisis could have affected feedstock costs and the price of energy inputs.This may have revealed a channel through biofuels which links energy and agricultural commodities by increasing the correlation between them after 2008.

REFERENCES

Adrangi, Bahram, Arjun Chatrath, Kathy K. Dhanda. 2001. Chaos in oil prices? Evidence from futures markets. **Energy Economics.** c. 23. s. 4: 405-425.

Ai, Chunrong, Arjun Chatrath, Frank Song, 2006. On the comovement of commodity prices. **American Journal of Agricultural Economics.** c. 88. s. 3: 574-588.

Akinlo, A. Enisan. 2008. Energy consumption and economic growth: Evidence from 11 Sub-Sahara African countries. **Energy Economics**. c.3. s.5:2391-2400.

Acaravci, Ali, Ilhan Ozturk. 2012. Electricity Consumption and Economic Growth Nexus: A Multivariate Analysis for Turkey. **The Amfiteatru Economic Journal**. c.14. s.31: 246-257.

Altinay, Galip, Erdal Karagol. 2004. Structural break, unit root, and the causality between energy consumption and GDP in Turkey. **Energy Economics**. c. 26. s. 6: 985–994.

Altinay, Galip, Erdal Karagol. 2005. Electricity consumption and economic growth: evidence from Turkey. **Energy Economics**. c. 27. s. 6: 849-856.

Baffes, John. 2007. Oil spills on other commodities. **Resources Policy**. c.32. s.3: 126-134.

Berndt, Ernst R. 1978. Aggregate energy, efficiency and productivity measurement. **Annual Reviews Energy**. c.3, 225-273.

Berument, Hakan, Hakan Taşçı. 2002. Inflationary Effect of Crude Oil Prices in Turkey. **Physica A: Statistical Mechanics and its Applications.** c. 316. s.1: 568-580.

Berument, M.Hakan, N. Başak Ceylan, Nukhet Dogan. 2010. The impact of oil price shocks on the economic growth of selected MENA countries. **Energy Journal.** c. 31. s. 1: 149–176.

Bigot Jeremie, Marieke Longcamp, Fabien Del Maso, David Amarantini. 2011. A new statistical test based on the wavelet cross-spectrum to detect time-frequency dependence between non-stationary signals: Application to the analysis of cortico-muscular interactions, **NeuroImage.** c. 55. s. 4:1504-1518.

Blanchard, Oliver. Jordi Gali. 2007. The macroeconomic effects of oil shocks: Why are the 2000s so different from the 197Os?. **NBER Working Paper Series**.

Brown, Stephen P.A., Mine K. Yücel. 2002. Energy Prices and Aggregate Economic Activity: An Interpretive Survey. **The Quarterly Review of Economics and Finance**. c. 42. s. 2:193-208.

Campiche, Jody L., Henry L. Bryant., James.W Richardson, Joe L. Outlaw. 2007. Examining the Evolving Correspondence Between Petroleum Prices and Agricultural Commodity Prices. American Agricultural Economics Association Annual Meeting. 29July -1 August 2007. Portland.

Chen, Shiu-Sheng. 2009. Oil price pass-through into inflation. **Energy Economics**. c. 31. s. 1: 126-133.

Ciner, Cetin. 2001. Energy shocks and financial markets: nonlinear linkages. **Studies in Nonlinear Dynamics and Econometrics**. c. 5. s. 3: 203-212.

Clarke, Kevin. A. 2005. The phantom menace: omitted variable bias in econometric research. **Conflict Management and Peace Science.** c. 22. s.4: 341-352.

Cleveland, Cutler. J., Robert K. Kaufmann, David I. Stern. 2000. Aggregation and the role of energy in the economy. **Ecological Economics**, c. 32. s: 301-317.

Costantini, V., Martini, C., (2010) "The causality between energy consumption and economic growth: a multi-sectoral analysis using non-stationary cointegrated panel data", Energy Economics, 32, pp. 591-603.

Croux, Cristophe, Mario Forni, Lucrezia Reichlin. 2001. A measure of comovement for economic variables: theory and empirics. **Review of Economics and Statistics** c. 83. s. 2: 232–241.

Crowley, Patrick M. 2007. A guide to wavelets for economists. **Journal of Economic Survey**. c. 21. s.2: 207-267.

World Economic Outlook Database. [01.11.2012] http:// www.imf.org/ external/pubs/ ft/weo /2012 / 02/pdf/text.pdf

Deb, Partha, Pravin K. Trivedi, Panayotis Varangis. 1996. The excess co-movement of commodity prices reconsidered. **Journal of Applied Econometrics**. c. 11. s. 3: 275–291.

Diboğlu, Selahaddin, Aykut Kibritçioğlu. 2004. Inflation, output growth, and stabilization in Turkey, 1980-2002. **Journal of Economics and Business.** c. 56. s. 1: 43-61.

Dickey, David. A., Wayne A. Fuller.1979. Distribution of the estimators for autoregressive time series with a unit root. **Journal of the American Statistical Association**. c. 74. s. 366: 427-31.

Energy Market Regulatory Authority [EMRA]. 2011. Legislation. http:// www.epdk.gov.tr/ index.php/elektrik-piyasasi/mevzuat

Engle, Robert F., Clive.W.J. Granger.1987. Cointegration and error correction representation, estimation and testing. **Econometrica**. c. 55. s. 2: 251–276.

Erdal, Gülistan, Hilmi Erdal, Kemal Esengün. 2008. The causality between energy consumption and economic growth in Turkey. **Energy Policy.** c. 36. s. 10: 3838–3842

Francisco, Penaranda, Ruperez M. Augusto. 2009. The Emergence of Biofuels and the Co-Move ment between Crude Oil and Agricultural Prices. Department of Economics and Business, Universitat Pompeu Fabra. http://ideas.repec.org/ p/upf/upfgen/1174.htmlS.

Ghouri, S.Saif, 2006. Assessment of the relationship between oil prices and US oil stocks. **Energy Policy.** c. 34. s. 17: 3327–3333.

Gohin, Alexandre, Francois Chantret. 2010. The long-run impact of energy prices on world agricultural markets: the role of macro-economic linkages. **Energy Policy.** c. 38. s. 1: 333-339.

Gregory, Allan W., Hansen, Bruce. E., 1996. Residual-based tests for cointegration in models with regime shifts. **Oxford Bulletin of Economics and Statistics**. c. 58. s. 3: 555-560.

Halicioglu, Ferda. Residential electricity demand dynamics in Turkey. **Energy Economics.** c. 29. s. 2 (2007) : 29, 199-210.

____." An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey". **Energy Policy.** c. 37. s. 3 (2009): 1156–1164.

Hamilton, James. D. “Oil and the Macroeconomy Since World War II”. **Journal of Political Economy.** c. 91. s. 2 (1983): 228-248.

____. “A Neoclassical Model of Unemployment and the Business Cycle”. **Journal of Political Economy.** c. 3. s. 2 (1988): 593-617.

____. Causes and consequences of the oil shock of 2007-08. **Brookings Papers on Economic Activity**. c. 40. s. 1(2009a): 215-283.

____. Understanding crude oil prices**. Energy Journal.** c. 30. s. 2(2009b): 179-206.

Harri, Ardian, Lawton L. Nalley, Darren Hudson. 2009. The Relationship between oil, exchange rates, and commodity prices. **Journal of Agricultural and Applied Economics.** c. 40. s. 2: 501-510.

Hatemi-J, Abdulnasser. 2008. Tests for Cointegration with Two Unknown Regime Shifts with an Application to Financial Market Integration. **Empirical Economics.** c. 35. s. 3: 497-505.

He, Yanan, Shouyang Wang, Kin K. Lai. 2010. Global economic activity and crude oil prices: a cointegration analysis. **Energy Economics**. c. 32. s. 4: 868-876.

Hendry, David. F., Katrina Juselius. 2000. Explaining Cointegration Analysis: Part I. **Energy Journal.** c. 0. s. 1: 1-42.

Hertel, Thomas, Jayson Beckman. 2011. Commodity price volatility in the biofuel era: an examination of the linkage between energy and agricultural markets. **NBER Working Paper No. 16824.**

Hooker, Mark A. 2002. Are oil shocks inflationary? Asymmetric and nonlinear specifications versus changes in regime. **Journal of Money, Credit, and Banking.** c. 34. s. 2: 540-561.

Huang, Roger D., Ronald W. Masulis, Hans R. Stoll. 1996. Energy shocks and financial markets. **Journal of Futures Markets.** c. 34. s. 2: 1-27.

Hubrich, Kristin, Helmut Lütkepohl, Pentti Saikkonen. 2001. A Review of Systems Cointegration Tests. **Econometric Reviews**. c. 20. s. 3: 247-318.

Huntington, Hillard. G. 1995. Macroeconomic Adjustments to Energy Price Shocks: an Empirical Investigation. OP 43, Energy Modeling Forum Stanford University. September 1995.

Jobert, Thomas, Fatih Karanfil. 2007. Sectoral energy consumption by source and economic growth in Turkey. **Energy Policy**. c. 35. s. 11: 5447–5456.

Jones, Donald.W., Paul N. Leiby, Inja K. Paik. 2004. Oil price shocks and the macroeconomy: What has been learned since 1996. **Energy Journal**. c. 25. s. 2: 12-32.

Kahn George A., Robert L. Hampton. 1990. Possible monetary policy responses to the Iraqi oil shock. **Federal Reserve Bank of Kansas City Economic Review.** 19-32.

Kara, Hakan, Fethi Öğünç. 2008. Inflation Targeting and Exchange Rate Pass-Through: The Turkish Experience. **Emerging Markets Finance and Trade.** c. 44. s. 6: 52-66.

Kojima, Masami, Robert Bacon. Vulnerability to Price Increases: A Decomposition Analysis of 161 Countries, Extractive Industries for Development Series. No. 1. June 2009.

Koopmann, Georg,, Klaus Matthies, Beate Reszat. 1989. **Oil and the International Economy: Lessons From Two Price Shocks**, New Brunswick: Transaction Publishers.

Kraft, John, Arthur Kraft. 1978. On the relationship between energy and GNP. **Journal of Energy and Development.** c. 3. s. 2: 401-403.

Koç University Turpraş Energy Center (KUTEM). 2012. Turkey's energy efficiency map and targets. http://www.enver.org.tr/UserFiles/Article/eff9ce19-a1ec-4cef-862d-7b8a5951a149.pdf [31.01.2013]

Kuzozumi, Eiji, Taku Yamamoto. 2000. Modified lag augmented autoregressions. **Economic Review.** c. 19. s. 2: 207-231.

Lardic, Sandrine, Valerie Mignon. 2008. Oil prices and economic activity: an asymmetric cointegration approach. **Energy Economics** c. 30. s. 3: 847–855.

Lee, Chien-Chiang, Chun-Ping Chang. 2007. The impact of energy consumption on economic growth: Evidence from linear and nonlinear models in Taiwan. **Energy**. c. 32. s. 12: 2282-2294.

Leigh, Daniel, Marco Rossi. 2002. Exchange Rate Pass-Through in Turkey. Working Paper 02/204. International Monetary Fund. Washington DC.

Lise, Wietze, Keez Van Montfort. 2007. Energy consumption and GDP in Turkey: is there a co-integration relationship?. **Energy Economics.** c. 29. s. 6: 1166–1178.

Lutkepohl, Helmut. 1982. Non-causality due to omitted variables. **Journal of Econometrics.** c. 19. s. 2-3: 367-378.

Mallat, Stephene. 1998. **A wavelet tour of signal processing: The Sparse Way.** 3rd press. New York: Academic press.

Maslyuk, Svetlana, Russell Smyth. 2009. Cointegration between oil spot and future prices of the same and different grades in the presence of structural change. **Energy Policy.** c. 37. s. 5: 1687-1693.

McCarthy, Jonathan. 1999. Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies. BIS Working Paper, No: 79.

MENR (Ministry of Energy and Natural Resources), 2011. Sunum. http://www.enerji.gov.tr/ yayinlar_raporlar/ Dunyada_ve_Turkiyede_Enerji_Gorunumu.pdf [16.02.2013]

Miller, J.Isaac, Ronald A. Ratti. 2009. Crude oil and stock markets: stability, instability, and bubbles. **Energy Economics.** c. 31. s. 4: 559-568.

Ministry of Energy and Natural Resources [MENR], 2011. İstatistik. http://www.enerji.gov.tr/index.php?dil=tr&sf=webpages&b=y_istatistik&bn=244&hn=244&id=398 [5.03.2013]

Mork, Knut A. 1994. Business Cycles and the Oil Market. **The Energy Journal.** c. 15. s. special: 15-38.

Narayan, Paresh. K., Russell. Smyth. 2009. Multivariate Granger causality between electricity consumption, exports and GDP: Evidence from a panel of Middle Eastern countries. **Energy Policy.** c. 31. s. 4: 229-236.

Narayan, Paresh. K., Russell. Smyth. 2007. Are shocks to energy consumption permanent or transitory? Evidence from 182 countries. **Energy Policy.** c. 35. s. 1: 333–341.

Narayan, Paresh. K., Stephan Popp. 2010. A New Unit Root Test with Two Structural Breaks in Level and Slope at Unknown Time. **Journal of Applied Statistics.** c. 37. s. 9: 1425-1438.

Narayan, Paresh. K., Arti Prasad. 2008. Electricity consumption-real GDP causality nexus: evidence from a bootstrapped causality test for 30 OECD countries. **Energy Policy.** c. 31. s. 4: 910-918.

Narayan, Paresh K., Russell Smyth. 2005. Electricity consumption, employment and real income in Australia evidence from multivariate Granger causality tests. **Energy Policy.** vol. c. 33. s. 9: 1109-1116.

Ocal, Oguz, Ilhan Ozturk, Alper Aslan. 2013. Coal Consumption and Economic Growth in Turkey. International Journal of Energy Economics and Policy. c. 3. s. 2: 193-198.

Oladosu, Gbadebo. 2009. Identifying the oil price-macroeconomy relationship: an empirical mode decomposition analysis of US data. **Energy Policy.** c. 37. s. 12: 5417–5426.

Ozturk, Ilhan. 2010. A literature survey on energy-growth nexus. **Energy Policy.** c. 38. s. 1: 340-349.

Perron, Pierre. 1989. The Great Crash, the Oil Shock and the Unit Root Hypothesis. **Econometrica.** c. 57. s. 6: 1361-1402

Papapetrou, Evangelia. 2001. Oil price shocks, stock market, economic activity and employment in Greece. **Energy Economics.** c. 23. s. 5: 511–532.

Payne, James E. 2010. Survey of the international evidence on the causal relationship between energy consumption and growth. **Journal of Economic Studies.** c. 37. s. 1: 53-95

Peñaranda F. Peñaranda, Augusto R. Micola. 2011. On the drivers of commodity co-movement: Evidence from biofuels. **Financial Markets Group Discussion Paper.** No. 695. October 2011.

Pesaran, M.Hashe, Yongcheol Shin. 1995. An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. Cambridge Working Papers in Economics 9514. Faculty of Economics. University of Cambridge.

Pesaran, M. Hashem., Yongcheol Shin, and Richard J. Smith. 2001. Bounds testing approaches to the analysis of level relationships. **Journal of Applied Econometrics.** c.16. s. 3: 289-326.

Phillips, Peter C. B., Pierre Perron. 1988. Testing for Unit Roots in Time Series Regression. **Biometrika.** c.75. s. 2: 335-346.

Pindyck, Robert S., Julio Rotemberg. 1990. The excess co-movement of commodity prices. **Economic Journal.** c.100. s. 403: 1173–1189.

Plourde, Andre, Watkins, Gordon C. 1998. Crude oil prices between 1985 and 1994: how volatile in relation to other commodities?. **Resource and Energy Economics**. c.20. s. 3: 245–262.

Quan, Jing. 1992. Two-step testing procedure for price discovery role of futures prices. **Journal of Futures Markets**. c.12. s. 2: 139–149.

Rua, Antonio. 2010. Measuring comovement in the time-frequency space**. Journal of Macroeconomics.** c.32. s. 2: 685-691.

Rua, A. (2011). Essays on Wavelets in Economics. PhD Thesis.Universidade Técnica De Lisboainstituto Superior De Economia E Gestão

Ren21. 2007. Renewables 2007: Global Status Report. http://www.ren21.net/ pdf/ RE2007_Global_Status_Report.pdf [11.03.2013]

Reynolds, Douglas.B., Marek Kolodziej. 2007. Institutions and the supply of oil: a case study of Russia. **Energy Policy.** c.35. s. 2: 939–949.

Runge C. Ford, Benjamin Senauer. 2007. How biofuels could starve the poor. **Foreign Affairs.** c. 86: 41-53.

Saikkonen, Pentti, HelmutLütkepohl. 2002. Testing For A Unit Root In A Time Series With A Level Shift At Unknown Time. **Econometric Theory.** c.18. s. 2: 313-348.

Saygılı, Şeref, Cengiz Cihan, Hasan Yurtoğlu. 2005. Türkiye Ekonomisinde Sermaye Birikimi, Verimlilik Ve Büyüme: 1972-2003. Ekonomik Modeller Ve Stratejik Araştırmalar Genel Müdürlüğü, DPT Yayın No: 2686, Ankara. http://ekutup.dpt.gov.tr/sermaye/saygilis/turkiye/2003.pdf. [18.11.2011]

Saygılı, Şeref, Cengiz Cihan. 2008. Türkiye Ekonomisinin Büyüme Dinamikleri: 1987-2007 Döneminde Büyümenin Kaynakları, Temel Sorunlar ve Potansiyel Büyüme Oranı. No. TÜSİAD-T/2008-06/462. İstanbul.

Shioji, Etsuro,Taisuke Uchino. 2010. Pass-Through of Oil Prices to Japanese Domestic Prices NBER Working Paper No. 15888.

Soytas, Uğur, Ramazan Sari. 2003. Energy consumption and GDP: causality relationship in G-7 countries and emerging markets. **Energy Economics.** c.25. s. 1: 33–37.

Stern, David I. 1993. Energy and economic growth in the USA: a multivariate approach. Energy Economics. c.15. s. 2: 137–150.

Stern, David I. 2000. A multivariate cointegration analysis of the role of energy in the US macroeconomy. **Energy Economics**. c.22. s. 2: 267-283.

Tatom, John A. 1988. Are the Macroeconomic Effects of Oil Price Changes Symmetric? **Carnegie-Rochester Conference Series on Public Policy.** c.28. s. 1: 325-68.

The World Bank, (2005f), "The Vulnerability of African Countries to Oil Price Shocks: Major Factors and Policy Options, the Case of Oil Importing Countries", ESMAP Report No. 308/05.World Bank, August 2005, Washington DC.

Toda, HiroY. and Yamamoto, Taku. 1995. Statistical Inferences in Vector Autoregressions with possibly integrated processes. **Journal of Econometrics**. c.66. s. 1-2: 225-250.

Torrence, C., and Compo, G. P. (1998), A practical guide to wavelet analysis. **Bulletin of the American Meteorogical Society.** c.79. s. 1: 61-78.

Tyner, Wallace. 2010. The integration of energy and agricultural markets. Agricultural Economics. c.41. s. Issue Supplement s1: 193-201

Uri, Noel D. 1996. Changing crude oil price effects on US agricultural employment. **Energy Economics.** c.18. s. 3: 185–202.

US Energy Information Administration, 2011, International Energy Outlook, Washington DC. http://www.eia.gov/forecasts/ieo [07.12.2011]

United states department of agriculture, United States national agricultural statistics service(NASS). http://www.nass.usda.gov/Publications/Ag_Statistics/2011/ [021.12.2012]

Vacha, Lukas, Josef Barunik. 2012. Co-movement of energy commodities revisited: Evidence from wavelet coherence analysis. **Energy Economics.** c.34. s. 1: 241-247.

Vinod, Hrishikesh. D. "Bootstrap methods: applications in econometrics". **Handbook of Statistics: Econometrics vol. 11**. ed. Gangadharrao Soundalyarao Maddala, Calyampudi Radhakrishna Rao, Hrishikesh D. Vinod .New York: North-Holland (1993): 629–661.

____. Ranking mutual funds using unconventional utility theory and stochastic dominance. **Journal of Empirical Finance.** c.11. s. 3 (2004): 353-377.

____. "**Hands-On Intermediate Econometrics Using R".** 1. ed. Singapore (2008): World Scientific Publishing Ltd.

Wolde-Rufael, Yamane. 2009. Energy consumption and economic growth: the African experience revisited. **Energy Economics.** c. 31. s. 2: 217–224.

Yalta, A.Talha. 2012. Analyzing Energy Consumption and GDP Nexus Using Maximum Entropy Bootstrap: The Case of Turkey. **Energy Economics.** c. 33. s. 3: 453 – 460.

Yazgan, Ertuğrul, Mehmet Korürek. 1996. **Tıp Elektroniği**. İstanbul: İTÜ.

Yu, Tun-Hsiang E., David A. Bessler, Stephen Fuller. 2006. Cointegration and Causality Analysis of World Vegetable Oil and Crude Oil Prices. **American Agricultural Economics Association Annual Meeting. 23-26 June 2006.**

Zagaglia, Paolo. 2010. Macroeconomic factors and oil futures prices: a data-rich model. **Energy Economics.** c. 32. s. 2: 409–417.

APPENDIX

A1 Summary of selected empirical studies on energy use-growth nexus

Table A1. Summary of selected empirical studies on energy use-growth nexus for country-specific studies

Author(s)	Countries	Period	Methodology	Causality
Kraft and Kraft (1978)	US	1947-1974	Granger causality	Y→EU
Akarca and The long (1980)	US	1950-1970	Sim's technique	Neutral
Yu and Hwang (1984)	US	1947-1979	Sim's technique	Neutral
Yu and Choi (1985)	South Korea			Y→EU
Abosedra and Baghestani (1989)	US	1947-1987	Co-integration, Granger causality	Y→EU
Hwang and Gum (1991)	Taiwan	1961-1990	Co-integration, error correction	Y↔EU
Yu and Jin (1992)	US	1974-1990	Co-integration, Granger causality	Neutral
Stern (1993)	US	1947-1990	Multivariate VAR model	EU→Y
Cheng (1995)	US	1947–1990	Co-integration, Granger causality	Neutral
Cheng and Lai (1997)	Taiwan	1954-1993	Granger causality	Y→EU
Cheng (1998)	Japan	1952–1995	Hsiao's Granger causality	Y→EU
Cheng (1999)	India	1952–1995	Co-integration, ECM, Granger causality	Y→EU
Stern (2000)	US	1948-1994	Co-integration, Granger causality	EU→Y
Soytas et al. (2001)	Turkey	1960–1995	Co-integration, Granger causality	EU→Y
Aqeel and Butt (2001)	Pakistan	1955-1996	Hsiao's version of Granger causality, co-integration	Y→EU
Fatai et al. (2002)	New Zealand	1960–1999	Granger causality, ARDL, Toda-Yamamoto causality test	Neutral
Hondroyiannis (2002)	Greece	1960-1996	Error correction model	Neutral
Glasure (2002)	South Korea	1961–1990	Co-integration, error correction, variance decomposition	Y↔EU
Altinay and Karagol (2004)	Turkey	1950-2000	Hsiao's version of Granger causality	Neutral
Ghali and El-Sakka (2004)	Canada	1961–1997	Co-integration, VECM, Granger causality	Y↔EU
Paul and Bhattacharya (2004)	India	1950-1996	Co-integration, Granger causality	Y↔EU
Oh and Lee (2004)	South Korea	1970–1999	Granger causality, error correction model	EU→Y
Wolde-Rufael (2004)	Shanghai	1952–1999	Toda–Yamamoto causality test	EU→Y
Lee and Chang (2005)	Taiwan	1954–2003	Johansen–Juselius, co-integration, VECM	EU→Y
Ang (2007)	France	1960–2000	Co-integration, VECM	EU→Y in the short-run
Jobert and Karanfil (2007)	Turkey	1960–2003	Granger causality test	Neutral
Ho and Siu (2007)	Hong Kong	1966–2002	Co-integration, VECM	EU→Y
Zamani (2007)	Iran	1967–2003	Granger causality, co-integration, VECM	Y→EU
Lise and Van Montfort (2007)	Turkey	1970–2003	Co-integration test	Y→EU
Ang (2008)	Malaysia	1971–1999	Johansen co-integration, VECM	Y→EU
Erdal et al. (2008)	Turkey	1970–2006	Pair-wise Granger causality, Johansen co-integration	Y↔EU
Yuan et al. (2008)	China	1963-2005	Johansen co-integration, VECM	Y→EU
Bowden and Payne (2009)	US	1949-2006	Toda–Yamamoto causality test	EU→Y
Payne (2009)	US	1949-2006	Toda–Yamamoto causality test	Neutral
Zhang and Cheng (2009)	China	1960-2007	Granger causality	Y→EU
Belloumi (2009)	Tunisia	1971-2004	Granger causality, VECM	EU→Y in the short-run Y↔EU in the long-run
Halicioglu (2009)	Turkey	1960-2005	Granger causality, ARDL, co-integration	Neutral
Soytas and Sari (2009)	Turkey	1960-2000	Toda–Yamamoto causality test	Neutral
Binh (2011)	Vietnam	1976-2010	Co-integration, VECM	Y→EU
Kaplan et al. (2011)	Turkey	1971-2006	Granger causality, VECM	Y↔EU

Note: Y→EU means that the causality runs from growth to energy use. EU→Y means that the causality runs from energy use to growth Y↔EU means that bi-directional causality exists between growth and energy use. Neutral means that no causality exists between growth and energy use.

Table A2. Summary of selected empirical studies on energy use-growth nexus for multi-country studies

Author(s)	Countries	Period	Methodology	Causality
Erol and Yu (1987)	Japan Italy, Germany Canada France, UK	1952-1982	Granger causality	Y↔EU Y→EU EU→Y Neutral
Masih (1996)	India Pakistan Indonesia Malaysia, Singapore, Philippines	1955-1990	Co-integration, error correction,	EU→Y Y↔EU Y→EU Neutral
Masih (1997)	Taiwan South Korea	1952-1992 1955-1991	Co-integration, error correction, variance decomposition	Y↔EU Y↔EU
Glasure and Lee (1997)	South Korea Singapore	1961-1990	Co-integration and Granger causality	Neutral EU→Y
Asafu-Adjaye (2000)	India, Indonesia Philippines, Thailand	1973-1995 1971-1995	Co-integration, Granger causality based on ECM	EU→Y Y↔EU
Soytas and Sari (2003)	Argentina Italy, South Korea Turkey, France, Germany, Japan Brazil, India, Indonesia, Mexico, Poland, South Africa, US, UK, Canada	1950-1992	Co-integration, Granger causality	Y↔EU Y→EU EU→Y Neutral
Lee (2005)	18 developing countries	1971-2001	Panel VECM	EU→Y
Al-Iriani (2006)	Bahrain, Kuwait, UAE Oman, Qatar, Saudi Arabia	1970–2002	Panel co-integration, GMM	Y→EU
Lee (2006)	UK, Germany Sweden, US Canada, Belgium, Netherlands, Switzerland France, Italy, Japan	1960-2001	Granger causality	Neutral Y↔EU EU→Y Y→EU
Soytas and Sari (2006)	Germany France, US Canada, Italy, Japan, UK	1960-2004	Multivariate co-integration, ECM, generalized variance decompositions	Y→EU EU→Y Y↔EU
Lee and Chang (2007)	18 developing countries 22 developed countries	1971-2002 1965-2002	Panel VAR, GMM	Y→EU Y↔EU
Mahadevan and Asafu-Adjaye (2007)	20 energy importers and exporters	1971–2002	Panel error correction model	Y↔EU (developed countries) EU→Y in the short-run (developing countries)
Mehrara (2007)	11 oil exporting countries	1965-2002	Panel co-integration	Y→EU
Akinlo (2008)	Gambia, Ghana, Sudan, Zimbabwe, Congo, Senegal. Cameroon, Cote d'Ivoire, Nigeria, Kenya, Togo.	1980-2003	Autoregressive distributed lag (ARDL) bounds test	Y→EU Neutral
Narayan and Smyth (2008)	G7 countries	1972-2002	Panel co-integration, Granger causality	EU→Y
Lee et al. (2008)	22 OECD countries	1960–2001	Panel co-integration, Panel VECM	Y↔EU
Lee and Chang (2008)	16 Asian countries	1971-2002	Panel co-integration and Panel ECM	Neutral in the short-run EU→Y in the long-run
Reynolds and Kolodzieji (2008)	FSU countries		Granger causality	Oil production→Y Y→coal production Y→natural gas production
Apergis and Payne (2009a)	Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama	1980-2004	Panel co-integration, error correction model	EU→Y
Apergis and Payne (2009b)	11 CIS countries	1991-2005	Panel co-integration, error correction model	EU→Y in the short-run Y↔EU in the long-run
Apergis and Payne (2009b)	Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama	1971-2004	Panel VECM	Y↔EU in the short-run
Lau et al. (2011)	17 Asian countries		Granger causality	EU→Y in the short-run Y→EU in the long-run
Farhani and Rejeb (2012)	15 MENA countries	1973-2008	Panel co-integration, error correction model	Neutral in the short-run Y→EU in the long-run

Note: Y→EU means that the causality runs from growth to energy use. EU→Y means that the causality runs from energy use to growth Y↔EU means that bi-directional causality exists between growth and energy use. Neutral means that no causality exists between growth and energy use.

A2. Data Appendix

Capital Stock:

$ssi_{1948}^{1990\,prices}$ = Gross fixed capital investments by kinds of main sectors (1990 prices, billion TL)

$ssi_{1948}^{1998\,prices}$ = Gross fixed capital investments (1000 YTL, 1998 prices)

sss_t^{1990} = Capital stock by kinds of main sectors (1990 prices, billion TL)

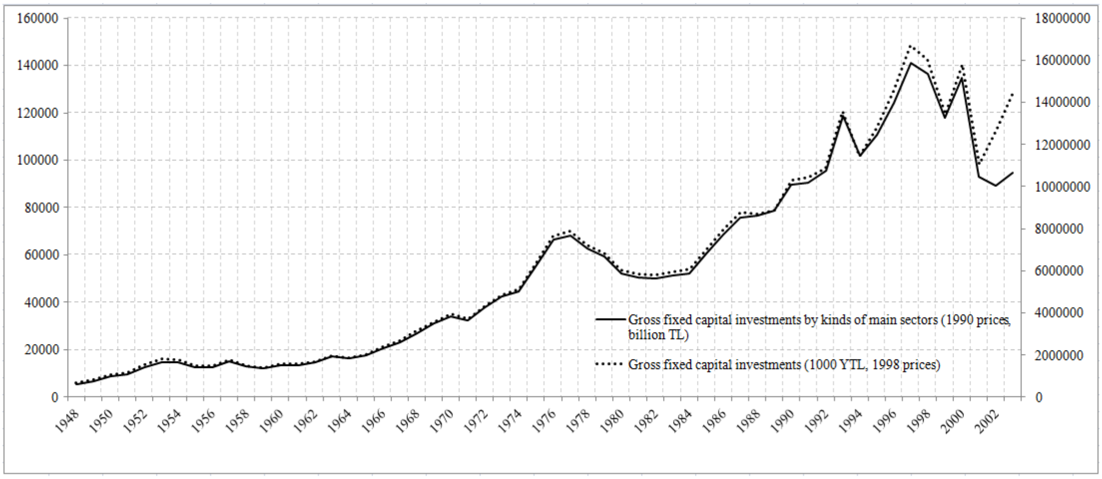
sss_t^{1998} = Capital stock by kinds of main sectors (1998 prices, billion TL)

The series of sss_t^{1990} , $ssi_{1948}^{1990\,prices}$ from1972 to 2003 and the series of sss_t^{1998} , $ssi_{1948}^{1998\,prices}$ between 1979-2007 are obtained from Saygılı, Ş., Cihan C. and Yurtoğlu H., (2005) and Saygılı, Ş., Cihan C., (2008) respectively.

$ssi_{1948}^{1990\,prices}$ is obtained from Saygılı, Ş., Cihan C. and Yurtoğlu H., (2005) and $ssi_{1948}^{1998\,prices}$ from Saygılı, Ş., Cihan C., (2008).

Both $ssi_{1948}^{1990\,prices}$ and $ssi_{1948}^{1998\,prices}$ series seem to be very similar to each other as is seen from Figure A.1 .

Figure A.1 $ssi_{1948}^{1990\,prices}$ and $ssi_{1948}^{1998\,prices}$



Source: Gross fixed capital investments by kinds of main sectors (1990 prices,billion TL) and Gross fixed capital investments (1000 YTL, 1998 prices) are obtained from Saygılı, Ş., Cihan C. and Yurtoğlu H., (2005), Saygılı, Ş., Cihan C., (2008) respectively. The graph is created according to forementioned data.

Thus, $ssi_{1948}^{1998\,prices}$ is divided by $ssi_{1948}^{1990\,prices}$ in order to obtain a conversion coefficient for the purpose of converting a series with 1990 prices to express in 1998 prices.

$$\frac{ssi_{1948}^{1998\,prices}}{ssi_{1948}^{1990\,prices}} = \delta \qquad (1)$$

By using the formula below we converted sss_t^{1990} to sss_t^{1998} .

$$\delta \times sss_t^{1990} = sss_t^{1998} \qquad (2)$$

As Cihan C. recommended capital stock in year *t* is depreciated by a constant rate of 4% then this amount and gross fixed investment of year *t* are summed up in order to obtain the approximate values between 2008 and 2010.

$$sss_t^{1998} = ssy_{t-1}^{1998} + (sss_{t-1}^{1998} \times 1 - 0,04) \quad (3)$$

On the other hand the approximate values for the period between 1972 and 1978 are calculated using (2).

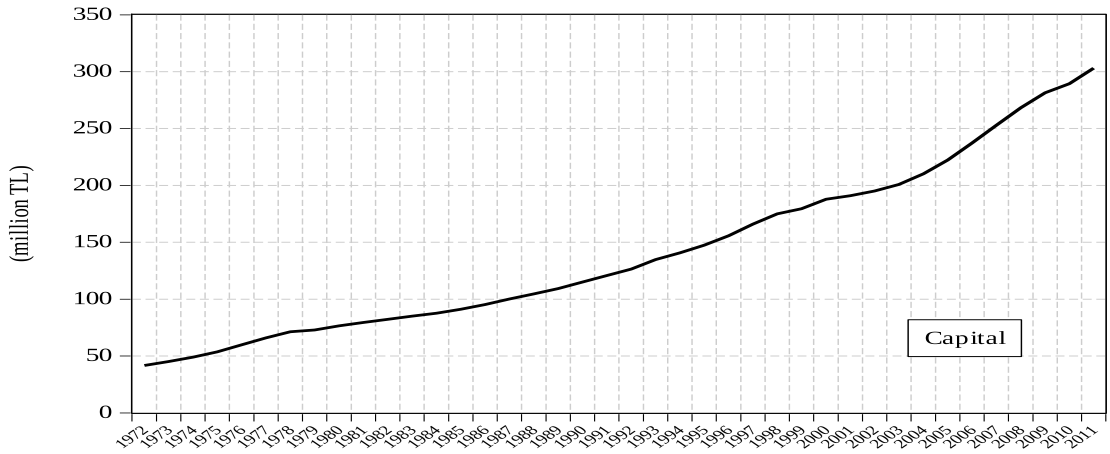


Figure A.2 Capital

Labor: Is employed persons by kind of economic activity(1000) and obtained from Turkstat.

GDP: Obtained from Turkey Data Monitor. Birleştirilmiş Seri (TL,1000000)

Energy Use: Obtained from World Development Indicators of World Bank. Measured in kt of oil equivalent. Tonnes of oil equivalent (toe) is the amount of energy released by burning one tonne of crude oil.

$CPI_{Turkey:}$ Obtained from International Financial Statistics (IFS).

$CPI_{US:}$ Obtained from International Financial Statistics (IFS).

US Exchange rate($/TL): Buying and selling prices of dollar are obtained from Electronic Data Deliveri System(EDDS)of Central Bank of Turkish Republic(CBRT) and arithmetic mean of buying and selling prices are used as US Exchange rate($/TL).

Real Exchange rate: Calculated using the folloving formula $e=E*[CPI_{TR}/CPI_{US}]$

Crude Oil Domestic First Purchase Prices: Obtained from U.S. Energy Information Administration (EIA).

Divisia Index:

$$\ln E_t^q - \ln E_{t-1}^q = \sum_{i=1}^{n}\left(\frac{1}{2}\left(\frac{P_{it}E_{it}}{\sum_{i=1}^{n}P_{it}E_{it}} \times \frac{P_{it-1}E_{it-1}}{\sum_{i=1}^{n}P_{it-1}E_{it-1}}\right)\times\left(\ln E_{it} - \ln E_{it-1}\right)\right)$$

where $\frac{P_iE_i}{\sum_{i=1}^{n}P_iE_i}$ is the cost share, P is the price of energy input i, n is the total number of energy inputs and E is the energy content in (petajoules or terajoules) for each energy input.

The fuel types for constructing the quality-adjusted aggregate of energy use are coal, petroleum, natural gas, primary electricity (hydro and solar), bio-fuel and wood etc. Energy data for all aggregate and disaggregate levels were compiled from MENR. Price data are compiled from Turkstat, EMRA, MENR from another source.

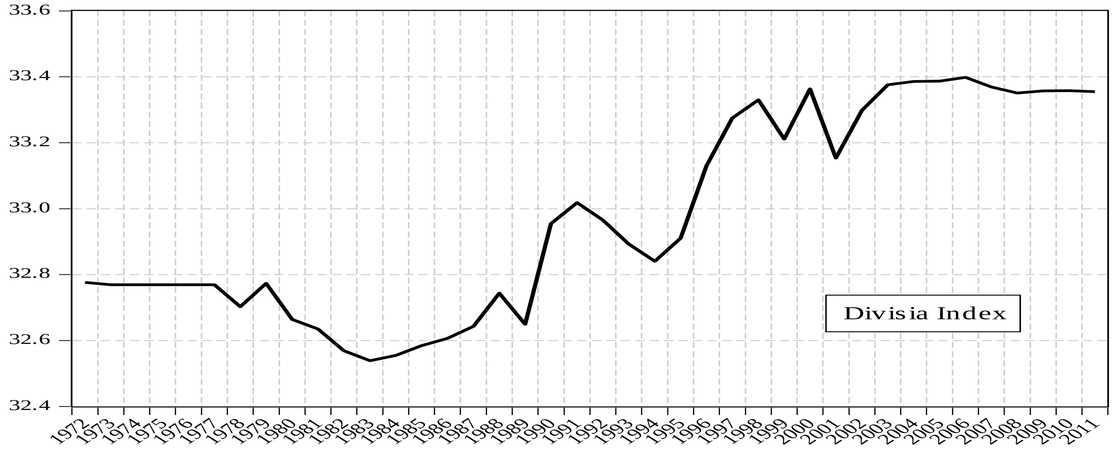


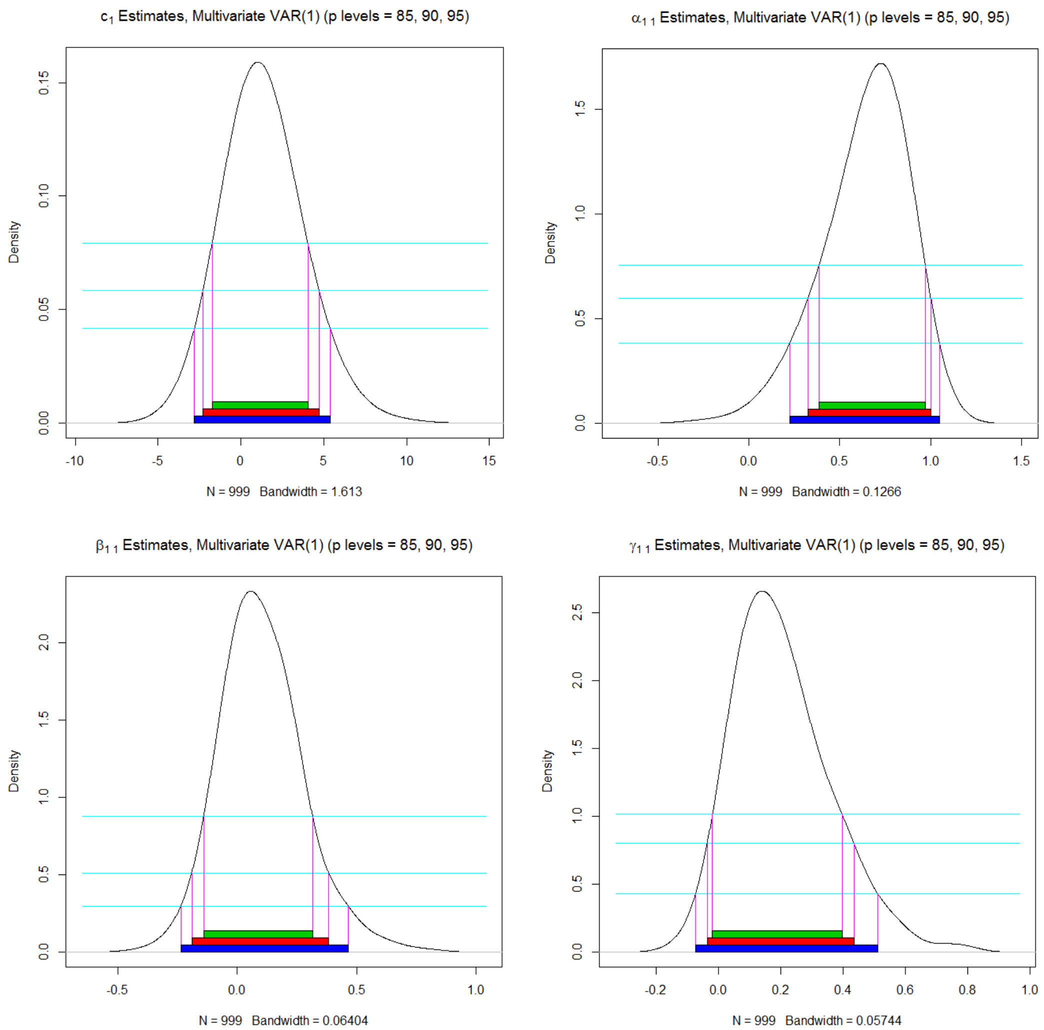
Figure A.3 Divisia Index

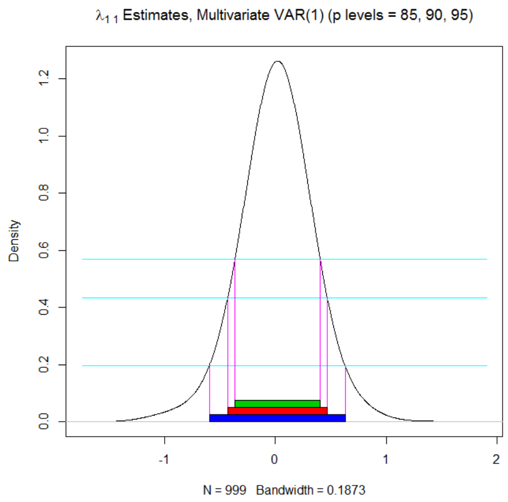
(Source: Own calculation)

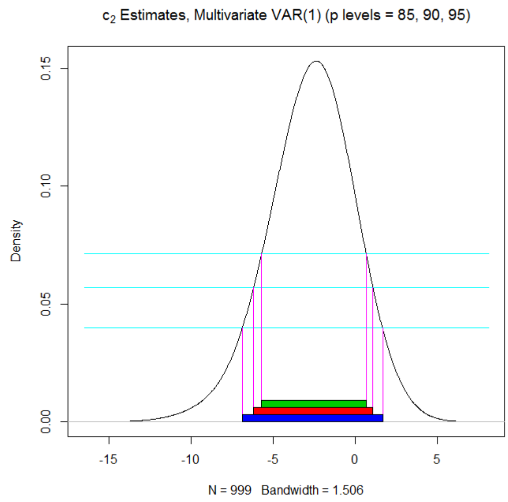
A3 Highest density confidence regions for the estimates

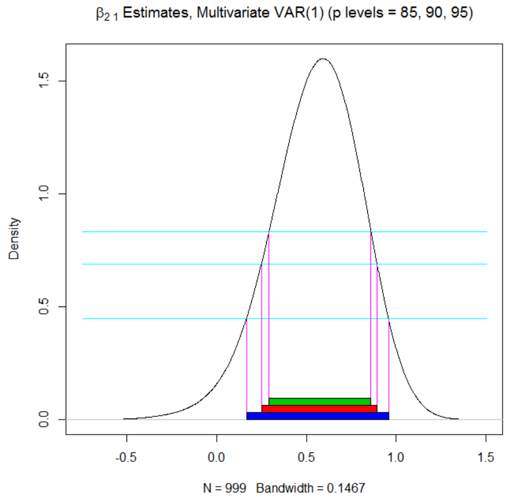
LNEU

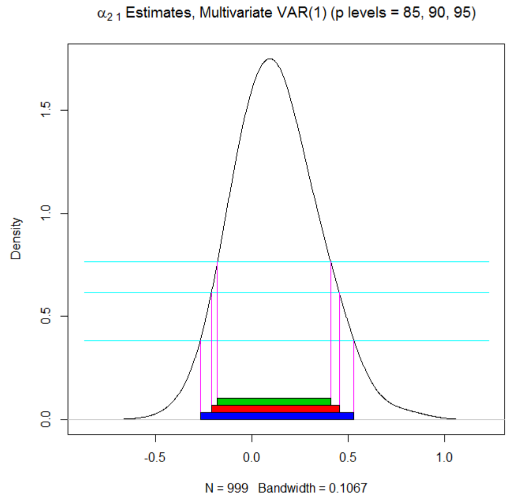
VAR(1)

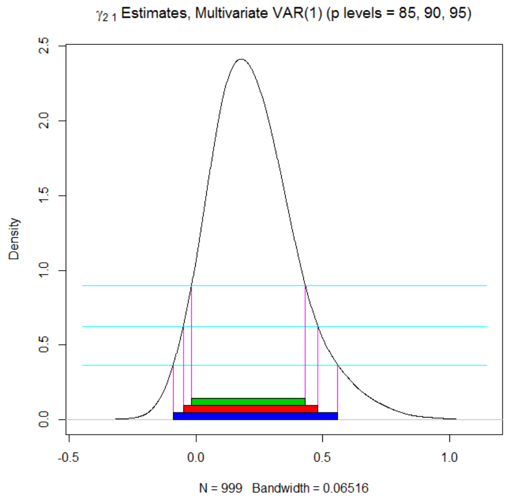


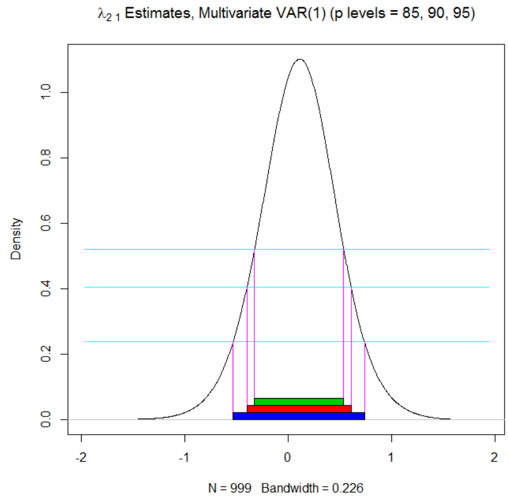

$\lambda_{1\,1}$ Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1873


c_2 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 1.506

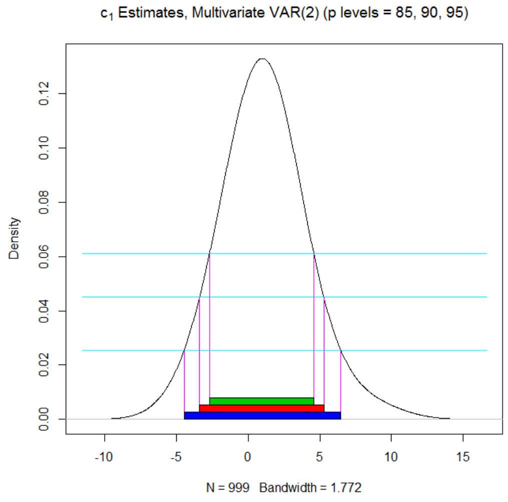

$\beta_{2\,1}$ Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1467

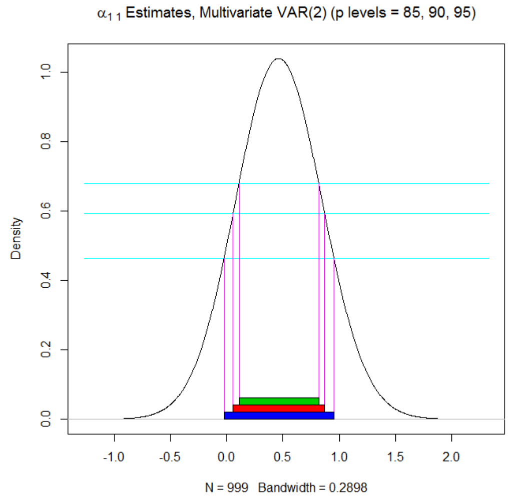

$\alpha_{2\,1}$ Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1067

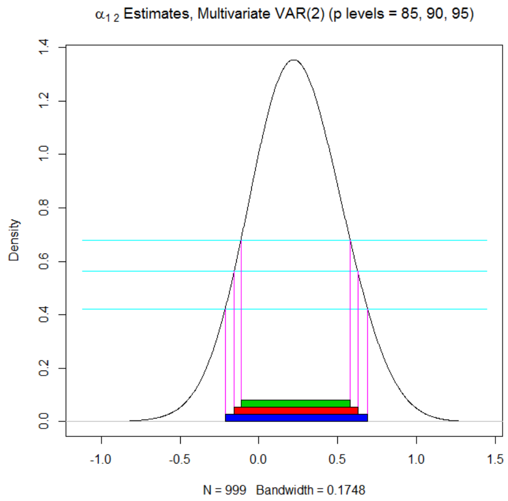

$\gamma_{2\,1}$ Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.06516

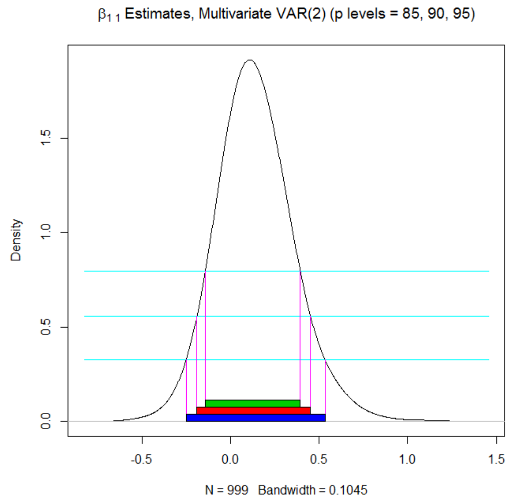

$\lambda_{2\,1}$ Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.226

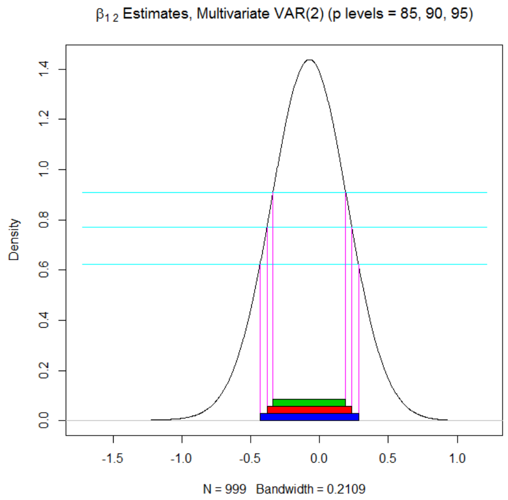
VAR(2)

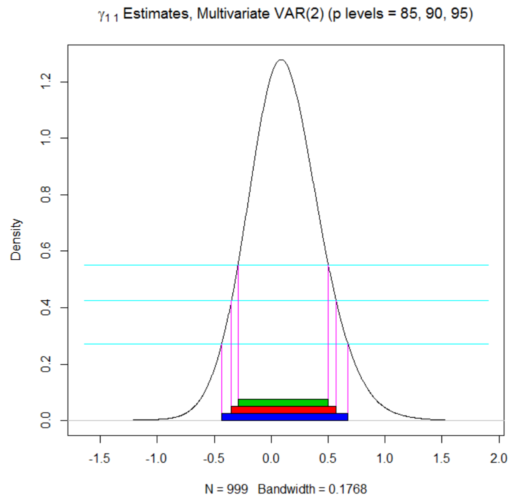

c1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 1.772

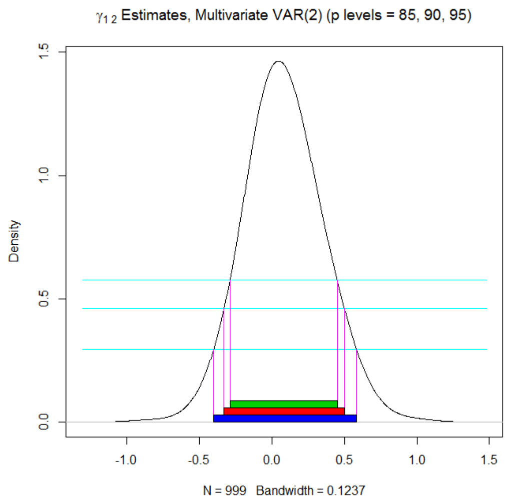

α1 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.2898


α1 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1748

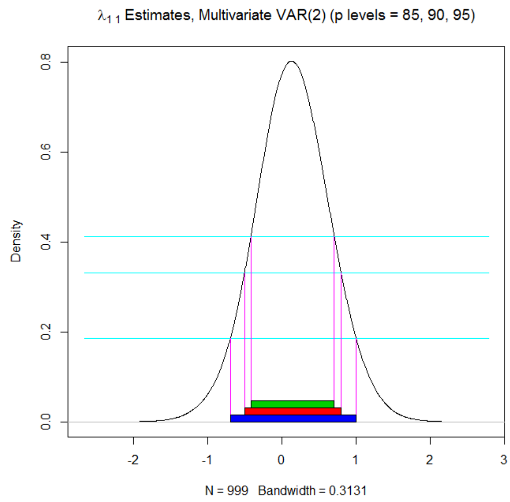

β1 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1045


β1 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.2109

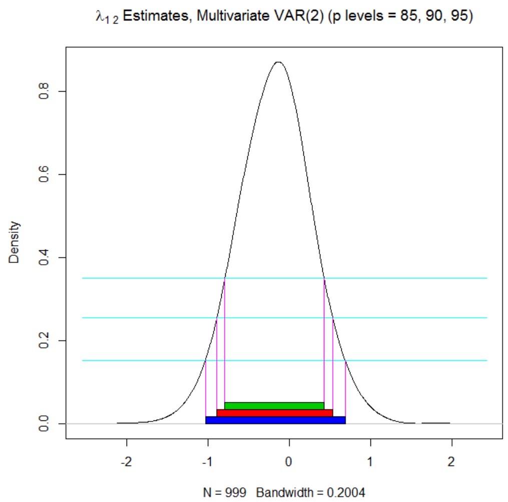

γ1 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1768



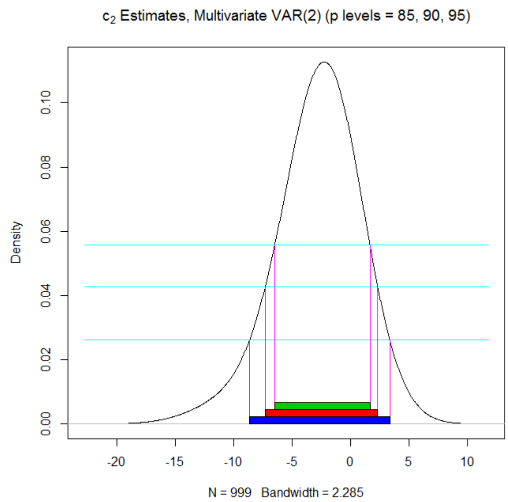
$\gamma_{1\,2}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1237



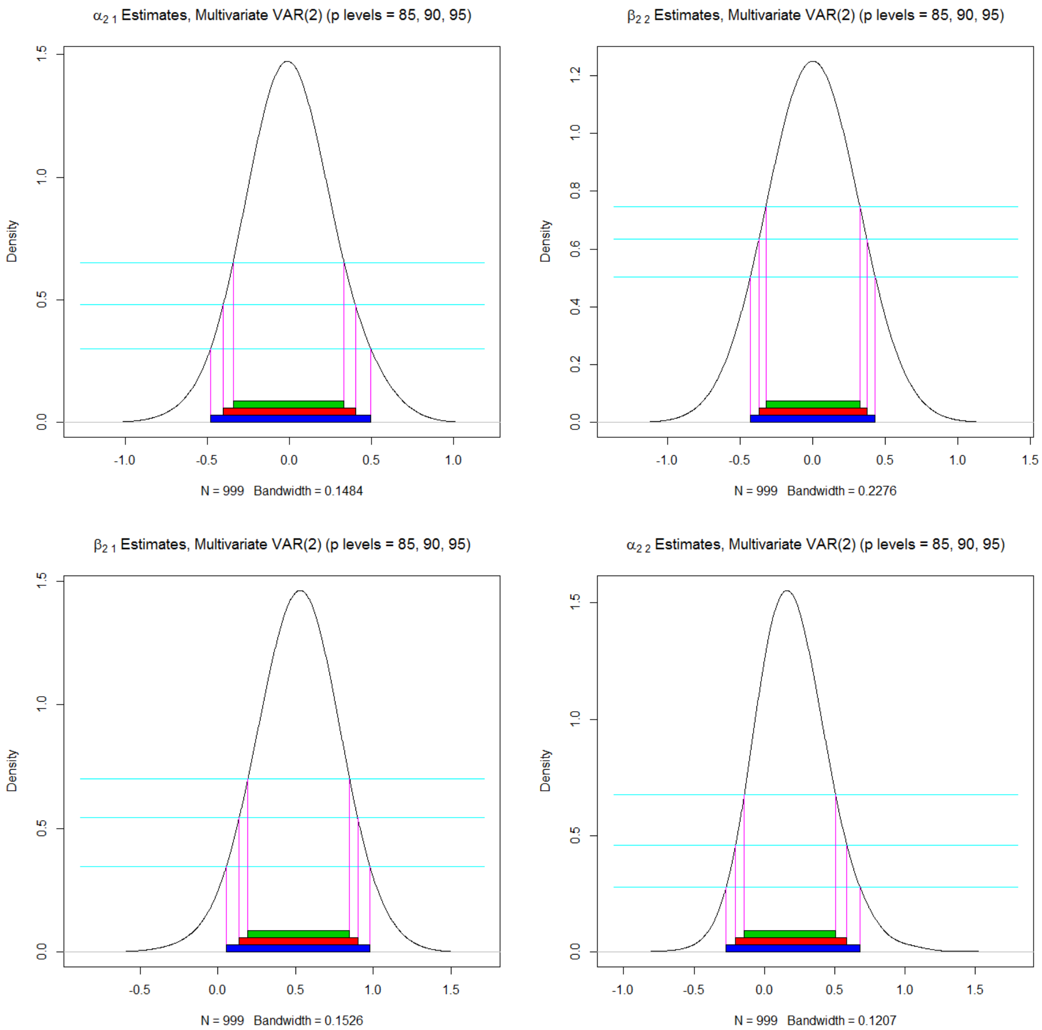
$\lambda_{1\,1}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.3131

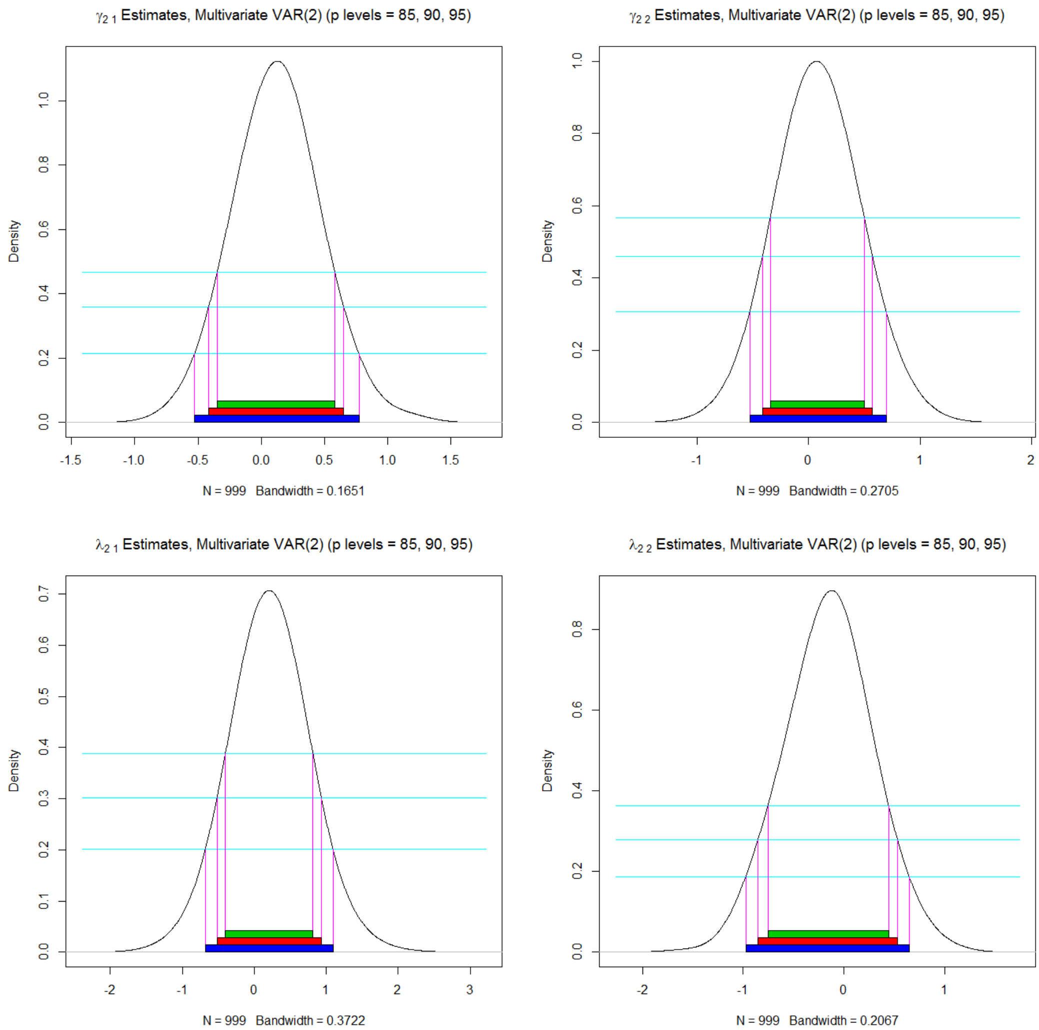


$\lambda_{1\,2}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.2004

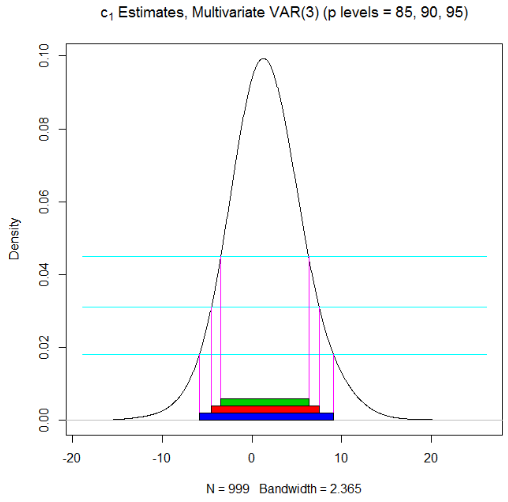


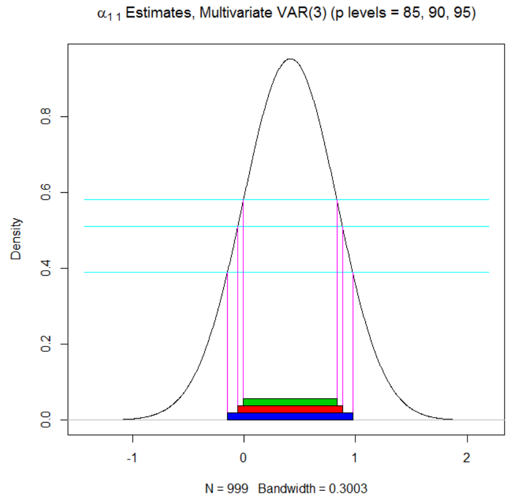
c_2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 2.285

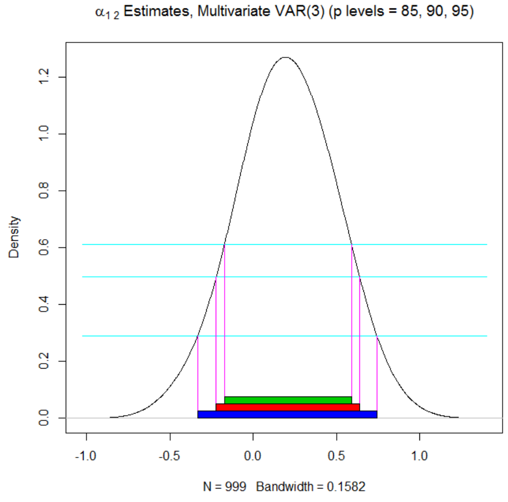

α2 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1484
β2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.2276
β2 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1526
α2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1207

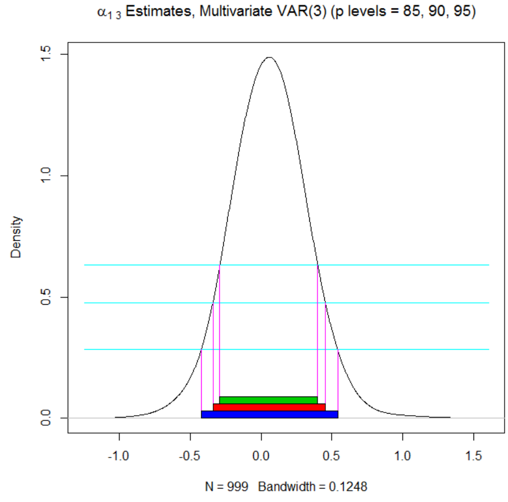

γ2 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1651
γ2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.2705
λ2 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.3722
λ2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.2067

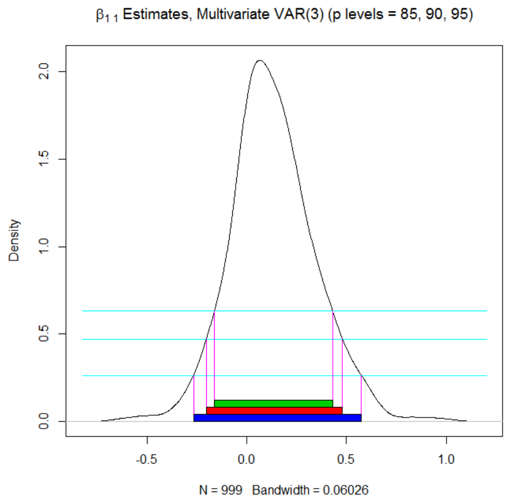
VAR(3)

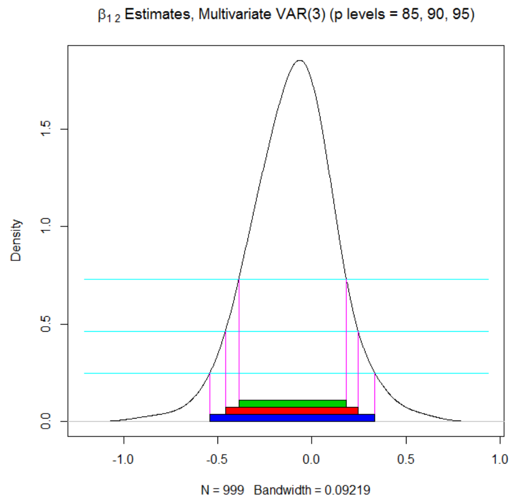

c_1 Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 2.365

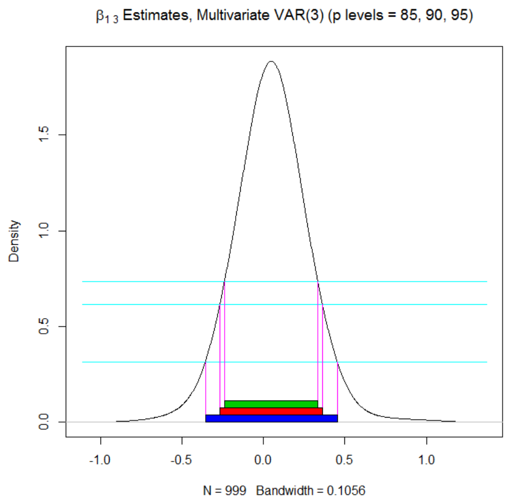

$\alpha_{1\,1}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.3003

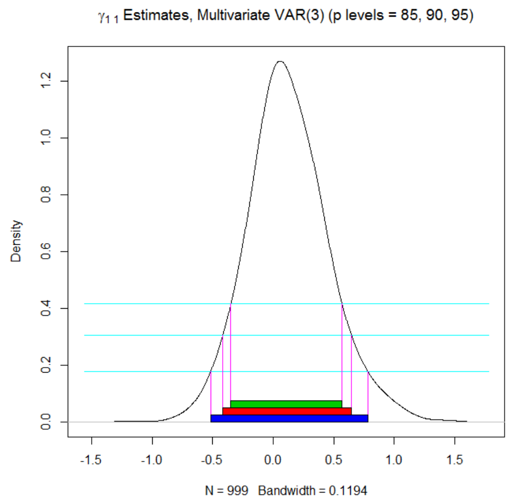

$\alpha_{1\,2}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1582

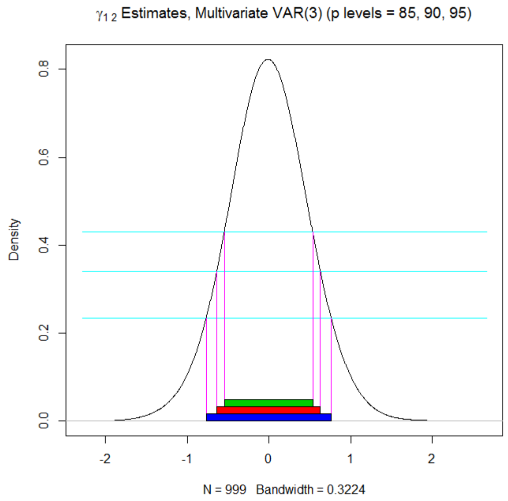

$\alpha_{1\,3}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1248

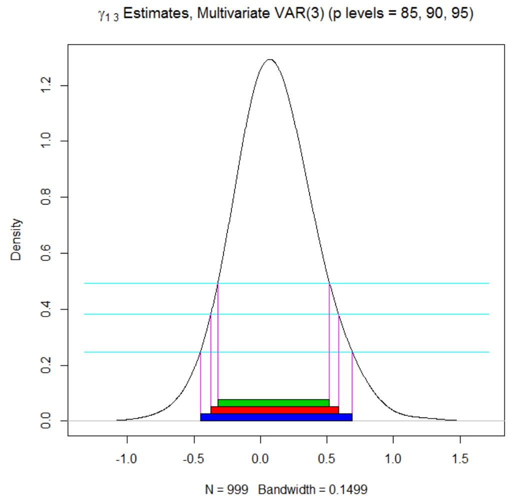

$\beta_{1\,1}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.06026

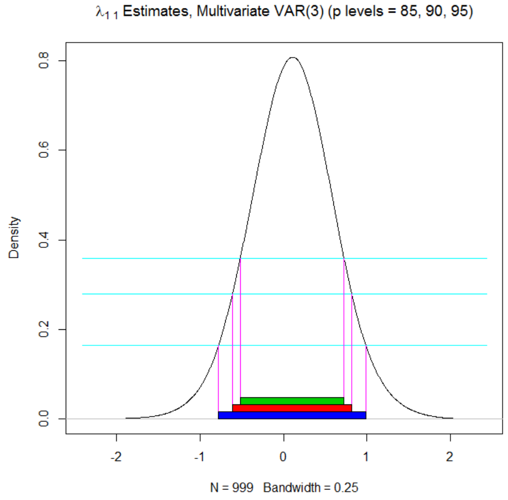

$\beta_{1\,2}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.09219

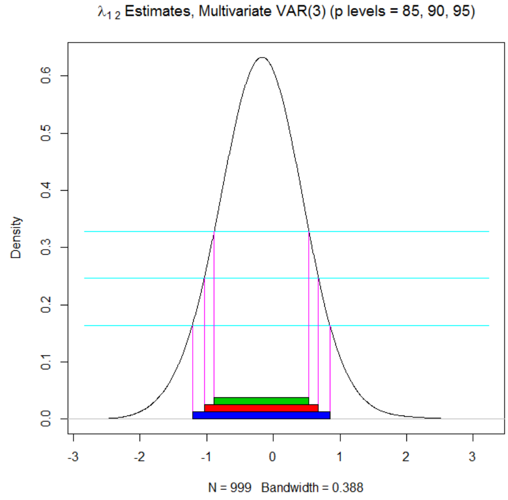

β_{13} Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
0.0
0.5
1.0
1.5
-1.0
-0.5
0.0
0.5
1.0
N = 999 Bandwidth = 0.1056


γ_{11} Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.2
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
N = 999 Bandwidth = 0.1194

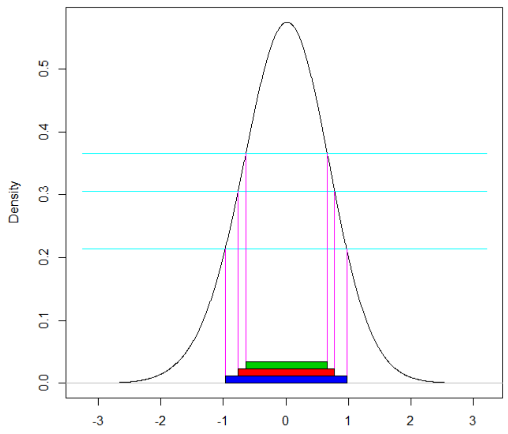

γ_{12} Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
0.0
0.2
0.4
0.6
0.8
-2
-1
0
1
2
N = 999 Bandwidth = 0.3224


γ_{13} Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.2
-1.0
-0.5
0.0
0.5
1.0
1.5
N = 999 Bandwidth = 0.1499


λ_{11} Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
0.0
0.2
0.4
0.6
0.8
-2
-1
0
1
2
N = 999 Bandwidth = 0.25

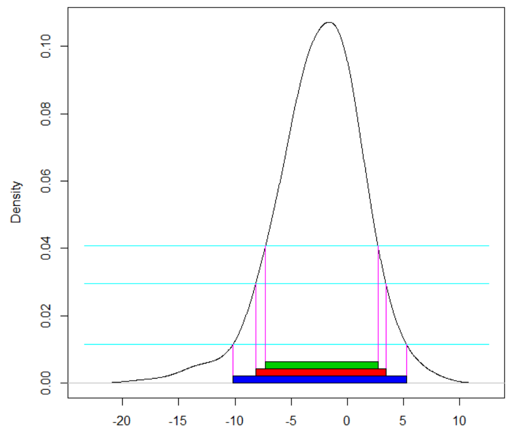

λ_{12} Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
0.0
0.1
0.2
0.3
0.4
0.5
0.6
-3
-2
-1
0
1
2
3
N = 999 Bandwidth = 0.388

$\lambda_{1\,3}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)



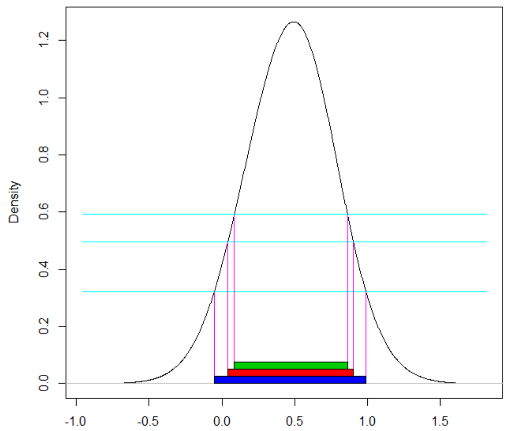
N = 999 Bandwidth = 0.5278

c_2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)



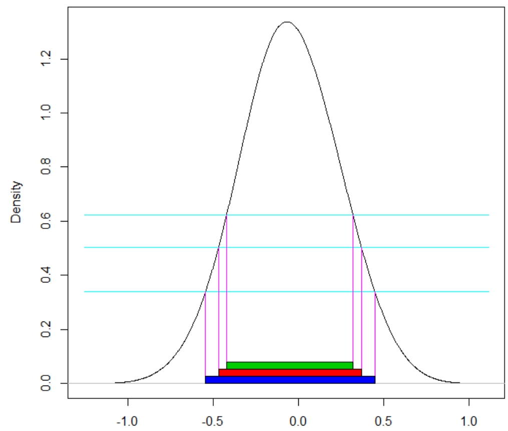
N = 999 Bandwidth = 1.432

$\beta_{2\,1}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)



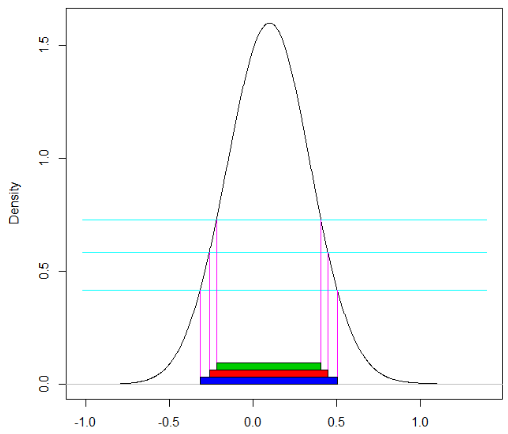
N = 999 Bandwidth = 0.1675

$\beta_{2\,2}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)



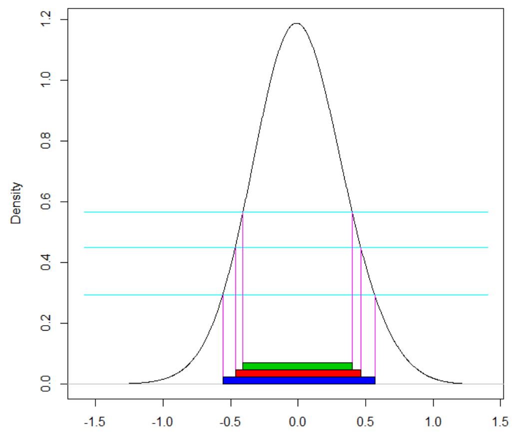
N = 999 Bandwidth = 0.1541

$\beta_{2\,3}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)

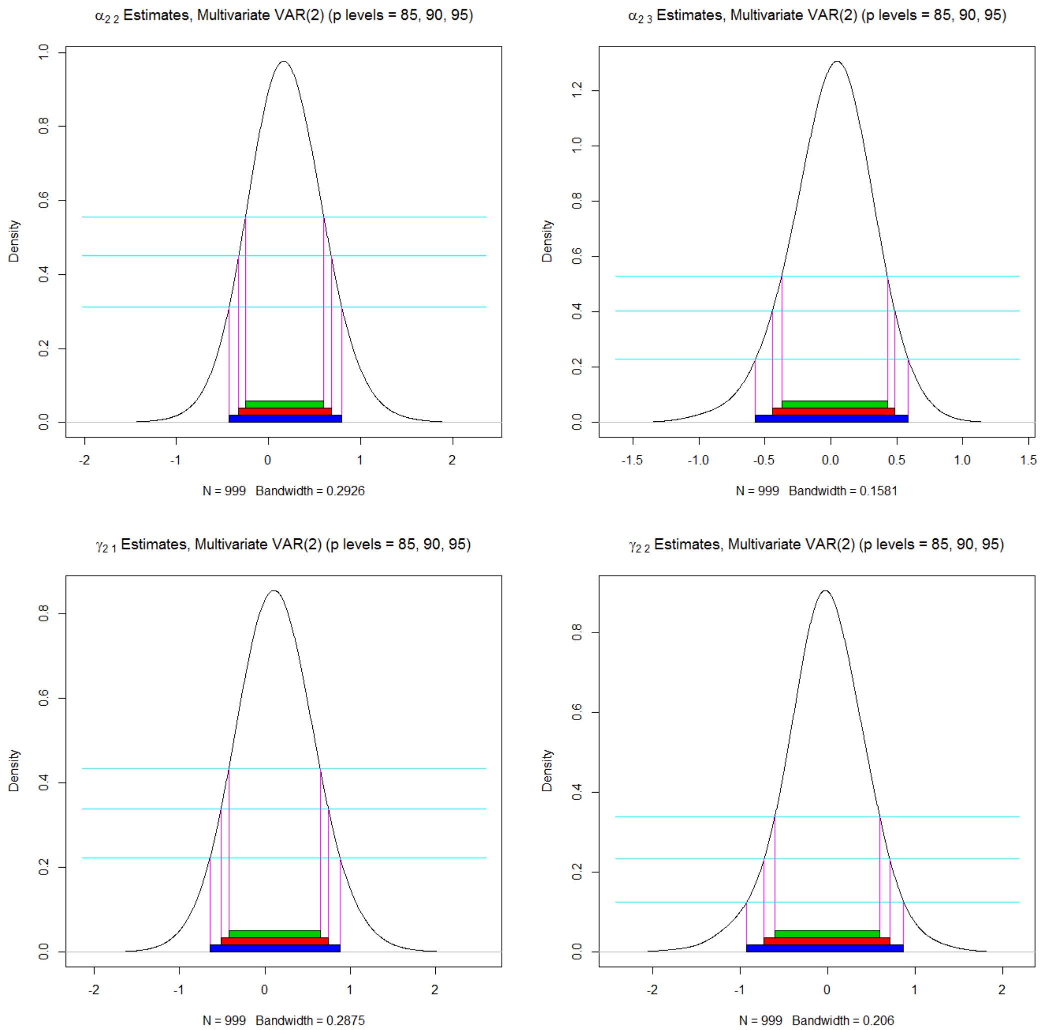


N = 999 Bandwidth = 0.1334

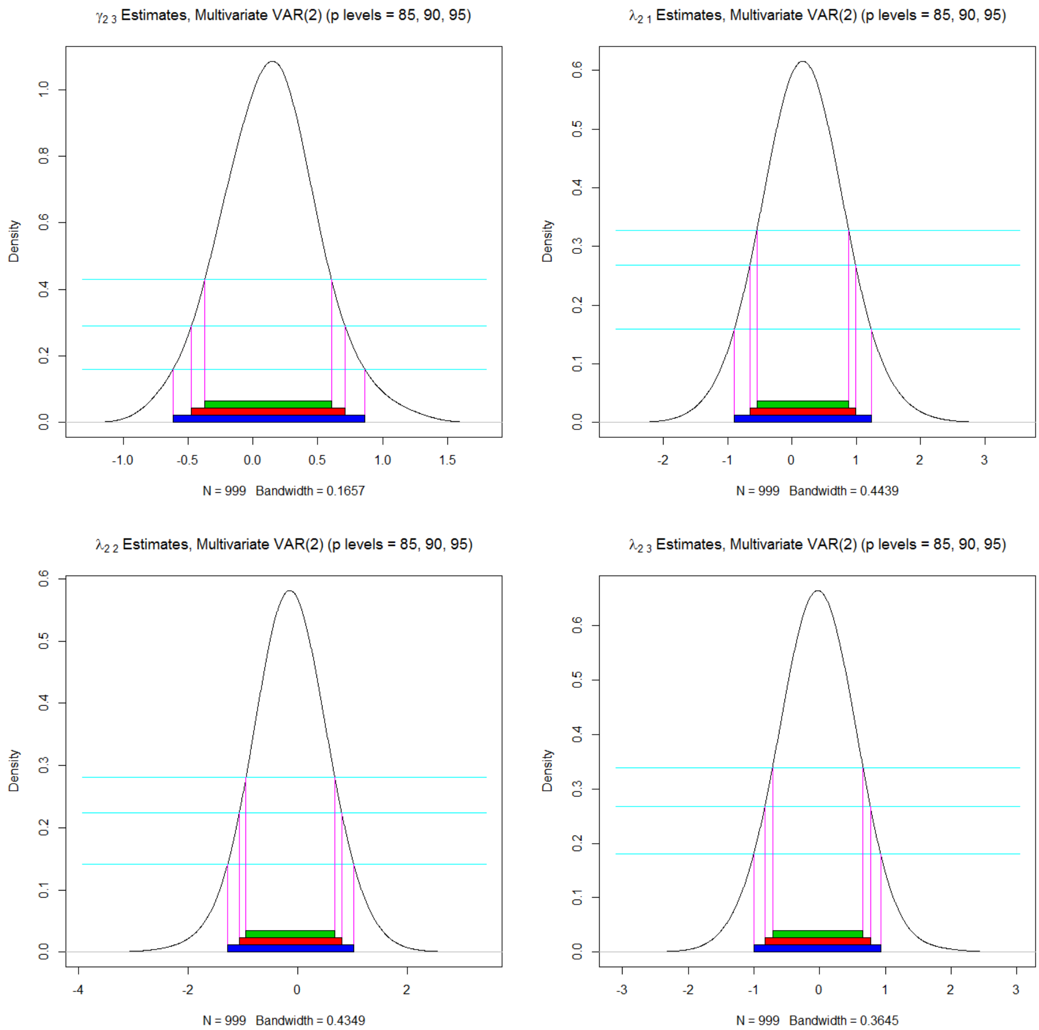
$\alpha_{2\,1}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)



N = 999 Bandwidth = 0.1928

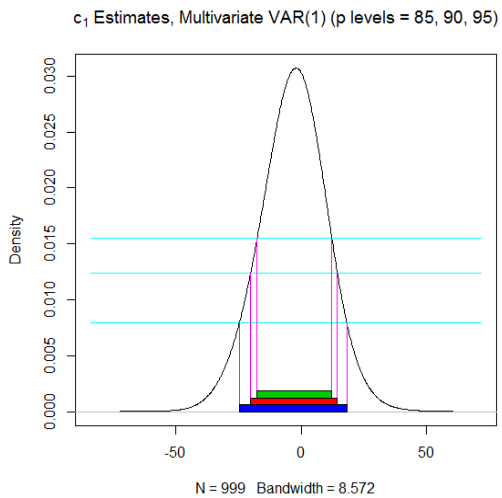


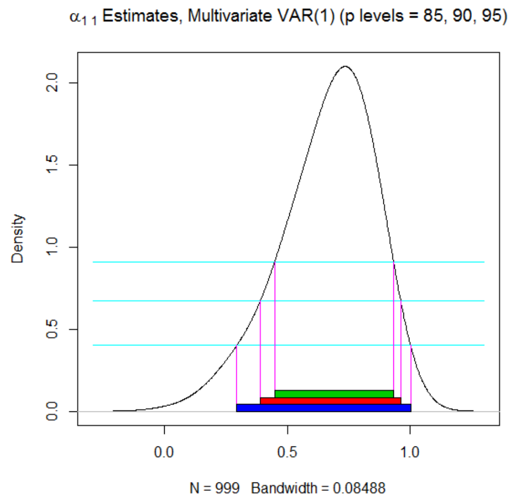
α2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.2926
α2 3 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1581
γ2 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.2875
γ2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.206

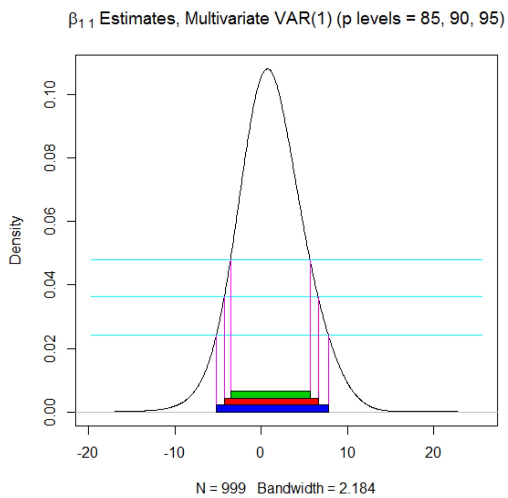

γ2 3 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
λ2 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
λ2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
λ2 3 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1657
N = 999 Bandwidth = 0.4439
N = 999 Bandwidth = 0.4349
N = 999 Bandwidth = 0.3645

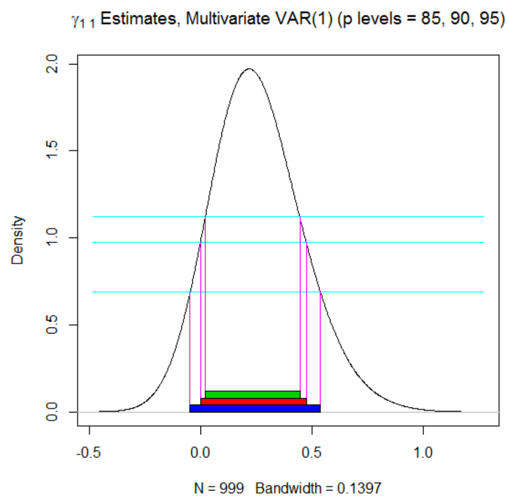
LNDI

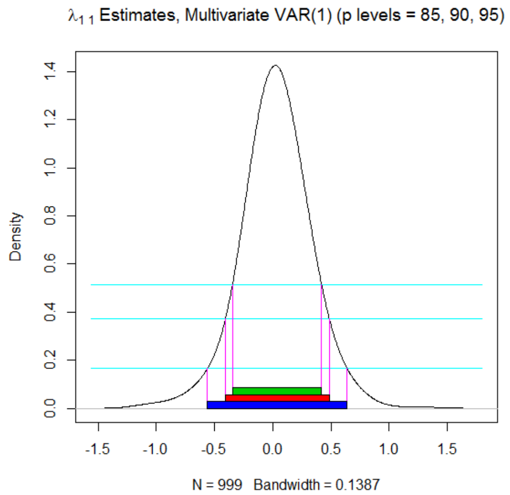
VAR(1)

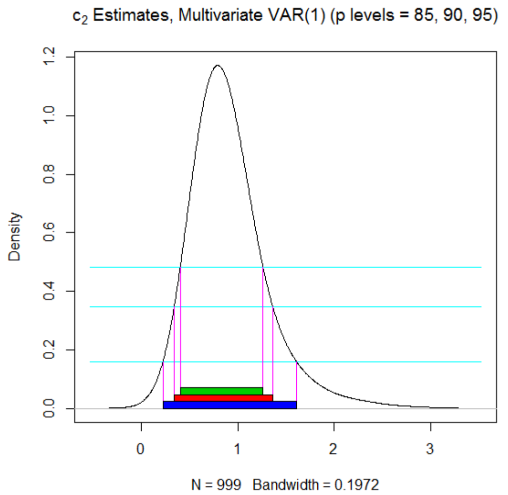

c1 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
0.000
0.005
0.010
0.015
0.020
0.025
0.030
-50
0
50
N = 999 Bandwidth = 8.572

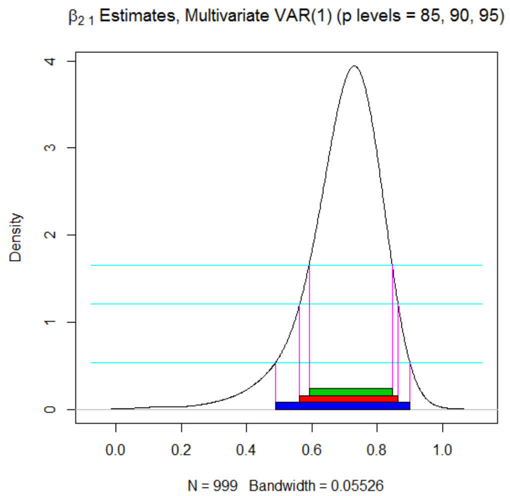

α1 1 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
0.0
0.5
1.0
1.5
2.0
0.0
0.5
1.0
N = 999 Bandwidth = 0.08488

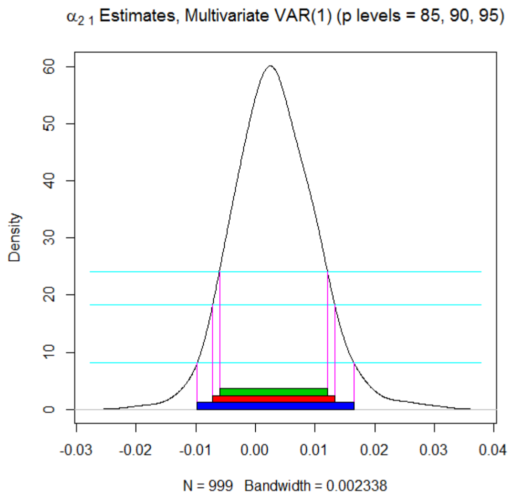

β1 1 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
0.00
0.02
0.04
0.06
0.08
0.10
-20
-10
0
10
20
N = 999 Bandwidth = 2.184

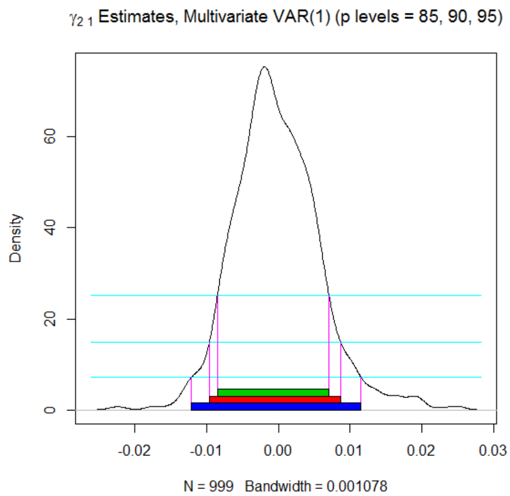

γ1 1 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
0.0
0.5
1.0
1.5
2.0
-0.5
0.0
0.5
1.0
N = 999 Bandwidth = 0.1397

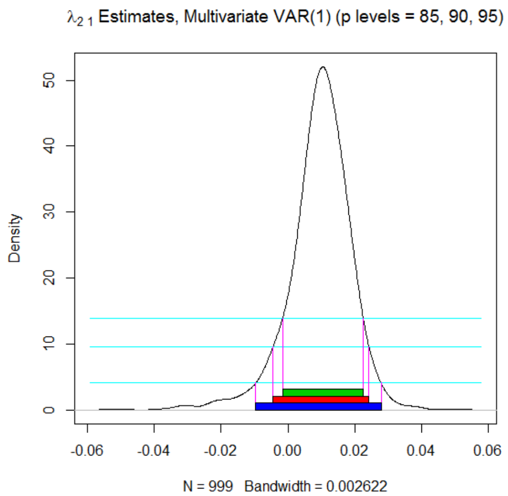

λ1 1 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1387


c2 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1972

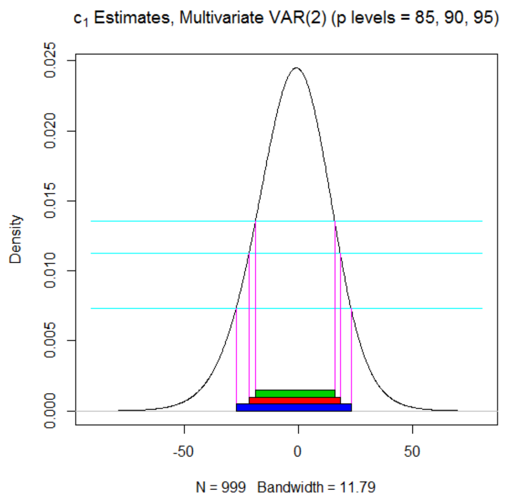

β2 1 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.05526

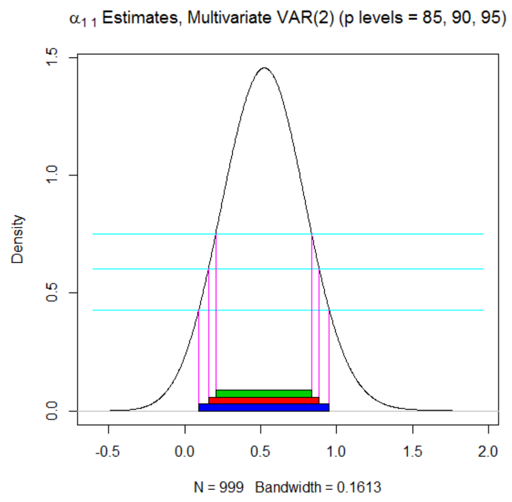

α2 1 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.002338

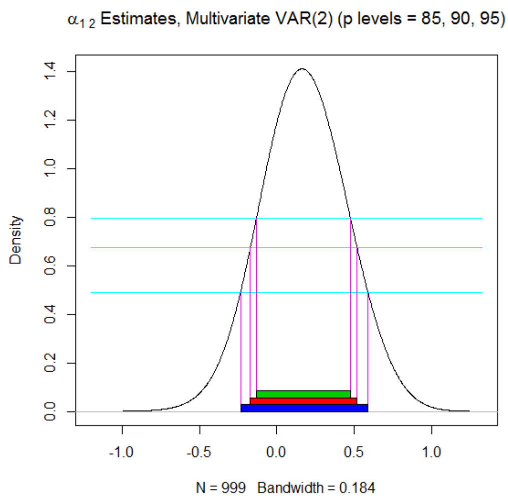

γ2 1 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.001078

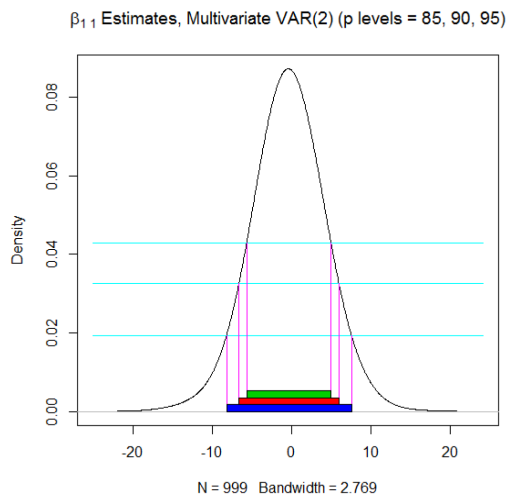

λ2 1 Estimates, Multivariate VAR(1) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.002622

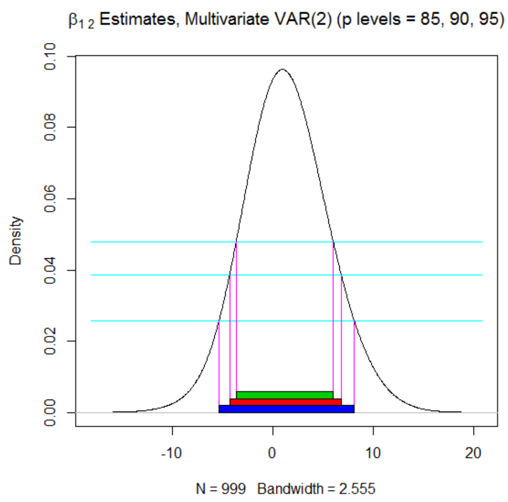
VAR(2)

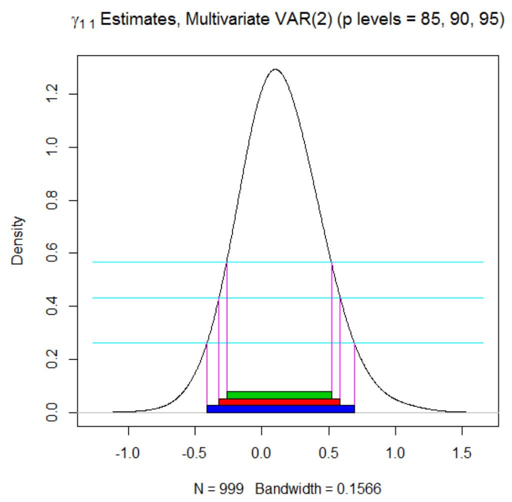

c1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0.000 0.005 0.010 0.015 0.020 0.025
-50 0 50
N = 999 Bandwidth = 11.79

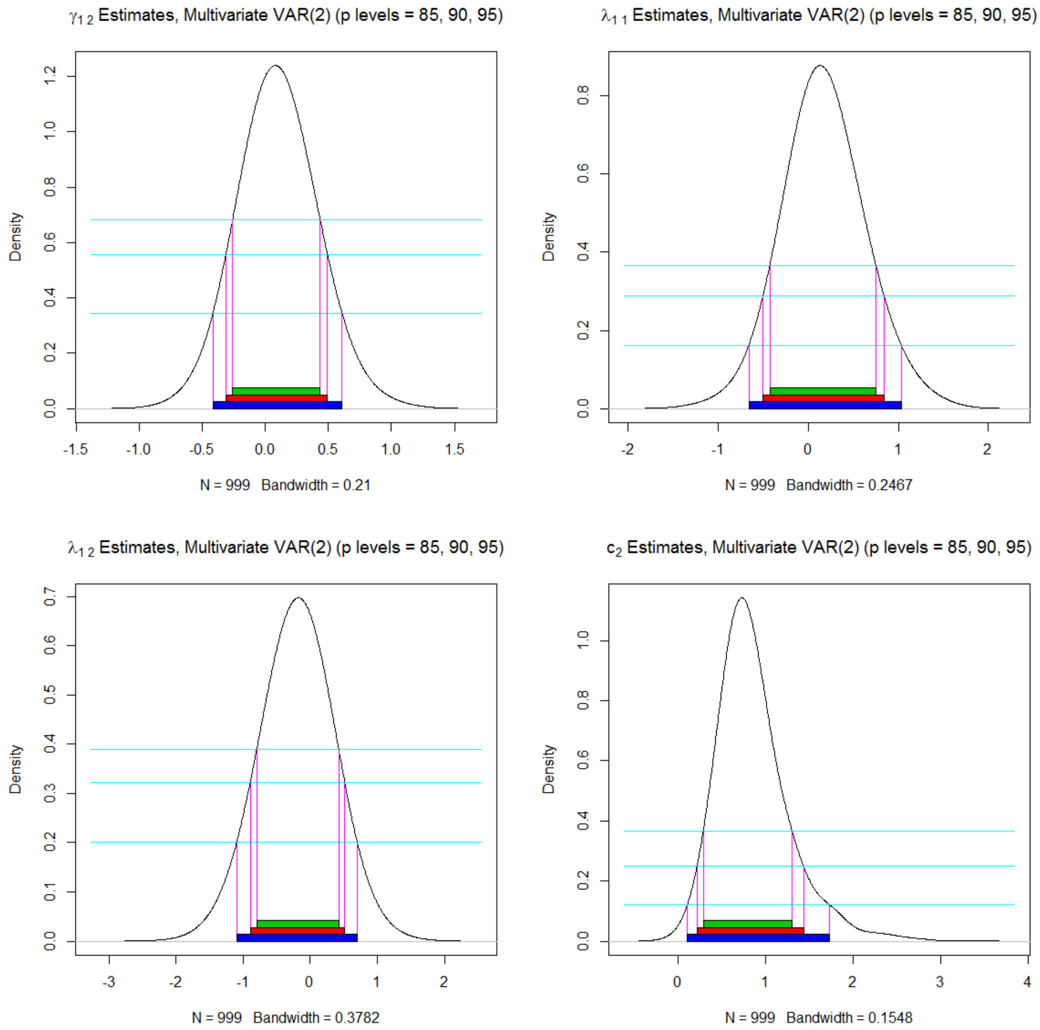

α1 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0.0 0.5 1.0 1.5
-0.5 0.0 0.5 1.0 1.5 2.0
N = 999 Bandwidth = 0.1613

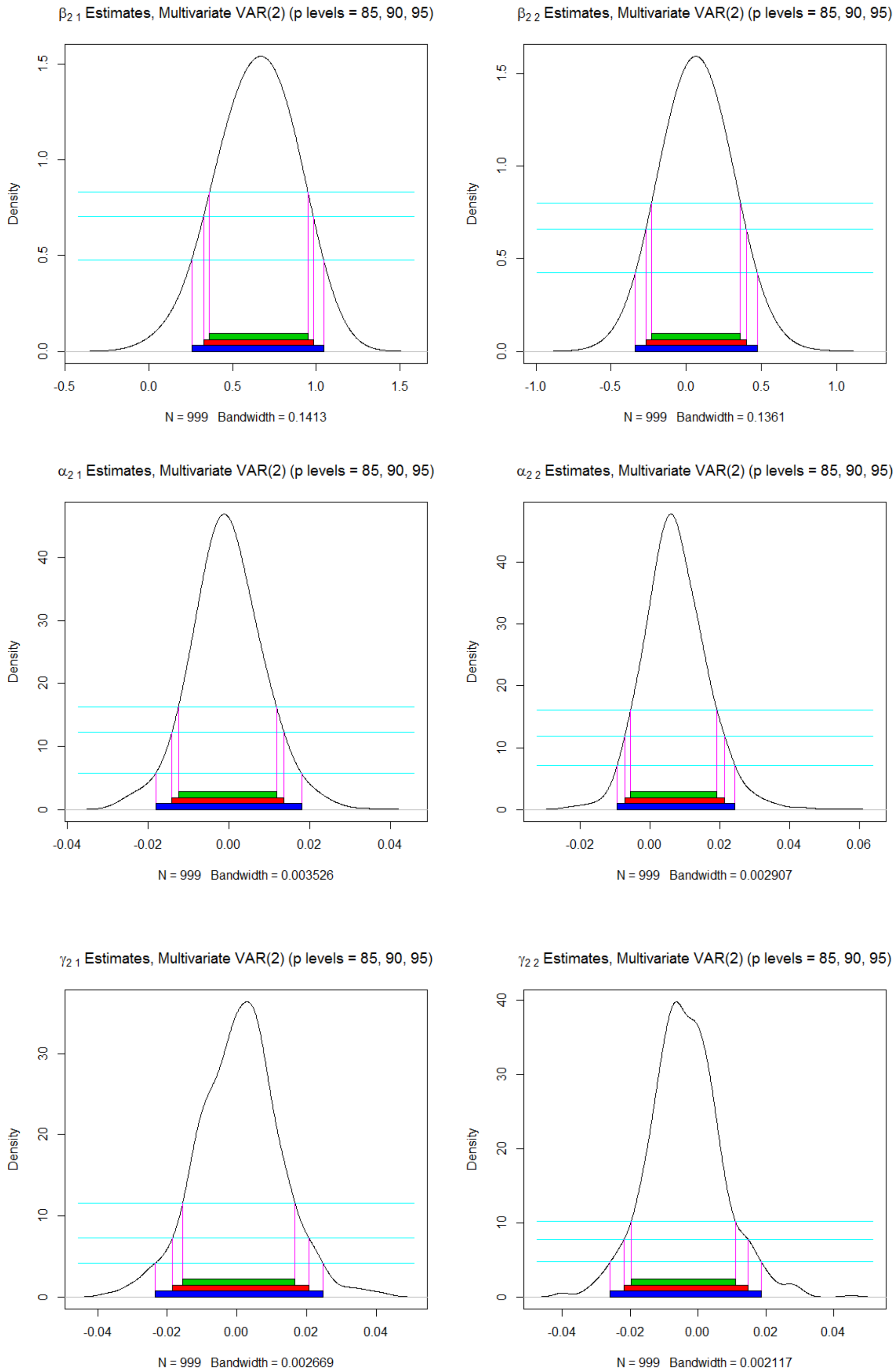

α1 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4
-1.0 -0.5 0.0 0.5 1.0
N = 999 Bandwidth = 0.184


β1 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0.00 0.02 0.04 0.06 0.08
-20 -10 0 10 20
N = 999 Bandwidth = 2.769

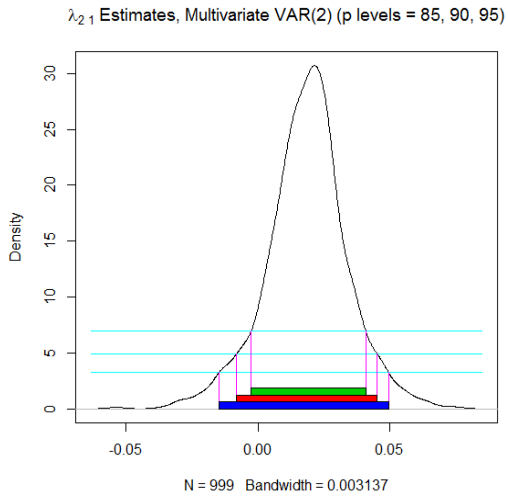

β1 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0.00 0.02 0.04 0.06 0.08 0.10
-10 0 10 20
N = 999 Bandwidth = 2.555

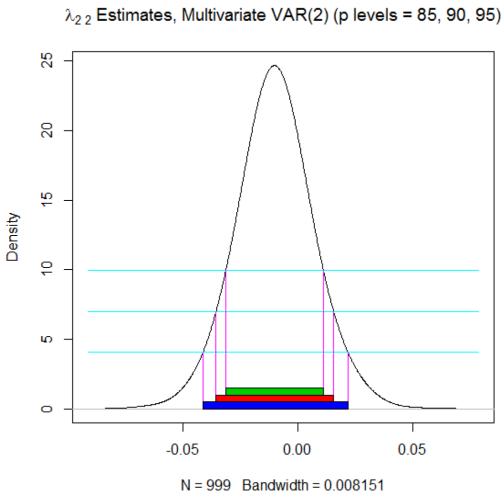

γ1 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0.0 0.2 0.4 0.6 0.8 1.0 1.2
-1.0 -0.5 0.0 0.5 1.0 1.5
N = 999 Bandwidth = 0.1566


γ12 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.21
λ11 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.2467
λ12 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.3782
c2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1548

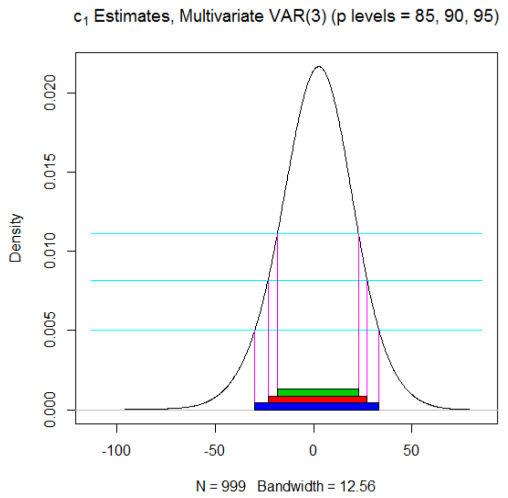


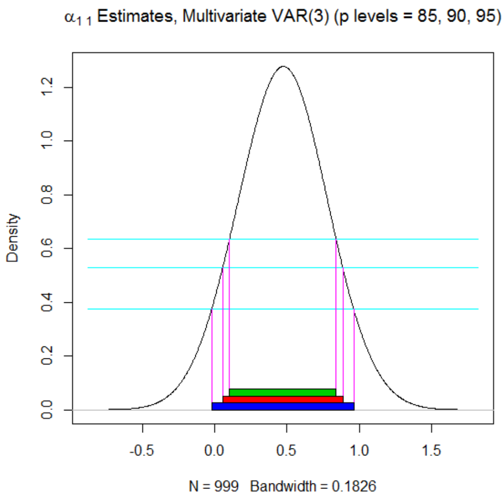
β2 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1413
β2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1361
α2 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.003526
α2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.002907
γ2 1 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.002669
γ2 2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.002117

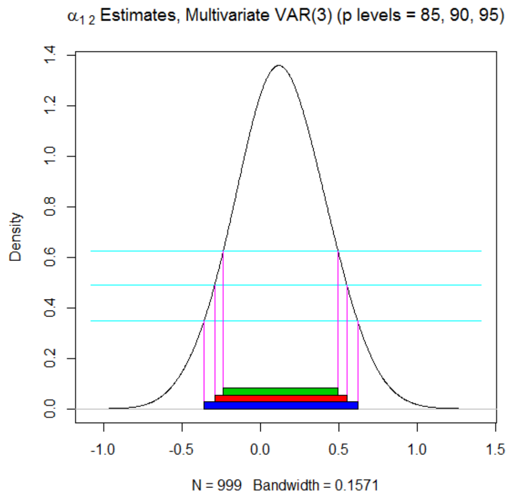

$\lambda_{2\,1}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.003137

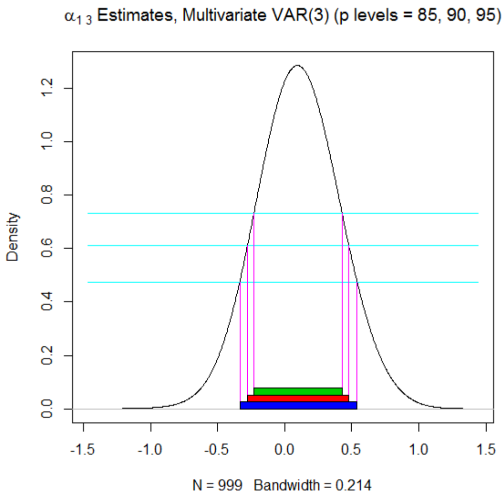

$\lambda_{2\,2}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.008151

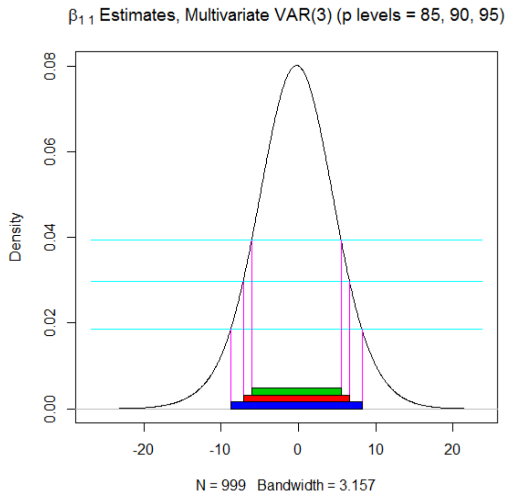
VAR(3)

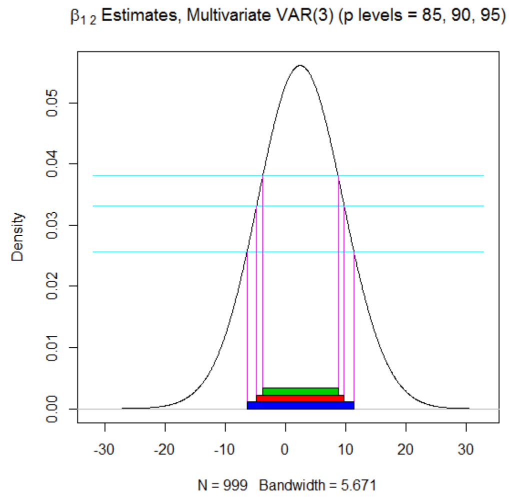

c_1 Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 12.56

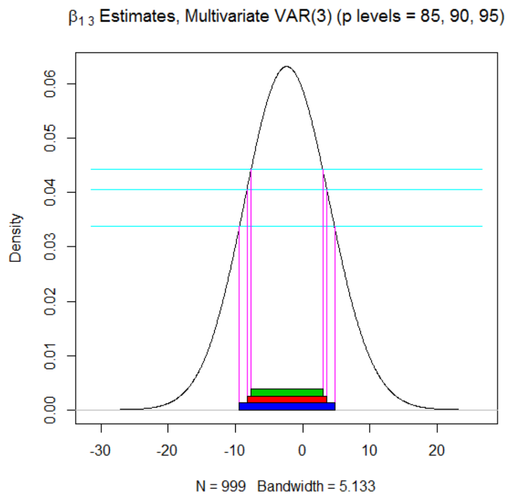

$\alpha_{1\,1}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1826

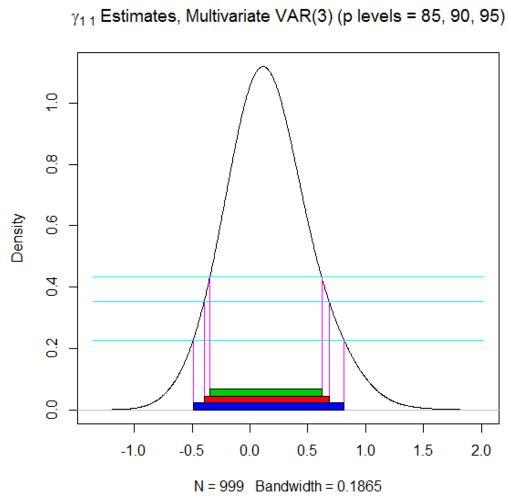

$\alpha_{1\,2}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1571

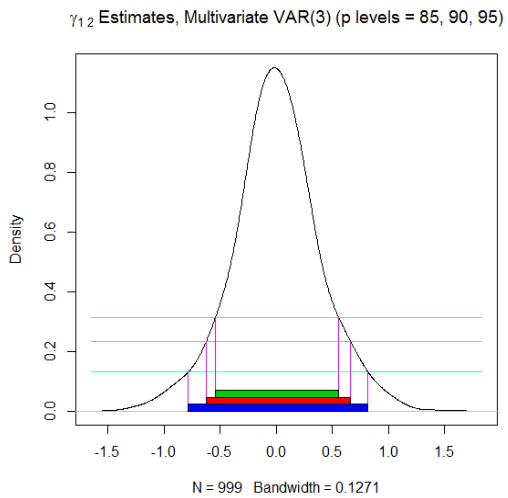

$\alpha_{1\,3}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.214

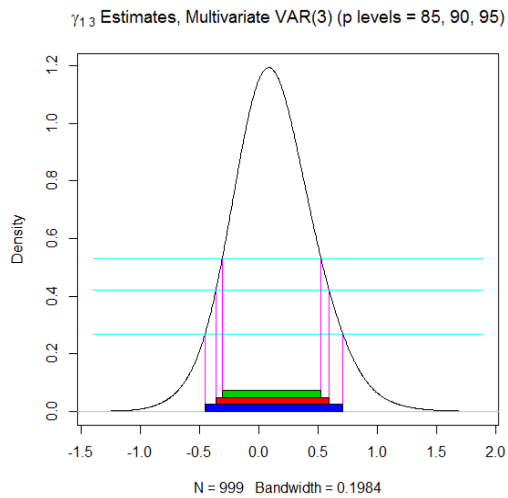

$\beta_{1\,1}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 3.157


$\beta_{1\,2}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 5.671

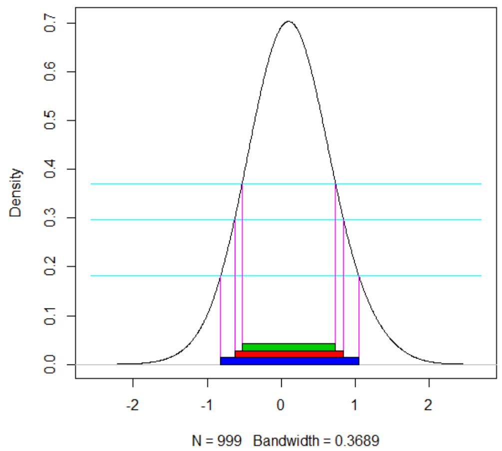

$\beta_{1\,3}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 5.133


$\gamma_{1\,1}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1865

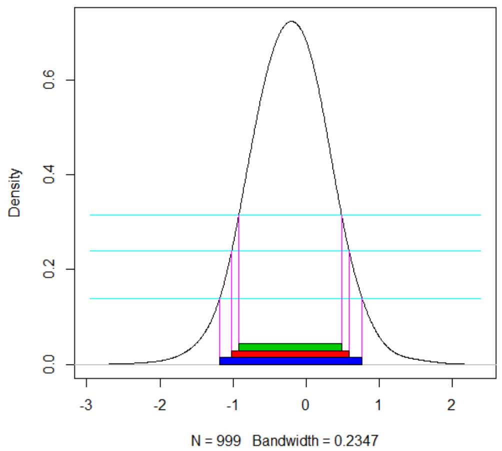

$\gamma_{1\,2}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1271


$\gamma_{1\,3}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1984

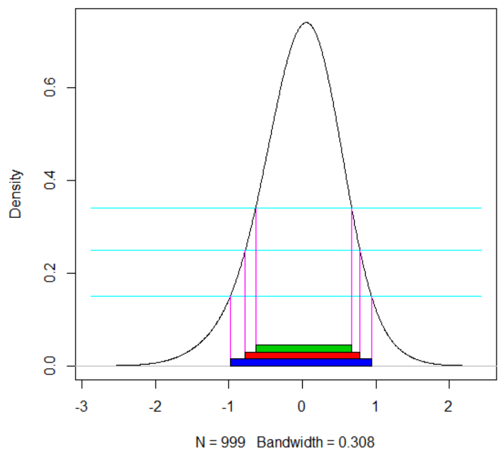
$\lambda_{1\,1}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)



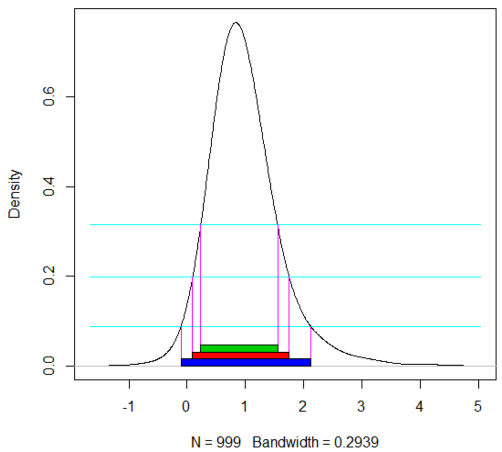
$\lambda_{1\,2}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)



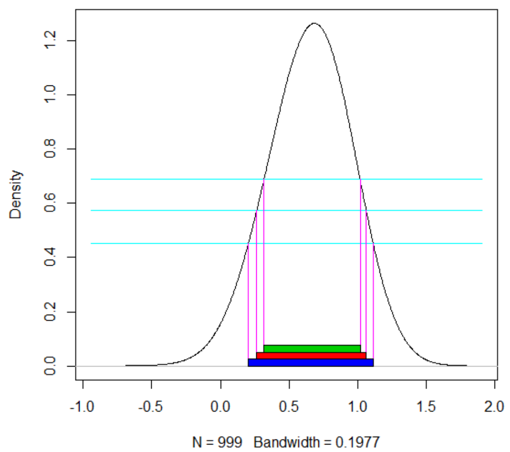
$\lambda_{1\,3}$ Estimates, Multivariate VAR(3) (p levels = 85, 90, 95)



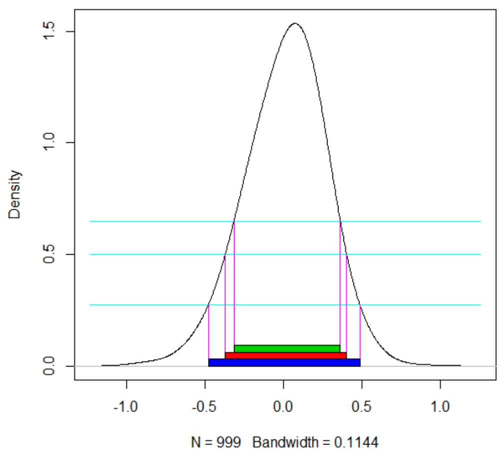
c_2 Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)

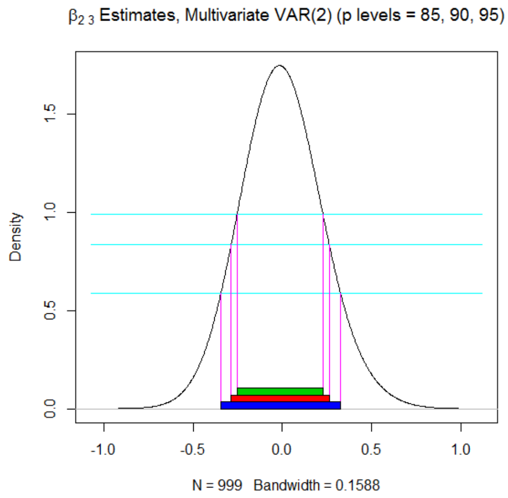


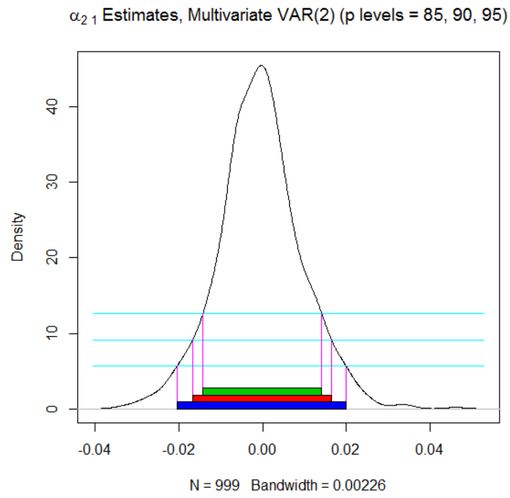
$\beta_{2\,1}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)

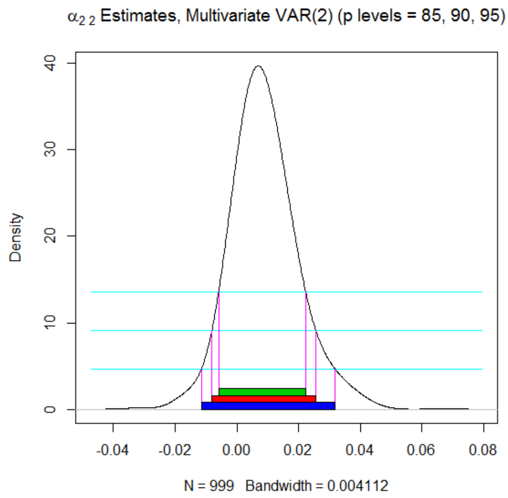


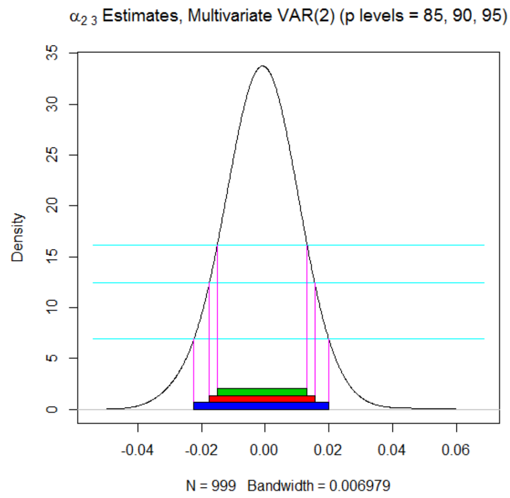
$\beta_{2\,2}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)

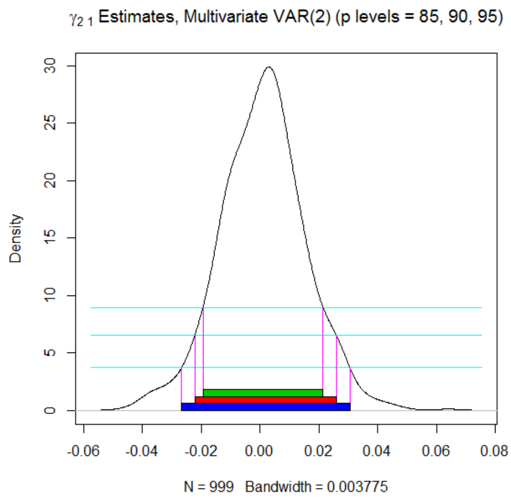


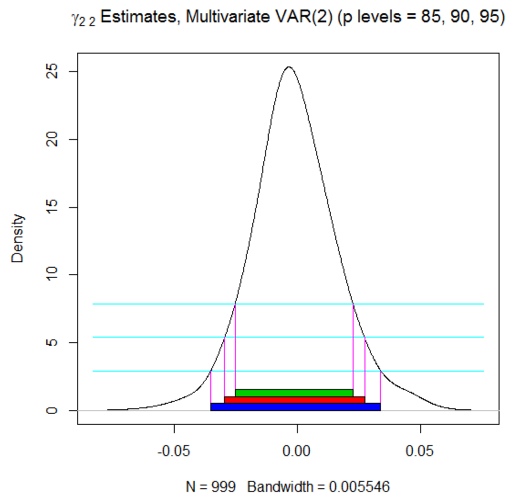

$\beta_{2\,3}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.1588

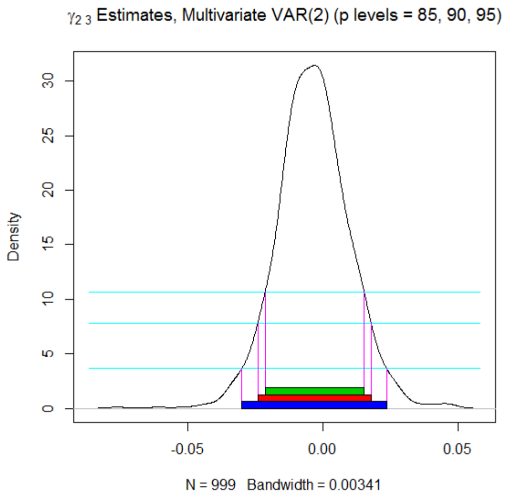

$\alpha_{2\,1}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.00226

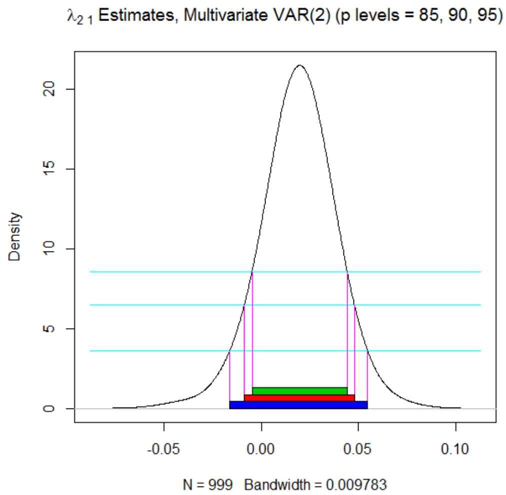

$\alpha_{2\,2}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.004112

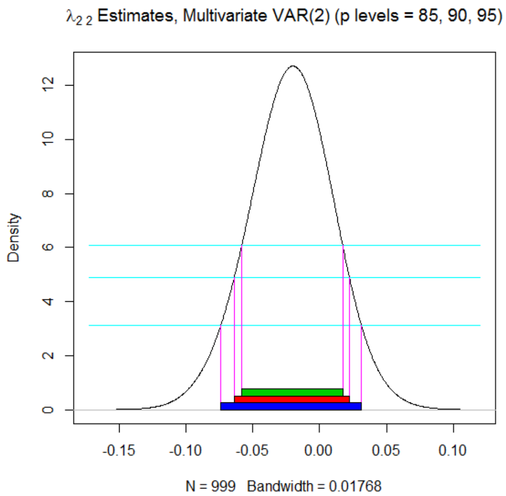

$\alpha_{2\,3}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.006979

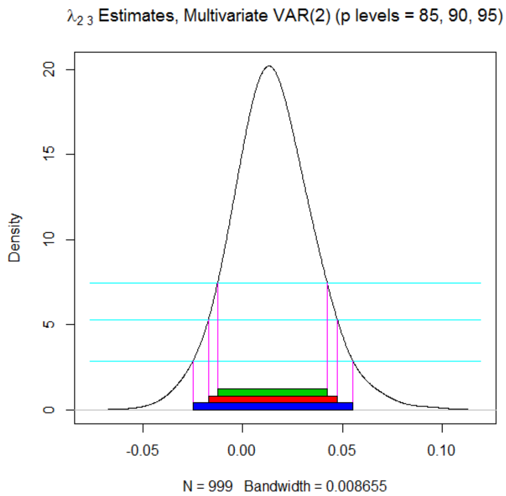

$\gamma_{2\,1}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.003775


$\gamma_{2\,2}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
N = 999 Bandwidth = 0.005546


$\gamma_{2\,3}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0
5
10
15
20
25
30
-0.05
0.00
0.05
N = 999 Bandwidth = 0.00341


$\lambda_{2\,1}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0
5
10
15
20
-0.05
0.00
0.05
0.10
N = 999 Bandwidth = 0.009783


$\lambda_{2\,2}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0
2
4
6
8
10
12
-0.15
-0.10
-0.05
0.00
0.05
0.10
N = 999 Bandwidth = 0.01768


$\lambda_{2\,3}$ Estimates, Multivariate VAR(2) (p levels = 85, 90, 95)
Density
0
5
10
15
20
-0.05
0.00
0.05
0.10
N = 999 Bandwidth = 0.008655

A4 Oil Price Pass-Through Rates

	PPI				CPI				DIF			
	Min	Max	First	Last	Min	Max	First	Last	Min	Max	First	Last
1 month	0.006	0.068	0.020	0.044	-0.012	0.035	-0.005	0.007	0.018	0.046	0.025	0.037
2 month	0.006	0.072	0.021	0.065	-0.036	0.040	0.005	0.011	0.016	0.063	0.016	0.054
3 month	0.004	0.083	0.021	0.077	-0.038	0.041	0.007	0.016	0.014	0.073	0.015	0.062
4 month	0.003	0.091	0.021	0.084	-0.038	0.041	0.007	0.019	0.014	0.078	0.014	0.065
5 month	0.002	0.095	0.022	0.087	-0.038	0.041	0.007	0.020	0.014	0.080	0.014	0.067
6 month	0.002	0.098	0.022	0.089	-0.038	0.041	0.008	0.021	0.014	0.081	0.014	0.068
7 month	0.003	0.100	0.022	0.091	-0.038	0.042	0.008	0.022	0.014	0.081	0.014	0.069
8 month	0.003	0.101	0.022	0.092	-0.038	0.042	0.008	0.022	0.014	0.082	0.014	0.070
9 month	0.004	0.107	0.022	0.093	-0.039	0.042	0.008	0.022	0.014	0.082	0.014	0.071
10 month	0.004	0.112	0.023	0.095	-0.039	0.042	0.009	0.022	0.014	0.083	0.014	0.072
11 month	0.005	0.118	0.023	0.096	-0.040	0.043	0.009	0.023	0.014	0.085	0.014	0.073
12 month	0.005	0.122	0.023	0.097	-0.040	0.046	0.009	0.023	0.014	0.086	0.014	0.074
13 month	0.006	0.127	0.023	0.098	-0.041	0.050	0.009	0.023	0.014	0.087	0.014	0.075
14 month	0.006	0.130	0.024	0.099	-0.041	0.053	0.010	0.023	0.014	0.088	0.014	0.076
15 month	0.007	0.134	0.024	0.100	-0.042	0.055	0.010	0.023	0.014	0.089	0.014	0.076
16 month	0.007	0.137	0.024	0.101	-0.043	0.058	0.010	0.024	0.014	0.089	0.014	0.077
17 month	0.008	0.140	0.025	0.102	-0.043	0.060	0.011	0.024	0.014	0.090	0.014	0.078
18 month	0.009	0.142	0.025	0.102	-0.044	0.062	0.011	0.024	0.014	0.091	0.014	0.079
19 month	0.009	0.144	0.026	0.103	-0.044	0.063	0.011	0.024	0.014	0.092	0.014	0.079
20 month	0.008	0.146	0.026	0.104	-0.045	0.065	0.012	0.024	0.014	0.092	0.014	0.080
21 month	0.008	0.148	0.026	0.105	-0.045	0.068	0.012	0.024	0.014	0.093	0.014	0.080
22 month	0.007	0.149	0.027	0.105	-0.046	0.070	0.013	0.025	0.014	0.093	0.014	0.081
23 month	0.007	0.151	0.027	0.106	-0.046	0.072	0.013	0.025	0.014	0.094	0.014	0.081
24 month	0.007	0.152	0.028	0.107	-0.047	0.075	0.014	0.025	0.014	0.095	0.014	0.082

CURRICULUM VITAE

Dincer Dedeoglu
Agust 28,1981, Single Male, Turkish
Kadıkoy, Istanbul, Turkey, 34744
dedeoglud@gmail.com

Work Experience

- Research Assistant

  Faculty of Economic and Administrative Sciences, Bahcesehir University

  2010-present

Education

- Ph.D. in Economics, Yıldız Technical University.
- M.A. in Financial Economics, Istanbul Bilgi University.
- B.A. in Economics, Istanbul Bilgi University.

Publications

- Energy use, exports, imports and GDP: New evidence from the OECD countries, Energy Policy, 2013 , 57(C), 469-476. (joint with Huseyin Kaya)
- A dynamic panel study of energy consumption-economic growth nexus: evidence from the former Soviet Union Countries. OPEC Energy Review, Organization of the Petroleum Exporting Countries, 2014, 38(1), 75-106. (joint with Ali Piskin)
- Evolution of comovement between commodity futures:does biofuels matter? Theoretical and Applied Economics, 2014, 6(595), 37-50.
- The Evolution of Exchange Rate Pass Through in Turkey: Does Inflation Targeting Matter?" Afro Euroasian studies, 2014, 3(1), 26-33. (joint with Huseyin Kaya)
- Pass-through of oil prices to domestic prices: Evidence from an oil-hungry but oil-poor emerging market. Economic Modelling, 2014, 43, 67-74. (joint with Huseyin Kaya)

Conference/Seminar Presentations

- Demokrasi ve Ekonomik Kalkınma: 1992 Sonrası Orta Asya Türk Cumhuriyetleri için Bir Analiz, Uluslararası Avrasya Ekonomileri Konferansı, 4-5 Kasım 2010, Beykent Üniversitesi, İstanbul. (joint with Ali Piskin)
- Oil Price Pass Though in Turkey, 9th EBES Conference, 11-13 January 2013 Rome, Italy
- Evolution Of Comovement Between Commodity Futures: Does Biofuels Matter International Conference on Eurasian Economies 17-18 September 2013, St. Petersburg.

Computer Skills

STATA, E-views, Standard Office packages, Matlab (basic level), Gauss (basic level), Rats and Cats (basic level)

Languages

Turkish (native), English (fluent), Spanish (beginner)

Interests

Semi-professioanl guitar player