Dynamic Effects of Shadow Economy and Environmental Pollution on the Energy Stock Prices

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ABSTRACT

This thesis aims to study the dynamic effects of shadow economies and environmental pollution on energy stock prices by empirically investigating the case of Turkey and the Organization for Economic Co-operation and Development (OECD) countries using Generalized Methods of Moments (GMM).

The GMM analysis of Turkey has been done years from 2006 to 2014. The results of GMM analysis show that; negative link exists between shadow economies and the energy stock prices of Turkey. Therefore, an increase in shadow economies decreases the energy stock prices. Additionally, energy stock performance is not significantly related to environmental deterioration. Nevertheless, it is also found that the level of shadow economies rises with growth in energy consumption and emission levels.

The analysis of OECD countries covers years from 2004 to 2014. The results of GMM analysis show a significant relationship exists between shadow economies, energy stock prices, and environmental pollution. Environmental pollution negatively affects energy stock prices even energy demand found positively linked with energy stock prices. On the other hand, U- shaped relationship found between energy stock prices and shadow economies, which means the response of energy stock prices to the volume of shadow economies is negative at the lower level of shadow economies; then beyond a trough point, this link turns to be positive with the higher level of shadow economies.

Keywords: energy stock prices, shadow economies, environmental pollution, generalized methods of moments, Turkey, OECD.

ÖZ

Bu tezin amacı çevre kirliliği ve kayıt dışı ekonominin enerji hisse senedi fiyatları üzerindeki dinamik etkilerini araştırmaktır. Bu konu üzerinde Genelleştirilmiş Momentler Yöntemi (GMM) kullanılarak Türkiye ve Ekonomik Kalkınma ve İşbirliği Örgütü (OECD) ülkeleri ile çalışılmıştır.

Çalışmada Türkiye için 2006 yılından 2014 yılına kadar olan yıllık dönem ele alınmıştır. Yapılan GMM analizleri sonucunda kayıt dışı ekonomiyle enerji hisse senedi fiyatları arasında negatif yönlü bir ilişki tespit edilmiştir. Böylelikle, kayıt dışı ekonominin hacmindeki artış enerji hisse senedi fiyatlarını düşürdüğü ortaya konulmuştur. Buna ek olarak, enerji hisse senedi fiyatları ve çevre kirliliği arasında bir ilişki saptanamamasına rağmen, enerji talebi ve karbon emisyonundaki artışın, kayıt dışı ekonomiyi artırdığı saptanmıştır.

OECD ülkeleri için 2004 yılından 2014 yılına kadar olan yıllık dönem ele alınmıştır. Elde edilen sonuçlar kayıt dışı ekonomi, enerji hisse senedi fiyatları ve çevre kirliliği arasında önemli bir ilişki olduğunu ortaya koymaktadır. Çevre kirliliğinin enerji hisse senedi fiyatlarını olumsuz etkilediği görülmesine rağmen, enerji talebindeki artışın enerji hisse senedi fiyatlarını artırdığı gözlemlenmiştir. Kayıt dışı ekonomi ile enerji hisse senedi fiyatları arasında U- şeklinde bir ilişki olduğu bulunmuş ve bu ilişki kayıt dışı ekonominin ilk aşamalarında enerji hisse senedi fiyatlarıyla negatif yönlü, dip noktasına eriştikten sonraysa pozitif yönlü olduğu şeklinde açıklanabilmektedir.

Anahtar Kelimeler: enerji hisse senedi fiyatları, kayıt dışı ekonomi, çevre kirliliği, genelleştirilmiş momentler yöntemi, Türkiye, OECD.

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LIST OF ABBREVIATIONS

CPI	Consumer Price Index
DOLS	Dynamic Ordinary Least Squares
FMOLS	Fully Modified Ordinary Least Squares
GDP	Gross Domestic Product
GMM	Generalized Methods of Moments
OECD	Organization for Economic Co-operation and Development

Chapter 1

INTRODUCTION

1.1 Determinants of Stock Markets in General and Energy Stock Markets

Stock prices are affected by macro and micro-level changes in the economy. The micro-level changes can be firm and market-level changes such as; earnings per share (Hussein et al., 2011), the expected future cash flows (Chen et al., 2013), capital structure (Sharpe, 1964; Hamada;1972), dividend yield, payout ratio (Baskin,1989; Docking and Koch,2005; Matthew et al., 2014; AlQudah and Yusuf, 2015), earning per share announcement (Baskin,1989; Docking and Koch,2005; Matthew et al., 2014), leverage ratio (Cai and Zhang, 2011), capital structure (Sharpe,1964; Hamada, 1972; Murniati, 2016). Besides, political stability (Pástor & Veronesi 2012; Baker et al.2016; Liu et.al., 2017) and macro-level changes in the economy of a country affect the entire stock market. The growth rate of the economy (Rays,2012; Ho,2018), changes in the price level (Zhao, 1999; Hadi et al., 2019; Katircioglu et al., 2019), interest rate policy (Shiller & Grossman, 1980; Mukherjee & Naka, 1995; Jenkins & Katircioglu, 2010; Hussein et al., 2011), money supply (Ibrahim, 2003; Bissoon et al., 2016) and industrial production (Mukherjee and Naka, 1995; Ibrahim, 2003) are significant factors that affect stock prices.

The determinants of stock prices are debated in the literature and these are effective to determine the energy stock prices also. However, as far as the main impact factors of the stock prices are investigated, literature is restricted to emphasize the factors that affect energy stock prices. Not only the energy stock prices but also all stock prices are influenced by oil prices. Memis and Kapusuzoglu (2015) investigated a significant link between oil prices and the stock market. According to Filis (2010), stock prices are negatively affected by any possible shock on the oil price level. In contrast, Aloui et al. (2012) investigated a positive link between oil price changes and the emerging stock market. Besides, energy stocks are more sensitive to the changes in the Crude Oil market (Broadstock et al., 2012). Oberndorfer (2009) investigated the relationship between energy price volatility and European energy stock price and results in oil price hikes appreciate oil and gas stocks and pre-forecasted oil price volatility has negative impacts on the energy stocks.

Energy consumption is a significant factor that affects energy stock prices whereas Ersoy and Ünlü (2013) investigated the effects of energy consumption on the stock prices. Fossil fuel energy firms are one of the pollutant firms and enhance carbon emission if the production is not environmentally friendly enough. The cost of carbon emission allowances of energy firms may impact firm value and be reflected in stock prices. Zhang et al. (2018) investigated the effects of carbon prices on the market value of energy firms by employing weekly data from July 2014 to June 2017 for China. Results state that carbon prices have negative effects on the market value of energy firms.

1.2 Interactions between Formal Economies and Energy Stock Market

The nexus between energy stock price and GDP (gross domestic product) can be interpreted by general economic theory; the stock prices of firms show the firm's future earnings (Arouri et al., 2011; Basher et al., 2018). Therefore, the profitability of firms is the important determinant of GDP, consumption, and investment. Stock prices are crucial determinants of economic indicators. The nexus between stock prices and GDP has been investigated in the literature. Bank and stock market development boosts economic growth (Arestis et al., 2001). Furthermore, economic growth also positively affects the stock markets (Rays, 2012; Ho, 2018). The pioneering study is done by Hamilton (2003) to investigate the relationship between oil prices and GDP growth. A nonlinear relationship is found between oil prices and GDP growth. The oil price increase is the most significant predictor of GDP rather than decrease. The relationship between crude oil prices and the GDP of leading oil supplier countries is investigated by an earlier study by Nyangarika et al. (2018). A strong relationship is found between crude oil prices and GDP. Therefore, energy prices are an important factor for the economy as a whole. Consequently, energy stock prices are the reflection of energy prices, and any changes in energy stock prices affect GDP.

1.3 Interactions between Shadow Economies and Energy Stock Markets

The sustainability of the financial sector is prevented by shadow financial activities. As the shadow activities expand within the financial market; formal agencies can only obtain limited funds. Therefore, a higher cost of credit is claimed by formal agencies (Gobbi and Zizza, 2007). On the other hand, initial costs of reaching capital (such as registration fees) are claimed by the official agencies causes official markets less attractive compared with unofficial agencies (Straub,2005). Hence, the improvements in the financial sector lower the cost of credit and shadow activities within the financial system (Base et al., 2008; Base et al., 2012). In literature, the possible link between shadow economy and the energy sector is expressed with the techniques of shadow economy measurement. The methods of measuring the size of shadow economic activities are debated by scholars and investigated several techniques. The most popular ones can be categorized into three groups. The informal activities can be measured into direct methods with income auditing and selected microeconomic taxes whereas indirect methods are used to employ analysis of differences among selected economic indicators (Tanzi 1980,1982,1999; Giles and Tedds, 2002). Schneider et.al. (2010) introduced an approach called the MIMIC (Dynamic Multiple Indicators Multiple Causes) model based on the application of shadow economy as a hidden variable whereas all economic factors are determinant of informal economy which is now most popular to use by scholars. On the other hand, the determination of the size of informal activities is gauged by the energy consumption rates. According to Lackò (2011) approach, the size of the shadow economy is determined by household energy consumption. Another approach is introduced by Kaufman and Kaliberda (1996) called the electricity input method whereas the total energy consumption of a country is used as the main determinant of the shadow economy. Furthermore, according to Medina and Schnieder (2017), the role of the shadow economy in oil-producing countries ranges between 11 percent to 62 percent which gives the mean of 32 percent for oil-producing countries which is interpreted as shadow economy plays important role in oil-producing countries. This shows that the energy sector and shadow economy are closely correlated. Accordingly, it is possible to have a relation with the shadow economy and energy stock prices of countries where the shadow economy exists. Previous studies mostly concentrated on the impacts of similar factors on the changes in stock prices. However, different factors that affect energy stock prices need attention. As the formal economy influences the stock market prices, it is also expected the informal economy to act on stock prices.

1.4 Interactions between Shadow Economies Environmental Performance and Energy Stock Prices

Environmental performance is a crucial and popular issue for national and international aspects (Blackman, 2010). The level of environmental degradation is explained with Environmental Kuznets Curve (EKC) as the economic growth of a country increases energy demand and this stimulates an increase in carbon emission levels (Katircioglu et al., 2018). The sustainability of environmental quality can only be reached by imposing policy and regulations on businesses and institutions. The size of the shadow economy and institutional weaknesses are significant factors for determining the success of environmental policies and level of pollution. Environmental sustainability is violated by informal economic activities (Abid,2015; Canh et al., 2019). Understanding and focusing on the effects of environmental regulations on the formal sector is not clear. Possible effects of shadow economy should be considered (Mazhar and Elgin, 2013; 72). Shadow economy plays a very important role in environmental pollution covering emissions (Imamoglu, 2018; Chen et al.,2018; Pang et al., 2020) and hazardous effluents especially in developing countries (Chaudhuri and Mukhopadhyay, 2010). Elgin and Öztunalı (2014) investigated the relationship between shadow sector size and carbon emission for Turkey by employing years from 1950 to 2009 based on Environmental Kuznets Curve (EKC). The inverted U shape relationship has been found between shadow sector size and pollution. The result is interpreted as small environmental pollution exists when the shadow economy level is small and large. Additionally, the medium level of shadow economy reasons environmental pollution to reach its maximum. Environmental degradation is attempted to control by the government by imposing emission taxes and several environmental regulations. Formal producers try to avoid these responsibilities by employing the shadow sector whose produces informally by ignoring environmental policies and reasoning emissions to increase (Blackman, 2000; Chaudri and Mukhopadhyay, 2003; Baksi and Bose,2010; Mazhar and Elgin, 2013 Chen et al.,2018). More stringent environmental regulations reduce the production of polluting goods (scale effect), at the same time shadow production is accelerated (composition effect) (Baksi and Bose, 2010). Similar results are achieved by Mazhar and Elgin (2013); the recorded and unrecorded carbon emissions are explained by the link between the shadow economy and environmental regulations. As the environmental policies get more stringent the recorded carbon emission slow down while unrecorded emission level raise. Consequently, the environmental pollution raises with shadow producers even with the stricter policies. Renewable energy and green production techniques are alternative factors to reduce production costs and pollution. A significant interaction between environmental degradation, energy sector, financial markets with income, and poverty is found (Baloch et al., 2019; Baloch et al., 2020a, b). According to Ye et al. (2013), the energy-saving activities of firms increase the market value of firms. Therefore, the upward trend in environmental degradation trigger firms to switch to alternative energy to prevent environmental degradation and increase the profitability of the firm so, the demand for fossil fuel energy mitigates, this fall down the energy stock prices.

1.5 Research Gap

This thesis debates that informal economic activities change energy stock market prices and boosts environmental degradation even as the formal economy is the main driver of environmental pollution. At the same time, financial investors need to consider the environmental degradation of the country, the volume of pollution caused by energy firms and greener energy investments, research and development policies of energy firms. The energy sector is one of the high pollutant sectors. These pollutant activities are negatively priced by the investors in the market (Dasgupta et al.,2001; Xu et al., 2012) has already been expressed in literature. Therefore, environmental degradation and energy stock prices are indirectly related. Furthermore, the link between energy stock prices, environmental degradation, and the informal economy is a new topic of debate and needs attention from researchers.

1.6 The Aim and Contribution of the Study

Against the relevant literature, this thesis aims to investigate the potential effects of the informal economy and environmental performance on energy stock prices. To the best of our knowledge, this thesis is the first for the topic of energy markets in the relevant literature.

1.7 Structure of the Study

This thesis is organized as follow; section 2 explains the Dynamic Relationship between Shadow Economies, Energy Stock Markets, and Environmental Performance: Empirical Evidence from Turkey, section 3 states Dynamic Effects of Shadow Economy and Environmental Pollution on the Energy Stock Prices: Empirical Evidence from OECD Countries and section 4 concludes the paper.

Chapter 2

DYNAMIC RELATIONSHIP BETWEEN SHADOW ECONOMIES ENERGY STOCK MARKETS AND ENVIRONMENTAL PERFORMANCE: EMPIRICAL EVIDENCE FROM TURKEY

2.1 Introduction

Environmental quality and energy markets have been on the agenda of scientists as well as scholars over a long time. It has been widely accepted that kinds of energy usage in the countries drive environmental quality levels. The Environmental Kuznets Curve (EKC) theory argues that economic growth in the countries results in additional energy demand, which also leads to changes in environmental quality levels (Katircioglu & Katircioglu, 2018; Kalayci & Koksal, 2015; Kapusuzoglu, 2014). On the other hand, energy prices have also been linked to the different economic agents in the relevant literature as well, and stock markets are among the others. Memis & Kapusuzoglu (2015) find that oil prices significantly affect stock markets. Many studies have focused on the same link; however, the other factors or the other economic aggregates influencing energy stock prices have not found interest from scholars yet to the best of our knowledge.

Stock prices are crucial for investor decisions. Studies find that stock prices are affected by changes in interest rates (Shiller & Grossman, 1980; Mukherjee & Naka, 1995; Maysami & Koh, 2000; Jenkins & Katircioglu, 2010), industrial productivity, macroeconomic stability of the country, and expectation of inflation (Soukhakian, 2007a; 2007b; Chen et.al., 1986; Gultekin, 1983), oil and gas prices (Benkraim et.al., 2018), money supply (Mukherjee & Naka, 1995; Chen et.al., 2013) and exchange rates (Mukherjee & Naka, 1995; Wongbangpo and Sharma, 2002). Additionally, the price of stocks is affected by the political events and the affairs which raise political uncertainty (Pástor & Veronesi 2012; Baker et al.2016; Liu et.al., 2017). Alternatively, as formal economic prospects are determinant factors for stock price changes, informal economies are also likely to affect this relationship and stock prices.

The definition of informal economies varies among researchers in the relevant literature (Williams, 2011; Schneider, 1999). According to Tanzi (1980), the description of informal economies is characterized as '*gross national product that, because of underreporting, is not measured by official statistics.'* Therefore, informal activities exert effects on the structure of the formal economy (Fethi et al., 2006). The size of informal economies has been estimated by researchers over the years (Hassan & Schneider, 2016; Fethi et al., 2013; Williams, 2011), which is widely found that the size of informal economies is more substantial in developing countries (Imamoglu et al., 2018). Tax burden and tax rates are boosted as a result of informal economic activities (Imamoglu et al., 2018). As the volume of informal economic activities increases, investors and entrepreneurs will be overburdened with high tax rates and strict government policies (Schneider, 1986). On the other hand, some studies find that shadow economies boost economies (Adam & Ginsburg, 1985; Choi & Thum, 2005) while some others find the reverse (Loayza, 1996; Buehn & Schneider, 2008; Schnieder & Williams; 2013).

Although the size of informal economies is closely related to the financial system by definition (Fethi et al., 2006; Williams, 2011), the nexus between these two has been linked recently in the relevant literatüre (Imamoglu et al., 2018). Imamoglu et al. (2018) find a feedback relationship between informal economies and financial markets; furthermore, they find that there is also an inverted U-shaped link between financial markets volume and informal economic activity in the case of European Union (EU) member states and the response of informal economic activity to a change in financial markets is positive at the initial level of financial activities whereas it becomes negative at the further levels. Thus, Imamoglu et al. (2018) conclude that financial markets are significant contributors to the volume of informal economic activity in the EU countries.

Since informality is a monetary phenomenon (Fethi et al., 2006; Williams, 2011), the environmental performance of countries is likely to be affected by significant changes in the financial system owing to informal economic activities. Therefore, it is reasonable to establish a link between environmental quality and informal economies as a result of such an argument. Furthermore, informal economies might impact environmental quality through the energy sector and energy consumption; financial stock prices of energy firms will probably be affected by this happening. Therefore, informal economies are likely to impact not only environmental quality through the patterns of energy consumption but also on the stock prices of energy firms.

Against this backdrop in the relevant literature, this study aims to investigate the possible effects of informal economies on energy stock prices, energy consumption, and environmental quality. To the best of our knowledge, searching this nexus will be the first of its kind in the literature. Results of such investigation are expected to deserve attention not only from scholars but also from policymakers. To investigate this nexus, Turkey is selected which is an exciting country due to numerous reasons: (1) Turkey has a developing economy with huge foreign energy dependency which results in persistent current account deficits over the long years; (2) financial markets progressed very well in the last three decades which provides attractive returns for investors with relatively high-interest rates regardless of how its economy operates; (3) the size of informal economies in Turkey is relatively high, about 32 percent (Imamoglu, 2016), compared to developed countries and some other counterparts; (4) and finally, Turkey is situated at the heart of the World which is very near to new gas and energy sources in the Mediterranean. Therefore, because of all of these reasons, Turkey is an exciting country case to establish a link between informal economies, energy markets, and environmental quality concerns.

This study is organized as follows; Section 2 describes the theoretical setting; section 3 describes data and methodology; section 4 presents results and discussions, and section 5 concludes the study together with policy implications.

2.2 Theoretical Setting

2.2.1 The Effects of Shadow Economies on Energy Stock Markets

The present study argues that the volume of shadow economic activities is likely to impact on stock prices of energy firms significantly owing to reasons mentioned in the previous section. Therefore, the following dynamic model is proposed in this study:

$$
\begin{bmatrix} \ln SP_t \\ \ln CO_{2t} \\ \ln SE_t \\ \ln EC_t \\ \ln GDP_t \\ \ln FD_t \\ \ln FDI_t \\ \ln CPI_t \\ RIR_t \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \\ \mu_4 \\ \mu_5 \\ \mu_6 \\ \mu_7 \\ \mu_8 \\ \mu_9 \end{bmatrix} + \begin{bmatrix} \eta_{11,1} & \eta_{12,1} & \eta_{13,1} & \eta_{14,1} & \eta_{15,1} & \eta_{16,1} & \eta_{17,1} & \eta_{18,1} & \eta_{19,1} \\ \eta_{21,1} & \eta_{22,1} & \eta_{23,1} & \eta_{24,1} & \eta_{25,1} & \eta_{26,1} & \eta_{27,1} & \eta_{28,1} & \eta_{29,1} \\ \eta_{31,1} & \eta_{32,1} & \eta_{33,1} & \eta_{34,1} & \eta_{35,1} & \eta_{36,1} & \eta_{37,1} & \eta_{38,1} & \eta_{39,1} \\ \eta_{41,1} & \eta_{42,1} & \eta_{43,1} & \eta_{44,1} & \eta_{45,1} & \eta_{46,1} & \eta_{47,1} & \eta_{48,1} & \eta_{49,1} \\ \eta_{51,1} & \eta_{52,1} & \eta_{53,1} & \eta_{54,1} & \eta_{55,1} & \eta_{56,1} & \eta_{57,1} & \eta_{58,1} & \eta_{59,1} \\ \eta_{61,1} & \eta_{62,1} & \eta_{63,1} & \eta_{64,1} & \eta_{65,1} & \eta_{66,1} & \eta_{67,1} & \eta_{68,1} & \eta_{69,1} \\ \eta_{71,1} & \eta_{72,1} & \eta_{73,1} & \eta_{74,1} & \eta_{75,1} & \eta_{76,1} & \eta_{77,1} & \eta_{78,1} & \eta_{79,1} \\ \eta_{81,1} & \eta_{82,1} & \eta_{83,1} & \eta_{84,1} & \eta_{85,1} & \eta_{86,1} & \eta_{87,1} & \eta_{88,1} & \eta_{89,1} \\ \eta_{91,1} & \eta_{92,1} & \eta_{93,1} & \eta_{94,1} & \eta_{95,1} & \eta_{96,1} & \eta_{97,1} & \eta_{98,1} & \eta_{99,1} \end{bmatrix} \begin{bmatrix} \ln SP_t \\ \ln CO_{2t} \\ \ln SE_t \\ \ln EC_t \\ \ln GDP_t \\ \ln FD_t \\ \ln FDI_t \\ \ln CPI_t \\ RIR_t \end{bmatrix}
$$

$$
+ \dots + \begin{bmatrix} \eta_{11,i} & \eta_{12,i} & \eta_{13,i} & \eta_{14,i} & \eta_{15,i} & \eta_{16,i} & \eta_{17,i} & \eta_{18,i} & \eta_{19,i} \\ \eta_{21,i} & \eta_{22,i} & \eta_{23,i} & \eta_{24,i} & \eta_{25,i} & \eta_{26,i} & \eta_{27,i} & \eta_{28,i} & \eta_{29,i} \\ \eta_{31,i} & \eta_{32,i} & \eta_{33,i} & \eta_{34,i} & \eta_{35,i} & \eta_{36,i} & \eta_{37,i} & \eta_{38,i} & \eta_{39,i} \\ \eta_{41,i} & \eta_{42,i} & \eta_{43,i} & \eta_{44,i} & \eta_{45,i} & \eta_{46,i} & \eta_{47,i} & \eta_{48,i} & \eta_{49,i} \\ \eta_{51,i} & \eta_{52,i} & \eta_{53,i} & \eta_{54,i} & \eta_{55,i} & \eta_{56,i} & \eta_{57,i} & \eta_{58,i} & \eta_{59,i} \\ \eta_{61,i} & \eta_{62,i} & \eta_{63,i} & \eta_{64,i} & \eta_{65,i} & \eta_{66,i} & \eta_{67,i} & \eta_{68,i} & \eta_{69,i} \\ \eta_{71,i} & \eta_{72,i} & \eta_{73,i} & \eta_{74,i} & \eta_{75,i} & \eta_{76,i} & \eta_{77,i} & \eta_{78,i} & \eta_{79,i} \\ \eta_{81,i} & \eta_{82,i} & \eta_{83,i} & \eta_{84,i} & \eta_{85,i} & \eta_{86,i} & \eta_{87,i} & \eta_{88,i} & \eta_{89,i} \\ \eta_{91,i} & \eta_{92,i} & \eta_{93,i} & \eta_{94,i} & \eta_{95,i} & \eta_{96,i} & \eta_{97,i} & \eta_{98,i} & \eta_{99,i} \end{bmatrix} \begin{bmatrix} \ln SP_t \\ \ln CO_{2t} \\ \ln SE_t \\ \ln EC_t \\ \ln GDP_t \\ \ln FD_t \\ \ln FDI_t \\ \ln CPI_t \\ RIR_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \varepsilon_{4,t} \\ \varepsilon_{5,t} \\ \varepsilon_{6,t} \\ \varepsilon_{7,t} \\ \varepsilon_{8,t} \\ \varepsilon_{9,t} \end{bmatrix} \quad (1)
$$

where $lnSP_t$ stands for the natural logarithm of stock prices of energy-related firms at period t; the same is for CO_{2t} standing for carbon dioxide emissions, SE_t standing for shadow economy, GDP standing for gross domestic product, RIR is real interest rates, FD is financial development proxy, FDI is foreign direct investments, EC is energy consumption, and SE is the volume of shadow economies.

In addition to SE, several control variables are added to equation (1) in parallel to previous literature. It is widely documented that the growth prospects of countries, as well as business conditions, are crucial for investors in the stock markets (Sodeyfi & Katircioglu, 2016); thus, GDP would be an essential control variable in the equation (1). A financial system (development), inflation, and interest rates are core determinants of stock prices as also advised in the literature (Hadi et al., 2019; Katircioglu et al., 2019; Shaeri et al., 2016). Foreign direct investments are dominant in energy sectors, especially in developing countries. Thus, energy consumption and energy stock markets are likely to be driven by FDI as well. Finally, energy consumption would be another vital control variable in equation (1) that drives energy stock prices.

2.3 Data and Methodology

2.3.1 Data

A panel data of 11 energy firms of Turkey is selected whose stocks are traded in the Istanbul Stock of Exchange (BIST). The panel data covers the annual period from 2006 to 2014. Variables of the study are energy stock prices of the selected energy firms in Turkey (SP) (2010 = 100), carbon dioxide emissions (CO_2) (kt), proxy of shadow economy (SE) as percent of GDP, energy consumption (EC) (kg of oil equivalent per capita), constant GDP (2010 = 100), financial development index (FD), foreign direct investment (FDI) (as percent of GDP), consumer price index (CPI) (2010 = 100), and real interest rates (RIR) (2010 = 100). Data for SP of energy firms are gathered from BIST (Borsa Istanbul) while data for SE is gathered from Medina and Schnieder (2018), and FD is obtained from the International Monetary Fund (2019). The rest of the variables is gathered from World Bank (2019). Table 1 presents descriptive statistics of the series under consideration:

Table 1: Descriptive statistics for Turkey data

	Stock Price (2010 = 100)	CO2 Emissions (kt. Of oil equivalent)	Shadow Economy (% of GDP)	Energy Consumption per Capita (kt. Of oil equivalent)	GDP (2010 = 100)	Financial Development Index (% of GDP)	FDI (% of GDP)	CPI (2010 = 100)	Interest Rate (%)
Mean	1.515945	297765.4	29.11596	1457.321	8.14E+11	0.473043	2.022313	98.68144	9.021154
Median	0.711144	298002.4	29.14000	1474.670	7.72E+11	0.476687	1.572572	100.0000	6.500000
Maximum	10.59553	345981.5	32.33000	1585.400	1.03E+12	0.517751	3.653480	135.6614	17.50000
Minimum	0.087250	237390.6	27.33000	1240.166	6.58E+11	0.432643	1.178777	65.85295	1.630000
Std. Dev.	2.409814	32333.18	1.523321	107.8523	1.19E+11	0.027613	0.808118	22.06740	5.542517
Skewness	2.788659	-0.248942	0.569299	-0.501456	0.507625	-0.042785	0.913892	0.152255	0.326766
Kurtosis	9.528659	2.079490	2.497169	2.214574	1.895796	1.952254	2.438530	1.860676	1.498418
Jarque-Bera	319.4961	4.745980	6.713391	7.031818	9.749994	4.788740	15.84286	6.026737	11.62137
Probability	0.000000	0.093202	0.034850	0.029721	0.007635	0.091230	0.000363	0.049126	0.002995
Sum	157.6583	30967602	3028.060	151561.4	8.47E+13	49.19645	210.3205	10262.87	938.2000
Sum Sq. Dev.	598.1420	1.08E+11	239.0123	1198108.	1.46E+24	0.078534	67.26460	50157.90	3164.107
Observations	104	104	104	104	104	104	104	104	104

2.3.2 Methodology

This study adopts the Generalized Method of Moments (GMM) approach, which is developed by Holtz-Eakin et al. (1988) and then improved by Arellano & Bond (1991), Arellano & Bover (1995), and Bundell & Bond (1998). It allows estimating the models with shorter periods but larger cross-sections (smaller T and larger N). This approach also allows the existence of a linear relationship in a system GMM (See Imamoglu et al. (2018), for further details) where the dependent variable also depends on its past values in a dynamic process.

2.4 Results

Table 2 presents the GMM results of equation (1) proposed in this study under a dynamic framework. In model option (1) of Table 3, where the stock price is the dependent variable, it is observed that the volume of shadow economies exert highly adverse effects on stock prices of energy firms ($\beta = -23.683$, $p < 0.01$), which denote that an increase in informal economic activities in Turkey would result in significant declines in stock prices. Energy usage exert highly positive effects on stock prices as expected ($\beta = 14.596$, $p < 0.01$). The coefficient of environment proxy (CO_2 emissions) is not statistically significant in model option (1).

In model option (2) of Table 2, where CO_2 emission is the dependent variable, it is observed that the volume of shadow economies exert a positively significant effect on emission levels as expected ($\beta = 0.457$, $p < 0.01$). It is also observed that the volume of the financial system (FD) exerts a negatively significant effect on emission levels ($\beta = -0.332$, p < 0.01), which denotes efficient use of financial sources for alternative

Table 2: GMM results for equation (1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable (DV):	lnSP	$lnCO_2$	lnSE	lnEC	lnGDP	lnFD	lnFDI	lnCPI	RIR
lnSP		-0.001	0.001*	0.000	-0.000	0.000	0.003	0.000	1.137
lnSP(-1)	0.994*								
$lnCO_2$	-4.882		1.484*	0.850*	1.464*	-5.312*	-15.502	-0.188*	0.579
$lnCO_2$(-1)		-0.047***							
lnSE	-23.683*	0.457*		-0.296*	-2.453*	3.800*	9.436	-0.375*	0.223**
lnSE(-1)			-0.352*						
lnEC	14.596*	0.992*	1.232*		-1.032*	4.697*	23.342	0.515*	1.487*
lnEC(-1)				0.027					
lnGDP	4.418*	0.086*	-0.022*	-0.046*		0.479*	-1.090	0.037*	0.943**
lnGDP(-1)					1.244*				
lnFD	6.584*	-0.332*	0.393*	0.234*	1.577*		-3.149	0.024*	-1.213**
lnFD(-1)						2.767*			
lnFDI	-6.339*	0.047*	-0.197*	-0.005	-0.239*	0.580*		-0.146*	0.196**
lnFDI(-1)							-1.515		
lnCPI	-17.127*	0.388*	-0.904*	-0.250*	-1.731*	1.708*	4.574		0.568*
lnCPI(-1)								0.777*	
RIR	0.145*	0.000	0.000*	-0.002*	-0.004*	-0.006*	0.194	0.007*	
RIR(-1)									1.552**
AR(1)	0.115**	-	0.133*	0.146*	-	-	-	-	-
Adj. R^2	0.927	0.994	0.999	0.988	0.996	0.993	0.448	0.999	0.662
S.E. of Regression	0.270	0.006	0.001	0.006	0.008	0.004	0.287	0.000	0.004
Sargan J-stat.	0.000	0.000	0.000	0.000	0.000	1.677	0.035	0.006	0.243
D.W.	2.185	2.448	2.166	2.995	2.200	2.580	2.370	2.116	2.577
Instrument Rank	10	9	10	10	9	9	9	9	9

*Note: *, **, and *** denotes statistical significance at 0.01, 0.05, and 0.10 levels respectively.*

energies (Katircioglu et al., 2018). In model option (3) of Table 2, where the volume of shadow economies is the dependent variable, it is observed that the coefficient of carbon emissions is positively significant as expected (β = 1.484, $p < 0.01$). Furthermore, results show that financial development results in an increase in the volume of shadow economies (β = 0.393, $p < 0.01$). It is interesting to observe that although the coefficient of energy stock prices is quite low, it is positively significant (β = 0.001, $p < 0.01$) meaning that an increase in energy stock prices would increase the volume of informal economic activities. This finding is reasonable and can be justified by the fact that an increase in energy activity would not only lead to improvements in energy stock prices but also encourage informal activities. The coefficient of energy usage also supports this finding in model option (3) which is positively significant as well (β = 1.232, $p < 0.01$).

In model option (4) of Table 2 where energy consumption is the dependent variable, it is observed that the coefficient of informal economies is negatively significant (β = -0.296, $p < 0.01$) denoting that an increase in the volume of informal economic activities would cause declines in energy usage which can be possible by government rules and regulations regarding a fight with informal economies. Table 2 present a total of nine different model options as formulated in equation (1), which show that several significant interactions exist between energy stock prices, shadow economies, and environmental pollution.

2.5 Conclusion

This study searched dynamic interactions among energy stock prices, shadow economic activities, and environmental pollution in Turkey. Stock prices of eleven energy firms in Turkey are selected. The GMM results show that the shadow economic activities exert highly detrimental effects on the stock prices of energy firms in Turkey. An increase in shadow activities results in considerable damages to the stock performance of energy firms. On the other hand, an expansion in energy usage and energy activity leads to the better stock performance of energy firms according to the results of this study. However, this study finds that the stock performance of energy firms is not significantly linked to environmental pollution concerns. Although stock prices are positively linked to energy demand growth, they are independent of emission pollutants. But, the current study finds that growth in energy demand and emission levels leads to increases in the volume of shadow economic activities in Turkey. This finding shows that energy and environmental planning in Turkey need to pay attention to preventing informal economic activities as well. Again, energy firms need to be aware of the significant finding of this study that their financial performance is negatively affected by shadow economies. Further researches can be done in a panel set of countries for comparison purposes.

Chapter 3

DYNAMIC EFFECTS OF SHADOW ECONOMY AND ENVIRONMENTAL POLLUTION ON THE ENERGY STOCK PRICES: EMPIRICAL EVIDENCE FROM OECD COUNTRIES

3.1 Introduction

Those economic activities that are hidden from official agencies because of regulatory, institutional, and financial purposes are called ‘shadow economies’. Tax evasion, avoiding paying social security funds, and illegal economic activities that are not recorded by official institutions are basic examples of financial purposes. Shadow economy is expressed with several names and definitions such as the black economy, informal economy, hidden economy, and cash economy (see Medina and Schneider, 2018; Markandya et al., 2013). The size of the shadow economy was investigated by scholars over the years (Hassan & Schneider, 2016; Williams, 2011). The strict government policies and high taxes are the results of growing informal economies. The high tax burdens mitigate the incentive to accomplish tax obligations and constitute a budget deficit. Consequently, the misspecification of economic indicators such as gross domestic product (GDP) arises due to the volume of the shadow economy (Schneider,1986).

Informal activities have important roles in the financial system of economies (Fethi et al., 2006; Williams, 2011). Firms should show up their books to creditors to attain funding. However, firms who want to hide their activities from official institutions, do not reflect all activities on their books for avoiding tax obligations. Consequently, it is very difficult to reach official credit sources and the only way to reach financial sources is to appeal to shadow creditors (Gobbi and Zizza, 2012). On the other hand, an efficient financial system might slow down shadow economic activities (Bayar and Ozturk, 2016). According to Capasso and Jappelli (2013), development in financial services mitigates the volume of shadow economic activity by introducing more efficient financial intermediaries serving with a lower cost of credits. The higher cost of credits in the financial market forces borrowers to appeal to informal agencies. However, financially developed markets mitigate the cost of credit and generate official markets more attractive for borrowers; accordingly, the financial system lowers the activities of the shadow economy within the financial markets (Bose et al., 2012; Cappasso and Jappelli, 2013).

The effects of financial development on energy consumption are widely emphasized as well (Sadorsky, 2010; Sadorsky 2011; Coban and Topcu, 2013; Ma and Fu, 2020). Ersoy and Ünlü (2013) employ the Johansen co-integration test and Granger causality test for the periods between 1995 to 2011 to assess the link between energy consumption and the stock market for Turkey. The results of the study indicate that there is indirect causality between the stock market and energy consumption whereas, the rise in energy consumption boots economic growth and as a result of economic growth it stimulates to increase in the stock exchange. Therefore, a positive relationship exists between energy consumption and the stock market.

The firm value is reduced with an increase in the price of carbon emission allowances (Mo et.al, 2012). According to Brouwers et al. (2016), the increase in carbon emission of firm costs to a reduction of firms' carbon quota results in a reduction of profitability. Zhang et al. (2018) investigate the negative effects of carbon prices on energy stock prices. As a result, the potential effects of environmental damages result from carbon emissions and shadow economies on the energy stock prices need to attention.

The environmental quality level, on the other hand, is closely associated with the level of shadow economic activities as expressed in the relevant literature. Informal economic activities might accelerate environmental degradation (Abid, 2015; Canh et al., 2019). Since governments try to control environmental degradation by imposing emission taxes, entrepreneurs attempt to reduce costs and avoid these taxes by employing shadow producers who omit environmental concerns and stimulate degradation (Blackman, 2000; Chaudri and Mukhopadhyay, 2006; Baksi and Bose, 2010; Mazhar and Elgin, 2013; Chen et al., 2018). Elgin and Oztunali (2014) investigate an inverted U- shaped relationship between shadow economies and environmental pollution. It is found that the impacts of informal economies on environmental pollution are of two stages: The preliminary one is the deregulation effect which declares a positive relationship between the informal economy and carbon emission where it turns to be scale effect which represents an upward trend in the size of informal activities and reduction in environmental pollution (Katircioglu & Katircioglu, 2018). Also, the environmental quality level is driven by energy consumption where it is widely discussed by scholars in the literature (Kalayci & Koksal, 2015; Kapusuzoglu, 2014). According to the environmental Kuznets Curve (EKC) theory, the rise in the energy demand is the consequence of the economic growth of the country which induces an increase in the level of carbon emission (Katircioglu et al., 2018). Previous studies such as Baloch et al (2020a, 2020b) and Baloch & Meng (2019) find significant links between environmental degradation, the energy sector, financial markets with income inequality, and poverty.

Changes in stock prices, on the other hand, are important indicators of the financial system and financial performance of firms, which relate to different economic agents as well as stock markets. Like other factors, inflation and interest rates are found as crucial determinants of stock prices (Hadi et al., 2019; Katircioglu et al., 2019; Shaeri et al., 2016). The positive causal relationship between economic growth and stock market development is also investigated (Greenwood and Jovanovic,1990; Greenwood and Smith,1997). On the other hand, any shock to oil prices among the others, for example, negatively affects stock prices (Filis, 2010). Aloui et al. (2012) state that the oil price risk is priced in emerging markets and asymmetric sensitivity of stock prices to the changes in oil prices exists and emerging market positively correlated with the oil price changes. Memis & Kapusuzoglu (2015) find that oil prices significantly affect stock markets.

Many studies concentrated on the effects of similar economic factors on stock prices; however, (other) factors driving energy stock prices deserve attention from researchers. As stock markets are impacted by formal economic activities, informal economic activities are likely expected to impact stock and financial markets. Gobbi and Zizza (2007) claim that the shadow economy prevents the sustainability of the financial sector; the expansion of shadow economies within the financial system prevents formal institutions to obtain funds. Berdiev and Saunoris (2016) express that any increase in the level of financial development decreases the presence of a shadow economy. Therefore, any upward trend in the shadow economy prevents financial development activities. Bose et al. (2008) state that the improved banking sector directs individuals to borrow from the formal banking sector with a lower cost of borrowing and rather than borrowing from shadow agencies. Therefore, as the quality of the banking sector raises the size of shadow activities gets smaller. Additionally, the depth and efficiency of the banking sector help to reduce the size of the informal economy. Bose et al. (2012) promote a previous study by employing 137 countries for the periods from 1995 to 2007. The depth and efficiency of the banking sector decrease the size of the informal economy. Elgin and Uras (2013) investigate the inverted U-shaped relationship that exists between the size of the informal sector and financial development. Also, the most recent study of Imamoglu et al. (2018) also finds an inverted-shaped relationship between shadow economies and financial markets. Ngalawa & Viegi (2013), on the other hand, find that a larger size of the informal financial sector results in a lower impact of monetary policy on economic activity. Georgiou (2013) claims that shadow economies can impact stock markets; he finds such a significant impact in the case of the most industrialized countries through panel setting.

This study argues that informal economic activity leads to changes not only in stock markets but also to environmental degradation as formal economies are a major driver of pollution. Furthermore, the volume of environmental degradation in the country, the degree of pollution caused by energy-related firms, alternative energy investments, and R & D policies of energy-related firms are major factors that financial investors might consider for stock markets. Thus, the stock prices of energy-related firms might be affected by such considerations. Therefore, the volume of pollution in the country might be indirectly linked to energy stock prices. Therefore, the nexus between stock prices, environmental degradation, and informal economies is a new debate and deserves attention from researchers.

Against the relevant literature, this paper aims to examine the potential effects of the shadow economy and environmental pollution on energy stock prices. To the best of our knowledge, this paper is the first of its kind for the case of energy markets in the relevant literature. Therefore, the following research hypotheses are proposed in this study:

H1: Shadow economies exert statistically significant effects on energy firms' stock prices;

H2: Environmental pollution exerts statistically significant effects on energy firms' stock prices.

To test the validity of these questions and research objectives in this study, OECD countries are selected to make more representative analysis years covering from 2004 to 2014. The OECD countries (Kahouli, 2019) consume 40.9 percent of the world's total energy capacity. Furthermore, carbon emissions (9.6 metric tons per capita) and energy consumption generated by OECD countries (4,153.6 Kg of oil per capita) are enormously higher than the world's average carbon emissions (4.98 metric tons per capita) and average energy consumption (1,922.48 Kg of oil per capita)[2]. Correspondingly, these reasons make OECD countries more attractive to analyze the link between energy stock prices environmental pollution, and shadow economies. According to Elgin & Schneider (2016) average size of shadow economies in the OECD countries varies between 20.24 percent and 20.33 percent while the minimum varies between 18.93 percent and 19.17 percent, and the maximum varies between

21.21 percent and 21.42 percent depending on the methodological approach adopted. Therefore, OECD countries with an average shadow economy of about 20 percent would be the right choice as a sample to study the nexus between informal economies, energy stock prices, and environmental degradation. On the other hand, Li et al. (2020) perform a study for the OECD countries and find a significant link between the overall stock market and carbon dioxide emissions. Their results reveal a negative relationship between stock market development and carbon emissions if OECD countries enjoy high economic growth meaning that they avoid carbon emissions through stock market development. Li et al. (2020) also find a positive relationship between the two if OECD countries experience low economic growth meaning that stock market development would not show the boycott-effect relationship with carbon emissions when they experience low levels of economic development. Thus, such findings would be another interesting reason for considering the link between shadow economies, energy stock prices, and environmental pollution in the case of OECD countries.

3.2 Theoretical Framework

This study argues that shadow economies, the energy sector, and therefore, the environmental quality level jointly lead to changes in stock prices of energy-related firms in stock markets. Thus, the following model is constructed in this study in parallel to literature studies (Chen et al., 2018; Memis & Kapusuzoglu, 2015; Mazhar & Elgin, 2013; Markandya et al., 2013):

$$\ln(\mathrm{SP}) = \beta_1 \ln(\mathrm{SP})_{\mathrm{it}-1} + \beta_1 \ln(\mathrm{SE}) + \beta_2 \ln(\mathrm{SE}^2) + \beta_3 \ln(\mathrm{GDP}) + \beta_4 \ln(\mathrm{FID}) + \beta_5 \ln(\mathrm{EU}) + \beta_6 \mathrm{l\,n}(\mathrm{CO}_2) + \beta_7 \ln(\mathrm{CPI}) + \gamma_\mathrm{t} + \delta_i + \varepsilon_\mathrm{t} \quad (2)$$

Where; SP represents energy stock prices which stand for the main dependent variable of the model. SP_{it-1} represents the lagged value of the dependent variable, SE is the size of shadow economies, SE^2 is squared shadow economies, FID is financial institutional depth, GDP is real per capita gross domestic product, EU is energy consumption, CO_2 is carbon emission, CPI consumer price index, and finally, δ_i is the country fixed effect, γ_t is a time-specific effect that stands for time dummy for the 2008 economic crisis for covering years both 2008 and 2009 when markets sharply fell.

The effects of several control variables in equation (2) on the stock market are highlighted in the existing literature (Memis & Kapusuzoglu, 2015; Shaeri et al., 2016). Economic growth positively affects the stock markets of countries (Ho, 2018; Rays, 2012). The growth of real per capita GDP is used to estimate economic growth effects on energy stock prices. Inflation is one of the important determinants of stock prices (Hadi et al., 2019; Katircioglu et al., 2019; Shaeri et al., 2016). Financial deepening enables faster economic growth and makes financial markets work properly (Rahman and Mustafa, 2017). According to Svirydzenka (2016) financial institution depth correlated with the stock market at 0.61. The financial institutional depth (FID) is used to estimate the effects on energy stock prices. The presence of financial development and institutional quality harm informal activities. The importance of the nexus between shadow economies, financial sector development, and institutional quality is investigated (Bayar and Ozturk, 2016). Besides, the financial institutional depth is substantial when the shadow economy exists. According to Gobbi and Zizza (2007), the presence of shadow economies reduces the capacity of financial institutions to reach funds. Additionally, Bose et al. (2012) claimed that financial depth slows down shadow activities. Therefore, the effectiveness of financial institutional depth needs more attention while assessing the potential effects of shadow economies on energy stock prices. Energy consumption leads to increases in stock prices (Ersoy and

Unlu, 2013). As a result of increased energy consumption, carbon emission is likely to increase as well. The carbon emission allowances of firms affect their stock prices. According to Mo et.al (2012), the rise in the price of carbon emission allowances decreases the firm value. As the carbon emission raises, it reduces the firm's quota which costs the firm a reduction in its profitability (Brouwers et al.,2016). It is also claimed by Zhang et al. (2018) that energy stock prices are negatively affected by carbon prices. Carbon emission is another significant estimator of energy stock prices as highlighted by scholars.

Finally, the shadow economic activities influence the financial sector (Dabla-Norris et al., 2008; Blackburn et al., 2012; Capasso and Jappelli, 2013). Apart from the relevant literature, this study focuses on the effects of shadow economies on the energy stock prices which will be the first study in literature.

3.3 Data and Methodology

3.3.1 Data

To analyze the effects of shadow economies on the energy stock prices, a balanced panel data of 571 energy firms in 31 OECD countries are constructed in this study. Energy stock prices of selected firms are gathered from where their stocks are traded in their stock exchanges which are all presented in Table 3.

Some countries could not be included in estimation due to the unavailability of data (Estonia, Iceland, Slovak Republic, Spain, and Mexico are excluded). The panel data covers the annual period from 2004 to 2014. The independent variable of the study is energy stock prices of OECD countries (SP) (2010 = 100), the regressors of the model

Table 3: Stock exchanges of OECD countries used in the study

Country	Stock of Exchange
Australia	Australian Securities Exchange (ASX)
Austria	Vienna Stock of Exchange (WBAG)
Canada	Toronto Stock Exchange (TSX)
Chile	Santiago Stock Exchange (SSE)
Czech Republic	Prague Stock Exchange (PSE)
Denmark	Copenhagen Index (OMX)
Belgium	Brussels Stock Exchange (BSE)
Finland	Helsinki Stock Exchange (OMXH)
France	Euronext Paris
Germany	Deutche Boersa AG (DAX)
Greece	Athens Exchange (ASE)
Hungary	Budapest Stock Exchange (BET)
Ireland	Irish Stock Exchange (ISE)
Israel	Tel Aviv Stock Exchange (TASE)
Italy	Milano Italia Borsa (MIB)
Japan	Tokyo Stock Exchange (TSE)
Korea	Korea Exchange (KRX)
Latvia	Latvia Stock Market (OMX Riga)
Lithuania	Lithuania Stock Market (OMX Vilnius)
Luxemburg	Luxemburg Stock Exchange (LUXSE)
Netherlands	Amsterdam Stock Exchange (AEX)
New Zealand	The stock of Exchange New Zealand (NZX)
Norway	Oslo Stock of Exchange (OSE)
Poland	Warsaw Stock of Exchange (WSE)
Portugal	Lisbon Stock of Exchange (Euronext Lisbon)
Slovenia	Ljubljana Stock Exchange (LJSE)
Sweden	Stockholm Stock Exchange (STO)
Switzerland	Swiss Stock Exchange (SIX)
Turkey	Istanbul Stock of exchange (BIST)
United Kingdom	London Stock Exchange (LSE)
United States	Newyork Stock of Exchange (NYSE) Nasdaq Stock Market (NASDAQ)

are explained respectively; the proxy of the shadow economy (SE) as a percent of GDP, the square of the shadow economy (SE-squared), growth of per capita GDP at constant prices (GDP) (2010 = 100), financial institutional depth (FID), energy use (UE) (kg of oil equivalent per capita), carbon dioxide emissions (CO_2) (kt), GDP deflator (base year varies by country). The natural logarithm of variables is taken. The data for stock prices is taken from Thomson Routers Datastream, shadow economies' data is taken from Medina and Schnieder (2018), and FID is obtained from the International Monetary Fund (2020) and the rest of the variables are taken from World Bank Development Indicators (2020). The introduction of descriptive statistics is a good step before the estimation. The descriptive statistics of variables are shown in Table 4.

Table 4: Descriptive statistics for OECD data

Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Energy Stock Price	6281	1.706	3.316	-9.292	19.192
Shadow Economies		2.326	0 .340	1.818	3.475
Squared-shadow Economies	6281	5.530	1.753	3.305	12.082
Gross Domestic Product	6281	2.705	0.236	-11.121	3.287
Financial Depth	6281	-0.244	0.289	-2.232	0.000
Energy Usage	6281	8.651	0.400	7.093	9.151
Carbon Emissions	6281	13.967	1.590	8.850	15.571
Consumer Price Index	6281	4.508	0 .086	4.062	4.955

Note: The descriptive statistics of variables are presented in natural logarithm form.

3.3.2 Cross-sectional Dependence and Panel Unit Root Tests

Before empirical analysis, it is essential to check if panel data avoids the spurious assumption of cross-sectional independence (Tecel et al., 2020). Therefore, the Pesaran (2007) cross-sectional dependency test is carried out to test for the null hypothesis of cross-sectional independence across cross-section units in panel data. Then, panel unit root tests from the Im, Pesaran, Shin (IPS) and augmented Dickey-Fuller (ADF) approaches are adapted to investigate the stationary nature of the series under consideration.

3.3.3 Model Estimation

Equation (2) is mainly estimated using the Generalized Methods of Moments (GMM) from Arellano and Bover (1995) and Blundell and Bond (1998). Then, equation (2) is also estimated in a dynamic system using fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) as further robustness checks and to observe the consistency of results.

The GMM model outperforms rather than OLS and within groups when estimating a dynamic model. The OLS and within groups do not estimate unobserved country-specific impacts unbiased and consistently (Nickell, 1981). System GMM estimation eliminates these biased and inconsistent estimation results. Additionally, system GMM estimation enables estimation with the existence of both heteroscedasticity and autocorrelation, gives consistent and not strictly exogenous variable results. Moreover, system GMM allows panel data to estimate with a small-time span and large cross-sections ($T < N$) (Roodman, 2009).

Energy stock prices can adjust with delay to changes in parameters such as shadow economies and carbon emissions. The dynamic panel model is the best model to estimate this assumption by taking the lagged value of the dependent variable as a regressor in the estimated model. The lagged value of the dependent variable is assumed to be endogenous due to correlation with country fixed effect and time-invariant effects. Ordinary Least Square estimation (OLS) and within-group estimation methods do not give consistent and unbiased estimates when employing dynamic panel data. The lagged dependent variable would not be consistent and unbiased and positively correlated with persistent impacts of dynamic panel regression when the OLS estimation method is employed (Hsiao, 2014).

The elimination of country fixed effects and time-invariant effects may be possible by taking the first difference of equation (2) as shown in equation (3) below. The endogeneity problem arises due to the transformed dependent variable (Imamoglu et al., 2018):

$$\Delta\ln(SP) = \beta_1\,\Delta\ln(SP)_{it-1} + \beta_1\Delta\ln(SE) + \beta_2\Delta\ln(SE^2) + \beta_3\Delta\ln(GDP) + \beta_4\Delta\ln(FID) + \beta_5\Delta\ln(EU) + \beta_6\Delta\ln(CO_2) + \beta_7\Delta\ln(CPI) + \Delta\varepsilon_t \quad (3)$$

$$E(\Delta lnSP_{i,t-1}\Delta\varepsilon_{it}) \neq 0 \quad (4)$$

In equation (3), the endogeneity problem is eliminated. However, another endogeneity problem arises due to the dependence among lagged dependent variables and error term as shown in equation (4). According to Arellano and Bond (1991), the additional lagged variables can be introduced if the orthogonality conditions between lagged values of the independent variable and error term are sustained, with introducing difference GMM estimation method:

$$E(\Delta lnSP_{i,t-j}\Delta\varepsilon_{it}) = 0 \quad \text{for } t\geq 3 \text{ and } j\geq 2 \quad (5)$$

As a result of difference GMM estimation, the possible presence of the high persistency between the dependent variable and its first lagged value states poor estimation outcomes. To solve this problematic phenomenon, an augmented version of GMM estimation is introduced by employing Arellano and Bover (1995) and Blundell and Bond (1998) estimators. System GMM enables to estimate of the differenced form and level form as a system of two equations:

$$E(\Delta lnSP_{i,t-j}, \alpha_i + \Delta\varepsilon_{it}) = 0 \quad (6)$$

Necessary conditions should be achieved to the validity of GMM estimates. Arellano and Bond (1991) offer no second-order AR (2) autocorrelation exists in residuals of estimation and over-identification of restrictions should be tested with the Sargan test. According to Bowsher (2002), the Sargan test underestimates over-identifying restrictions and is not robust. The power of the Sargan test reduces when the heteroscedasticity condition of data exists in the estimation. The robust estimation of over-identifying restrictions can be achieved with Hansen J-statistics which is also appropriate for the two-step system GMM (Baum and Schaffer,2003). Roodman (2009) introduced the collapsing technique to mitigate the number of instruments. The collapse technique is important for preventing instrument proliferation and the number of instruments should be smaller than the number of groups.

3.4 Results

As an initial step, results in Table 5 exhibit that the null hypothesis of cross-sectional independence across cross-section units is rejected and its alternative, cross-sectional dependence, is accepted for each variable under consideration. And correlation coefficients in Table 5 support this conclusion.

In the next step, panel unit root tests in Table 6 show that the null hypothesis of a unit root in series is strongly rejected; thus, it is concluded that panel series in this study are integrated of order zero, I (0), as expected. Therefore, further steps in estimating equation (1) of this study would provide robust results (Tecel et al., 2020).

Table 5: Cross-sectional dependence test from Pesaran (2007)

Variable	CD-Test Statistic	p-value	Corr.
Energy Stock Price	32.122*	0.000	0.833
Shadow Economies	26.741*	0.000	0.712
Squared-shadow Economies	5.423*	0.001	0.615
Gross Domestic Product	27.045*	0.000	0.726
Financial Depth	2.469**	0.026	0.856
Energy Usage	5.789*	0.007	0.413
Carbon Emissions	7.457*	0.000	0.234
Consumer Price Index	3.789**	0.016	0.456

Note: the null hypothesis presents that there exists cross-sectional independence CD ~N (0, 1)
*Note: *. **,and *** stand for statistical significance at the 0.01, 0.05 and 0.10 levels respectively.*

Table 6: Panel unit root tests

Variable	CIPS	ADF
Energy Stock Price	-3.264*	47.960*
Shadow Economies	-5.192*	36.443*
Gross Domestic Product	-4.789*	42.445*
Financial Depth	-3.991*	28.234*
Energy Usage	-4.333*	47.448*
Carbon Emissions	-3.769*	40.456*
Consumer Price Index	-5.736*	45.478*

*Note: * denotes statistical significance at the 0.01 level.*

Regression results of the GMM approach are presented in Tables 7 (two-step GMM) and 8 (one-step GMM). The estimation results are passed from robustness checks successfully. Both tables exhibit no autocorrelation at AR (2) level and Hansen Test could not reject the null hypothesis of over-identifying restrictions which provides validity of instruments in the model.

No matter which model option is adapted as seen in Tables 7 and 8, the U- shaped relationship between energy stock prices and shadow economies is confirmed in the OECD countries. The energy stock prices fall at the initial levels of shadow economies, but following a trough point, energy stock prices start to rise over time. This is because the coefficient of shadow economies is negatively significant while the coefficient of squared-shadow economies is positively significant in the great majority of model options in Tables 7 and 8.

On the other hand, Tables 7 and 8 show that GDP, financial institutional depth, and energy consumption (usage) exert positively significant effects on energy stock prices which this finding is in parallel to the findings of Rays (2012) and Ho (2018) in the case of GDP and stock price nexus, and Ersoy and Ünlü (2013) in the case of the financial system, energy usage, and stock price nexus. It is also found that carbon emissions exert negatively significant effects on energy stock prices which this finding is also in parallel with the findings of Zhang et al. (2018). Finally, the rise in the price level negatively affects energy stock prices as expected. It is worthy to note that Tables 7 and 8 provided similar and consistent results as far as robustness is concerned.

Finally, Table 9 presents further estimations by FMOLS and DOLS approaches as robustness checks of results in Tables 7 and 8. Estimations in Table 9 are done under two options which are (1) model with constant and (2) model with trend specifications. Results from Table 9 give strong support for earlier findings from the GMM approach. Again, a U-shaped link is confirmed between energy stock price and shadow economies while positively significant effects of GDP, financial institutional depth, and energy usage on energy stock prices, and negatively significant effects of carbon emissions and inflation are obtained as found by the FMOLS and DOLS functions.

Table 7: Two-step system GMM results

Two-Step System GMM						
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Dependent Variable	lnresp	lnresp	lnresp	lnresp	lnresp	lnresp
Lag of lnESP	0.884***(0.049)	0 .886***(0.049)	0.882***(0.053)	1.020***(0.024)	0 .866*** (0 .041)	0 .756***(0.049)
lnSE	-1.011***(0.245)	-1.335***(0.343)	-1.288***(0.371)	-4.835***(1.010)	-4.175*** (0.910)	-2.329***(0 .864)
lnSE-squared	0.290***(0.057)	0.354***(0.071)	0.348***(0.077)	1.041***(0.203)	0.875***(0.183)	0 .366*(0.177)
lnGDP	-	0.143 (0.120)	0.151 (0.055)	0.099*(0.056)	0.102*** (0.039)	0 .0283* (0.016)
lnFID	-	-	0 .681***(0.249)	0 .094 (0.176)	0.496** (0.194)	0.762***(0.201)
lnEU	-	-	-	0 .564*** (0.131)	3.334*** (0.562)	2.494***(0.468)
lnCO2	-	-	-	-	-1.651***(0.317)	-0.790***(0.236)
lnCPI	-	-	-	-	-	-1.788***(0.212)
Time Dummy	YES	YES	YES	YES	YES	YES
No.of Observations	6281	6281	6281	6281	6281	6281
No.of Firms	571	571	571	571	571	571
No. of Instruments	9	10	11	12	13	14
Arenallo-Bond AR(1) P-value	0.000	0.000	0.000	0.000	0.000	0.000
Arenallo-Bond AR(2) P- value	0.787	0.800	0.799	0.743	0.790	0.842
Sargan Test (P-value)	0.026	0.036	0.023	0.033	0.281	0.304
Hansen Test (P-value)	0.203	0.247	0.142	0.237	0.624	0.655
F Test (P-value)	242.651 (0.000)	202.992 (0.000)	199.081 (0.000)	376.953 (0.000)	253.775 (0.000)	247.624 (0.000)

*Note: The robust standard errors are expressed in parenthesis. ***, **, and * express rejection of null hypothesis at significance levels of 1 %, 5%, and 10 % respectively. Year dummies are only used for the 2008 economic crisis for covering years both 2008 and 2009. Syntax xtabond2 two-step h(2) small robust orthogonal is used to estimate with Stata 13.*

Table 8: One- step system GMM results

One Step System GMM						
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Dependent Variable	lnESP	lnESP	lnESP	lnESP	lnESP	lnESP
Lag of lnESP	0.955***(0.051)	0.952***(0.051)	0.956***(0.053)	1.012***(0.026)	0.687 *** (0.114)	0.788***(0.077)
lnSE	-0.865**(0.241)	-1.150**(0.303)	-1.086***(0.304)	-5.000***(1.000)	-3.541*** (0.833)	-2.246**(0.912)
lnSE-squared	0.235***(0.062)	0.294***(0.071)	0.281***(0.071)	1.083***(0.200)	0.755***(0.176)	0.359*(0.190)
lnGDP	-	0.120 (0.081)	0.120 (0.085)	0.0972*(0.052)	0 .079** (0.0305)	0.029 (0.018)
lnFID	-	-	0.411 (0.261)	0.151 (0.179)	0 .847*** (0.225)	0 .696**(0.244)
lnEU	-	-	-	0.570***(0.130)	3.362*** (0.594)	2.273***(0.627)
LnCO2	-	-	-	-	-1.673***(0.444)	-0.697**(0.317)
lnCPI	-	-	-	-	-	-1.692***(0.274)
Time Dummy	YES	YES	YES	YES	YES	YES
No.of Observations	6281	6281	6281	6281	6281	6281
No.of Firms	571	571	571	571	571	571
No. of Instruments	9	10	11	12	13	14
Arenallo-Bond AR(1) P-value	0.000	0.000	0.000	0.000	0.000	0.000
Arenallo-Bond AR(2) P- value	0.757	0.769	0.767	0.747	0.728	0.824
Sargan Test (P-value)	0.026	0.036	0.023	0.033	0.281	0.304
Hansen Test (P-value)	0.203	0.247	0.142	0.237	0.624	0.655
F Value (P-value)	187.020 (0.000)	156.990 (0.000)	171.750 (0.000)	250.782 (0.000)	211.402 (0.000)	199.176 (0.000)

*Note: The robust standard errors are expressed in parenthesis. ***, **, and * express rejection of null hypothesis at the significance levels of 1 %, 5%, and 10 % respectively. Year dummies are only used for the 2008 economic crisis for covering years both 2008 and 2009. Syntax xtabond2 one-step h(2) small robust orthogonal is used to estimate with Stata 13.*

Table 9: Robustness checks by the FMOLS and DOLS functions

	FMOLS		DOLS	
	Constant	Trend	Constant	Trend
Dependent Variable	lnresp	lnresp	lnresp	lnresp
lnSE	-3.566***	-2.636**	-2.075**	-3.994***
lnSE-squared	0.786***	0.863***	1.128***	1.050*
lnGDP	0.226*	0.332***	0.455**	0.396***
lnFID	0.046**	0.102**	0.478*	0.368**
lnEU	0 .657***	0 .205**	0.417***	0.350
lnCO2	-0.456***	-0.478*	-0.112	-0.204*
lnCPI	-0.741***	-0.700***	-0.477**	-0.334***
R2	0.976	0.955	0.982	0.978
Adj. R2	0.972	0.949	0.979	0.971
S.E. of Reg.	0.205	0.214	0.207	0.242
Long run var.	0.014	0.023	0.018	0.015

*Note: ***, **, and * express rejection of the null hypothesis at the significance levels of 1 %, 5%, and 10 % respectively.*

3.5 Conclusion

This study is conducted to analyze the effects of shadow economies and environmental degradation on energy stock prices for the OECD countries. Research hypotheses proposed in this study are confirmed by econometric procedures where significant effects of shadow economies and environmental pollution on energy stock prices are found. Results suggest a U- shaped relationship between shadow economies and energy stock prices. This finding indicates that at the initial levels of shadow economies, stock prices decline while beyond a trough point prices start to increase at further levels of shadow economies. On the other hand, this study finds negative effects of carbon emissions on energy stock prices; that is, at a higher level of pollution, stock prices tend to decline over time. One other finding of this study is that financial institutional depth enables better energy stock performance in OECD and a rise in the energy demand stimulates energy stock prices up.

The results of this study reveal important policy messages. Firstly, results prove that the energy firms of OECD countries perform well in stock markets in the long term of shadow economies owing to a U-shaped link. However, this link is negative in the short term periods. Secondly, a negative link between carbon emissions and energy stock prices shows that demand for energy firms' stocks in the OECD countries is significantly and negatively influenced by changes in the volume of carbon emissions. Therefore, policymakers need to pay attention to this finding by adapting appropriate precautions to create a positive investment climate in energy stock markets. Among such precautions might be to (1) promote alternative energy investments, (2) environment-friendly investments, and (3) increase R&D expenditures towards energy efficiency and a clean environment.

This study selected OECD countries to analyze the effects of shadow economies and environmental degradation on stock prices of energy-related firms from 2004 to 2014. A larger span of data set might be used for larger panel settings as a further research study; for example, larger data for countries with a high rate of shadow economies and countries with a low rate of shadow economies can be compared and analyzed as a later step.

Chapter 4

CONCLUSION

4.1 Summary of the Major Findings

This thesis studied the dynamic relationship between energy stock prices, environmental degradation, and shadow economies in Turkey and OECD countries.

Primarily, the interaction among shadow economies, energy stock prices, and environmental pollution are analyzed for 11 energy firms in Turkey. The result of this study reveals that; the growth in shadow economic activities deteriorates energy stock performance in Turkey. Additionally, energy stocks perform well when demand for energy consumption increases. On the other hand, the energy stock performance of Turkey is not related to the emission pollutants. Therefore, energy stock prices positively related to energy demand, whereas not linked with environmental pollution. Nevertheless, shadow economic activities raise with growth in energy demand and environmental pollution.

The second study of the thesis analyzed the dynamic effects of environmental degradation and shadow economies on the energy stock prices of OECD countries. 571 energy-related firms are employed in 31 OECD countries' annual period from 2004 to 2014. Findings of this study reveal that; U- shaped relationship exists between shadow economies and energy stock prices which are interpreted as; at the initial levels of shadow economies energy stock prices fall, after a certain level of point energy stock prices appreciates with growth in shadow economies. It is also found that carbon emissions negatively affect energy stock performance. Therefore, as environmental pollution raises stock prices to fall. Energy stock prices appreciate by the energy demand growth. The change in the price level negatively affects energy stock prices, whereas economic growth appreciates the value of energy stock prices as expected. Finally, it is also found that; financial institutional depth enables energy stocks to perform better.

4.2 Policy Implications

The result of this thesis introduced significant policy messages. Primarily, findings proved that energy stock markets are affected by shadow economies in the short-run for both Turkey and OECD countries and U- shaped link is investigated for OECD countries, which proves the energy stock market is positively affected by shadow economies in the long-run. On the other hand, the energy stock performance of Turkey is not affected by the changes in the volume of carbon emissions whereas, the energy stocks of OECD countries have deteriorated from environmental pollution.

The findings of these studies show that the nexus between the energy sector and environmental pollution needs to pay attention to by policymakers to prevent the growth of shadow economies. Hence, policymakers should take an action for reducing environmental pollution by employing some precautions such as; alternative energy investments, environment-friendly investments, and further R&D expenditures. These positive climates then will be reflected in the energy stock performance.

The government should take crucial actions against the local energy producers to prevent both carbon emission rises and the shadow economy. The government should control local energy producers not only carbon emission levels and size of total energy generated but also environment-friendly investment activities. Therefore, the government can manage these environmentally friendly investment activities by promoting them with financial and regulatory contributions. Alternative energy production, research and development, and environment-friendly production techniques can be financially contributed by the government and afterward, the government can reward these environmentally friendly activities with lower taxes and contributory regulations while penetrating pollutant activities. Since the close relationship between the shadow economy and the energy sector is investigated; energy firms, their energy production, and energy distribution channels should be closely inspected by the government.

4.3 Research Limitations and Further Directions in Research

This thesis is constructed to analyze the effects of environmental pollution and shadow economies on the stock prices of energy-related firms in Turkey for an annual period from 2006 to 2014 and OECD countries for an annual period from 2004 to 2014 with two separate studies. For further researches, a larger data span might be used to analyze for example; the effects of shadow economies on the renewable energy stock and non-renewable energy stock might be compared with larger panel or energy stock prices of countries with lower shadow economies and countries with higher shadow economies might be compared.

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