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Relationship between Industrial Production, Financial Development and Carbon Emissions: The Case of Turkey

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Abstract

It is widely accepted that industrialization causes air pollution due to increased fossil fuel consumption. On the other hand, recent literature related with the impacts of financial development on air pollution has produced some mixed results. It is argued that not having proper energy policies has become a more severe problem for Turkey as the industrial activities have been accelerated in the country. The present study investigates the long run relationship between industrialization, financial development and carbon emissions by using Granger causality test in Turkey. Findings of the present study reveal a unidirectional relationship from financial development to carbon emissions.

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Keywords: Industrialization; Financial development; Air pollution; Granger Causality

1. Introduction

Energy is an indispensable part of the modern world. Almost all our activities depend on the usage of energy. Considerable amount of the energy is consumed by four major sectors; namely commercial sector, industrial sector, residential sector, and transportation and it is reported that industrial energy consumption constitutes 51% of total global energy usage (Sieminski, 2013). Development of these sectors leads to increase in energy consumption, especially fossil fuels those have detrimental environmental effects, and the situation causes growing concerns about negative outcomes of the industrial production on climate.

Using more fossil fuel in industrial production could be a significant factor behind high level of carbon emissions but it may not be the only reason. Financial development can be an important source as well. The impact of financial

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development on carbon emissions has been investigated by many scholars. Among them, Frankel and Romer (1999), Dasgupta et al. (2001), Sadorsky (2010) and Zhang (2011) argue that financial development is a factor which causes carbon emissions to increase. There are number of factors those can explain the impact of financial development on air pollution. First, improvement of stock market aids listed companies to decrease their financing costs, increase credit channels and spread operational risk, which in turn make firms able to invest more, install new facilities and increase their production capacities hence increase the level of carbon emissions produced. Second, development of financial sector may lead to attract foreign direct investments that raise economic activity and ultimately cause more carbon emissions. Also, an effective financial intermediation contributes to ease consumers' loan exercises by making them able to reach more costly items such as automobiles, air conditioners, bigger houses and etc. which in turn causes more carbon dioxide to be emitted (Sadorsky, 2010). An alternative argument states that financial development can contribute environmental protection and help air pollution to be diminished. Financial intermediation channel is the most crucial way of raising funds and an important factor for firms to develop. A firm that grows by the help of financial development might achieve a better performance in terms of effective use of their resources and become more efficient in its energy use. As a result of such a development carbon dioxide emissions is expected to diminish (Tamazian et al., 2009; Claessens and Feijen, 2007). On the other hand; as firms grow and institutionalized, their social responsibility towards environment may enhance which in turn can decrease carbon dioxide emissions.

After 1980s Turkey has experienced structural economic reforms toward liberalization. Since then, Turkish economy has been heavily emphasized on industrialization as well as financial liberalization. Particularly, Turkish financial sector has developed considerably over the last decade mostly due to sound growth of its banking sector. As a rapidly growing economy, Turkey stimulates industrial production which is mostly dependent on fossil fuel consumption. Fossil fuel energy consumption constitutes around 90% of its total energy consumption as of 2012 (World Bank, 2015). Turkey has been criticized for its increasing carbon emissions (CO2) over the last years. According to Climate Change Performance Index (Burck et al., 2014) Turkey is ranked as 51st in climate protection performance among 61 countries those are responsible for 90% of the total carbon emission in the world. It is pointed that the country suffers from lack of energy policies as its dominance of consuming fossil fuels in energy industry as well as growing inferior energy efficiencies contrast to other countries (Ediger et al., 2006). Given the debate on the relationships between financial development and air pollution together with the Turkey's both industrial and financial sector growth and also criticism for its climate protection performance, makes the study rather interesting.

This study aims to investigate whether financial development is interconnected with Turkey's industrialization and carbon emissions. To this aim, time series data covering 1976-2012 period is used. First, Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root test are applied to check for the integration order of the data. Then, Johansen co-integration test is conducted to investigate any possible long-run relationship between the variables. Granger Causality test is employed to specify direction among each other.

The following section of this study will cover a brief literature review, and then data and methodology used will be explained. Section four contains empirical results and finally conclusion and policy implications will be presented in the final section.

2. Literature review

Many studies have found positive and significant relationship between energy consumption and carbon emissions (Soytas et al., 2007; Halicioglu, 2009; Dhakal, 2009; Cho et al., 2009). The IPCC Fourth Assessment Report (2007) states that carbon emission from the fossil fuel consumption is the major reason of Greenhouse Gas intensity. It is also indicated that industrial energy consumption constitutes 51% of the global energy usage. Chang and Lin (1999) investigated the factors that alter carbon emissions in Taiwan by taking 34 different industries into account in order to uncover an integrated perspective of the industrial, environmental, and economic performance. By using Grey Relation Analysis they discovered that industrial production has the closest relationship with carbon emissions which is followed by electricity consumption. Zhao et al. (2010) analyzed the factors those cause carbon emissions

in Shanghai between the years 1996-2007 by using Log-Mean Divisia Index method. It was found that industrial production was the primary force to accelerate carbon emissions level.

Previous studies have reported mixed results about the relationship between financial development and carbon emissions. Sadorsky (2010) investigated the impact of financial development on energy consumption levels in 22 developing economies by using panel data approach. The study revealed that overall financial development in these countries causes energy consumption to increase which in turn leads more carbon dioxide to be emitted. Boutabba (2014) carried a study to explore if financial development, income, energy and trade have an influence on carbon emissions in the Indian economy. As a result of cointegration test and dynamic vector error correction model, it is reported that financial development has a positive impact on environmental pollution through carbon emissions. Also, Granger causality test proved a unidirectional long run impact from financial development to carbon emissions. Zhang (2011) analyzed if financial development has a significant impact on China's; one of the fastest growing economy in the last three decades, carbon emissions. The results of cointegration, variance decomposition and Granger causality tests show that financial development, particularly financial intermediation sector, has a crucial positive impact on carbon emissions. On the other hand; Tamazian et al. (2009) examined the relationship between economic growth, financial development and climate quality for BRIC countries. It was found that financial development helps new technologies to emerge so as to boost energy efficiency and carbon emission concentration is to decrease.

The relationship between financial development and industrialization has been studied broadly in the literature. Neusser and Kugler (1998) investigated the nexus of manufacturing growth and financial development among OECD countries. The neo-Schumpeterian growth model is constructed and analyzed by using Johansen cointegration method and Granger causality tests. The results suggested a long term relationship between total factor productivity and financial development. Also, Granger causality indicated bidirectional causality from financial sector to manufacturing factor productivity. In the case of production output volatility; it has been revealed that industrial output is more stable in industrialized countries in comparison to developing ones (Acemoglu et al. 2003). Financial development provides wider opportunities for firms to borrow more freely since financial constraints in those countries are relaxed. Moreover, financial constraints cause agency costs and asymmetric information to increase which are reduced as financial development is improved (Hubbard, 1997; Stein, 2003).

Turkey's economic and financial sector growth has raised concerns for the environment due to negative outcome that might be created by inefficient usage of the resources. Apak and Atay (2013) claim that industrial sector of Turkey is responsible for 40 percent of total energy consumption. Especially, iron and steel production and cement manufacturing consume energy intensively, most of which comes from fossil fuels. Furthermore, statistics unveil that due to electricity demand, natural gas consumption reached to its highest level in 2013 by 1.6 trillion cubic feet (EIA, 2015). Between 2011 and 2012 Turkey's growth of energy demand counted as fastest compare to the OECD countries. Chandler et al, (2002) indicated that as a result of high growth rate of energy intense demand, emissions are expected accelerate and reach up to 210 million tons in 2020.

Despite the fact that literature focuses on empirical investigation of the environment and financial nexus, such studies are very limited for the case of Turkey. Ozturk and Acaravci (2013) investigated the long run causal relationship of energy, economic growth, openness and financial development in Turkey. The study revealed that there is long term relationship between per capita carbon emissions, per capita energy consumption, per capita real income, and the square of per capita real income, openness and financial development. They also further investigated if the EKC hypothesis is supported by the given variables. It is concluded that as income reach to its threshold level, carbon emissions per capita starts to decline. Although it is noted that financial development has no significant impact on carbon emissions in the long run in this context, there is evidence for a short run unidirectional causal relationship from financial development to per capita energy consumption.

3. Data and Methodology

3.1. Data

The data used in the present study are carbon emission metric ton per capita, industry value added percentage of GDP and domestic credit private sector (DCP) percentage of GDP for Turkey. The data is obtained from World Bank Development database (2014). Time period for the data covers 1960 to 2010.

3.2. Methodology

In its first stage, the variables are tested for stationarity. Augmented Dickey Fuller (ADF) (Dickey and Fuller, 1981); and Philips-Perron (PP) (Philips and Perron, 1988) unit root tests are applied to determine the integration orders of the variables. After stationarity conditions of the variables are examined, Johansen's (1988) co-integration test is applied in order to capture variables' possible long term movements with each other. Finally, Granger (1969) causality test is conducted to define the direction of long term relationship between variables.

3.2.1. Unit Root Tests

Since it is crucial to determine to whether a series is stationary or not, unit root test in time series is developed by Dickey and Fuller is defined by the following:

$$y_t = \Phi y_{t-1} + \varepsilon_t \quad (1)$$

Dickey-Fuller (DF) tests the null hypothesis if $\Phi = 1$ which indicates series contains a unit root against the alternative $\Phi < 0$ that the series is stationary. However, the DF test is proved to be valid only if the error term is not to be autocorrelated. Augmented Dickey Fuller (ADF) unit root test is introduced to overcome the problem of possibility that a correct null hypothesis is incorrectly rejected. So, that alternative structure is written as;

$$\Delta y_t = \Phi y_{t-1} + \sum_{i=1}^{p} \alpha i \, \Delta y_{t-i} + \varepsilon_t \quad (2)$$

Philips and Perron (1988) introduced an alternative approach over ADF unit root test by allowing autocorrelated residuals to be included.

3.2.2. Cointegration Test

When series are proved to be integrated of order one, I(1), it indicates that those series can be stationary as trend component is removed. However, as the trend is removed the series' long term relationship cannot be analyzed. Therefore, Engel and Granger (1987) have introduced the cointegration methodology in order to test if the variables are converging in the long run. Johansen (1988) cointegration approach is used to test if any two or more series are integrating each other in the long run even though the series are I(1).

$$y_t = \mu + \Gamma_1 y_{t-1} + \ldots + \Gamma_K y_{t-K} + \varepsilon \qquad (\text{for } t = 1, \ldots T) \quad (3)$$

Where y_t, y_{t-1}, …, y_{t-K} are vectors of level and lagged values of P variables respectively that are I(1) in the model; $\Gamma_1, \ldots, \Gamma_K$ are coefficient matrices with (PXP) dimensions; μ is an intercept vector; and ε is a vector of random errors. The number of lagged values is found by the assumption that error terms are not autocorrelated. The rank of Γ represents the numbers of co-integrating vectors which are determined by testing whether its Eigen values (λ_i) are statistically significant. Johansen (1988) and Johansen and Juselius (1990) propose that using the Eigen values is for specification of trace statistics. The trace statistic (λtrace) can be computed by the following formula;

$$\lambda_{trace} = -T\sum Ln(1-\lambda_i)_{\text{, i = r+1, …, n-1}} \quad (4)$$

The null hypotheses are:

H0: v = 0 H1: v ≥ 1

H0: v ≤ 1 H1: v ≥ 2

H0: v ≤ 2 H1: v ≥ 3

3.2.3. Granger Causality Test

If there is cointegration between variables, Granger (1988) causality test can be applied in order to identify the directional relationship between those variables. Even though the impact of one variable to another cannot be measured with this test, Granger causality reveals if there is a bidirection, unidirection or no direction at all.

$$X_t = \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t \quad (5)$$

$$Y_t = \sum_{j=1}^{m} c_j X_{t-j} + \sum_{j=1}^{m} d_j Y_{t-j} + \eta_t \quad (6)$$

4. Empirical results

4.1. Unit root test

Between 1960 and 2010; carbon emissions, industrialization and domestic credit to private sector variables for Turkey are tested for unit root. ADF and PP results are given in Table 1. As it can be seen, all the variables for both ADF and PP are non-stationary in their level form. However, these variables turn out to be stationary as their first differences are taken.

Table 1. ADF and PP Unit Root Tests

Statistics (Level)	*CO2*	*Lag*	*IND*	*Lag*	*DCP*	*lag*
τ_T (ADF)	-3.319	(0)	-1.037	(0)	1.012	(0)
τ_μ (ADF)	-0.039	(0)	-1.890	(0)	2.044	(0)
τ (ADF)	3.479	(0)	0.542	(0)	1.955	(0)
τ_T (PP)	-3.387	(1)	-0.959	(1)	0.614	(1)
τ_μ (PP)	0.181	(5)	-1.889	(1)	1.784	(2)
τ (PP)	3.938	(3)	0.568	(1)	1.582	(2)
Statistics (First Difference)	*ΔCO2*	*lag*	*ΔIND*	*Lag*	*ΔDCP*	*Lag*
τ_T (ADF)	-7.549*	(0)	-7.645*	(0)	-5.099*	(0)
τ_μ (ADF)	-7.621*	(0)	-7.262*	(0)	-4.808*	(0)

τ (ADF)	-5.815*	(0)	-7.212*	(0)	-4.570*	(0)
τ_T (PP)	-7.656*	(4)	-8.027*	(5)	-5.099*	(0)
τ_μ (PP)	-7.728*	(4)	-7.262*	(0)	-4.808*	(0)
τ (PP)	-5.928*	(3)	-7.212*	(1)	-4.629*	(1)

*Note:*CO2 represents CO2 emmisions; IND is the industry, value added; DCP is the domestic credit to private sector. τ_T stands for the general model with a drift and trend; τ_μ is the model with a drift but without trend; τ is the one without drift and trend. Numbers in parantheses show optimum lag levels. * represents the rejection of the null hypothesis at 5% level of alpha.

Since the all variables are I(1), Johansen cointegration test can be applied to observe long run relationship of the series. Table 2 presents the cointegration test results. The null hypothesis of there is no cointegrationg vector in the model is rejected at 1% level of alpha. This indicates that, there is a long run equilibrium relationship between CO2 emissions, industrialization and financial development.

Table 2. Johansen Cointegration Test Results

Hypothesized No. of CE(s)	*Eigenvalue*	*Trace Statistic*	*5 Percent Critical Value*	*1 Percent Critical Value*
None *	0.486264	36.36844	29.68	35.65
At most 1	0.181882	9.060538	15.41	20.04
At most 2	0.020037	0.829850	3.76	6.65

Note: * *denotes rejection of the null hypothesis at the 1% level of alpha.*

After revealing the long run interconnection between the variables, Granger causality test is conducted to specify the direction of the causal relation if there is any. Table 3 shows the computed causality results.

Table 3. Granger Causality Results

Null Hypothesis:	*F-Statistic*	*Prob.*
IND does not Granger Cause CO2	0.55134	0.8332
CO2 does not Granger Cause IND	0.49646	0.8726
DCP does not Granger Cause CO2*	1.99921	0.0899
CO2 does not Granger Cause DCP	1.68709	0.1533
DCP does not Granger Cause IND	0.17462	0.9964
IND does not Granger Cause DCP	0.32374	0.9647

Note:* *represents the rejection of the null hypothesis at 10% level of alpha*

The null hypothesis of domestic credit to private sector does not Granger causes carbon emissions is rejected at 10% level of alpha. This represents a unidirectional relationship between DCP and CO2. DCP is used as a proxy for the financial development and it shows the size of financial intermediation in an economy. DCP also implies the relative importance of the private sector for the financial development because private sector utilizes funds more effectively and efficiently than public sector. An increase in DCP indicates the development of the financial intermediation and the financial system and causes an increase in economic activity, foreign direct investments and trade activities. A unidirectional relationship observed between the DCP and CO2 emissions suggest that a change

in financial development precedes a change in air pollution in Turkey. Any bidirectional relationship could not be observed in the current study.

5. Conclusion

As a developing economy, industrialization and financial sector have been growing rapidly in Turkey. Together with the concerns regarding global warming and air pollution, there has been a controversy for the Turkey's energy polices. Therefore, the aim of the present study is to empirically examine any possible connection between financial development, industrialization and carbon emissions. In this extent, it has been found that there is a long term relationship among the mentioned variables. After estimating a long term relationship by Johansen's cointegration test, Granger causality test is applied to investigate any possible causal relationship between the variables. The results show that there is a unidirectional causality from financial development to carbon emissions for the period investigated.

A similar study, conducted by Ozturk and Acaravci (2013), investigates the causal relationship between several variables including financial development, economic growth and carbon emissions for Turkey and finds long run causal relationship from financial development to per capita carbon emissions. Our study however, substitutes economic growth with industrialization in order to observe its specific role for carbon dioxide emissions. The first reason for this is the criticisms made against uncontrolled growth of the industrial sector of Turkey. The second reason is the abundance of the articles devoted to investigate the relationship between economic growth and carbon emission (among others, Li et al., 2011; Arouri et al., 2012). However, the causal relationship between carbon emission and a particular segment of the economy deserve attention (Katircioglu, 2014) and industry is one of the most important ones.

Following various empirical tests, our study concludes that air pollution is financial development driven in Turkey. This finding has some policy implications. The countries' financial regulatory bodies must consider practical ways of channeling financial development into an environmental friendly and sustainable system. Also, financial institutions should take theinitiativeinprotecting the environment. For instance; as the major part of the financial system, financial intermediaries may offer special loans with lower discounts if the investments are going to be made on low carbon based products. In this way, businesses as well as individuals can shift to more renewable energy items.

Future studies should be devoted on the investigation of the long term and causal relationship between different sectors of the economy and the environment. Also, any possible nonlinear relationship among these variables should be taken into consideration by the prospective studies. To propose efficient and effective solutions for the establishment of sustainable economic system and environmental friendly institutional structure should be one of the main focuses of the further studies.

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