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SOCIAL CAPITAL AND AIR POLLUTION: EVIDENCE FROM TURKEY

SOSYAL SERMAYE VE HAVA KİRLİLİĞİ: TÜRKİYE'DEN KANITLAR

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Abstract

This study analyses the impact of social capital on air pollution in all 81 cities of Turkey between 2008 and 2018 via utilizing the panel data method to test for the EKC hypothesis. Within this context, five panel groups are formed, where four of those are formulated vis-à-vis their socioeconomic development levels by taking into account the SEGE report issued by the Ministry of Development. Moreover a city-based social capital index is developed by utilizing the principal component analysis (PCA). Empirical findings show that a U-shaped income-emission relationship is prevalent in Turkey, whereas no significant income-emission interdependency exists within the aforementioned panel groups developed. In addition, it is deduced that population density is a pre-determinant of the rise in air pollution for all panel groups studied, while the hypothesis that social capital index has a significant impact on the latter variable is rejected. It is expected that this work will contribute to the existing literature through its investigation of the impact of social capital index structured via taking into account the cities' socioeconomic development levels on air pollution. The dataset used has a significant lack of observations for certain cities, so it would be valuable to formulate advanced technical modeling by creating a more complete dataset. Also, various other proxies explaining environmental degradation such as water pollution can be included in the model.

Keywords: Air Pollution, Panel Data, Social Capital.

Öz

Bu çalışma, EKC hipotezi kapsamında Türkiye'de 81 ilde 2008-2018 yıllarına ait sosyal sermaye değişkeninin hava kirliliği üzerine etkisini panel veri yöntemiyle analiz etmiştir. Çalışmada beş panel grubu oluşturulmuştur. Panel gruplarından dördü Kalkınma Bakanlığı'nın yayınladığı SEGE raporu dikkate alınarak sosyo-ekonomik gelişmişlik düzeylerine göre yapılmıştır. Ayrıca çalışmada temel bileşenler analiz (PCA) tekniği kullanılarak il bazında sosyal sermaye endeksi oluşturulmuştur. Ampirik bulgular Türkiye geneli için U şekilli gelir-emisyon ilişkisinin geçerli olduğunu göstermektedir. Buna karşın sosyo-ekonomik gelişmişlik düzeylerine göre oluşturulan panel gruplarında herhangi bir gelir-emisyon ilişkisine rastlanmamıştır. Bunun yanında bütün panel grupları için nüfus yoğunluğunun hava kirliliğinin artmasında belirleyici olduğu saptanmıştır. Çalışmanın amacını oluşturan sosyal sermaye endeksinin hava kirliliği üzerine etkisi bulunamamıştır. Çalışmanın illerin sosyo-ekonomik gelişmişlik düzeylerini dikkate alarak oluşturulan sosyal sermaye endeksiyle hava kirliliği üzerine etkiyi incelemesi bakımından literatüre katkı sunması beklenmektedir. Kullanılan veri seti belirli şehirler için önemli ölçüde gözlem eksikliği taşımaktadır, bu nedenle daha eksiksiz bir veri seti oluşturularak ileri teknik modellemenin formüle edilmesi değerli olacaktır. Ayrıca, su kirliliği gibi çevresel bozulmayı açıklayan çeşitli diğer vekiller modele dahil edilebilir.

Anahtar Kelimeler: Hava Kirliliği, Panel Veri, Sosyal Sermaye.

GENİŞLETİLMİŞ ÖZET

Çalışmanın Amacı

Hava kirliliği, düşük, orta ve yüksek gelirli ülkelerdeki herkesi etkileyen önemli bir çevre sağlığı sorunudur. Bu durumdan özellikle düşük ve orta gelirli ülkeler daha fazla etkilenmektedir. Gelişmekte olan ülkelerden biri olan Türkiye'de de son dönemlerde hava kirliliğinde artışlar yaşanmaktadır. IQAir grubunun hazırladığı 2020 Dünya Hava Kalitesi raporuna göre, Türkiye hava kalitesi bakımından 106 ülke arasında 46'ncı sıradadır. Türkiye atmosferindeki partikül maddeler, son 17 yıldır Avrupa ülkelerine göre sürekli olarak yüksek düzeyde olmuştur. Üstelik Avrupa atmosferindeki partikül maddeler yıllar bazında düzenli olarak azalırken Türkiye'de artmaktadır. Bunun sonucu olarak, Türkiye'nin 2003 yılında Avrupa'dan %5,6 oranında daha fazla olan kirlilik düzeyi, 2019 yılında %31,0 oranına ulaşmıştır (TMMOB, 2019). Gelişmekte olan ülkelerde olduğu gibi Türkiye'de de politika yapıcılar, çevre sorunlarının çözümünde sosyal sermayenin önemini henüz fark etmemiştir. Bu nedenle, mevcut çalışma; sosyal sermayenin çok yönlü yapısını dikkate alarak, sosyal sermayeyi Türkiye toplumunun özelliklerine göre hesaplamaktadır. Bu bağlamda çalışmanın iki amacı bulunmaktadır: birincisi sosyal sermayenin alt bileşenlerinden oluşan verilere dayanılarak il bazında toplumsal koşullara daha uygun olan sosyal sermaye değişkenini hesaplamaktır. İkincisi, sosyal sermayenin hava kalitesi performansı üzerindeki etkisi illerin sosyo-ekonomik gelişmişlik düzeylerine göre analiz etmektir.

Araştırma Soruları

Sosyal sermaye gibi gayri resmi mekanizmalar idari ve piyasa koşullarının yeterince gelişmediği ülkelerde özellikle de gelişmekte olan ülkelerde tamamlayıcı role sahip olabilir. Bu bakımdan "Gelişmekte olan ülkelerden biri olan Türkiye'de sosyal sermayenin hava kirliliğini azaltmada rolü var mı?", "Varsa bu illerin gelişmişlik düzeylerine göre farklılaşmakta mıdır?" sorularına cevap aranmaktadır.

Literatür Araştırması

Son yıllarda sosyal sermayenin çevre kirliliği üzerindeki etkisini araştıran çalışmalarda artış olsa da çalışmalar sınırlı sayıdadır. Genel olarak sosyal sermayenin çevre kirliliği üzerindeki etkisi olumlu olmakla birlikte sonuçlar farklılık arz etmektedir. Bu farklı sonuçlar, çalışmanın zaman çerçevesi, açıklayıcı değişkenlerin seçimi ve metodolojik uyarlama nedeniyle ortaya çıkabilir. Literatürdeki çalışmalar da bu durumu desteklemektedir. Örneğin, Paudel ve Schafer (2009), Ibrahim ve Law (2014), Keene ve Deller (2015), Rahnama ve Sharifzadeh Aghdam (2018), Yildirim vd. (2020), Zhou vd. (2020), Wang et al. (2020), sosyal sermayenin çevre kirliliği üzerinde iyileştirici etkiye sahip olduğu sonucuna ulaşırken; Grafton ve Knowles (2004) çalışmasına göre ise hiçbir etki bulamamıştır. Bu bulgular sosyal sermayenin daha derinlemesine ve daha kapsamlı incelenmesine olan gerekliliği ortaya koymaktadır. Bu bilgiler ışığında Türkiye örneğini ele alan yalnızca bir çalışmaya (Yildirim vd. 2020) rastlanmıştır. Bu çalışmada sosyal sermayeyi temsil için dernek üyeliği kullanılmıştır. Mevcut çalışmada ise bu araştırma alanına katkıda bulunmak için daha fazla girişimde bulunarak sosyal sermaye için il bazında bir endeks oluşturulmuştur. Böylece bu çalışmada sosyal sermayenin daha kapsamlı olarak değerlendirilmesiyle hava kirliliği üzerine oynadığı roller analiz edilmektedir.

Yöntem

Bileşik bir sosyal sermaye endeksi oluşturulmasında sosyal sermaye için alt değişkenler (veri bölümünde gösterilmiştir) seçilerek; bunların tek bir endekste birleştirilmesi amacıyla göreli ağırlıkları belirlenmesi gerekmektedir. Bu bağlamda Temel Bileşen Analizi (PCA), en küçük kare mesafeyi en aza indirmek yerine, varyansı en üst düzeye çıkardığı için uygun bir yöntemdir. PCA, orijinal değişken kümesini, bir değişken kümesine indirgemektedir. İkinci olarak PCA tekniği ile elde edilen veriler panel veri analiz yöntemiyle analiz edilmiştir. Bütün panel gruplarına ait modellerin hata terimlerinde değişen varyans, otokorelasyon ve yatay kesit bağımlılığının (YKB) tespitine yönelik yapılan testler; modellerin hata terimlerinde değişen varyans, otokorelasyon ve YKB (Panel C hariç) olduğunu göstermektedir. Bu bulgular doğrultusunda parametre tahminlerine dokunulmadan standart hatalar dirençli standart hatalarla düzetilmelidir (Hoechle, 2007). Değişen varyans, otokorelasyon ve YKB'nin sorunları varlığında tahminleme yapmak için çeşitli dirençli tahminciler geliştirilmiştir. Bunlardan bir tanesi Arellano, Froot ve Rogers'ın tahmincisidir. Arellano, Froot ve Rogers tahmincisi hem RE hem de FE modellerinde değişen varyans ve otokorelasyonun varlığında kullanılabilmektedir. Ancak RE modellinde değişen varyans, otokorelasyon ve YKB'nin varlığı durumunda dirençli tahminci bulunmamaktadır. Bu durumda Arellano, Froot ve Rogers tahmincisi kullanılabilmektedir. Dolayısıyla Panel C grubunda yer alan modellerde her üç sorun (değişen varyans, otokorelasyon ve YKB) varlığında Arellano, Froot ve Rogers tahmincisi kullanılmıştır.

Sonuç ve Değerlendirme

Mevcut çalışma, EKC hipotezi kapsamında Türkiye'de 81 ilde 2008-2018 yıllarına ait sosyal sermaye değişkeninin hava kirliliği üzerine etkisini analiz etmiştir. İller, 2011 yılında Kalkınma Bakanlığı'nın yayınladığı SEGE raporu dikkate alınarak sosyo-ekonomik gelişmişlik düzeylerine göre dört gruba ayrılmıştır. Ampirik bulgular Türkiye geneli için U şekilli gelir-emisyon ilişkisinin geçerli olduğunu göstermektedir. Buna karşın sosyo-ekonomik gelişmişlik düzeylerine göre sınıflandırılan illerin oluşturulduğu panel gruplarına göre herhangi bir gelir-emisyon ilişkisine rastlanmamıştır. İlaveten panel gruplarının hepsinde hava kirliliğinin artmasında nüfus yoğunluğunun belirleyici olduğu bulgusuna ulaşılmıştır. Çalışmanın amacını oluşturan sosyal sermaye endeksi değişkeni bütün panel gruplarında teorik beklentiyi desteklemesine rağmen istatiksel olarak anlamsızdır. Bu durum literatürde elde edilen sonuçlarla tutarlıdır. Çünkü literatürde yer alan çalışmalarda da elde edilen bulgular; çalışmanın zaman çerçevesi, açıklayıcı değişkenlerin seçimi ve metodolojik uyarlama gibi nedenlerle farklılaşmaktadır. Örneğin, Paudel and Schafer (2009), Ibrahim ve Law (2014), Keene ve Deller (2015), Rahnama ve Sharifzadeh Aghdam (2018), Yildirim vd. (2020), Zhou vd. (2020), Wang vd. (2020), sosyal sermayenin çevre kirliliği üzerinde iyileştirici etkiye sahip olduğunu bulurken, Grafton ve Knowles (2004) çalışması ise hiçbir etki bulamamıştır. EKC çerçevesinde Türkiye'yi inceleyen Yıldırım vd. (2020) çalışmasında sosyal sermaye anlamlı olmasına rağmen nüfus yoğunluğu için kullanılan değişken istatiksel olarak anlamlı değildir. Mevcut çalışma, Yıldırım vd. (2020) çalışması gibi, Türkiye'de U şekilli gelir-emisyon ilişkisinin geçerli olduğunu doğrulamaktadır. Buna karşın mevcut çalışma hava kirliliğinin artmasında nüfus yoğunluğunun temel belirleyici olduğunu göstermektedir. Dolayısıyla sonuçlar açıklayıcı değişkenlerin seçimi ve metodolojik uyarlama gibi nedenlerle farklılık gösterebilmektedir.

1. INTRODUCTION

Air pollution is a detrimental environmental health problem that impacts all peoples of low, middle and high income countries; the first two categories being relatively more affected. Recent studies show that 98% of the cities in developing countries with a population of more than 100.000 fails to fulfill World Health Organization's (WHO) air quality standards (WHO, 2021).

A developing country herself, Turkey, has recently seen rises in air pollution. According to the World Air Quality Report published by IQAir in 2020, Turkey ranks 46th among 106 countries in terms of its air quality. The density of particles in the atmosphere has remained higher in Turkey than its European counterparts for the past 17 years. Furthermore, whereas this density has gradually been declining for the latter part of countries, it has been on the rise when it comes to Turkey. As a result, the pollution gap between Turkey and Europe has soared to 31.0% in 2019 from a mere 5.6% in 2003 (TMMOB, 2019).

Surging pollution levels and their equally increasing social, political and economic impacts have given rise to academic work focusing on these phenomena, where the economic interdependency between emissions and economic development gained popularity in the last 20 years (Ibrahim & Law, 2014). The literature shows that, in the early phases of development, as the economy proceeds within its development path; environmental degradation also speeds up through various factors such as air, land and water pollution and deforestation. In this stage, the rising of income levels is of primary concern for citizens and policy makers so the trade-off between economic development and environmental deterioration is utilized to benefit the former factor. Increasing income levels give rise to higher living standards which results in people's expectation of better environmental quality. This surge in demand, therefore brings structural reforms mainly in the form of production facilities replacing the obsolete and contaminating technologies with their newer and greener alternatives; and governments putting in their agendas various environmental protection policies and regulations. These developments, having stemmed from the demand for a better environment facilitate the improvement of environmental quality. This process is explained by the Environmental Kuznets Curve (EKC) theory which posits that environmental problems have an inverted-U-shaped relationship with greenhouse gas emissions and economic development. In addition, parameters obtained show that this interdependency is expressed in various ways such as bearing no relationship, linearly increasing and decreasing, U and inverted-U shaped, N and inverted-N shaped (Shahbaz & Sinha, 2019). The assumed emissions-economic growth relationship has been embedded to empirical applications, especially starting with Grossman and Kruger's pioneering work (Ibrahim & Law, 2014).

Increasing environmental pollution and corresponding work has led countries to undertake various measures to control the aforementioned phenomenon. Developed economies have been utilizing their institutional structures and market incentives as well as other policy measures, all of which have proven to be successful. Apart from the aforementioned measures, these countries also put informal mechanisms such as social capital into forefront (Wang et al., 2020). These informal mechanisms, simply described as "non-economic factors" in the economic, sociological and regional science literature are proposed to have a robust influence in economic growth. Furthermore, increasing social capital levels and stronger non-governmental organizations are suggested to create a wider capacity for economic development than markets and political institutions (Paudel & Schafer, 2009).

The concept of social capital has evolved from the economic term of "capital". The first systematic discourse of social capital theory has been put forward by Pierre Bourdieu, a French sociologist (Wang et al., 2020) and the concept is partitioned into the notions of social network, social trust and social norms (Liu & Feng, 2021). Therefore, social capital is a difficult concept to accurately describe. When literature developed within this context is reviewed, a myriad of definitions structured by various academics (Coleman, 1990; Fukuyama, 1995; Putnam, 1995; etc.) can be discovered (Yıldırım, Alpaslan & Eker, 2020). These authors suggest that social capital facilitates cooperation among individuals to more effectively produce collective goods and prevent societal diseases like crime (Paudel & Schafer, 2009).

The multifaceted nature of social capital enables a wide range of descriptions formulated within the literature, resulting in the lack of a consensus on the methods to measure the concept (Zhou, Liu & Wang, 2020). In line with this information, social capital can be described as the social norms and networks that facilitate the cooperation and coordination for collective action to enable and ensure trust and mutual benefit (Paudel & Schafer, 2009).

Even though differences of opinion are prevalent vis-a-vis the aforementioned notion, the fact that social capital bears norms and networks that facilitate collective action emphasizes its importance in the efforts to prevent environmental degradation and ensure protection (Ibrahim & Law, 2014; Yildirim et al., 2020).

First, the peer group effect created by social networks can accelerate the conscious instinct to protect the environment. Second, trust, a component of social capital can enable social cooperation. Therefore, environmental concerns can be eased and collective action can be facilitated (Liu & Fend, 2021; Yildirim et al. 2020). Compared to formal governance structures, these functions of social capital do not rely on legal or administrative powers, allows for polluter companies to change their applications and triggers the directive role of social norm via ethical and cultural pressures. Consequently, members of the community reduce their consumption of goods produced by those polluters and increase their support for practices that help reduce pollution at its very source (Wang et al., 2020).

Apart from bearing these favorable components, social capital does not necessarily need to directly contribute to the management and protection of the ecological environment. Social capital's normative side that relies on trust and collectivity has a significant negative impact on the environment on rural areas. In addition, low social capital stock has a relatively higher unfavorable effect on urban environment governance. Moreover, a handful of research propose the prevalence of a non-linear relationship between social capital and pollution, suggesting that the impact of the latter on the former can first be of a facilitative nature then to transform into a suppressive one (Wang et al., 2020).

Even though the literature focusing on social capital’s impact on environmental issues has been growing, one can state that the amount of research still remains limited. These works generally accept the hypothesis that social capital has a positive impact on environmental pollution, yet varying results are also prevalent. These differing outcomes can arise out of differences in time spans, explanatory variables and methodological adaptation. Existing literature also supports this proposal. For example, while Paudel and Schafer (2009), Ibrahim and Law (2014), Keene and Deller (2015), Rahnama & Sharifzadeh Aghdam (2018), Yildirim et al. (2020), Zhou et al. (2020), Wang et al. (2020) state that social impact has a recuperative effect on environmental pollution, Grafton & Knowles (2004) fail to find a significant interdependency between the two aforementioned variables.

These findings emphasize the need for the more robust and thorough analysis of social capital. In line with this information, the author of this paper could only find one study that conducted this work for Turkey (Yildirim et al. 2020) where memberships to associations are used as a proxy for social capital. To contribute to this field, this study constructs a city-based index for social capital to more comprehensively analyze the concept and its influence on air pollution.

This study comprises of four parts. The existing literature is reviewed in the next section. Then the data set utilized and methodology constructed is explained. Last, the findings and conclusions are presented.

2. LITERATURE

A myriad of studies prevalent in the existing literature investigate environmental degradation by testing the significance of factors as economic growth, innovation and social capital vis-a-vis the EKC hypothesis. Work focusing on the environmental impact of economic growth date back to the start of 1990s. In their pioneering effort, Grossman and Krueger (1995) analyze the issue by taking into account alternative degradation indicators such as urban air pollution and the status of the oxygen regime in river basins. Khan, Khan and Regan (2020) show that energy consumption and economic growth between 1965 and 2015 in Pakistan contribute to CO_2 emissions. Bulus and Koç (2021) demonstrate an N-shaped relationship between GDP per capita and CO_2 emissions for the period spanning 1970 to 2018 in South Korea, whereas Balsalobre-Lorente et al. (2021) posit an inverse U-shaped interconnection between economic growth and CO_2 emissions for five EU countries in a sample containing data from 1990 to 2015.

Testing of innovation within the context of EKC has also been a popular research subject. Töbelmann and Wendler (2019), for EU-27 countries between 1992 and 2014, put forward that environmental innovation has a facilitative effect on the hampering of CO_2 emissions, whereas general innovative activity is not thought to have such a significant influence on the aforementioned dependent variable. Ibrahim and Ajide (2021) confirm that technological innovation significantly reduces CO_2 emissions in G-20 countries for the period spanning 1990 to 2018. Cheng et al. (2021) don't reject the EKC hypothesis for China from 1988Q1 to 2018Q4 and put forth a two-way causality between eco-innovation, human capital and CO_2 emissions; as well as a one-way causal relationship from social capital and economic growth to the aforementioned dependent variable. In addition, Lin et al. (2021) suggest that innovative human capital has a favorable impact on the environmental degradation, for 30 Chinese cities between 2003 and 2017. On the contrary, Cai (2021), in their study comprising of data collected from 2006 to 2019 for 30 Chinese cities, posit that while green technology innovation curtails CO_2 emissons for eastern and middle regions of China, an opposite relationship emerges when it comes to the western regions. Zhang (2022) demonstrates that energy consumption and technological advances have a significant positive impact on CO_2 emissions for South Asian economies in the period spanning 1998 to 2018.

Upon the testing of social capital within the context of EKC, Rudd (2000) clarifies the interdependencies between social interactions and outputs of those interactions that contribute to the underlying factors that result in the production of environmental quality, public and economic welfare and long-term social and economic sustainability. Grafton & Knowles, (2004) evaluate the relationship between social capital, social discrepancies and social capacity with environmental performance for a sample comprising of under-developed, developing and developed countries. They reject the hypothesis that the aforementioned variables have significant explanatory power over environmental performance. Dutt (2009) shows that the countries with better governance, more robust political institutions, improved socioeconomic conditions and higher investment in education have lower greenhouse gas emissions than their counterparts, from a sample of 124. Paudel & Schafer, (2009) investigate the interdependencies between social capital and water pollution in US. They find out a U-shaped relationship, concluding that a high level of pollution is related to both low and high social capital. Paudel, Poudel, Bhandari, & Johnson, (2011) assess social capital and pollution via utilizing panel data analysis. The study's outcome posits that social capital is a significant determinant in prevention of environmental pollution. Dulal, Foa and Knowles (2011) present findings that demonstrate significant relationship between certain aspects of social capital and improved environmental performance. Ibrahim & Law, (2014) analyze the impact of social capital on CO_2 emissions in a sample of 69 observations containing both developing and developed economies. The results of this analysis propose that social capital proves effective in recuperating environmental pollution in proportion to the development levels of the respective economies. Keene & Deller, (2015) examine the relationship between social capital and air pollution in US within the scope of EKC. The findings support the EKC hypothesis that bolstering economic growth in relatively lower income levels can contribute to environmental deterioration, but the aforementioned explanatory variable can have the opposite impact as income levels increase. Disli et al. (2016) confirm the prevalence of EKC in 69 developed and developing countries and aver the importance of culture on the interdependency between income and emissions. Rahnama & Sharifzadeh Aghdam, (2018) explore the role of social capital on sustainable environmental governance in Iran. They deduce that the former variable has strong explanatory power over the latter. Zhou, et al. (2020) examine the relationship between state-level social capital and pollution in China through panel data analysis. Results show that while social capital is effective in hampering pollution, the magnitude of this effect changes as the states' level of development varies. Wang, et al. (2020) assess the deterrent and encouraging role of social capital on pollution in a state-wide basis in China through panel data analysis. It is concluded that a low level of social capital intensifies pollution, but the effect is reversed when the level of social capital increases. Yildirim, et al. (2020) examine the relationship between city-level social capital and pollution in Turkey through spatial panel data analysis. The authors find out that social capital is effective in ameliorating pollution. Tinta (2022) validates the significant and positive effect of corporate quality and human capital on ecological transformation for Sub-Saharan African countries between 1980 and 2019. Bayar, et al. (2022) study 11 transition economies of the EU in the period of 2000 to 2018. They put forward that for Croatia, Czech Republic, Hungary and Slovenia, human capital has an adverse effect on CO_2 emissions and institutions have a significant yet negative impact on the aforementioned dependent variable for Czech Republic. On the contrary, both these explanatory factors are shown to have a positive impact on greenhouse gas emissions for Letonia and Lithuania. Zhuang and Ye (2022) focus on how social capital facilitates proactive environmental strategy through various perspectives including marketing, human resources, supply chain and big data analytics and how it affects managerial decision making.

If the examined studies are evaluated in general, in the context of economic growth-EKC; Khan, Khan and Rehan (2020) for Pakistan; Bulus and Koc (2021) for South Korea; Balsalobre-Lorente, et al. (2021) for 5 EU-5 countries. Studies show that economic growth increases environmental pollution in the first stages and then decreases it.

In the context of Innovation-EKC; Töbelmann and Wendler (2019) for EU-27 countries; Ibrahim and Ajide (2021) for G-20 countries; Lin, et al. (2021) and Cai (2021) for 30 Chinese provinces and found that innovation reduces environmental pollution. In contrast, Cheng et al. (2021) for China and Zhang (2022) for South Asian countries found that innovation increases environmental pollution.

In the context of social capital-EKC; Rudd (2000) theoretical work; Dutt (2009) for 124 countries; Paudel & Schafer (2009) and Keene & Deller (2015) for USA; Grafton & Knowles (2004), Ibrahim & Law (2014) and Disli et al. (2016) for developed and developing countries; Rahnama &

Sharifzadeh Aghdam (2018) for Iran; Wang, et al. (2020) For China; Yildirim et al. (2020) for Turkey; Tinta (2022) for Sub-Saharan African countries; Bayar et al. (2022) for 11 EU transition countries examined the effect of social capital on environmental pollution. All these studies, except for Grafton and Knowles (2004); Bayar et al. (2022) conclude that social capital has significant effect on environmental pollution.

Similar to their peers in respective developing economies, policy makers in Turkey have a relatively lower and lagged level of awareness of the importance of social capital in the resolution of environmental problems. This emphasizes the need for a more robust and thorough analysis of the concept in question, as the author(s) of this work could only find one study that focus on Turkey (Yildirim et al., 2020). The study uses membership to an association as a proxy for social capital, which can prove to have its limitations, considering the multi-faceted structure of the aforementioned phenomenon. This analysis takes into account this sophisticated nature of social capital and calculates this factor by incorporating the societal characteristics of Turkey. Within this context, a social capital variable that is relatively more adaptable to social conditions is measured through data comprising of the sub-components of social capital. Then, the effect of social capital on air quality performance is analyzed vis-à-vis the cities' socioeconomic development levels. It is expected that this study contributes to the existing literature in two ways via being one of the first that incorporates a city-based index and allowing for a thorough analysis that focus on the interdependencies between social capital index and air pollution via taking into account cities' socioeconomic development levels.

3. DATA AND METHODOLOGY

3.1. Data

Most of the work focusing on EKC take factors related to air and/or water quality as dependent variables and various economic and demographic proxies like income per capita and population density as explanatory variables. This study, in line with the existing literature, additionally incorporates social capital into the model. Nevertheless, it should be stated that the means to generate a complete and consistent data set comprising of detailed information regarding a certain region or city by years, or all regions and cities in a stated year proves to be difficult, thus hampering the ability to undertake a regional or city-based analysis. Still, to compensate for that drawback, the methodology proposed either uses variables frequently used in the existing literature or their proxies. These variables are listed as follows: *Tax Collection/Accrual Ratio:* It is expected that higher social integration results in the decline of tax evasion activities. Therefore, one can state that a positive correlation exists between tax collection/accrual ratio and social capital index value. Taking this lemma as a starting point, Tüysüz (2011) and Putnam (1995) take this variable to account for social capital in their respective studies. *Suicide Rate:* It is predicted that suicide rate, an indicator of the level of social integration, has a negative correlation with social capital index value. Tüysüz (2011), Bullen and Onyx (1998) use this proxy in their work. *Crime Rate:* It is estimated that the crime rate has a negative impact on social capital index value. Grootaert (1998) and Putnam (1995) incorporate crime rate into their respective models to proxy for social capital. *Crude Divorce Rate:* One can posit that societies with high levels of individual social capital experience a soar in divorce rates, hence a positive interdependency is prevalent between crude divorce rate and social capital index value. Tüysüz (2011) utilizes the former variable as an indicator for the latter. *Number of Associations per Thousand People*: This indicator is accepted to be one of the most important proxies that signify civic participation, therefore the hypothesis that a higher level of number of associations resulting in an increased level of social capital index value is frequently accepted. This indicator is used by Uğuz et al. (2011), Tüysüz (2011), Kara (2008), Grootaert (1998) and Putnam (1995) in their respective studies. *Number of Foundations per Thousand People*: Similar to the previous proxy, this variable is also posited to be one of the most important indicators of civic participation. It is predicted that the number of foundations per thousand people and social capital index value are positively correlated. This variable is used interchangeably with its aforementioned counterpart by Uğuz et al. (2011), Tüysüz (2011), Grootaert (1998) and Putnam (1995), whereas it is incorporated into the model as a separate factor by Kara (2008), akin to the methodology this study develops. *Net Migration Rate:* Migration, through its influence on the strength of the relationship and trust between the members of the society, reduces the social capital level (Rupasingha, 2006:91), thus it is forecasted that as the net migration rate increases, the social capital index value decreases. This indicator is incorporated into the models proposed by Rupasingha et al. (2006), Tüysüz (2011) and Filiztekin (2009). *Participation Rate in General Elections:* One of the most critical indicators of civic participation, the variable is thought to have a positive correlation with social capital. It is frequently hypothesized that an increasing participation rate in general elections has a soaring impact on social capital index value. Uğuz et al. (2011) and Putnam (1995) use this indicator in their respective models.

Owing to the reasons stated above, and correspondingly indicated by Tüysüz (2011), data indicating region and/or city-based trust level in Turkey cannot be compiled, resulting in the limitation that the model proposed in this study lacking one of the most vital components of social capital. Nevertheless, as emphasized in the existing literature, it is expected that the embedding of net migration rate into the methodology may compensate for that drawback.

Accordingly, this work examines the impact of social capital on air pollution in all the 81 cities of Turkey between 2008 and 2018 within the scope of EKC hypothesis. Cities are categorized based on their socio-economic status, where the Socio-Economic Development Ranking (SEDR) research conducted by Ministry of Development in 2011 is taken into account. The aforementioned report classifies Turkish cities in four groups based on their socio-economic conditions. This classification is presented in Table 1 and the abbreviations, definitions and sources of the variables used in the model in Table 2.

Table 1. Sosyo-Economic Development Ranking

First Region	Second Region	Third Region	Fourth Region
TR10 (İstanbul)	TR21 (Tekirdağ, Edirne, Kırklareli)	TR63 (Hatay, Kahramanmaraş, Osmaniye)	TRA2 (Ağrı, Kars, Iğdır, Ardahan)
TR31 (İzmir)	TR22 (Balıkesir, Çanakkale)	TR71 (Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir)	TRB2 (Van, Muş, Bitlis, Hakkari)
TR41 (Bursa, Eskişehir, Bilecik)	TR32 (Aydın, Denizli, Muğla)	TR82 (Kastamonu, Çankırı, Sinop)	TRC2 (Şanlıurfa, Diyarbakır)
TR42 (Kocaeli, Sakarya, Düzce, Bolu, Yalova)	TR33 (Manisa, Afyon, Kütahya, Uşak)	TR90 (Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane)	TRC3 (Mardin, Batman, Şırnak, Siirt)
TR51 (Ankara)	TR52 (Konya, Karaman)	TRA1 (Erzurum, Erzincan, Bayburt)	
TR61 (Antalya, Isparta, Burdur)	TR62 (Adana, Mersin)	TRB1 (Malatya, Elazığ, Bingöl, Tunceli)	
	TR72 (Kayseri, Sivas, Yozgat)	TRC1 (Gaziantep, Adıyaman, Kilis)	
	TR81 (Zonguldak, Karabük, Bartın)		
	TR83 (Samsun, Tokat, Çorum, Amasya)		

Source: Ministry of Development (2011).

Table 2. Summary of Variables

Abbreviations	Variables	Description	Source
Air	Air pollution	PM10 value is taken for the unit measurement of air quality	Ministry of Environment, Urbanization and Climate Change (Republic of Turkey)
GDP**	Income per capita	Real gross domestic product per capita	Turkish Statistical Institute
Pop	Population density	Population per area (km^2)	Turkish Statistical Institute
EC	Electricity consumption	Total electricity consumption	Turkish Statistical Institute
SC*	Social capital	Tax collection/accrual ratio	Turkish Revenue Administration
		Suicide rate	Turkish Statistical Institute
		Crime rate	Turkish Statistical Institute
		Crude divorce rate	Turkish Statistical Institute
		Number of associations per thousand people	Turkish Statistical Institute
		Number of foundations per thousand people	Turkish Statistical Institute
		Net migration rate	Turkish Statistical Institute
		Participation rate in general elections	Turkish Statistical Institute

Note: * The index variable is developed by authors by using the Principal Component Analysis (PCA). **Variables GDP2 and GDP3 are obtained by taking the second and third power of GDP, respectively.

3.2. Methodology

Estimation of economic relationships via models constructed through panel date is defined as a panel data analysis, a methodology frequently used by researchers. The panel data model including time and cross section data for each unit is presented below (Baltagi, 2005:11)

$$Y_{it} = \beta_{0it} + \beta_{1it}X_{1it} + \cdots \dots \dots \dots \dots . + \beta_{kit}X_{kit} + \mathcal{E}_{it} \quad (1)$$

$$i = 1,2, \dots \dots \dots \dots \dots . . N;\ t = 1,2, \dots \dots \dots \dots \dots \dots \dots . T$$

In equation (1), Y_{it} represents the explained variable, X_{it} is used to denote the explanatory variable, β_0 is used to denote the constant term and $\mathcal{E}_{it}$ represents the error term with a fixed variance and a zero-mean.

The models to be forecasted in this study are presented below:

Model I $\text{lnair} = \beta_{0it} + \beta_{1it}\ln GDP + \beta_{2it}\ln GDP^2 + \beta_{3it}\ln \text{pop} + \beta_{4it}\text{lnEC} + \varepsilon_{\text{it}}$ (2)

Model II $\text{lnair} = \beta_{0it} + \beta_{1it}\ln GDP + \beta_{2it}\ln GDP^2 + \beta_{3it}\ln GDP^3 + \beta_{4it}\ln \text{pop} + \beta_{4it}\text{lnEC} + \varepsilon_{\text{it}}$ (3)

Model III $\text{lnair} = \beta_{0it} + \beta_{1it}\ln GDP + \beta_{2it}\ln GDP^2 + \beta_{3it}\ln GDP^3 + \beta_{4it}\ln \text{pop} + \beta_{4it}\text{lnEC} + \beta_{5it}\text{lnSC} + \varepsilon_{\text{it}}$ (4)

i=1,2,3,……N represent cross section units whereas t=1,2,3,……T represent the time variable and Ɛ is used for the panel error.

3.2.1. Indexing Social Capital

To construct a compounded social capital index, sub-variables –shown in the Data section- are selected and their relative weights are identified for their effective incorporation into the overall index. Within this context, Principal Component Analysis (PCA) is a reliable method to overcome the aforementioned task since it maximizes variance instead of minimizing the least square distance. PCA reduces the original variable set into another set that includes most of the information. Transformation of the original variables into the social capital index is conducted via the equation presented below:

$$SC_1 = a_{11}x_1 + a_{12}x_2 + .\dots + a_{1p}x_p = \sum_{i=1}^{r} a_{1i}x_i$$

PCA determines the optimal weight vector (a11, a12, ..., a1p) and SC1’s related variance. Variables that have the highest charge on a variable are selected, based on Cattell’s Scree Test. Social Capital Index (SCI), is then constructed by dividing each obtained SC value into the maximum SC value, therefore its value ranges between 0 and 1 (Paudel & Schafer, 2009).

3.3. Empirical Findings

In this part of the research, some pre-tests made in panel data analysis and the findings of the models created will be included.

Table 3. Descriptive Statistics

Level		AIR	GDP	GDP^2	GDP^3	POP	EC	SC
First Region (Panel A)	**Mean**	64.94211	29.17914	1023.029	42461.67	350.3951	3598.51	22.94598
	S.D	20.19595	13.14263	999.2661	69235.76	667.7469	1505.60	3.364472
	Min.	23	11.67	136.1889	1589.324	32.32	1852	16.78407
	Max.	114	79.254	6281.197	497809.9	2899.87	8325	34.45632
	Obs.	123	154	154	154	154	154	154
Second Region (Panel B)	**Mean**	64.35462	21.36056	562.8347	18252.57	94.74136	3124.04	18.62154
	S.D	20.64259	10.34094	638.8255	39877.34	85.66027	1876.51	3.756596
	Min.	18	7.503	56.29501	422.3815	21.67	980	5.621404
	Max.	115	79.254	6281.197	497809.9	527.79	8779	28.77941
	Obs.	234	286	286	286	286	286	286
Third Region (Panel C)	**Mean**	52.57316	17.00592	342.2978	7923.444	74.0934	2000.87	17.30889
	S.D	19.94459	7.299042	296.2259	10488.7	66.70638	1061.23	5.745612
	Min.	12	5.673	32.18293	182.5738	10.32	504	-10.9762
	Max.	126	39.538	1563.253	61807.91	297.49	8102	57.45122
	Obs.	228	297	297	297	297	297	297

Fourth Region (Panel D)	**Mean**	66.47467	11.4869	156.7065	2467.29	62.45539	921.25	10.38398
	S.D	27.39839	4.991934	137.8821	3318.41	28.19329	301.86	3.357242
	Min.	18	3.927	15.42133	60.55956	20.05	471	.890595
	Max.	143	26.659	710.7023	18946.61	128.59	2217	21.24106
	Obs.	122	154	154	154	154	154	154
All Cities (Panel E)	**Mean**	60.78254	19.28176	478.8584	14977.33	121.3454	2396.584	17.43894
	S.D	22.38021	10.35338	588.4034	34279.66	299.6992	1574.769	5.767124
	Min.	12	3.927	15.42133	60.55956	10.32	471	-10.9762
	Max.	143	79.254	6281.197	497809.9	2899.87	8779	57.45122
	Obs.	705	891	891	891	891	891	891

To identify the prevalence of any effect of social capital on air pollution within the scope of EKC hypothesis, an appropriate selection among Fixed Effects Model (FE), Random Effects Model (RE) and classical model (Pooled) for the most effective forecasting model should be made. For this decision, F-test, Breuch-Pagan LM and Hausman tests (H-Test) are conducted and the analysis outcomes are presented in Table 4.

Table 4. Results of F test, LM, and Hausman Tests

	Tests	**Type**	**Statis.**	**Effective Estimator**					
				Model I		**Model II**		**Model III**	
Panel A	F-Test	Pooled	F-sta.	14.49	FE	14.44	FE	14.16	FE
		FE	Prob	0.00		0.00		0.00	
	LM Test	Pooled	χ^2 sta.	173.2	RE	175.1	RE	170.8	RE
		RE	Prob> χ^2	0.00		0.00		0.00	
	H-Test	FE	χ^2 sta.	2.38	RE	1.46	RE	1.52	RE
		RE	Prob	0.66		0.917		0.95	
	Tests	**Type**	**Statis.**	**Effective Estimator**					
				Model I		**Model II**		**Model III**	
Panel B	F-Test	Pooled	F-sta.	19.00	FE	18.90	FE	18.81	FE
		FE	Prob	0.00		0.00		0.00	
	LM Test	Pooled	χ^2 sta.	415.4	RE	415.4	RE	415.2	RE
		RE	Prob> χ^2	0.00		0.00		0.00	
	H-Test	FE	χ^2 sta.	1.61	RE	0.91	RE	0.92	RE
		RE	Prob	0.80		0.963		0.972	
	Tests	**Type**	**Statis.**	**Effective Estimator**					
				Model I		**Model II**		**Model III**	
Panel C	F-Test	Pooled	F-sta.	9.93	FE	18.90	FE	9.73	FE
		FE	Prob	0.00		0.00		0.00	
	LM Test	Pooled	χ^2 sta.	178.1	RE	175.6	RE	173.2	RE
		RE	Prob> χ^2	0.00		0.00		0.00	
	H-Test	FE	χ^2 sta.	3.28	RE	4.76	RE	4.74	RE
		RE	Prob	0.51		0.45		0.57	
	Tests	**Type**	**Statis.**	**Effective Estimator**					
				Model I		**Model II**		**Model III**	
Panel D	F-Test	Pooled	F-sta.	7.24	FE	7.26	FE	7.19	FE
		FE	Prob	0.00		0.00		0.00	
	LM Test	Pooled	χ^2 sta.	39.71	RE	39.79	RE	39.44	RE
		RE	Prob> χ^2	0.00		0.00		0.00	
	H-Test	FE	χ^2 sta.	25.27	FE	18.03	FE	14.11	FE
		RE	Prob	0.00		0.00		0.02	
	Tests	**Type**	**Statis.**	**Effective Estimator**					
				Model I		**Model II**		**Model III**	
Panel E	F-Test	Pooled	F-sta.	12.69	FE	12.80	FE	12.72	FE
		FE	Prob	0.00		0.00		0.00	
	LM Test	Pooled	χ^2 sta.	842.14	RE	845.74	RE	839.18	RE
		RE	Prob> χ^2	0.00		0.00		0.00	
	H-Test	FE	χ^2 sta.	1.50	RE	2.78	RE	6.88	RE
		RE	Prob	0.826		0.733		0.331	

Note: FE, Fixed Effect; RE, Random Effect

For the identification of the efficient estimator, first a F-Test (for FE and Pooled), then an LM Test (for RE and Pooled) and last a Hausman test (for FE and RE) is conducted. The results indicate that the efficient estimator for all panel groups except for the fourth cluster is the RE model. For the fourth group, it is found out that the efficient estimator is the FE model.

One should also test the model for autocorrelation, heteroscedasticity, endogeneity and cross section dependence (CD) before conducting the general assessment. For panel groups where the efficient estimator is the RE model; Levene, Brown and Forsythe Test is undertaken for the identification of heteroscedasticity, Durbin-Watson and Baltagi-Wu tests are conducted for the discerning of autocorrelation and Pesaran tests are conducted for the pinpointing of CD. In the fourth panel group, where the efficient estimator is the FE model; modified Wald test is undertaken for the identification of heteroscedasticity, Durbin-Watson and Baltagi-WU LBU tests are conducted to discover autocorrelation and Pesaran tests are conducted to identify for possible CD. Information regarding those tests are presented in Table 5.

Table 5. Heteroscedasticity, Autocorrelation, Endogeneity and CD Test Results

			Model I		Model II		Model III	
		Tests	**Test sta.**	**Result**	**Test sta.**	**Result**	**Test sta.**	**Result**
Panel A	HC	Levene, Brown, Forsythe	7.532	✓	7.532	✓	7.532	✓
			0.000		0.000		0.000	
			4.092	✓	4.092	✓	4.092	✓
			0.000		0.000		0.000	
			7.324	✓	7.324	✓	7.324	✓
			0.000		0.000		0.000	
	AC	D-W and Baltagi-Wu LBI	.7333	✓	.7356	✓	.7356	✓
			1.0158		1.0218		1.0277	
	CD	Pesaran	-0.027	X	0.360	X	0.338	X
			0.9781		0.718		0.735	
	END	Durbin	.05366/ 0.8168		.01431/ 0.9048		.01004/ 0.9202	
		Wu-Hausman	.04972/ 0.8242		.01307/ 0.9093		.00905/ 0.9245	
Panel B	HC	Levene, Brown, Forsythe	2.628	✓	2.628	✓	2.628	✓
			0.000		0.000		0.000	
			1.699	✓	1.699	✓	1.699	✓
			0.024		0.024		0.024	
			2.481	✓	2.481	✓	2.481	✓
			0.000		0.000		0.000	
	AC	D-W and Baltagi-Wu LBI	1.010	✓	1.010	✓	1.010	✓
			1.344		1.344		1.344	
	CD	Pesaran	-0.251	X	-0.254	X	-0.263	X
			0.8020		0.7997		0.7929	
	END	Durbin	1.2486/ 0.2638		1.3356/ 0.2478		1.3461/ 0.2459	
		Wu-Hausman	1.2103/ 0.2730		1.2867/ 0.2585		1.2882/ 0.2582	
Panel C	HC		1.763		1.763		1.763	

		Levene, Brown, Forsythe	0.014	✓	0.014	✓	0.014	✓
			1.337 0.131	✓	1.337 0.131	✓	1.337 0.131	✓
			1.690 0.021	✓	1.690 0.021	✓	1.690 0.021	✓
	AC	D-W and Baltagi-Wu LBI	.9653 1.239	✓	.9653 1.239	✓	.9665 1.240	✓
	CD	Pesaran	2.410 0.016	✓	2.734 0.006	✓	2.410 0.003	✓
	END	Durbin	5.5038/ 0.0190		5.6188/ 0.0178		5.4213/ 0.0199	
		Wu-Hausman	5.4845/ 0.0206		5.5639/ 0.0197		5.3211/ 0.0226	
Panel D	HC	MWald	2075.8 0.000	✓	1123.8 0.000	✓	1307.3 0.000	✓
	AC	D-W and Baltagi-Wu LBI	.7166 1.150	✓	.7201 1.149	✓	.7300 1.161	✓
	CD	Pesaran	-0.464 0.6429	X	-0.464 0.6429	X	-0.465 0.6429	X
	END	Durbin	3.9710/ 0.0463		4.0372/ 0.0445		4.0380/ 0.0445	
		Wu-Hausman	3.8650/ 0.0531		3.8797/ 0.0527		3.8274/ 0.0543	
Panel E	HC	Levene, Brown, Forsythe	3.317 0.000	✓	3.317 0.000	✓	3.317 0.000	✓
			2.327 0.000	✓	2.327 0.000	✓	2.327 0.000	✓
			3.204 0.000	✓	3.204 0.000	✓	3.204 0.000	✓
	AC	D-W and Baltagi-Wu LBI	.85056 1.1870	✓	.85687 1.1952	✓	.85738 1.1957	✓
	CD	Pesaran	0.917 0.3594	X	0.985 0.3245	X	0.707 0.4794	X
	END	Durbin	1.54507/ 0.2139		1.7416/ 0.1869		1.7295/ 0.1885	
		Wu-Hausman	1.53012/ 0.2167		1.7217/ 0.1901		1.7059/ 0.1922	

AC, Autocorrelation; HC, Heteroscedasticity; END, Endogeneity, ✓, Available; X, None

All the tests conducted to identify for potential heteroscedasticity, autocorrelation and CD issues in error terms in models attributed to all panel groups show the prevalence of these conditions (except for Panel C). Also according to the endogeneity test results, the variables are exogenous for all panel groups except Panel C. In line with these findings, standard errors should be corrected with robust standard errors without any changes to estimators (Hoechle, 2007). Various robust estimators are developed for the effective estimation in the prevalence of the aforementioned conditions, one of them being the estimator of Arellano, Froot and Rogers. Arellano, Froot and Rogers estimator is used in the existence of heteroscedasticity and autocorrelation for both RE and FE models. Nevertheless, no robust estimator exists to account for heteroscedasticity, autocorrelation and CD in RE model. Under these circumstances Arellano, Froot and Rogers estimator can be utilized. Therefore, for the models in Panel

C, the aforementioned estimator is used in the existence of all the three conditions (Driscoll and Kraay, 1998). Estimation results are presented in Table 6.

Table 6. Estimation Results

Dependent Variable (air pol.)		C	lnGDP	$lnGDP^2$	$lnGDP^3$	lnpop	lnEC	lnSC	R^2 Wit.	R^2 Bet.	R^2 Over.	Prob
Panel A	Model I	1.51**	.33	-.18***		.13***	-.17		.115	.240	.192	0.003
		(.58)	(.76)	(.25)		(.05)	(.13)					
	Model II	5.30	-7.48	-1.18	-.41	.13***	.01		.126	.236	.193	0.000
		(5.46)	(7.44)	(1.63)	(.29)	(.05)	(.02)					
	Model III	5.33	-7.32	5.01	-1.16	.13**	-.17	-.01	.126	.238	.195	0.000
		(5.46)	(11.3)	(1.63)	(1.67)	(.05)	(.14)	(.02)				
Panel B	Model I	2.21***	-.95	.28		.17**	.02		.137	.038	.061	0.003
		(.51)	(.83)	(.31)		(.08)	(.03)					
	Model II	2.24	-1.03	.35	-.02	.17**	.021		.138	.038	.061	0.000
		(2.73)	(6.38)	(4.93)	(1.26)	(.08)	(.03)					
	Model III	2.26	-.98	.31	-.01	.17**	.021	-.002	.138	.038	.061	0.000
		(2.74)	(6.44)	(4.97)	(1.27)	(.08)	(.03)	(.01)				
Panel C	Model I	2.35***	-1.31**	.41		.19***	-.04		.174	.355	.283	0.003
		(.43)	(.64)	(.27)		(.07)	(.03)					
	Model II	4.21**	-6.04	4.34	-1.08	.19***	-.04		.178	.363	.289	0.000
		(2.08)	(5.37)	(4.52)	(1.25)	(.08)	(.03)					
	Model III	4.25**	-6.12	4.41	-1.09	.19***	-.04	-.001	.178	.359	.289	0.000
		(2.05)	(5.40)	(4.55)	(1.25)	(.068)	(.03)	(.02)				
Panel D	Model I	2.65	-.54	.004		-.18	.01		.352	.411	.004	0.000
		(2.58)	(1.08)	(.524)		(1.53)	(.01)					
	Model II	4.03	-3.87	3.36	-1.09	-.35	.01		.351	.401	.006	0.000
		(3.39)	(4.24)	(4.51)	(1.55)	(1.60)	(.01)					
	Model III	4.22	-3.66	3.16	-1.03	-.37	.01	-.02	.352	.411	.004	0.000
		(3.46)	(4.25)	(4.52)	(1.56)	(1.60)	(.01)	(.04)				
Panel E	Model I	2.01*	-1.16*	.32**		.17*	.11		.189	218	192	0.00
		(.30)	(.29)	(.12)		(.039)	(.083)					
	Model II	2.68*	-2.79**	1.66	-.35	.18*	.09		.194	215	192	0.00
		(.63)	(1.45)	(1.14)	(.29)	(.04)	(.08)					
	Model III	2.70*	-2.79**	1.69	-.36	.18*	.09	-.046	.197	191	175	0.00
		(.61)	(1.43)	(1.12)	(.29)	(.04)	(.07)	(.04)				

Note: ***, **,* denote confidence levels of 0.01, 0.05 and 0.10 respectively.

It can be deduced that Model I bears significance in Panel A. Explanatory variables, GDP2 –structured in the quadric form- and population density (lnpop) are found to be statistically significant and in compliance with the theoretical assumptions. It is seen that while income per capita (GDP) has a positive magnitude without statistical significance; its quadric form (GDP2) has a significant negative explanatory power, leading to the deduction that the relationship between income and emissions is inconclusive. lnpop, the other statistically significant variable of the model, triggers air pollution by 13% when it rises by 1%. Even though GDP is in line with theoretical assumptions, the hypothesis that the variable has significant explanatory power is rejected. Moreover, lnEC which represents electricity consumption is found to be both theoretically and statistically insignificant.

All variables except for population density in Model II and Model III are found to be statistically insignificant. It is deduced that social capital, which forms the basis of this study, does not have significant explanatory power over pollution, despite confirming theoretical expectations.

Similar to their counterparts in Panel A, models in Panel B are also generally significant. Nevertheless, none of the variables except for lnpop in all the models is deduced to bear significance. A 1% rise in lnpop, the only variable statistically significant and in compliance with theoretical assumptions, is found out to increase air pollution by 17%. In addition, similar to the findings in Panel A, social capital remains insignificant, despite confirming theoretical expectations.

Models are also generally significant in Panel C as well. GDP and lnpop in Model I are statistically significant and are in line with theoretical assumptions. It can be inferred that the relationship between income and emissions are inconclusive, given that GDP2 is of no statistical significance, despite GDP bearing a negative sign. Moreover a 1% rise in lnpop increases air pollution by 19%. All variables in Model II and Model III, apart from lnpop are statistically insignificant. Similar to previous findings in prior models, social capital remains insignificant for Panel C as well.

Contrary to the tests undertaken in other panels, the FE model is used as an efficient estimator for Panel D, where models are deduced to be significant. Nevertheless, none of the variables are discovered to be statistically significant. Again, social capital remains insignificant for Panel D too, despite being in line with theoretical assumptions.

Models are deduced to be significant for Panel E, a group that includes all cities of Turkey. Apart from lnEC, all variables in Model I are statistically significant and attest to a U-shaped relationship between economic growth and air pollution. The results also show that coefficients of both linear and quadric lnGDP variables are $\beta1<0$, and $\beta2>0$, respectively. A 1% rise in lnpop is shown to increase air pollution by 19%. All variables in Model II and Model III, except for lnGDP and lnpop are discovered to be statistically insignificant. It is deduced that social capital, which forms the basis of this study, does not have significant explanatory power over pollution, despite confirming theoretical expectations.

In summary, this study exhibits that there is a U shaped relationship between growth and air pollution, within the EKC hypothesis. Furthermore, it is concluded that the main determinant of air pollution is population density both in a regional and a country-wide basis for Turkey. Nevertheless, social capital is found to have no significant explanatory power over the aforementioned concern.

4. CONCLUSION

It is of crucial importance to have sufficient information about the pre-determinants of environmental degradation, in order to formulate and undertake an effective environmental protection policy. To help contribute to this objective, this study analyzes the impact of social capital on air pollution for all 81 cities of Turkey between 2008 and 2018, within the context of EKC hypothesis. Cities are classified into four groups based on their socioeconomic development, by taking into account the SEDR report published by Ministry of Development in 2011.

Empirical findings show that a U-shaped relationship exists between income and emissions for Turkey. Nevertheless, statistical significance cannot be found when it comes to the panel groups formulated by categorizing cities that have similar socioeconomic conditions. In addition, it is concluded that population density is an important determinant in the rise of air pollution for all panel groups studied. Social capital, the independent variable that forms the basis of this research fails to statistically explain environmental degradation, despite bearing resemblance to theoretical assumptions. It should be stated that this conclusion is consistent with existing literature, since research findings differ with varying time span, independent variables incorporated in respective models and methodological adaptation considerations. For example, Paudel and Schafer (2009), Ibrahim & Law (2014), Keene and Deller (2015), Rahnama & Sharifzadeh Aghdam (2018), Yildirim et al. (2020), Zhou et al. (2020), Wang et al. (2020) emphasize the recuperative effect of social capital on environmental pollution, while Grafton & Knowles (2004) fail to find such an impact.

Conducting a similar assessment on Turkey within the scope of EKC, Yildirim et al. (2020) observe social capital to be of statistical importance, but reject the hypothesis that population density has a non-negligible impact on pollution. This work also confirms the proposition of Yildirim et al. (2020) that a U-shaped relationship between income and emissions exist in Turkey. Moreover, this study also shows population density to have significant explanatory power over the rise in air pollution. It can safely be stated that results can vary with differing independent variables and methodological adaptations.

A myriad of suggestions can be put forward for further research and policy making, in line with these findings. For academic research; the data set utilized in this study spanning 2008 to 2018 bears significant lack of observations for certain cities, therefore limits the ability to conduct advanced technical analysis and reach more robust conclusions. Consequently, construction of a more comprehensive, complete and consistent data set and formulating advanced technical modelling via utilizing this set will prove valuable. Furthermore, various other proxies accounting for environmental degradation, such as water pollution, can be incorporated into the model. For policy making, this study posits the main determinant of air pollution in Turkey to be population density, both vis-à-vis the cities socioeconomic conditions and for the country in general. Therefore, it is thought that environmental policies that take into account population density would prove effective.

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