Chapter 14
How Does Environmental Degradation React to Stock Market Development in Developing Countries?

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Abstract As capital markets develop, the issue of whether this development improves the environmental quality rises very rapidly. Although not very documented, the literature has reached a consensus on the positive role of stock market development on carbon emissions in developing countries. Previous studies, however, do not include great number of countries to reach a broad consensus and assume that the effect does not change over time. Given these motivations, this study examines the impact of stock market development on carbon emissions in a panel of 60 developing countries over the period 1990–2014. Findings reveal that stock market development decreases environmental degradation in the short-run, whereas further development leads to environmental degradation in the long-run. Policy implications depending on these results are also discussed.

Keywords Stock market development · Environmental degradation · Developing counties

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14.1 Introduction

Over the last decade, energy economics literature has provided augmented energy demand functions, which add a set of socio-economic variables onto the basic energy model. Financial development is one of the promising ones, which has been built

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by referring to the finance-growth theory. Even though the literature has not yet as expanded as energy-growth literature, the number of these studies has been steadily increasing.

Theoretical settings of finance-energy literature have basically inspired from finance-led growth hypothesis. Therefore, previous literature has addressed that financial development can affect energy demand via three channels according to the previous literature. Direct effect channel implies that consumers can find easier and cheaper borrowing opportunity as financial system develops in order to purchase durable goods which consume energy a lot. Business effect channel implies that business sector can also find opportunity to borrow easily and less costly as financial markets improve which in turn affect energy demand via investment and production decisions. Finally, wealth effect channel implies that increasing financial activities can affect economic agents' confidence by creating a wealth effect which can promote economic activity and demand for energy. However, Sadorsky (2010) argues that energy demand might be irresponsive to financial development given the validity of growth-led finance hypothesis, and this relationship can only be resolved through empirical analyses.

Most of the previous studies looking into the impact of financial development on energy consumption have measured financial development using bank-related variables and as a matter of fact, indeed, investigated the impact of banking sector development (see, for example: Tang and Tan 2014; Zeren and Koc 2014; Aslan et al. 2014; Altay and Topcu 2015; among others). However, relatively little research has been done with the stock market variables on the impact that financial development has on energy consumption (see: Sadorsky 2011; Coban and Topcu 2013; Topcu and Altay 2017; Topcu and Payne 2017; Altay and Topcu 2017).

Unlike finance-energy literature, the number of studies in finance-environment literature is relatively limited (see, for example: Tamazian and Rao 2010; Jalil and Feridun 2011; Al-mulali and Sab 2012a, b; Lee 2013; Omri 2013; Ozturk and Acaravci 2013; Shahbaz 2013; Shahbaz et al. 2013a, b, c, d, 2016; Boutabba 2014; Al-mulali et al. 2015a, b; Mugableh 2015; Salahuddin et al. 2015; Ziaei 2015; Dogan and Seker 2016; Dogan and Turkekul 2016; Farhani and Ozturk 2015; Rafindadi 2016). Specifically, the impact of stock market on environment is an area which is almost untouched. To best of our knowledge, the literature includes only a few number of studies. For instance, Paramati et al. (2018) stock market indicators have a positive impact on carbon emissions in a panel of 20 developing countries, whereas the impact turns out negative in a panel of 23 developed countries. Likewise, Paramati et al. (2017)'s stock market development has a negative impact on emissions in developed G20 nations, whereas it has a positive impact in developing G20 nations. Lanoie et al. (1998) report for two developed nations (the US and Canada) that efficient capital markets spur environmental quality. Dasgupta et al. (2001) find for a four number of developing countries (Argentina, Chile, Mexico, and the Phillipines) that stock market development improves environmental performance. Tamazian et al. (2009) report that stock market development decreases carbon emissions in BRIC countries. Zhang (2011) finds for China that the stock market is not yet well-developed to significantly decrease carbon emissions. Abbasi and Riaz (2016) report that stock market development dramatically increases emissions in Pakistan. In the case Malaysia, Iatridis (2013) finds that carbon emissions increase with the stock market development.

Overall, the aforementioned literature roughly suggests that stock market development increases carbon emissions and deteriorates the environment. However, this evidence is not very robust as previous attempts include limited number of developing countries. Therefore, the aim of this study is to extend the analysis with the inclusion of more developing countries to provide better insights for policy makers. Given this motivation, this study intends to be the encompassing one in the literature. Unlike previous attempts, in addition, this study not only investigates the long-run relationship, but also provides short-run evidences.

Rest of the study is structured as follows: Sect. 14.2 describes model and data, Sect. 14.3 presents empirical approaches and findings, and finally, Sect. 14.4 discusses policy implications and gives concluding remarks.

14.2 Model and Data

As a proxy of environmental degradation, per capita carbon emissions (CO_2) are described as a function of per capita energy consumption (e), per capita income (y), its squared term (ysq), and stock market development (s). The analysis includes 60 developing countries and is based on annual observations spanning from 1990 to 2014. Table 14.1 lists these countries.

Environmental degradation is represented by carbon emissions measured by metric tons per capita, energy consumption is represented by energy use kg of oil equivalent per capita, income is represented by GDP per capita measured using constant 2010 US$, and stock market development is represented by stock market capitalization measured as a share of GDP. All data are sourced from World Bank World Development Indicators Database (2018), with the exception of the stock market data which is sourced from World Bank Global Financial Development Database (2018). To interpret the results in terms of elasticities, all variables are transformed into natural logarithms.

Table 14.2 presents the descriptive statistics of the data. When we review the mean values of the variables, carbon emissions are 14.72, energy consumption is quite closer to 7, income is 8.38, and stock market indicator is slightly less than 3. Notice that, the variable that has the highest standard derivation is the stock market development proxy, which is closely followed by carbon emissions.

Table 14.1 Sample of countries

South-East Asia	Middle East and North Africa	Europe and Central Asia	Central and South America	Sub-Saharan Africa
Bangladesh	Egypt	Bulgaria	Argentina	Botswana
China	Iran	Croatia	Bolivia	Cote d'Ivoire
Fiji	Jordan	Cyprus	Brazil	Ghana
India	Morocco	Czech Rep.	Chile	Kenya
Indonesia	Oman	Greece	Colombia	Mauritius
Korea	Saudi Arabia	Hungary	Costa Rica	Namibia
Malaysia	Tunisia	Iceland	Ecuador	Nigeria
Mongolia		Kazakhstan	El Salvador	South Africa
Nepal		Malta	Jamaica	Swaziland
Pakistan		Moldova	Mexico	Tanzania
Philippines		Poland	Paraguay	Uganda
Sri Lanka		Russian Fed.	Peru	
Thailand		Serbia	Trinidad and Tobago	
		Slovak Rep.	Uruguay	
		Turkey		

Table 14.2 Descriptive statistics

	ln CO_2	ln e	ln y	ln s
Mean	14.72509	7.033550	8.383148	2.979693
Median	14.85355	6.943061	8.471089	3.092500
Maximum	17.40161	9.623058	10.39366	5.581856
Minimum	11.46288	4.812745	5.999065	−4.655306
Std. dev.	1.151492	0.846511	0.990997	1.245914
Observations	1138	1138	1138	1138

14.3 Methods and Findings

14.3.1 Unit Root Testing

Necessary precondition for implementing an Engle-Granger-based panel cointegration analysis is to provide that the variables in consideration are integrated of order one. Besides, prior to a panel ARDL estimation, it is necessary to ensure that the variables in interest are level or first-difference stationary. In this context, panel unit root

Table 14.3 Unit root results

Variables	Level	First difference
ln CO_2	−0.176 (0.43)	−28.400 (0.00)
ln *e*	1.353 (0.91)	−24.608 (0.00)
ln *y*	9.796 (1.00)	−18.342 (0.00)
ln *s*	−7.057 (0.00)	−14.909 (0.00)

[a]Numbers in parentheses are *p*-values
[b]Tests include only constant
[c]Maximum lag length is determined considering SIC

tests developed by Im et al. (2003, IPS) were utilized, and findings were reported in Table 14.3. Accordingly, there seems no restriction for conducting the related analyses.

14.3.2 Cointegration

Since the variables in consideration are integrated of order one, this study employs an Engle-Granger-based panel cointegration analysis which was recently developed by Pedroni (1999, 2004) for the investigation of a possible cointegration relationship.

Within dimension tests		
1.	Panel-ν stat:	$Z_\nu = T^2 N^{3/2}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^2\right)^{-1}$
2.	Panel-rho stat:	$Z_\rho = T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^2\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_i)$
3.	Panel-pp stat:	$Z_t = \left(\tilde{\sigma}_{N,T}^2\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^2\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_i)$
4.	Panel-adf stat:	$Z_t^* = \left(\tilde{s}_{N,T}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{*2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{e}_{i,t-1}^*\Delta\hat{e}_{i,t}^*)$
Between dimension tests		
5.	Group-rho stat:	$\tilde{Z}_\rho = TN^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{e}_{i,t-1}^2\right)^{-1}\sum_{t=1}^{T}(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_i)$
6.	Group-pp stat:	$\tilde{Z}_t = N^{-1/2}\sum_{i=1}^{N}\left(\hat{\sigma}_i^2\sum_{t=1}^{T}\hat{e}_{i,t-1}^2\right)^{-1/2}\sum_{t=1}^{T}(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_i)$
7.	Group-adf stat:	$\tilde{Z}_t^* = N^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{s}_i^{*2}\hat{e}_{i,t-1}^{*2}\right)^{-1/2}\sum_{t=1}^{T}\hat{e}_{i,t-1}^*\Delta\hat{e}_{i,t}^*$

Table 14.4 Cointegration results

Tests	Stat
Panel-ν	−1.441(0.92)
Panel-rho	−1.828(0.03)
Panel-pp	−8.313(0.00)
Panel-adf	−7.390(0.00)
Group-rho	1.122(0.86)
Group-pp	−10.131(0.00)
Group-adf	−9.032(0.00)

[a]Numbers in parentheses are *p*-values

Pedroni (1999, 2004) has proposed seven test statistics, which are shown above. These statistics assume that the variables are not level-stationary, and the cointegration vector is heterogeneous across the cross-section units. In this sense, the null of no cointegration was tested against the alternative hypothesis of cointegration by using the tests, four of which are termed as "panel statistics" and the others as "group statistics". Findings presented in Table 14.4 support the cointegration relationship.

14.3.3 Estimation

The present study employs a panel ARDL model for investigating the impact of financial development on environmental degradation. Our model incorporates with the pooled mean group estimator (PMG) that was developed by Pesaran et al. (1999). The considered model is formulated in the following manner:

$$\begin{aligned} \ln \mathrm{CO2}_{it} = \alpha_i + \sum_{j=1}^{ki} \beta_{ij} \ln \mathrm{CO2}_{i,t-j} + \sum_{j=0}^{fi} \delta_{ij} \ln \mathrm{FD}_{i,t-j} + \sum_{j=0}^{hi} \phi_{ij} \ln \mathrm{EC}_{i,t-j} \\ + \sum_{j=0}^{ri} \partial_{ij} \ln \mathrm{GDPPC}_{i,t-j} + \sum_{j=0}^{di} \tau_{ij} \ln \mathrm{GDPPC2}_{i,t-j} + \varepsilon_{it} \end{aligned} \quad (14.1)$$

In order to see the separate effects (i.e., short and long) of financial development on environmental degradation, Eq. (14.1) can be parameterized as follows:

$$\Delta \ln CO_{2\,it} = \alpha_i + \varpi_i \ln CO_{2\,i,t-1} + \delta_i^* \ln FD_{it} + \phi_i^* \ln EC_{it} + \partial_i^* \ln GDPPC_{it} + \tau_i^* \ln GDPPC2_{it} + \sum_{j=1}^{ki-1} \beta_{ij}^{**} \Delta \ln CO_{2\,i,t-j} + \sum_{j=0}^{fi} \delta_{ij}^{**} \Delta \ln FD_{i,t-j} + \sum_{j=0}^{hi} \phi_{ij}^{**} \Delta \ln EC_{i,t-j} + \sum_{j=0}^{ri} \partial_{ij}^{**} \Delta \ln GDPPC_{i,t-j} + \sum_{j=0}^{di} \tau_{ij}^{**} \Delta \ln GDPPC2_{i,t-j} + \varepsilon_{it} \quad (14.2)$$

where ϖ represents error correction coefficient, the notations $\delta^*, \phi^*, \partial^*, \tau^*$ and $\delta^{**}, \phi^{**}, \partial^{**}, \tau^{**}$ illustrate the long- and short-run coefficients, respectively.

Pesaran et al. (1999) developed two estimators, namely the mean group (MG) and the pooled mean group (PMG) which both can be utilized to estimate Eq. (14.2). However, since the MG does not allow certain parameters to be distributed homogenously across cross-section units, this study utilizes the PMG for the estimation of Eq. (14.2).

As both pooling and averaging, the PMG estimator allows the intercepts, short-run coefficients, and error variances to differ freely across groups, but constraints the long-run coefficients to be the same (Pesaran et al. 1999). Because of initial conditions or some structural factors that have a possibility to influence all groups in a similar way, utilizing the PMG estimator seems to be appropriate for the considered purpose.

According to findings illustrated in Table 14.5, the model that we try to solve has a stable equilibrium. It is proved by negative and statistically significant error correction coefficient. Besides, estimates reveal that stock market development decreases environmental degradation in the short-run, while the impact turns to positive in the long-run. As expected, energy consumption is the major factor that raises carbon dioxide emissions either in the long or in the short-run. Finally, carbon dioxide emission is positively affected by per capita income in the long-run, whereas the link is statistically insignificant in the short-run. Despite of the desired signs, the environmental Kuznets curve hypothesis is not satisfied given the insignificant coefficients provided either from the short- or long-run estimations.

14.4 Conclusion

In recent years, the number of studies that investigate the impact of global warming and climate change on environmental quality has increased. A great number of these studies have employed urbanization, financial development, energy consumption, and trade into the function. The results of these studies, however, are volatile across the income level of related countries.

Table 14.5 Panel ARDL estimation results

Dependent variable: ln CO_2	
Long-run coefficients	
ln *e*	0.965 (0.00)
ln *y*	0.624 (0.06)
ln *y*sq	−0.024 (0.18)
ln *s*	0.009 (0.00)
Error correction parameter	−0.538 (0.00)
Short-run coefficients	
ln *e*	0.567 (0.00)
ln *y*	−0.899 (0.88)
ln *y*sq	0.089 (0.82)
ln *s*	−0.018 (0.03)

[a]Numbers in parentheses are *p*-values

Unlike previous studies in the area, this study considers the simultaneous use of energy consumption, income, and stock market development in order to estimate the separate impact of each (i.e., short and long) variable on environmental degradation. For this purpose, panel ARDL model is utilized for 60 developing countries over the period 1990–2014. Due to the production structure of developing countries, the relationship between economic activity and environmental degradation could be nonlinear, which has been called the environmental Kuznets hypothesis. The environmental Kuznets curve hypothesis argues that in the initial stages of development, environmental degradation raises and then it decreases as incomes increase.

The results of this study show that stock market development decreases environmental degradation in the short-run; however, environmental degradation rises with stock market development in the long-run. As discussed earlier, the existing literature documents that stock market development positively affects carbon emissions in developing countries. This is very consistent with the long-run results of this study. However, the short-run results of this study show that stock market development is not harmful to the environment in the short-run. This split reveals that the impact of stock market development on environment can vary over time. This is probably due to the underdeveloped capital market structure of developing countries. Because developing countries are not better able to transform stock market development into the production, this development does not strictly lead to an environmental degradation in the short-run.

References

Abbasi, F., & Riaz, K. (2016). CO_2 emissions and financial development in an emerging economy: An augmented VAR approach. *Energy Policy, 90,* 102–114.

Al-Mulali, U., & Sab, C. N. B. C. (2012a). The impact of energy consumption and CO_2 emission on the economic and financial development in 19 selected countries. *Renewable and Sustainable Energy Reviews, 16*(7), 4365–4369.

Al-Mulali, U., & Sab, C. N. B. C. (2012b). The impact of energy consumption and CO_2 emission on the economic growth and financial development in the Sub Saharan African countries. *Energy, 39*(1), 180–186.

Al-Mulali, U., Ozturk, I., & Lean, H. H. (2015a). The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. *Natural Hazards, 79*(1), 621–644.

Al-Mulali, U., Weng-Wai, C., Sheau-Ting, L., & Mohammed, A. H. (2015b). Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation. *Ecological Indicators, 48,* 315–323.

Altay, B., & Topcu, M. (2015). Relationship between financial development and energy consumption: The case of Turkey. *Bulletin of Energy Economics, 3*(1), 18–24.

Aslan, A., Apergis, N., & Topcu, M. (2014). Banking development and energy consumption: Evidence from a panel of Middle Eastern countries. *Energy, 72*, 427–433.

Altay, B., & Topcu, M. (2017). Re-examining the impact of financial system on economic growth: New evidence from heterogeneous regional panels. In *Handbook of Research on Global Enterprise Operations and Opportunities* (pp. 1-16). IGI Global.

Boutabba, M. A. (2014). The impact of financial development, income, energy and trade on carbon emissions: Evidence from the Indian economy. *Economic Modelling, 40,* 33–41.

Coban, S., & Topcu, M. (2013). The nexus between financial development and energy consumption in the EU: A dynamic panel data analysis. *Energy Economics, 39,* 81–88.

Dasgupta, S., Laplante, B., & Mamingi, N. (2001). Pollution and capital markets in developing countries. *Journal of Environmental Economics and management, 42*(3), 310–335.

Dogan, E., & Seker, F. (2016). The influence of real output, renewable and non-renewable energy, trade and financial development on carbon emissions in the top renewable energy countries. *Renewable and Sustainable Energy Reviews, 60,* 1074–1085.

Dogan, E., & Turkekul, B. (2016). CO_2 emissions, real output, energy consumption, trade, urbanization and financial development: Testing the EKC hypothesis for the USA. *Environmental Science and Pollution Research, 23*(2), 1203–1213.

Farhani, S., & Ozturk, I. (2015). Causal relationship between CO_2 emissions, real GDP, energy consumption, financial development, trade openness, and urbanization in Tunisia. *Environmental Science and Pollution Research, 22*(20), 15663–15676.

Iatridis, G. E. (2013). Environmental disclosure quality: Evidence on environmental performance, corporate governance and value relevance. *Emerging Markets Review, 14,* 55–75.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of econometrics, 115*(1), 53–74.

Jalil, A., & Feridun, M. (2011). The impact of growth, energy and financial development on the environment in China: A cointegration analysis. *Energy Economics, 33*(2), 284–291.

Lanoie, P., Laplante, B., & Roy, M. (1998). Can capital markets create incentives for pollution control? *Ecological Economics, 26*(1), 31–41.

Lee, J. W. (2013). The contribution of foreign direct investment to clean energy use, carbon emissions and economic growth. *Energy Policy, 55,* 483–489.

Mugableh, M. I. (2015). Economic growth, CO_2 emissions, and financial development in Jordan: Equilibrium and dynamic causality analysis. *International Journal of Economics and Finance, 7*(7), 98.

Omri, A. (2013). CO_2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. *Energy Economics, 40,* 657–664.

Ozturk, I., & Acaravci, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. *Energy Economics, 36,* 262–267.

Paramati, S. R., Alam, M. S., & Apergis, N. (2018). The role of stock markets on environmental degradation: A comparative study of developed and emerging market economies across the globe. *Emerging Markets Review, 35,* 19–30.

Paramati, S. R., Mo, D., & Gupta, R. (2017). The effects of stock market growth and renewable energy use on CO_2 emissions: Evidence from G20 countries. *Energy Economics, 66,* 360–371.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics, 61*(S1), 653–670.

Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory, 20*(3), 597–625.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association, 94*(446), 621–634.

Rafindadi, A. A. (2016). Does the need for economic growth influence energy consumption and CO_2 emissions in Nigeria? Evidence from the innovation accounting test. *Renewable and Sustainable Energy Reviews, 62,* 1209–1225.

Sadorsky, P. (2010). The impact of financial development on energy consumption in emerging economies. *Energy Policy, 38*(5), 2528–2535.

Sadorsky, P. (2011). Financial development and energy consumption in Central and Eastern European frontier economies. *Energy Policy, 39*(2), 999–1006.

Salahuddin, M., Gow, J., & Ozturk, I. (2015). Is the long-run relationship between economic growth, electricity consumption, carbon dioxide emissions and financial development in Gulf cooperation council countries robust? *Renewable and Sustainable Energy Reviews, 51,* 317–326.

Shahbaz, M. (2013). Does financial instability increase environmental degradation? Fresh evidence from Pakistan. *Economic Modelling, 33,* 537–544.

Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., & Leitão, N. C. (2013a). Economic growth, energy consumption, financial development, international trade and CO_2 emissions in Indonesia. *Renewable and Sustainable Energy Reviews, 25,* 109–121.

Shahbaz, M., Khan, S., & Tahir, M. I. (2013b). The dynamic links between energy consumption, economic growth, financial development and trade in China: Fresh evidence from multivariate framework analysis. *Energy Economics, 40,* 8–21.

Shahbaz, M., Shahzad, S. J. H., Ahmad, N., & Alam, S. (2016). Financial development and environmental quality: The way forward. *Energy Policy, 98,* 353–364.

Shahbaz, M., Solarin, S. A., Mahmood, H., & Arouri, M. (2013c). Does financial development reduce CO_2 emissions in Malaysian economy? A time series analysis. *Economic Modelling, 35,* 145–152.

Shahbaz, M., Tiwari, A. K., & Nasir, M. (2013d). The effects of financial development, economic growth, coal consumption and trade openness on CO_2 emissions in South Africa. *Energy Policy, 61,* 1452–1459.

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries. *Energy Policy, 37*(1), 246–253.

Tamazian, A., & Rao, B. B. (2010). Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. *Energy Economics, 32*(1), 137–145.

Tang, C. F., & Tan, B. W. (2014). The linkages among energy consumption, economic growth, relative price, foreign direct investment, and financial development in Malaysia. *Quality & Quantity, 48*(2), 781–797.

Topcu, M., & Altay, B. (2017). New insight into the finance-energy nexus: Disaggregated evidence from Turkish sectors. *International Journal of Financial Studies, 5*(1), 1–16.

Topcu, M., & Payne, J. E. (2017). The financial development-energy consumption nexus revisited. *Energy Sources, Part B: Economics, Planning and Policy, 12*(9), 822–830.

World Bank. (2018). *Global financial development database*.

World Bank. (2018). *World development indicators database*.
Zeren, F., & Koc, M. (2014). The nexus between energy consumption and financial development with asymmetric causality test: New evidence from newly industrialized countries. *International Journal of Energy Economics and Policy, 4*(1), 83–91.
Zhang, Y. J. (2011). The impact of financial development on carbon emissions: An empirical analysis in China. *Energy Policy, 39*(4), 2197–2203.
Ziaei, S. M. (2015). Effects of financial development indicators on energy consumption and CO_2 emission of European, East Asian and Oceania countries. *Renewable and Sustainable Energy Reviews, 42,* 752–759.