IRANIAN ECONOMIC REVIEW
Print ISSN: 1026-6542
Online ISSN: 2588-6096
https://ier.ut.ac.ir/
University of Tehran

Sustainable Development Spillover in MENA and Europe: Regional Interactions of Social, Environment and Economy

Vahid Mohamad Taghvaee[a,b], Abbas Assari Arani[a,*], Susanne Soretz[b], Lotfali Agheli[c]

a. Department of Economic Development and Planning, Faculty of Management and Economics, Tarbiat Modares University, Tehran, Iran.
b. Chair of Growth Economics, Structural Change, and Trade, Faculty of Law and Economics, Greifswald University, Greifswald, Germany.
c. Economic Research Institute, Tarbiat Modares University, Tehran, Iran.
* Corresponding Author, E-mail: ASSARI_A@modares.ac.ir

Article Info

Article Type: Research Article

Article History:
Received: 28 April 2021
Received in revised form: 11 June 2021
Accepted: 17 July 2021
Published online: 01 July 2023

Keywords:
Sustainability, Sustainable Development, Spillover, Globalization, Openness.

JEL Classification:
O19, O24, O21, Q52, Q56.

ABSTRACT

In 2015, the United Nations (UN) launched a unique platform, including 17 Sustainable Development Goals (SDGs) for improving the global sustainability. However, it remains ambiguous whether the globalization as a result of the UN agenda is beneficial for (or detrimental to) the global sustainability. This study aims to investigate if globalization and openness are helpful for the sustainability. To this aim, our research estimates the elasticities of sustainable development pillars between two regions of MENA and Europe as a case study within 1971–2016. It uses econometric methodology to develop SEY model which includes simultaneous equations system, Granger causality, and VAR. The results show that the spatial sustainability elasticities are mostly positive between MENA and Europe, confirming the constructive role of globalization and openness on sustainability. The policymakers are advised to follow flow-based governance to tackle the sustainable development issues. Thus, the unique global agenda of the UN has sufficient capability to improve sustainable development in the world.

Cite this article: Mohamad Taghvaee, V., Assari Arani, A., Soretz, S., & Agheli, L. (2023). Sustainable Development Spillover in MENA and Europe: Regional Interactions of Social, Environment and Economy. *Iranian Economic Review, 27*(2), 471-503. DOI: https://doi.org/10.22059/ier.2021.83906

Publisher: University of Tehran Press.
DOI: https://doi.org/10.22059/ier.2021.83906

1. Introduction

In 2015, the United Nations (UN) as one of the most international organizations launched a unique platform for improving the global sustainability (Ahmadi et al., 2021). This platform has 17 Sustainable Development Goals (SDGs), covering the three pillars of sustainable development of social, environment, and economy (Farooq et al., 2020; Taghvaee et al., 2023). From the economic perspective, many countries and regions have the needs for money-making, recovery, and financial welfare (Nodehi and Taghvaee, 2022; Shirazi et al., 2020). In Burundi, for example, per capita income is less than 1 US$ per day; and it is less than 3 US$ in more than 20 countries[1] in the Middle East and North Africa (MENA) in 2019 (World Bank, 2021). In these countries, the severe poverty is so disastrous that the UN assigns the 1st and 2nd SDGs to No Poverty and No Hunger, respectively (Allen et al., 2019; Fullman et al., 2017; Hák et al., 2016; Lyytimäki et al., 2020; Nilsson et al., 2016; Smith et al., 2018). In addition to the economic threats, the globe suffers from the environmental dangers including global warming, climate change and air pollution which are degrading the environmental pillar of sustainable development (Nasrollahi et al., 2020; Nodehi and Mohamad Taghvaee, 2021a). The environmental health, in 2018, causes 23% of the total mortality in the world (WHO, 2018). Based on anticipations, water scarcity threatens about half of the world population, exiling more than 700 million people from their own homelands in the next decades up to 2030 and 2050 (World Bank and United Nations, 2018). These risks are degrading the health and social pillar of sustainable development in the world (Mohamad Taghvaee et al., 2022b). To tackle these issues and to improve the sustainable development pillars, the UN proposes 17 SDGs as a global agenda

1. Afghanistan, Burkina Faso, Central African Republic, Chad, Congo, Ethiopia, Gambia, Guinea, Guinea-Bissau, Liberia, Madagascar, Malawi, Mali, Mozambique, Nepal, Niger, Rwanda, Sierra Leone, Tanzania, Timor-Leste, Togo, Uganda, Yemen.

which promotes globalization, peace and partnership around the world (Allen et al., 2019; Fullman et al., 2017; Hák et al., 2016; Lyytimäki et al., 2020; Nilsson et al., 2016; Smith et al., 2018; Taghvaee et al., 2021).

However, it remains ambiguous whether globalization as a result of the UN agenda is beneficial for (or detrimental to) the global sustainability. Many theories such as the *Ricardo's Comparative Advantage theory* claim that globalization and international relations can improve various pillars of sustainable development considerably. According to the *Ricardo's comparative advantage theory*, the international trade and openness improve the economic welfare with advances in the communication, transportation, and trade regulations (Mohamad Taghvaee et al., 2019; Štreimikienė and Kačerauskas, 2020; Taghvaee et al., 2017, 2022; Tremblay et al., 2020; Umar et al., 2020; Xu et al., 2020). However, the opponents believe in the damaging role of globalization in the sustainability. Pollution haven hypothesis, for instance, claims that openness and international relationships are endangering the environmental development in the developing countries. The supporters of this hypothesis argue that the developed countries with strong and strict regulations of the environmental tend to export their polluting investment to the developing countries with weak and lax environmental-regulations (Omri et al., 2019; Youssef et al., 2020). This investment flows cause degradation in the environmental pillar of sustainable development through international trade and openness. These conflicting views raise the question of if globalization and openness have sufficient capability to improve the sustainable development in the world as the UN suggests.

This study aims to investigate if globalization and openness are helpful for the sustainability. To this aim, this paper estimates the elasticities of sustainable development pillars between two distinctive regions of MENA and Europe as a case study. By considering these

elasticities as proxy for spatial spillover effect, this research shows that the sustainability spillover effects are synergetic or trade-off between the two regions. The positive sustainability elasticity is synergy which affirms the Ricardo's comparative advantage theory about the beneficial role of globalization and openness on sustainability. The negative one, however, is trade-off which confirms the pollution haven hypothesis for the detrimental role of globalization and openness. In case of the synergistic and trade-off relationships, the policymakers should follow flow-based or placed-based governance, respectively. In general, the main contribution of this study is the addition of spillover effect as a new pillar to the three well-known pillars of sustainable deployment (i.e., social, environment and economy). In this way, this study has the capability to propose "Integrated Sustainability" as a new perspective of sustainability based on the traditional perspectives of weak and strong sustainability. This viewpoint is an encouragement for the policy-makers to promote peace and partnership among countries, economies, regions and around the globe via establishment of strong international unions, treaties and agreements and supporting SDGs 16 and 17. In particular, it offers a measurement for European Union officials how to address the conflicts in MENA. It also affects the MENA authorities' attitudes how to consider European Union: as an exploiter or a synergy.

The structure of this paper is as follows. The next section reviews the concepts, theories and perspectives about sustainable development and spillover effects of sustainability. Section 3 represents the econometric methodology, employed to estimate the sustainability elasticities. Section 4 explains the resulted and estimated coefficients and statistics. Section 5 offers the main findings of this research. Finally, the last section concludes this research.

2. Literature Review

Sustainability considers the interaction of human, nature and economic activities in a harmonized way, enabling stability, resilience and prosperity for current and future generations (Brown et al., 1987). In other words, sustainability interrelates a chain of variables incorporating the socioeconomic and environmental interactions to offer possible solutions for sustainable development issues (Batabyal and Folmer, 2020; Hull and Liu, 2018; Liu et al., 2015; Nodehi and Mohamad Taghvaee, 2021b; Wang and Taghvaee, 2023) From this viewpoint, these interconnections (or spillover effects) need profound insight to investigate the total and real effect of a particular factor in a flow-based framework (Nodehi et al., 2022; Taghvaee et al., 2022a,b,c). Based on these spillover effects and externalities (Uyar et al., 2021), many studies focus on the effects of geographically-closed regions on the domestic sectors and dimensions of economies and societies (Wang and Wu, 2016). Therefore, regional and geographical proximity causes synergistic and trade-off interrelations among various regions, countries and economies, referred to as "spatial diffusion with friction" (Geoffrey, 2007).

Recent studies claim that these interactions and spillover effects are heterogeneous among various regions depending on the geographical distances (according to the spatial friction hypothesis). This non-linear effect of spatial heterogeneity shows the regional spillover effects based on the region-to-region and local-to-local scales (Basile, 2008; Batabyal & Nijkamp, 2017). In another word, spillover effect is a geographically-interdependent element (Basile et al., 2011). Regarding this analysis, the 3 well-known pillars of sustainable development (social, environment and economy) as exogenous variables bring deep insight into the intensities of regional spillover effects.

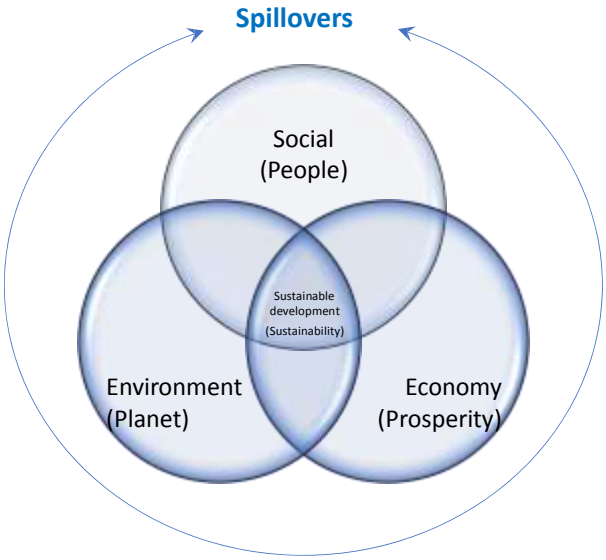
International researchers and organizations assume that sustainable development has many key elements. The UN, for instance, considers

three pillars for the sustainable development, according to the Earth Charter document, issued in the Earth Summit by 178 countries in Brazil in 1992 to improve both the human's life and the environmental quality, simultaneously. In the Earth Charter, Agenda 21 covers three fundamental sections of social, environment and economy. Regarding this classification, the sustainable development researchers look at sustainable development as a triangle with three pillars, as in Figure 1a which shows a glimpse of the integrated sustainability perspective (Amos and Lydgate, 2020; Clune and Zehnder, 2020; Glavič and Lukman, 2007; Purvis et al., 2019; Saner et al., 2019). In the same way, there are many researchers who translate the triangle into three Ps of people, planet and prosperity, according to Figure 1a (Ben-Eli, 2018; Hopkins et al., 2020; Schneider et al., 2019). From this analysis, sustainable development and sustainability consist of three major pillars.

According to the weight of each sustainable development pillar, there are two known perspectives for sustainability: weak and strong sustainability. In the weak sustainability, all the three pillars of social, environment and economy have identical values (Agheli and Taghvaee, 2022), while in strong sustainability, the environment pillar has the greatest value, compared with the social and economy (Arushanyan et al., 2017).

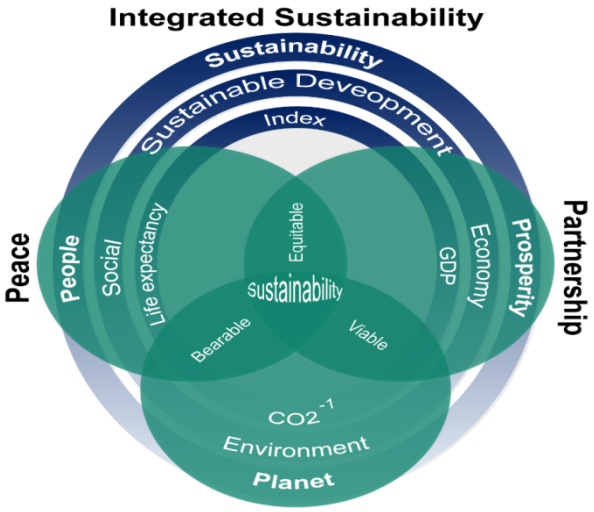
Although, these perspectives of sustainability are greatly important, they ignore the interactions and spillovers among the sustainable development pillars. The development of each pillar of sustainability in a region can affect other pillars of sustainability not only in the same region, but also in the other regions (Kajikawa et al., 2017; Schaubroeck, 2018). Based on this analysis, global sustainability needs a comprehensive plan which attaches great importance to the peace, partnership, and spillover effects of sustainability (Alcamo et al., 2020; Amadei, 2021; Sharifi et al., 2020). In this way, spillover effect can be the fourth pillar of sustainable development besides

social, environment and economy. In other words, sustainability can add peace[1] and partnership[2] as the fourth P to people, planet, and prosperity (Dolley et al., 2020; Menton et al., 2020; Orchard et al., 2020) (see Figure 1b). This consideration can launch a new perspective of sustainability (integrated sustainability) which appreciates the spillover effect, peace, and partnership as the most important pillars of sustainable development and sustainability (Mohamad Taghvaee et al., 2022b).



a. Simple Schema Of Integrated Sustainability And Spillover Effects

1. Peace is SDG 16 (peace, justice, and strong institutions).
2. Partnership is SDG 17 (partnership for the goals).



b. Integrated Sustainability Perspective with Its Pillars and Indexes

Figure 1. Pillars and Perspectives of Sustainability and Sustainable Development in a Glimpse
Source: Hopkins et al. (2020); Nasrollahi et al. (2020); Parsa et al. (2019); Schneider et al. (2019)

3. Methodology

To estimate the sustainability elasticities between MENA and Europe from 1971 to 2016, this research uses the following model which is referred to as SEY model. The SEY model assumes that each sustainable development pillar (i.e. social, environment and economy) in a region is a function of the sustainable development pillars in another region as follows (Mirshojaeian Hosseini and Kaneko, 2012).

$$S_i = f(S_j, E_j, Y_j)$$
$$E_i = f(S_j, E_j, Y_j)$$
$$Y_i = f(S_j, E_j, Y_j) \quad (1)$$

where S is social development, E is environmental development, Y is economic development, and i and j are the two regions under study (MENA and Europe). To estimate the SEY model, this paper transforms it into the following log-linear model in the form of simultaneous equations system (Abdouli and Omri, 2020; Ben

Youssef et al., 2016; Kahouli and Omri, 2017; Mohamad Taghavee et al., 2016).

$$LE_{it} = \alpha_{0j} + \alpha_{1j} LE_{jt} + \alpha_{2j} {CO^{-1}}_{jt} + \alpha_{3j} GDP_{jt} + \varepsilon_{1t}$$
$${CO^{-1}}_{it} = \beta_{0j} + \beta_{1j} LE_{jt} + \beta_{2j} {CO^{-1}}_{jt} + \beta_{3j} GDP_{jt} + \varepsilon_{2t}$$
$$GDP_{it} = \theta_{0j} + \theta_{1j} LE_{jt} + \theta_{2j} {CO^{-1}}_{jt} + \theta_{3j} GDP_{jt} + \varepsilon_{3t} \quad (2)$$

where *LE* is life expectancy measured in year as a proxy for social development, CO^{-1} is per capita CO_2 emissions inversed in Kiloton as a proxy for environmental development, GDP is per capita GDP in constant US Dollar 2010 as a proxy for economic development, *t* is year, and εs are error terms. The coefficients are α, β, and θ which are the elasticities of the corresponding sustainable development pillar since all the variables are in natural logarithm form.

Only those elasticities are considered in our analysis about the sustainability which show causal relationships, estimated with VAR and Granger causality approach as follows (Boutabba and Ahmad, 2017; Ismael et al., 2018; Mamipour et al., 2019; Tan and Lu, 2015).

$$\Delta LE_{it} = C_t + \sum_{l=1}^{p} \alpha_{1l} \Delta LE_{jt-l} + \sum_{l=1}^{p} \alpha_{2l} \Delta {CO^{-1}}_{jt} + \sum_{l=1}^{p} \alpha_{3l} \Delta GDP_{jt} + \varepsilon_{1t}$$
$$\Delta {CO^{-1}}_{it} = C_t + \sum_{l=1}^{p} \beta_{1l} \Delta LE_{jt} + \sum_{l=1}^{p} \beta_{2l} \Delta {CO^{-1}}_{jt-1} + \sum_{l=1}^{p} \beta_{3l} \Delta GDP_{jt} + \varepsilon_{1t}$$
$$\Delta GDP_{it} = C_t + \sum_{l=1}^{p} \theta_{1l} \Delta LE_{jt} + \sum_{l=1}^{p} \theta_{2l} \Delta {CO^{-1}}_{jt} + \sum_{l=1}^{p} \theta_{3l} \Delta GDP_{jt-1} + \varepsilon_{1t} \quad (3)$$

where *l* is lag, and *p* is the optimal lag. It gives impulse response functions, showing how each pillar of sustainability in region *i* responses to the changes in sustainability pillars in region *j*.

The SEY model employs simultaneous equations system, Granger causality, and VAR approaches to estimate the sustainability elasticities and spatial spillover effects. The positive coefficients confirm the presence of synergistic spillover effects of sustainability between the two regions of MENA and Europe, while the negative coefficients imply the trade-off relationships (Štreimikienė and Kačerauskas, 2020; Tremblay et al., 2020; Umar et al., 2020; Xu et al., 2020). The synergistic and trade-off relationships affirm that the effects of globalization and openness are constructive or detrimental to the sustainability, respectively.

To show the reliability of the results, this research goes further to estimate all the above models and equations with alternative proxies and variables for the three pillars of sustainable development. In the second round of estimations, this study considers school enrolment primary (% gross)[1], inverse of greenhouse gas emissions (in kilo of CO2 equivalent per capita) and energy use (in kg of oil equivalent per capita) as proxies for the social, environmental and economic pillars of sustainable development. In the equations and models, their symbols are SC, GH^{-1} and EN, respectively.

All the data are extracted from the World Development Indicators, World Bank, within 1971-2016; and for the alternative variables, the period is 1971-2014 (World Bank, 2021). They are normalized values of the natural logarithm form.

More details of methodology and data are accessible at the following link (Nodehi et al., 2021):
https://data.mendeley.com/datasets/xvd7bv6mjb/2

4. Results

The results of this study show that the spatial sustainability elasticities are mostly positive between MENA and Europe, confirming the constructive role of globalization and openness on sustainability.

Tables 1 and 2 and Figure 2 indicate the results of simultaneous equations system, Granger causality, and VAR approaches. According to Tables 1 and 2, the signs are positive for most of the elasticities with statistically significant causal and long-run relationship, supporting the synergistic nature of sustainability spillover effects between MENA and Europe. Although, this study uses various methods to estimate the SEY model including limited information

1. "Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Primary education provides children with basic reading, writing, and mathematics skills along with an elementary understanding of such subjects as history, geography, natural science, social science, art, and music" (World Bank, 2021).

(OLS, WOLS, 2SLS, and WSLS) and full information (3SLS, SUR, GMM, and FIML), all the methods give the same results. It shows the validity and robustness of our estimations and results. In addition, Figure 2 displays the impulse functions of the SEY model. Both the tables and the figure depict the interactions of life expectancy, CO_2 emissions, and GDP per capita between the two regions. It is an evidence for the presence of positive sustainable development spillover effects between the regions.

Table 3 represents only those elasticities in Tables 1 and 2, which are statistically significant not only in the long-run relationships of the simultaneous equations system, but also in the causality relationships of the Granger causality. According to Table 3, there are three synergistic and one trade-off relationship among the sustainable development pillars of MENA and Europe. Regarding Table 3, life expectancy in MENA as a proxy for social development has +2% spillover effect on inversed per capita CO_2 emissions as a proxy for environmental development. It also has +91% spillover effect on the per capita GDP as a proxy for economic development in Europe. Life expectancy in Europe has the highest spillover effect about +148% on the life expectancy in MENA as a proxy for social development. However, the inversed per capita CO_2 emissions are the only variable which has a negative effect of about -8% on the life expectancy in MENA. Despite the minor trade-off nexus, the sustainable development in each region has a positive effect on the sustainable development in the other region, given the estimated interactive sustainability elasticities which is the average effect. Sustainability in MENA shows an effect of +47% on the sustainability in Europe, and sustainability in Europe has an effect of +70% on sustainability in MENA. Thus, most of the spillover effects are synergistic between MENA and Europe sustainability which is consistent with (Štreimikienė & Kačerauskas, 2020; Tremblay et al., 2020; Umar et

al., 2020; Xu et al., 2020), and displayed in Figure 3 as the graphical translation of Table 3.

To show the robustness of the results, this study replicates all the estimated models with another set of proxies for the pillars of sustainable development, summarized in Table 6. The spillover effects of sustainable development show positive and synergetic nature even in case of changing the proxies. It is also another evidence for the reliability of the model estimations in this research. Based on these results, the nature of the sustainable development pillars is positive and synergetic even in case of altering the variable sets and region interactions.

Table 1. The Estimated Relationships and Causality Directions of Sustainable Development Pillars from Middle East and North Africa to European Union via Simultaneous Equations System and Granger Causality Test

EUROPEAN UNION (EU) ⇐ Middle East and North Africa (MENA)									
	Limited information approach (single equation)				**Full information approach (multiple equations)**				**Granger causality**
	OLS	**WOLS**	**2SLS**	**WSLS**	**3SLS**	**SUR**	**GMM**	**FIML**	
LE equation $_{EU}$									Optimal lag = 5
C	0.5917^{***} $(0.00)^{***}$	0.5917^{***} $(0.00)^{***}$	0.5917^{***} $(0.00)^{***}$	0.5917^{***} $(0.00)^{***}$	0.5917^{***} $(0.00)^{***}$	0.5917^{***} $(0.00)^{***}$	0.5917^{***} $(0.00)^{***}$	0.5917^{***} $(0.17)^{***}$	--
LE_{MENA}	0.8818^{***} $(0.00)^{***}$	0.8818^{***} $(0.00)^{***}$	0.8818^{***} $(0.00)^{***}$	0.8818^{***} $(0.00)^{***}$	0.8818^{***} $(0.00)^{***}$	0.8818^{***} $(0.00)^{***}$	0.8818^{***} $(0.00)^{***}$	0.8818^{***} $(0.00)^{***}$	$LE \Longrightarrow LE^{***}$ (0.16)
$CO^{-1}{}_{MENA}$	-0.1366^{***} $(0.00)^{***}$	-0.1366^{***} $(0.00)^{***}$	-0.1366^{***} $(0.00)^{***}$	-0.1366^{***} $(0.00)^{***}$	-0.1366^{***} $(0.00)^{***}$	-0.1366^{***} $(0.00)^{***}$	-0.1366^{***} $(0.00)^{***}$	-0.1366^{***} $(0.00)^{***}$	$CO^{-1} \Longrightarrow LE^{***}$ (0.61)
GDP_{MENA}	0.0152^{***} $(0.27)^{***}$	0.0152^{***} $(0.25)^{***}$	0.0152^{***} $(0.27)^{***}$	0.0152^{***} $(0.25)^{***}$	0.0152^{***} $(0.25)^{***}$	0.0152^{***} $(0.25)^{***}$	0.0152^{***} $(0.23)^{***}$	0.0152^{***} $(0.80)^{***}$	$GDP \Longrightarrow LE^{***}$ (0.35)
CO^{-1} equation $_{EU}$									
C	5.4988^{***} $(0.00)^{***}$	5.4988^{***} $(0.00)^{***}$	5.4988^{***} $(0.00)^{***}$	5.4988^{***} $(0.00)^{***}$	5.4988^{***} $(0.00)^{***}$	5.4988^{***} $(0.00)^{***}$	5.4988^{***} $(0.00)^{***}$	5.4988^{***} $(0.08)^{***}$	--
LE_{MENA}	0.0247^{***} $(0.85)^{***}$	0.0247^{***} $(0.84)^{***}$	0.0247^{***} $(0.85)^{***}$	0.0247^{***} $(0.84)^{***}$	0.0247^{***} $(0.84)^{***}$	0.0247^{***} $(0.84)^{***}$	0.0247^{***} $(0.89)^{***}$	0.0247^{***} $(0.93)^{***}$	$LE \Longrightarrow CO^{-1***}$ (0.00)
$CO^{-1}{}_{MENA}$	-0.5193^{***} $(0.00)^{***}$	-0.5193^{***} $(0.00)^{***}$	-0.5193^{***} $(0.00)^{***}$	-0.5193^{***} $(0.00)^{***}$	-0.5193^{***} $(0.00)^{***}$	-0.5193^{***} $(0.00)^{***}$	-0.5193^{***} $(0.00)^{***}$	-0.5193^{***} $(0.37)^{***}$	$CO^{-1} \Longrightarrow CO^{-1***}$ (0.20)
GDP_{MENA}	-0.1333^{***} $(0.19)^{***}$	-0.1333^{***} $(0.17)^{***}$	-0.1333^{***} $(0.19)^{***}$	-0.1333^{***} $(0.17)^{***}$	-0.1333^{***} $(0.17)^{***}$	-0.1333^{***} $(0.17)^{***}$	-0.1333^{***} $(0.37)^{***}$	-0.1333^{***} $(0.69)^{***}$	$GDP \Longrightarrow CO^{-1***}$ (0.86)
GDP equation $_{EU}$									
C	0.2579^{***} $(0.10)^{***}$	0.2579^{***} $(0.08)^{***}$	0.2579^{***} $(0.10)^{***}$	0.2579^{***} $(0.08)^{***}$	0.2579^{***} $(0.08)^{***}$	0.2579^{***} $(0.08)^{***}$	0.2579^{***} $(0.18)^{***}$	0.2579^{***} $(0.63)^{***}$	--
LE_{MENA}	0.9191^{***} $(0.00)^{***}$	0.9191^{***} $(0.00)^{***}$	0.9191^{***} $(0.00)^{***}$	0.9191^{***} $(0.00)^{***}$	0.9191^{***} $(0.00)^{***}$	0.9191^{***} $(0.00)^{***}$	0.9191^{***} $(0.00)^{***}$	0.9191^{***} $(0.00)^{***}$	$LE \Longrightarrow GDP^{***}$ (0.00)
$CO^{-1}{}_{MENA}$	-0.0838^{***} $(0.00)^{***}$	-0.0838^{***} $(0.00)^{***}$	-0.0838^{***} $(0.00)^{***}$	-0.0838^{***} $(0.00)^{***}$	-0.0838^{***} $(0.00)^{***}$	-0.0838^{***} $(0.00)^{***}$	-0.0838^{***} $(0.00)^{***}$	-0.0838^{***} $(0.07)^{***}$	$CO^{-1} \Longrightarrow GDP^{***}$

EUROPEAN UNION (EU) ⇐ Middle East and North Africa (MENA)									
	Limited information approach (single equation)				**Full information approach (multiple equations)**				**Granger causality**
	OLS	**WOLS**	**2SLS**	**WSLS**	**3SLS**	**SUR**	**GMM**	**FIML**	
									(0.85)
GDP $_{MENA}$	0.0439*** (0.00)***	0.0439*** (0.00)***	0.0439*** (0.00)***	0.0439*** (0.00)***	0.0439*** (0.00)***	0.0439*** (0.00)***	0.0439*** (0.00)***	0.0439*** (0.47)***	$GDP \Longrightarrow GDP^{***}$ (0.34)

Source: Research finding.

Note: *, **, and *** show the statistical significance of the causal relationship at 10%, 5%, and 1% levels.

Table 2. Estimated Relationships and Causality Directions of Sustainable Development Pillars from European Union to Middle East and North Africa via Simultaneous Equations System and Granger Causality Test

MIDDLE EAST and NORTH AFRICA (MENA) ⇐ European Union (EU)									
	Limited information approach (single equation)				**Full information approach (multiple equation)**				**Granger Causality**
	OLS	**WOLS**	**2SLS**	**WSLS**	**3SLS**	**SUR**	**GMM**	**FIML**	
LE equation $_{MENA}$									Optimal lag = 5
C	0.4174*** (0.00)***	0.4174*** (0.00)***	0.4174*** (0.00)***	0.4174*** (0.00)***	0.4174*** (0.00)***	0.4174*** (0.00)***	0.4174*** (0.00)***	0.4174*** (0.13)***	--
LE $_{EU}$	0.4869*** (0.03)***	0.4869*** (0.02)***	0.4869*** (0.03)***	0.4869*** (0.02)***	0.4869*** (0.02)***	0.4869*** (0.02)***	0.4869*** (0.07)***	0.4869*** (0.31)***	$LE \Longrightarrow LE^{***}$ (0.07)
CO^{-1} $_{EU}$	-0.0795*** (0.00)***	-0.0795*** (0.00)***	-0.0795*** (0.00)***	-0.0795*** (0.00)***	-0.0795*** (0.00)***	-0.0795*** (0.00)***	-0.0795*** (0.11)***	-0.0795*** (0.21)***	$CO^{-1} \Longrightarrow LE^{***}$ (0.01)
GDP $_{EU}$	0.5327*** (0.02)***	0.5327*** (0.01)***	0.5327*** (0.02)***	0.5327*** (0.01)***	0.5327*** (0.01)***	0.5327*** (0.01)***	0.5327*** (0.04)***	0.5327*** (0.28)***	$GDP \Longrightarrow LE^{***}$ (0.22)
CO^{-1} equation $_{MENA}$									
C	7.0465*** (0.00)***	7.0465*** (0.00)***	7.0465*** (0.00)***	7.0465*** (0.00)***	7.0465*** (0.00)***	7.0465*** (0.00)***	7.0465*** (0.00)***	7.0465*** (0.00)***	--
LE $_{EU}$	-2.3412*** (0.05)***	-2.3412*** (0.04)***	-2.3412*** (0.05)***	-2.3412*** (0.04)***	-2.3412*** (0.04)***	-2.3412*** (0.04)***	-2.3412*** (0.24)***	-2.3412*** (0.14)***	$LE \Longrightarrow CO^{-1***}$ (0.38)
CO^{-1} $_{EU}$	-0.4318***	-0.4318***	-0.4318***	-0.4318***	-0.4318***	-0.4318***	-0.4318***	-0.4318***	$CO^{-1} \Longrightarrow$

MIDDLE EAST and NORTH AFRICA (MENA) ⇐ European Union (EU)									
	Limited information approach (single equation)				**Full information approach (multiple equation)**				**Granger**
	OLS	**WOLS**	**2SLS**	**WSLS**	**3SLS**	**SUR**	**GMM**	**FIML**	**Causality**
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.13)***	(0.16)***	CO^{-1}*** (0.83)
GDP $_{EU}$	1.6635*** (0.16)***	1.6635*** (0.14)***	1.6635*** (0.16)***	1.6635*** (0.14)***	1.6635*** (0.14)***	1.6635*** (0.14)***	1.6635*** (0.38)***	1.6635*** (0.33)***	$GDP \Longrightarrow CO^{-1}$*** (0.62)
GDP equation $_{MENA}$									
C	1.7010*** (0.04)***	1.7010*** (0.03)***	1.7010*** (0.04)***	1.7010*** (0.03)***	1.7010*** (0.03)***	1.7010*** (0.03)***	1.7010*** (0.18)***	1.7010*** (0.58)***	--
LE $_{EU}$	-1.1804*** (0.53)***	-1.1804*** (0.51)***	-1.1804*** (0.53)***	-1.1804*** (0.51)***	-1.1804*** (0.51)***	-1.1804*** (0.51)***	-1.1804*** (0.54)***	-1.1804*** (0.81)***	$LE \Longrightarrow GDP$*** (0.15)
CO^{-1} $_{EU}$	0.1487*** (0.53)***	0.1487*** (0.51)***	0.1487*** (0.53)***	0.1487*** (0.51)***	0.1487*** (0.51)***	0.1487*** (0.51)***	0.1487*** (0.66)***	0.1487*** (0.84)***	$CO^{-1} \Longrightarrow GDP$*** (0.53)
GDP $_{EU}$	1.4736*** (0.42)***	1.4736*** (0.40)***	1.4736*** (0.42)***	1.4736*** (0.40)***	1.4736*** (0.40)***	1.4736*** (0.40)***	1.4736*** (0.43)***	1.4736*** (0.76)***	$GDP \Longrightarrow GDP$*** (0.24)

Source: Research finding.

Note: *, **, and *** show the statistical significance of the causal relationship at 10%, 5%, and 1% levels.

Table 3. Alternative Variables for Relationships and Causality Directions of Sustainable Development Pillars From Middle East and North Africa to European Union via Simultaneous Equations System and Granger Causality Test

EUROPEAN UNION (EU) ⇐ Middle East and North Africa (MENA)									
	Limited information approach (single equation)				**Full information approach (multiple equations)**				**Granger causality**
	OLS	**WOLS**	**2SLS**	**WSLS**	**3SLS**	**SUR**	**GMM**	**FIML**	
SC equation $_{Asia}$									Optimal lag = 5
C	5.1744*** (0.00)***	5.1744*** (0.00)***	5.1744*** (0.00)***	5.1744*** (0.00)***	5.1744*** (0.00)***	5.1744*** (0.00)***	5.1744*** (0.00)***	5.1744*** (0.68)***	--
SC $_{N.\ America}$	-0.0242*** (0.88)***	-0.0242*** (0.88)***	-0.0242*** (0.88)***	-0.0242*** (0.88)***	-0.0242*** (0.88)***	-0.0242*** (0.88)***	-0.0242*** (0.88)***	-0.0242*** (0.97)***	$SC \Longrightarrow SC$*** (0.80)
GH^{-1} $_{N.}$	0.0400***	0.0400***	0.0400***	0.0400***	0.0400***	0.0400***	0.0400***	0.0400***	$GH^{-1} \Longrightarrow SC$***

EUROPEAN UNION (EU) ⇐ Middle East and North Africa (MENA)									
	Limited information approach (single equation)				**Full information approach (multiple equations)**				**Granger causality**
	OLS	**WOLS**	**2SLS**	**WSLS**	**3SLS**	**SUR**	**GMM**	**FIML**	
$_{America}$	(0.74)***	(0.73)***	(0.74)***	(0.73)***	(0.73)***	(0.73)***	(0.73)***	(0.90)***	(0.02)
$EN_{N.}$ $_{America}$	-0.4133*** (0.04)***	-0.4133*** (0.03)***	-0.4133*** (0.04)***	-0.4133*** (0.03)***	-0.4133*** (0.03)***	-0.4133*** (0.03)***	-0.4133*** (0.02)***	-0.4133*** (0.85)***	$EN \Longrightarrow SC^{***}$ (0.42)
GH equation $_{Asia}$									
C	4.8650*** (0.00)***	4.8650*** (0.00)***	4.8650*** (0.00)***	4.8650*** (0.00)***	4.8650*** (0.00)***	4.8650*** (0.00)***	4.8650*** (0.01)***	4.8650*** (0.55)***	--
$SC_{N.}$ $_{America}$	-0.5572*** (0.02)***	-0.5572*** (0.01)***	-0.5572*** (0.02)***	-0.5572*** (0.01)***	-0.5572*** (0.01)***	-0.5572*** (0.01)***	-0.5572*** (0.03)***	-0.5572*** (0.70)***	$SC \Longrightarrow GH^{-1***}$ (0.92)
$GH^{-1}{}_{N.}$ $_{America}$	0.0401*** (0.78)***	0.0401*** (0.77)***	0.0401*** (0.78)***	0.0401*** (0.77)***	0.0401*** (0.77)***	0.0401*** (0.77)***	0.0401*** (0.73)***	0.0401*** (0.94)***	$GH^{-1} \Longrightarrow GH^{-1***}$ (0.84)
$EN_{N.}$ $_{America}$	0.0954*** (0.63)***	0.0954*** (0.61)***	0.0954*** (0.63)***	0.0954*** (0.61)***	0.0954*** (0.61)***	0.0954*** (0.61)***	0.0954*** (0.74)***	0.0954*** (0.88)***	$EN \Longrightarrow GH^{-1***}$ (0.99)
EN equation $_{Asia}$									
C	-0.0066*** (0.99)***	-0.0066*** (0.99)***	-0.0066*** (0.99)***	-0.0066*** (0.99)***	-0.0066*** (0.99)***	-0.0066*** (0.99)***	-0.0066*** (0.99)***	-0.0066*** (0.99)***	--
$SC_{N.}$ $_{America}$	0.3786*** (0.00)***	0.3786*** (0.00)***	0.3786*** (0.00)***	0.3786*** (0.00)***	0.3786*** (0.00)***	0.3786*** (0.00)***	0.3786*** (0.00)***	0.3786*** (0.59)***	$SC \Longrightarrow EN^{***}$ (0.93)
$GH^{-1}{}_{N.}$ $_{America}$	0.9000*** (0.00)***	0.9000*** (0.00)***	0.9000*** (0.00)***	0.9000*** (0.00)***	0.9000*** (0.00)***	0.9000*** (0.00)***	0.9000*** (0.00)***	0.9000*** (0.00)***	$GH^{-1} \Longrightarrow EN^{***}$ (0.42)
$EN_{N.}$ $_{America}$	-0.0923*** (0.10)***	-0.0923*** (0.08)***	-0.0923*** (0.10)***	-0.0923*** (0.08)***	-0.0923*** (0.08)***	-0.0923*** (0.08)***	-0.0923*** (0.02)***	-0.0923*** (0.57)***	$EN \Longrightarrow EN^{***}$ (0.79)

Source: Research finding.

Note: *, **, and *** show the statistical significance of the causal relationship at 10%, 5%, and 1% levels.

Table 4. Alternative Variables for Relationships and Causality Directions of Sustainable Development Pillars from European Union to Middle East and North Africa via Simultaneous Equations System and Granger Causality Test

MIDDLE EAST and NORTH AFRICA (MENA) ⇐ European Union (EU)									
	Limited information approach (single equation)				**Full information approach (multiple equation)**				**Granger**
	OLS	**WOLS**	**2SLS**	**WSLS**	**3SLS**	**SUR**	**GMM**	**FIML**	**Causality**
SC equation $_{N.\ America}$									Optimal lag = 5
C	7.3503^{***}	7.3503^{***}	7.3503^{***}	7.3503^{***}	7.3503^{***}	7.3503^{***}	7.3503^{***}	7.3503^{***}	--
	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	
SC $_{Asia}$	-0.3741^{***}	-0.3741^{***}	-0.3741^{***}	-0.3741^{***}	-0.3741^{***}	-0.3741^{***}	-0.3741^{***}	-0.3741^{***}	$SC \Longrightarrow SC^{***}$
	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.02)^{***}$	$(0.08)^{***}$	(0.32)
GH^{-1} $_{Asia}$	-0.3430^{***}	-0.3430^{***}	-0.3430^{***}	-0.3430^{***}	-0.3430^{***}	-0.3430^{***}	-0.3430^{***}	-0.3430^{***}	$GH^{-1} \Longrightarrow SC^{***}$
	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.32)^{***}$	(0.98)
EN $_{Asia}$	-0.2702^{***}	-0.2702^{***}	-0.2702^{***}	-0.2702^{***}	-0.2702^{***}	-0.2702^{***}	-0.2702^{***}	-0.2702^{***}	$EN \Longrightarrow SC^{***}$
	$(0.02)^{***}$	$(0.02)^{***}$	$(0.02)^{***}$	$(0.02)^{***}$	$(0.02)^{***}$	$(0.02)^{***}$	$(0.10)^{***}$	$(0.29)^{***}$	(0.66)
GH equation $_{N.\ America}$									
C	-2.2597^{***}	-2.2597^{***}	-2.2597^{***}	-2.2597^{***}	-2.2597^{***}	-2.2597^{***}	-2.2597^{***}	-2.2597^{***}	--
	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.01)^{***}$	
SC $_{Asia}$	0.0461^{***}	0.0461^{***}	0.0461^{***}	0.0461^{***}	0.0461^{***}	0.0461^{***}	0.0461^{***}	0.0461^{***}	$SC \Longrightarrow GH^{-1***}$
	$(0.52)^{***}$	$(0.50)^{***}$	$(0.52)^{***}$	$(0.50)^{***}$	$(0.50)^{***}$	$(0.50)^{***}$	$(0.55)^{***}$	$(0.85)^{***}$	(0.57)
GH^{-1} $_{Asia}$	1.0362^{***}	1.0362^{***}	1.0362^{***}	1.0362^{***}	1.0362^{***}	1.0362^{***}	1.0362^{***}	1.0362^{***}	$GH^{-1} \Longrightarrow$
	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	GH^{-1***}
									(0.08)
EN $_{Asia}$	0.3543^{***}	0.3543^{***}	0.3543^{***}	0.3543^{***}	0.3543^{***}	0.3543^{***}	0.3543^{***}	0.3543^{***}	$EN \Longrightarrow GH^{-1***}$
	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	(0.26)

MIDDLE EAST and NORTH AFRICA (MENA) ⇐ European Union (EU)									
	Limited information approach (single equation)				**Full information approach (multiple equation)**				**Granger**
	OLS	**WOLS**	**2SLS**	**WSLS**	**3SLS**	**SUR**	**GMM**	**FIML**	**Causality**
EN equation $_{N.\ America}$									
C	5.5707^{***}	5.5707^{***}	5.5707^{***}	5.5707^{***}	5.5707^{***}	5.5707^{***}	5.5707^{***}	5.5707^{***}	--
	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.22)^{***}$	
SC	0.1357^{***}	0.1357^{***}	0.1357^{***}	0.1357^{***}	0.1357^{***}	0.1357^{***}	0.1357^{***}	0.1357^{***}	$SC \Longrightarrow EN^{***}$
$_{Asia}$	$(0.45)^{***}$	$(0.43)^{***}$	$(0.45)^{***}$	$(0.43)^{***}$	$(0.43)^{***}$	$(0.43)^{***}$	$(0.21)^{***}$	$(0.92)^{***}$	(0.97)
GH^{-1}	-0.0519^{***}	-0.0519^{***}	-0.0519^{***}	-0.0519^{***}	-0.0519^{***}	-0.0519^{***}	-0.0519^{***}	-0.0519^{***}	$GH^{-1} \Longrightarrow EN^{***}$
$_{Asia}$	$(0.71)^{***}$	$(0.69)^{***}$	$(0.71)^{***}$	$(0.69)^{***}$	$(0.69)^{***}$	$(0.69)^{***}$	$(0.72)^{***}$	$(0.92)^{***}$	(0.83)
EN	-0.6166^{***}	-0.6166^{***}	-0.6166^{***}	-0.6166^{***}	-0.6166^{***}	-0.6166^{***}	-0.6166^{***}	-0.6166^{***}	$EN \Longrightarrow EN^{***}$
$_{Asia}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.00)^{***}$	$(0.01)^{***}$	$(0.50)^{***}$	(0.52)

Source: Research finding.

Note: *, **, and *** show the statistical significance of the causal relationship at 10%, 5%, and 1% levels.

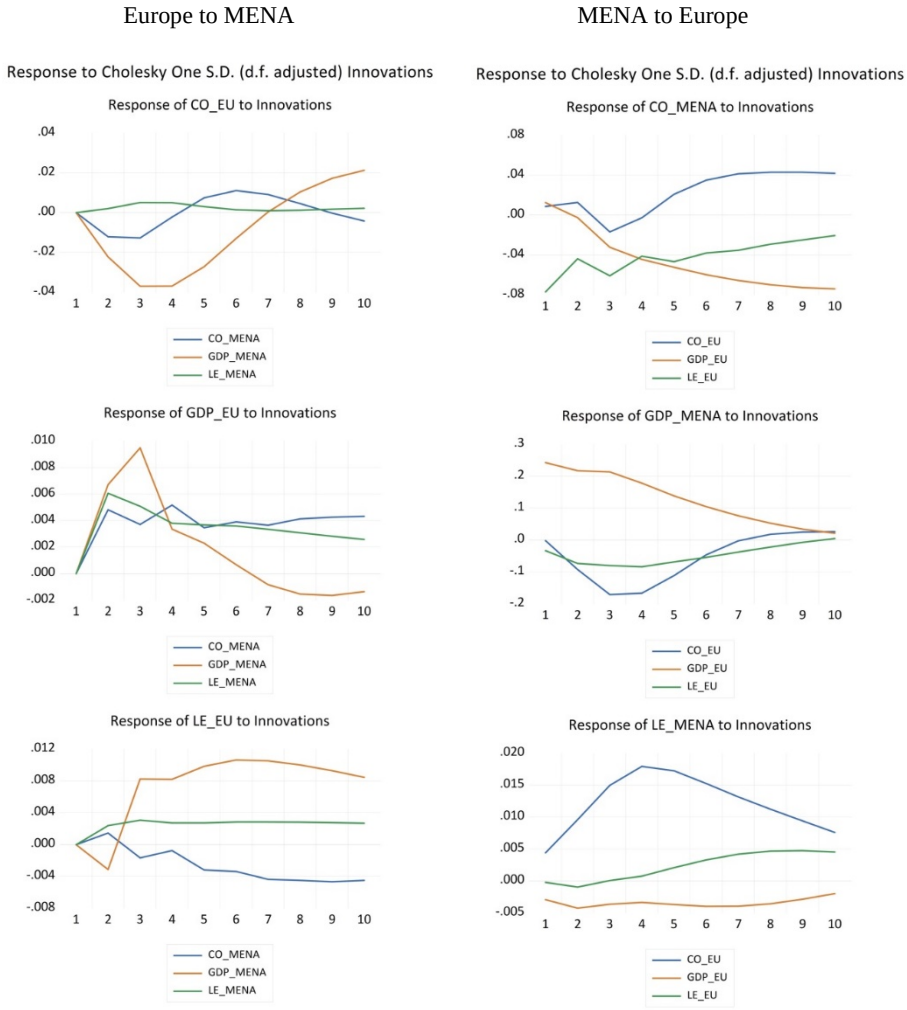


Figure 2. Impulse Functions of Sustainable Development Pillars between MENA and Europe
Source: Research finding.
Note: CO is the inverse of per capita CO_2 emissions, GDP is per capita GDP, and LE is life expectancy.

Table 5 and 6 display the statistically significant causalities with *average* long-run relationships of the sustainable development pillars between Europe and MENA. The long-run relationships are the sustainability elasticities (or spatial spillover effects among the

sustainable development pillars). The positive effects are synergies and the negative ones are trade-offs. The interactive sustainability elasticity is the *average of the averages*.

Table 5. Interactive Sustainability Elasticities between European Union and Middle East & North Africa (With the Proxies of Life Expectancy, CO2 and GDP)

Region j => Region i		MENA => EU	EU => MENA
Social $_i$			
Social $_j$	$LE_j \Longrightarrow LE_i$	--	+1.4869***
Environment $_j$	$CO^{-1}{}_j \Longrightarrow LE_i$	--	-0.0795***
Economy $_j$	$GDP_j \Longrightarrow LE_i$	--	--
Environment $_i$			
Social $_j$	$LE_j \Longrightarrow CO^{-1}{}_i$	+0.0247***	--
Environment $_j$	$CO^{-1}{}_j \Longrightarrow CO^{-1}{}_i$	--	--
Economy $_j$	$GDP_j \Longrightarrow CO^{-1}{}_i$	--	--
Economy $_i$			
Social $_j$	$LE_j \Longrightarrow GDP_i$	+0.9191***	--
Environment $_j$	$CO^{-1}{}_j \Longrightarrow GDP_i$	--	--
Economy $_j$	$GDP_j \Longrightarrow GDP_i$	--	--
Interactive sustainability elasticities		+47%	+70%***

Source: Research finding.

Table 6. Interactive Sustainability Elasticities between North America and East Asia & Pacific (With the Proxies of School Enrolment, Greenhouse Gas Emissions and Energy Consumption)

Region j => Region i		MENA => EU	EU => MENA
Social $_i$			
Social $_j$	$SC_j \Longrightarrow SC_i$	--	--
Environment $_j$	$GH^{-1}{}_j \Longrightarrow SC_i$	--	--
Economy $_j$	$EN_j \Longrightarrow SC_i$	--	--
Environment $_i$			
Social $_j$	$SC_j \Longrightarrow GH^{-1}{}_i$	--	--
Environment $_j$	$GH^{-1}{}_j \Longrightarrow GH^{-1}{}_i$	--	+1.0362***
Economy $_j$	$EN_j \Longrightarrow GH^{-1}{}_i$	--	--
Economy $_i$			
Social $_j$	$SC_j \Longrightarrow EN_i$	--	--
Environment $_j$	$GH^{-1}{}_j \Longrightarrow EN_i$	+0.9000***	--
Economy $_j$	$EN_j \Longrightarrow EN_i$	--	--
Interactive Sustainability Elasticities		+53%	+90%

Source: Research finding.

5. Discussion

Findings of this research support the positive role of globalization and openness in the global sustainability. Figure 3 presents our findings graphically and summarily. The most significant elasticities of sustainable development pillars are positive between MENA and Europe. In spite of the negligible negative nexus from environmental development in Europe to the social development in MENA, other spatial spillover effects are positive and considerable. With regard to Figure 3, social development in Europe improves social development in MENA, and social development in MENA, in turn, improves both the environmental and economic development in Europe. It is consistent with the *Ricardo's comparative advantage theory* in supporting the beneficial role of globalization and openness in sustainability. In contrast, it rejects the pollution haven hypothesis for the negative role of international trade and relationship. The spillover effect of sustainability is considerably great to add another pillar to the three sustainable development pillars of social, environment and economy. In another word, peace and partnership are fundamental as this research adds peace and partnership as the fourth P to the sustainability pillars of people, planet and prosperity. Based on this analysis, the policymakers should follow flow-based governance to solve the sustainable development issues. Thus, the UN should pursue and promote its unique platform for globalization, peace and partnership to improve the global sustainability.

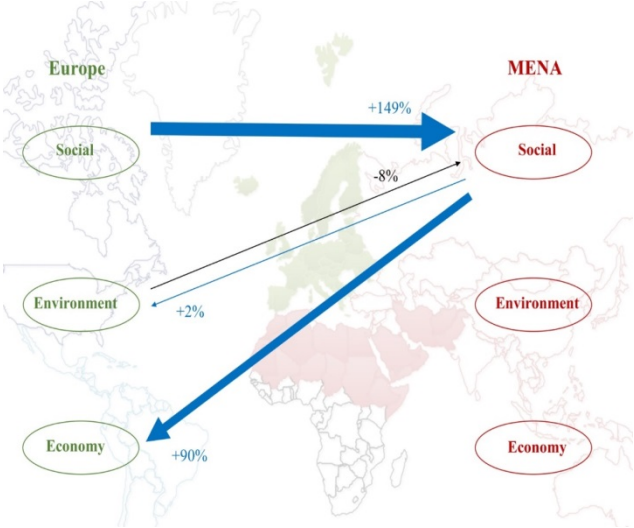


Figure 3. The Estimated Spillover Effects (or Elasticities) of Sustainable Development Pillars between MENA and Europe
Source: Research finding.
Note: Blue arrows represent the positive relationships and synergetic spillover effects, while the black arrow shows the negative relationship and trade-off nexus. The size of each arrow is accorded with the elasticity and the amount of its effectiveness.

6. Conclusion

This research aims to estimate the sustainability elasticities between MENA and Europe to reveal if the globalization and openness, as a result of the UN global platform, are beneficial for the sustainable development. It uses the econometric methodology to develop SEY model which includes simultaneous equations system, Granger causality, and VAR approaches. The main findings of this study are as follows.

- The sustainability elasticities are positive between MENA and Europe;
- The sustainability spillover effects are synergistic, not trade-off, between the regions;
- Globalization and openness are beneficial for the global sustainability;

- Spillover effect is the 4th pillar of sustainable development beside social, environment, and economy;
- Peace and partnership are the 4th pillar of sustainability beside people, planet, and prosperity.
- The policymakers are advised to follow flow-based governance to tackle the sustainable development issues;
- The unique global agenda of the UN has sufficient capability to improve sustainable development in the world.

As a future study, the researcher can test the not only cross-region but also, cross-pillar spillover effects, among and within other regions, economies and countries of the world.

Data Availability

More details of methodology and data are accessible at the following link (Nodehi et al., 2021):
https://data.mendeley.com/datasets/xvd7bv6mjb/2

References

Abdouli, M., & Omri, A. (2020). Exploring the Nexus Among FDI Inflows, Environmental Quality, Human Capital, and Economic Growth in the Mediterranean Region. *Journal of the Knowledge Economy, 12*, 788-810.

Agheli, L., & Taghvaee, V. M. (2022). Political Stability Effect on Environment and Weak Sustainability in Asian Countries. *Sustainability Analytics and Modeling*, *2*, 1-20.

Ahmadi, H., Mohebi, M., Nikbeen, H., Rasoli, K., Sharifpour, Y., Soleymani, A., Taghvaee, V. M., & Yousefi, A. (2021). Sustainable Development and Modern Customs: A Review on Customs Conventions of World Customs Organization. *Global Trade and Customs Journal, 7/8*, 363–383.

Alcamo, J., Thompson, J., Alexander, A., Antoniades, A., Delabre, I., Dolley, J., Marshall, F., Menton, M., Middleton, J., & Scharlemann, J. P. W. (2020). Analysing Interactions among The Sustainable Development Goals: Findings and Emerging Issues from Local and Global Studies. *Sustainability Science*, *15*(6), 1561–1572.

Allen, C., Metternicht, G., & Wiedmann, T. (2019). Prioritising SDG Targets: Assessing Baselines, Gaps and Interlinkages. *Sustainability Science*, *14*(2), 421–438.

Amadei, B. (2021). The Sustainability – Peace Nexus in the Context of Global Change A Systems Approach to The Sustainability – Peace Nexus. *Sustainability Science*, *16*, 1111-1124.

Amos, R., & Lydgate, E. (2020). Trade, Transboundary Impacts and The Implementation of SDG 12. *Sustainability Science*, *15*(6), 1699–1710.

Arushanyan, Y., Ekener, E., & Moberg, Å. (2017). Sustainability assessment framework for scenarios – SAFS. *Environmental Impact Assessment Review*, *63*, 23–34.

Basile, R. (2008). Regional Economic Growth in Europe: A Semiparametric Spatial Dependence Approach. *Papers in Regional Science*, *87*(4), 527–544.

Basile, R., Capello, R., & Caragliu, A. (2011). Interregional knowledge Spillovers and Economic Growth: The Role of Relational Proximity. *Advances in Spatial Science*, *68*, 21–43.

Batabyal, A. A., & Folmer, H. (2020). Spatial Economic Aspects of Climate Change. *Spatial Economic Analysis*, *15*(3), 209–218.

Batabyal, A. A., & Nijkamp, P. (2017). *Regional Growth and Sustainable Development in Asia*, 7 (Eds.). New Delhi: Springer International Publishing.

Ben-Eli, M. U. (2018). Sustainability: Definition and Five Core Principles, A Systems Perspective. *Sustainability Science*, *13*(5), 1337–1343.

Ben Youssef, A., Hammoudeh, S., & Omri, A. (2016). Simultaneity Modeling Analysis of The Environmental Kuznets Curve Hypothesis. *Energy Economics*, *60*, 266–274.

Boutabba, M. A., & Ahmad, N. (2017). On the Economic Determinants of Biofuel Consumption: An Empirical Analysis for OECD Countries. *International Journal of Global Energy Issues*, *40*(6), 400–418.

Brown, B. J., Hanson, M. E., Liverman, D. M., & Merideth, R. W. (1987). Global Sustainability: Toward Definition. *Environmental Management*, *11*(6), 713–719.

Clune, W. H., & Zehnder, A. J. B. (2020). The Evolution of Sustainability Models, from Descriptive, to Strategic, to The Three Pillars Framework for Applied Solutions. *Sustainability Science*, *15*(3), 1001–1006.

Dolley, J., Marshall, F., Butcher, B., Reffin, J., Robinson, J. A., Eray, B., & Quadrianto, N. (2020). Analysing Trade-Offs and Synergies Between Sdgs for Urban Development, Food Security and Poverty Alleviation in Rapidly Changing Peri-Urban Areas: A Tool to Support Inclusive Urban Planning. *Sustainability Science*, *15*(6), 1601–1619.

Farooq, Q., Hao, J., Liu, X., Xiao, D., & Hao, Y. (2020). Social and

Environmental Development: Fresh Concepts and Soft Measures Towards Sustainable Development. *Sustainable Development, 28*(6), 1796–1803.

Fullman, N., Barber, R. M., Abajobir, A. A., Abate, K. H., Abbafati, C., Abbas, K. M., Abd-Allah, F., Abdulle, A. M., Abera, S. F., Aboyans, V., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., Adedeji, I. A., Adetokunboh, O., Afshin, A., Agrawal, A., Agrawal, S., Kiadaliri, A. A., Ahmadieh, H., & Murray, C. J. L. (2017). Measuring Progress and Projecting Attainment on The Basis of Past Trends of The Health-Related Sustainable Development Goals in 188 Countries: An Analysis from the Global Burden of Disease Study 2016. *The Lancet*, *390*(10100), 1423–1459.

Geoffrey, J. (2007). *Advances in Spatial Science.* New York: Springer. Glavič, P., & Lukman, R. (2007). Review of Sustainability Terms and Their Definitions. *Journal of Cleaner Production*, *15*(18), 1875–1885.

Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable Development Goals: A Need for Relevant Indicators. *Ecological Indicators*, *60*, 565–573.

Hopkins, S. R., Sokolow, S. H., Buck, J. C., De Leo, G. A., Jones, I. J., Kwong, L. H., LeBoa, C., Lund, A. J., MacDonald, A. J., Nova, N., Olson, S. H., Peel, A. J., Wood, C. L., & Lafferty, K. D. (2020). How to Identify Win–Win Interventions that Benefit Human Health and Conservation. *Nature Sustainability, 4*, 298–304.

Hull, V., & Liu, J. (2018). Telecoupling: A New Frontier for Global Sustainability. *Ecology and Society*, *23*(4), 1-15.

Ismael, M., Srouji, F., & Boutabba, M. A. (2018). Agricultural

Technologies and Carbon Emissions: Evidence from Jordanian Economy. *Environmental Science and Pollution Research*, *25*(11), 10867–10877.

Kahouli, B., & Omri, A. (2017). Foreign Direct Investment, Foreign Trade and Environment: New Evidence from Simultaneous-Equation System of Gravity Models. *Research in International Business and Finance*, *42*, 353–364.

Kajikawa, Y., Saito, O., & Takeuchi, K. (2017). Academic landscape of 10 Years of Sustainability Science. *Sustainability Science*, *12*(6), 869–873.

Liu, J., Mooney, H., Hull, V., Davis, S. J., Gaskell, J., Hertel, T., Lubchenco, J., Seto, K. C., Gleick, P., Kremen, C., & Li, S. (2015). Systems Integration for Global Sustainability. *Science*, *347*(6225), 1201-1220.

Lyytimäki, J., Salo, H., Lepenies, R., Büttner, L., & Mustajoki, J. (2020). Risks of Producing and Using Indicators of Sustainable Development Goals. *Sustainable Development*, *28*(6), 1528–1538.

Mamipour, S., Yahoo, M., & Jalalvandi, S. (2019). An Empirical Analysis of the Relationship Between the Environment, Economy, and Society: Results of a PCA-VAR Model for Iran. *Ecological Indicators*, *102*, 760–769.

Menton, M., Larrea, C., Latorre, S., Martinez-Alier, J., Peck, M., Temper, L., & Walter, M. (2020). Environmental Justice and the SDGs: from Synergies to Gaps and Contradictions. *Sustainability Science*, *15*(6), 1621–1636.

Mirshojaeian Hosseini, H., & Kaneko, S. (2012). Causality between

Pillars of Sustainable Development: Global Stylized Facts or Regional Phenomena? *Ecological Indicators*, *14*(1), 197–201.

Mohamad Taghavee, V., Seifi Aloo, A., & Jalil, K. S. (2016). Energy, Environment, and Economy Interactions in Iran with. *Procedia of Economics and Finance*, *36*, 414–424.

Mohamad Taghvaee, V., Agheli, L., Assari Arani, A., Nodehi, M., & Khodaparast Shirazi, J. (2019). Environmental Pollution and Economic Growth Elasticities of Maritime and Air Transportations in Iran. *Marine Economics and Management*, *2*(2), 114–123.

Mohamad Taghvaee, V., Assari Arani, A., & Agheli, L. (2022b). Sustainable Development Spillover Effects between North America and MENA: Analyzing The Integrated Sustainability Perspective. *Environmental and Sustainability Indicators*, *14*, 100-182.

Mohamad Taghvaee, V., Nodehi, M., Assari Arani, A., Rishehri, M., Nodehi, S. E., & Khodaparast Shirazi, J. (2022a). Fossil fuel Price Policy And Sustainability: Energy, Environment, Health And Economy. *International Journal of Energy Sector Management, 17*(2), 41-60.

Nasrollahi, Z., Hashemi, M., Bameri, S., & Mohamad Taghvaee, V. (2020). Environmental Pollution, Economic Growth, Population, Industrialization, and Technology in Weak and Strong Sustainability: Using STIRPAT Model. *Environment, Development and Sustainability*, *22*(2), 1105–1122.

Nilsson, M., Griggs, D., Visbeck, M., & Ringler, C. (2016). A Draft Framework for Understanding SDG Interactions. International Council for Science, Retrieved from https://co-galapagos.org/wp-

content/uploads/2021/06/ICSU-SDG-interactions-working-paper.pdf

Nodehi, M., & Mohamad Taghvaee, V. (2021a). Alkali-Activated Materials and Geopolymer: A Review of Common Precursors and Activators Addressing Circular Economy. *Circular Economy and Sustainability, A, 1-32.*

Nodehi, M., Arani, A. A., & Taghvaee, V. M. (2022). Sustainability Spillover Effects and Partnership between East Asia & Pacific Versus North America: Interactions of Social, Environment and Economy. *Letters in Spatial and Resource Sciences*, *15*(3), 311–339.

Nodehi, M., & Mohamad Taghvaee, V. (2021b). Sustainable Concrete For Circular Economy: A Review on Use of Waste Glass. *Glass Structures & Engineering*, *7*, 3-22.

Nodehi, M., Taghvaee, V. M., & Arani, A. A. (2022). Data and Methodology for Estimating Sustainability Spillover Effects between Two Regions. *Letters in Spatial and Resource Sciences, 15*, 311–339.

Nodehi, M., & Taghvaee, V. M. (2022). Applying Circular Economy to Construction Industry through Use of Waste Materials: A Review of Supplementary Cementitious Materials, Plastics, and Ceramics. *Circular Economy and Sustainability, 2*, 987-1020.

Omri, A., Euchi, J., Hasaballah, A. H., & Al-Tit, A. (2019). Determinants of Environmental Sustainability: Evidence from Saudi Arabia. *Science of the Total Environment, 657*, 1592–1601.

Orchard, S., Glover, D., Thapa Karki, S., Ayele, S., Sen, D., Rathod, R., & Rowhani, P. (2020). Exploring Synergies and Trade-Offs Among The Sustainable Development Goals: Collective Action and Adaptive Capacity in Marginal Mountainous Areas of India.

Sustainability Science, *15*(6), 1665–1681.

Parsa, H., Keshavarz, H., & Taghvaee, V. M. (2019). Industrial Growth And Sustainable Development in Iran. *Iranian Economic Review*, *23*(2), 319-339.

Purvis, B., Mao, Y., & Robinson, D. (2019). Three Pillars of Sustainability: In Search of Conceptual Origins. *Sustainability Science*, *14*(3), 681–695.

Saner, R., Yiu, L., & Kingombe, C. (2019). The 2030 Agenda Compared with Six Related International Agreements: Valuable Resources for SDG Implementation. *Sustainability Science, 14*(6), 1685-1716.

Schaubroeck, T. (2018). Towards a General Sustainability Assessment of Human/Industrial and Nature-Based Solutions. *Sustainability Science, 13*(4), 1185–1191.

Schneider, F., Kläy, A., Zimmermann, A. B., Buser, T., Ingalls, M., & Messerli, P. (2019). How can Science Support the 2030 Agenda for Sustainable Development? Four Tasks to Tackle The Normative Dimension of Sustainability. *Sustainability Science*, *14*(6), 1593–1604.

Sharifi, A., Simangan, D., & Kaneko, S. (2020). Three Decades Of Research On Climate Change and Peace: A Bibliometrics Analysis. *Sustainability Science*, *16*, 1079-1095.

Shirazi, J. K., Taghvaee, V. M., Nasiri, M., & Assari Arani, A. (2020). Sustainable Development and Openness in Oil-Exporting Countries: Green Growth and Brown Growth. *Journal of Economic Structures*, *9*(1), 21-40.

Smith, M. S., Cook, C., Sokona, Y., Elmqvist, T., Fukushi, K., Broadgate, W., & Jarzebski, M. P. (2018). Advancing Sustainability Science for the SDGs. *Sustainability Science*, *13*(6), 1483–1487.

Štreimikienė, D., & Kačerauskas, T. (2020). The Creative Economy and Sustainable Development: The Baltic States. *Sustainable Development*, *28*(6), 1632–1641.

Taghvaee, V. M., Abbas, A. A., Mehrab, N., Jalil, K. S., Lotfali, A., Mohammad, N. G. H., Nafiseh, S., Amir, M., Saeed, T., Raziyeh, M. S., Hady, F., Reza, A., & Hosein, A. R. (2021). Sustainable Development Goals: Transportation, Health and Public Policy. *Review of Economics and Political Science*, *8*(2), 134-161.

Taghvaee, S. M., Omaraee, B., & Taghvaee, V. M. (2017). Maritime Transportation, Environmental Pollution, and Economic Growth in Iran: Using Dynamic Log Linear Model and Granger Causality Approach. *Iranian Economic Review, 21*(2), 185-210.

Taghvaee, V. M., Nodehi, M., Arani, A. A., Jafari, Y., & Shirazi, J. K. (2022a). Sustainability Spillover Effects of Social, Environment and Economy: Mapping Global Sustainable Development in A Systematic Analysis. *Asia-Pacific Journal of Regional Science*, *7*, 329-353.

Taghvaee, V. M., Nodehi, M., & Saboori, B. (2022b). Economic Complexity and CO2 Emissions in OECD Countries: Sector-Wise Environmental Kuznets Curve Hypothesis. *Environmental Science and Pollution Research, 29*(53), 80860–80870.

Taghvaee, V. M., Nodehi, M., Saber, R. M., & Mohebi, M. (2022c). Sustainable Development Goals And Transportation Modes: Analyzing Sustainability Pillars Of Environment, Health, And

Economy. *World Development Sustainability, 1*, 100-118.

Taghvaee, V. M., Arani, A. A., Soretz, S., & Agheli, L. (2023). Diesel Demand Elasticities and Sustainable Development Pillars of Economy, Environment and Social (Health): Comparing Two Strategies of Subsidy Removal and Energy Efficiency. *Environment, Development and Sustainability*, *25*(3), 2285–2315.

Tan, F., & Lu, Z. (2015). Study on the Interaction and Relation of Society, Economy and Environment Based on PCA-VAR Model: As A Case Study of the Bohai Rim Region, China. *Ecological Indicators*, *48*, 31–40.

Tremblay, D., Fortier, F., Boucher, J. F., Riffon, O., & Villeneuve, C. (2020). Sustainable Development Goal Interactions: An Analysis Based on The Five Pillars of The 2030 Agenda. *Sustainable Development*, *28*(6), 1584–1596.

Umar, M., Ji, X., Kirikkaleli, D., Shahbaz, M., & Zhou, X. (2020). Environmental Cost of Natural Resources Utilization and Economic Growth: Can China Shift Some Burden Through Globalization for Sustainable Development? *Sustainable Development*, *28*(6), 1678–1688.

Uyar, A., Kuzey, C., & Kilic, M. (2021). Testing the Spillover Effects of Sustainability Reporting: Evidence from the Public Sector. *International Journal of Public Administration*, *44*(3), 231–240.

Wang, F., & Taghvaee, V. M. (2023). Impact of Technology and Economic Complexity on Environmental Pollution and Economic Growth in Developing and Developed Countries: Using IPAT and STIRPAT Models. *Environmental Science and Pollution*

Research, *30*, 73349–73360.

Wang, C. C., & Wu, A. (2016). Geographical FDI Knowledge Spillover and Innovation of Indigenous Firms in China. *International Business Review*, *25*(4), 895–906.

WHO. (2018). WHO Webside. *World Health Organization (WHO)*, Retrieved from http://www.who.int/airpollution/en/

World Bank. (2021). World Development Indicator, Retrieved from https://databank.worldbank.org/source/world-development-indicators

World Bank and United Nations. (2018). A Joint Report by World Bank and United Nations, Retrieved from https://sustainabledevelopment.un.org/content/documents/17825HLPW_Outcome.pdf

Xu, Z., Li, Y., Chau, S. N., Dietz, T., Li, C., Wan, L., Zhang, J., Zhang, L., Li, Y., Chung, M. G., & Liu, J. (2020). Impacts of International Trade on Global Sustainable Development. *Nature Sustainability*, *3*, 964–971.

Youssef, A. Ben, Boubaker, S., & Omri, A. (2020). Financial Development and Macroeconomic Sustainability: Modeling Based on A Modified Environmental Kuznets Curve. *Climatic Change*, *163*(2), 767–785.