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Abstract

The paper investigates the relationship between carbon emissions, environmental provisions in Regional Trade Agreements (RTAs) and Global Value Chains (GVCs) using a panel data gravity model for the Middle East and North Africa (MENA) region over the period 1990-2015. We find that RTAs have a positive effect on carbon emissions. However, good institutional quality in MENA region decreases carbon footprint. Participation of MENA countries in GVCs rises environmental degradation in upstream Low-Tech Manufacturing (LTM) sectors and downstream High-Tech Manufacturing (HTM) and Primary sectors. Moreover, we examine the interaction effects between RTAs with environmental laws and participation of MENA countries in GVCs. Results confirm that participating in upstream activities in GVCs and signing more RTAs with environmental laws reduce pollution in LTM sectors. Furthermore, our study proves that RTAs (with or without environmental laws) could reduce carbon emissions in MENA region participating in backward GVCs. Backward participation is related to trade in LTM and primary sectors. Therefore, there is a need to understand the GVC landscape in MENA region to be able to set suitable RTAs with environmental provisions in order to reduce pollution and contribute to sustainable upgrading in GVCs.

Keywords: CO2 emissions, Global Value Chains, Environmental Provisions, Middle East and North Africa.
JEL Classification: F15, F18.

I. Introduction

The consequences of trade on environment have been one of the main public concerns in the last decades. Environmental effects of trade openness have been also widely explored in the literature. In their seminal work, Grossman and Krueger (1991) point out that reducing trade barriers introduces what is called scale, composition, and technique effects. Scale effect indicates that trade liberalization causes an expansion of economic activity which increases pollution as the output and energy consumption are higher. Composition effect is explained by improvements in economic efficiency. Trade liberalization makes countries shift their production towards products under the umbrella of their comparative advantage. In this case, pollution depends on the sectors in which a country has comparative advantage. Pollution increases in sectors with high energy consumption. Technique effect is explained by the fact that free trade enhances technologies and lowers the cost of environmentally-friendly goods. This leads to less pollution. Technique effect allows countries with no access to technological and environmentally-friendly goods and services to improve their energy efficiency. They study the environmental impact of the North American Free Trade Agreement (NAFTA) and show that the impact of trade liberalization on environment depends on not only the scale effect of the expansion of economic activity but also on the technologies used and the composition of economic activity by sector.

In addition, Ren et al. (2014) show that china's trade openness increases carbon emissions. They indicate that Foreign Direct Investment (FDI) inflows increase air pollution. Environmental repercussions of trade in developing countries is different from those in developed countries. In this respect, Managi et al. (2009) find that the effect of trade on environment varies depending on the country and the pollutant. They show that trade has a positive impact on the environment in Organization for Economic Co-operation and Development (OECD) countries.

Recently, the importance of Global Value Chains (GVCs) in trade activities lead some researchers to explore the impact of participation in GVCs on environmental degradation in developing countries (WDR, 2020). Several channels through which GVCs harm or benefit environment are identified. First, it appears from the work of Wang et al. (2019) which examine the effect of vertical specialization on carbon emissions that participation in GVCs benefits the country from competition and technique effects. Both effects make use of green technologies and eco-friendly products which benefit the environment and enhance its quality. However, growth or scale effect driven by early stage participation in GVCs increases per capita carbon emissions.

Second, international transport related to trade and to global production networks is linked to growing carbon emissions. Air pollution coming from international freight transport could increase by 160 percent by 2050 (OECD/ITF, 2017). Consequently, pollution coming from transport is higher in GVCs compared to standard trade as the product in global production networks crosses border many times before reaching its final destination. Third, migration of industries in countries with weak environmental protection is becoming a major concern in GVCs (WDR, 2020). Ben-David et al., (2020) shed light on the reasons behind the decision of firms to relocate in countries with lenient environmental regulations. Firms and multinationals operating in a wide range of countries relocate to avoid costly environmental requirements. They explain how carbon leakage transfers high polluting manufacturing activities to countries with less stringent environmental laws. Cole (2004) indicates that moving 'dirty' activities to countries with less stringent environmental regulations is known as 'pollution haven' hypothesis. He argues that stringent environmental regulations shift production in most polluting manufacturing sectors from developed to developing countries. Global Value Chains (GVCs) may lead to executing pollution-intensive tasks in countries where environmental policies are lenient. Carbon dioxide (CO2) emissions, as indication for air pollution, were shifted from developed countries to developing countries (Kanemoto et al., 2014). Ramzy and Zaki (2018) are among the few authors who explored the link between environmental regulation and exports for the MENA region. They use a gravity model approach to analyze the effect of environmental regulations on trade between European Union (EU) and MENA region. Results indicate that stringent environmental regulations positively impact agricultural exports. They conclude that provisions related to the environment could reduce pollution.

Recent studies question the role that could be played by environmental provisions in trade agreements in order to reduce these negative impacts (Martínez-Zarzoso, 2018; Martínez-zarzozo and Núňez-Rocha, 2018; Baghdadi et al., 2013). Martínez-Zarzoso (2018) empirically analyzes the effect of Environmental Provisions (EPs) in Regional Trade Agreements (RTAs) on pollution. The author proxied pollution using three indicators: concentrations of suspended particulate matter less than 2.5 microns (PM2.5), Sulphur dioxide (SO2) and nitrogen oxide (NOx). She finds that RTAs (with or without environmental provisions) have a positive relationship on environmental quality related to two pollutants (SO_2 and NO_x). Furthermore, Baghdadi et al. (2013) analyze the effect of environmental provisions on pollution levels of 182 countries over the period 1980 to 2008 using the gravity model. Their study estimates the impact of RTAs with environmental provisions on relative and absolute CO_2 emissions. Results indicate that countries belonging to the same RTA with environmental provisions have converged CO_2 emissions. Similarly, Zhou et al. (2017) use a panel data for 136 countries from 2001 to 2010 and show that RTAs without environmental provisions harm air quality. Whereas RTAs with environmental laws are linked to lower level of pollution. Contrary to Baghdadi et al. (2013) who use CO_2 emissions as dependent variable in the gravity equation, Zhou et al. (2017) use PM2.5 (fine particulate matter =< 2:5 μm in diameter) as a proxy for pollutants.

The impact of GVC participation on environment depending on the type of task or activity in value chain is still unclear. Some GVC activities are linked to forward participation and other to backward participation. It is not yet known whether joining global production networks in terms of forward participation and backward participation in specific sectors increases or decreases environmental degradation. Forward participation is often related to upstream activities (Balié et al. (2017)). Upstreamness is linked to early stage activities in the production process. However, backward participation consists of importing foreign value-added to be exported again. It describes the extent of involvement in downstream activities. The product crosses border two times and may engender higher transport costs compared to upstream activities. Moreover, a country is downstream in the production process when it executes post-fabrication tasks such as customer service (Cheng et al. ,2013).

This paper contributes to understanding to which extent integration in GVCs and signing RTAs with provisions related to the environment could affect pollution in the Middle East and North Africa (MENA) region during 1990-2015. We focus on carbon emissions as a measure of environmental quality. Furthermore, we try to explore the impact of forward and backward linkages on pollution taking into consideration participation by sector in GVCs focusing on the MENA region. We hypothesize that forward participation and backward participation in GVCs impact differently pollution depending on whether the type of GVC sector is high polluting sector or low polluting sector. We use the gravity model to study the effects of RTAs with environmental provisions and GVC participation on CO_2.

Overall, our results show that good governance of institutions in the MENA region decreases carbon footprint. We find that RTAs increase carbon emissions. This study proves that RTAs with environmental provisions could reduce carbon emissions in MENA region in upstream Low-Tech Manufacturing (LTM) sectors and in downstream LTM and Primary sectors. Therefore, there is a need for MENA countries to set more stringent environmental standards related to those sectors. The environment suffers deterioration when countries engage to upstream Low-Tech Manufacturing (LTM) sectors and downstream High-Tech Manufacturing (HTM) and Primary sectors. We analyze the impact of RTAs with and without environmental provisions on carbon emissions using the gravity model. This study contributes to the literature in several ways. First, we focus the analysis of trade–environment relation to the MENA region which has received relatively little attention. Second, we enrich the literature on MENA by examining the effect of the level of integration into GVCs on pollution taking into account forward linkages and backward linkages at sectoral levels. The organization of the paper is as follows. Section 1 introduces the paper. Section 2 reviews related studies on environmental provisions and on GVCs participation and pollution. Data and model specification are followed in section 3. Then, section 4 details the empirical results. Finally, section 5 summarizes the main findings and provides concluding remarks.

II. Methodology

1. Data

Data are available for 20 MENA countries originating pollution for the period from 1990 to 2015. Countries considered in the empirical analysis are listed in table A.3 in the Appendix. We provide an overview of all used variables as well as some descriptive statistics in table A.1 in Appendix. This study makes use of data extracted from Eora Global Supply Chain Database. The Eora global supply chain database allows using global input–output tables to measure the extent to which production is globalized. Carbon emissions are taken from Eora Global Supply Chain Database for carbon footprints. CO2 emissions are a proxy of air quality. They report flows of embodied CO2 from each origin/emitter country to each destination/consumer country. Units are Gg CO2 (1 gigagram (Gg) = 1 kiloton (Kt)). CO2 accounts for emissions associated with imported and exported goods.

GVC trade is measured using country global input–output tables to account for value-added flows. Recently, more attention is paid to trade flows which are measured in value-added terms (Balié et al., 2017). The level of integration in GVCs is measured by the participation index which encompasses forward and backward linkages. Forward participation constitutes domestic production exported to a third country which will be export it again. However, Backward participation is the share of foreign inputs. The Participation index is the sum of forward participation index and backward participation index and is expressed as a percentage of gross exports. In other words, backward GVC participation is defined as exports of value-added already imported. It means, the production process includes intermediates from abroad. Forward GVC participation is defined as exports of value-added which will be embodied in the importer exports to a third party. In this case, value-added flows cross at least two borders in GVC trade (WDR, 2020).

The GVC participation index is defined as follows:

GVC participation index = Forward GVC participation index + Backward participation index

$$\text{Where, Forward GVC participation index} = \frac{\text{Indirect value added (DVX)}}{\text{Gross exports}} \times 100$$

And,

$$\text{Backward participation index} = \frac{\text{Foreign Value Added (FVA)}}{\text{Gross exports}} \times 100$$

Furthermore, forward and backward GVC participation indexes are calculated from UNCTAD-Eora Global Value Chain Database. Casella et al. (2019) give more details about the methodology applied to construct value-added data which we used in this study to calculate GVC indexes. Sectoral classification of GVC participation indexes are according to Foster-Mcgregor et al., (2015). Twenty-five sectors of Eora are classified into: Primary, Low-Tech Manufacturing, High-

Tech Manufacturing, Low-Tech Services, High-Tech Services. As the contribution of services to pollution is low, we only include manufacturing and primary trade in this analysis.

We use bilateral data of preferential trade agreements (PTAs) from Hofmann et al. (2017) to account for agreements with and without environmental regulations. This database includes all RTAs notified to the World Trade Organization (WTO) until the year 2015. This data maps 52 provisions in PTAs, including environmental ones, notified at WTO signed between 1958 and 2015.

We use Government Effectiveness indicator following Nunez-Rocha and Martínez-Zarzoso (2018) to account for institutional quality. Government Effectiveness explains “the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies” as defined by the World Bank (WB). Government Effectiveness data are taken from WB Worldwide Governance Indicators. Ibrahim and Law (2016) assess the impact of the interaction between quality of institution and trade carbon emissions of 40 Sub-Sahara African (SSA) countries. They find that governmental reforms related to institutions improve environmental quality. Thus, we investigate if the quality of institutions, proxied by Government Effectiveness indicator, increases or decreases pollution.

Other variables used in the gravity estimations are mentioned in what follows. Weighted distances, dummy variables for common language, colony, contiguity are from CEPII database. Gross domestic product of origin and destination countries are from World Development Indicators Database (WDID) of the World Bank (see table A.1 in Appendix for all data description).

2. Model

This study investigates the effect of sectoral forward and backward GVC participation of MENA countries on carbon emissions. Giving the importance of environmental quality and sustainability concerns, we aim to dig into the impact of environmental provisions of deep PTAs on pollution.

We use the gravity model to assess the effect of participation in GVCs and RTAs with and without environmental provisions on CO_2 emissions in the region. A number of empirical studies have used the gravity model to assess the impact of RTAs and environmental provisions on CO_2 emissions (Yao et al., 2019; Baghdadi et al., 2013). Similarly, Duarte et al., (2019) use the gravity model to explain the effect of economic, geographical and environmental factors on the flow of virtual water exports.

Our empirical study implements the gravity model where the dependent variable is bilateral carbon emissions. The rationale behind applying this methodology is to understand the implications of environmental measures as well as participation in GVCs on pollution. It is crucial to assess global production networks' effect on sustainability in terms of ecological environment. Therefore, let CO2 symbolize the pollution in terms of carbon dioxide emissions content of exports from country "o" to country "d" at year "t". "o" is the exporter of pollution and it belongs to MENA region.

The log-linearized estimated equation is as follows:

$$
\begin{aligned}
\ln CO2_{odt} = {} & \phi_{od} + \vartheta_t + X_{odt} + \alpha_9 \text{Government Effectiveness}_{ot} \\
& + \alpha_{10} \text{Government Effectiveness}_{dt} \\
& + \alpha_{11} (\text{RTA\_noenvlaws}_{odt} \times \text{Government Effectiveness}_{ot}) \\
& + \alpha_{12} (\text{RTA\_noenvlaws}_{odt} \times \text{Government Effectiveness}_{dt}) \\
& + \alpha_{13} (\text{RTA\_envlaws}_{odt} \times \text{Government Effectiveness}_{ot}) \\
& + \alpha_{14} (\text{RTA\_envlaws}_{odt} \times \text{Government Effectiveness}_{dt}) + \alpha_{15} \text{GVC\_HTM}_{ot} \\
& + \alpha_{16} \text{GVC\_LTM}_{ot} + \alpha_{17} \text{GVC\_P}_{ot} + \alpha_{18} (\text{RTA\_noenvlaws}_{odt} \times \text{GVC\_HTM}_{ot}) \\
& + \alpha_{19} (\text{RTA\_noenvlaws}_{odt} \times \text{GVC\_LTM}_{ot}) \\
& + \alpha_{20} (\text{RTA\_noenvlaws}_{odt} \times \text{GVC\_P}_{ot}) + \alpha_{21} (\text{RTA\_envlaws}_{odt} \times \text{GVC\_HTM}_{ot}) \\
& + \alpha_{22} (\text{RTA\_envlaws}_{odt} \times \text{GVC\_LTM}_{ot}) + \alpha_{23} (\text{RTA\_envlaws}_{odt} \times \text{GVC\_P}_{ot}) \\
& + \varepsilon_{odt}
\end{aligned}
$$

Where,

$$
\begin{aligned}
X_{odt} = {} & \alpha_1 \ln \text{gdp}_{ot} + \alpha_2 \ln \text{gdp}_{dt} + \alpha_3 \ln \text{distance}_{od} + \alpha_4 \text{contiguity}_{od} + \alpha_5 \text{language}_{od} + \alpha_6 \text{colony}_{od} \\
& + \alpha_7 \text{RTA}_{odt} + \alpha_8 \text{RTA\_envlaws}_{odt}
\end{aligned}
$$

X_{odt} contains the common gravity variables. The variables of ln $distance_{od}$, ln gdp_{ot} and ln gdp_{dt} are the log of the weighted distance, log of origin GDP and log of destination GDP respectively. Contiguity_{od} is a dummy variable which takes the value of 1 if the two countries share a common border and 0 otherwise; language_{od} takes a value of 1 if the two countries share a common language; colony_{od} denotes if pair countries were ever in colonial relationship.

$\text{RTA\_noenvlaws}_{odt}$ is a dummy variable. It is equal to one for regional trade agreement which does not include environmental provisions between countries of origin and destination at year t. It indicates that all PTAs signed between countries do not have environmental laws. RTA_envlaws_{odt} denotes if there is at least one RTA with environmental provision mentioned in the agreement. Furthermore, GVC_HTM_{ot} indicates the forward participation index and backward participation index in High-Tech Manufacturing (HTM) sectors, GVC_LTM_{ot}denotes the forward participation index and backward participation index in Low-Tech Manufacturing (HTM) sectors. Last but not least, GVC_P_{ot} expresses the forward participation index and backward participation index in Primary sectors.

The interaction term between RTAs and the GVC participation index for origin countries in the primary sectors is given by ($\text{RTA}_{odt} \times \text{GVC\_P}_{ot}$). The interaction term between RTAs with environmental provisions and the GVC participation index for origin countries in HTM sectors is given by ($\text{RTA\_envlaws}_{odt} \times \text{GVC\_HTM}_{ot}$). Similarly, we have applied other sort of interaction terms in the previous equation with already defined variables. Moreover, ϕ_{od} and $\vartheta_t$denote country-pair (origin and destination) and year fixed effects respectively. Finally, ε_{odt} is the error term.

Theoretical approaches to estimate the gravity model give recommendations which solve the unbiased estimates of bilateral trade cost. We apply a Fixed effects (FE) estimation to the precedent gravity model. This paper includes country-pair fixed effects (FE) and time fixed effects (FE) to control for endogeneity biases. We replace multilateral resistance terms with origin and destination dummies (Anderson and Van Wincoop, 2004) to control for country-pair effects. Moreover, we estimate the model using Ordinary Least Square (OLS) for robustness check.

III. Results

There is a considerable interest in the efficiency of Environmental Provisions (EPs) included in Regional Trade Agreements (RTAs) to resolve environmental concerns such as pollution at the country level (Martínez-Zarzoso, 2018; Ramzy and Zaki, 2018; Martínez-zarzozo and Núňez-Rocha, 2018; Jug and Mirza, 2005; Núñez-Rocha and Martínez-Zarzoso, 2018) and at the firm level (Ben-David et al., 2018; Baboukardos, 2018). Therefore, we study the impact of RTAs (with and without EPs) on pollution when GVCs are important.

Table 1 shows the empirical findings of the baseline equation estimated using Ordinary Least Squares (OLS) in column 1 and 2 and Fixed Effects (FE) in column 3 and 4. It shows the impact of RTAs (with and without environmental laws) as well as the quality of institutions (proxied by government effectiveness) on carbon emissions. Regressions of CO2 from origin MENA countries to the world are presented in table 1. Flows of embodied CO2 are from each origin/emitter country to each destination/consumer country. Results are obtained for the gravity model. Estimations include CO2 emissions as dependent variable estimated in natural logarithm. Column 1 and 2 includes the gravity bilateral variables (distance, contiguity, language and colony). They are dropped when doing estimation with FE. Distance coefficient is significant and negative as expected. This means that distance between countries contribute to low pollution rate. Contiguity, language and colony coefficients are significant and positive. Furthermore, the log of gdp of origin and destination countries has the expected sign and significance levels. This indicates that high economic growth in origin and destination countries increases pollution.

Table 1 illustrates the effect of the quality of institutions, proxied by government effectiveness, on carbon emissions. Results show that government effectiveness decreases pollution in MENA (emitter of CO2) and increases pollution to destination countries (consumer of CO2). In other words, environmental quality is ensured when the country which originates CO2 has good quality of institutions. Good quality of institutions in the country receiving CO2 increases pollution originated elsewhere.

For MENA origin of carbon emissions, coefficients of RTAs with and without environmental provisions are positive in both estimation methods (column 1, 3 and 4) and significant (column 1 and 4). This indicates that signing more agreements increases air pollution. This supports previous findings of Martínez-Zarzoso (2018). She implements three indicators of pollutants as dependent variables. She shows that there is a positive and significant impact of RTAs both with and without environmental provisions on environmental quality for two out of three pollutants which are SO2 and NOx, but not for PM2.5. In FE estimation, coefficients of the interaction terms between RTAs, with and without environmental laws and Government Effectiveness in MENA, are insignificant. Thus, signing more RTAs between MENA countries and other destination countries does not guarantee environmental quality even when institutional quality is ensured. This may be explained by the fact that low income countries suffer from pollution even after signing more FTAs due to lenient environmental standards (Yao et al., 2019).

Table 1: RTAs, environmental provisions and Carbon emissions

VARIABLES	(1) OLS	(2) OLS	(3) FE	(4) FE
Ln gdp_o	0.676*** (0.00380)	0.682*** (0.00381)	0.0951*** (0.0112)	0.0936*** (0.0112)
Ln gdp_d	0.682*** (0.00318)	0.688*** (0.00319)	0.496*** (0.0121)	0.495*** (0.0120)
Ln distance	-0.419*** (0.00924)	-0.421*** (0.00881)		
Contiguity	0.913*** (0.0661)	0.984*** (0.0628)		
Language	0.135*** (0.0164)	0.257*** (0.0173)		
Colony	0.716*** (0.0997)	0.688*** (0.0964)		
RTA_envlaws	0.425*** (0.0659)		0.0754 (0.0569)	
RTA_noenvlaws		-1.413*** (0.0985)		0.121** (0.0593)

Government Effectiveness _o	-0.00435***	-0.00578***	-0.00157***	-0.00160***
	(0.000247)	(0.000241)	(0.000346)	(0.000345)
Government Effectiveness _d	0.0121***	0.0109***	0.00120***	0.00127***
	(0.000239)	(0.000225)	(0.000375)	(0.000376)
RTA_envlaws × Government Effectiveness _o	-0.0102***		5.03e-05	
	(0.000842)		(0.000542)	
RTA_envlaws × Government Effectiveness _d	0.000615		-0.00114	
	(0.000845)		(0.000703)	
RTA_noenvlaws × Government Effectiveness _o		0.00989***		-0.000313
		(0.00111)		(0.000663)
RTA_noenvlaws × Government Effectiveness _d		0.0125***		-0.00223***
		(0.00118)		(0.000610)
Constant	-28.23***	-28.39***	-12.64***	-12.59***
	(0.140)	(0.138)	(0.379)	(0.378)
Observations	52,818	52,818	52,818	52,818
R-squared	0.716	0.718	0.728	0.728
Number of id			3,319	3,319
Country pair FE	NO	NO	YES	YES
Year FE	NO	NO	YES	YES

Note: (1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1

Table 2 introduces different independent variables indicating forward participation of origin MENA countries classified into 3 main categories: Hight-Tech Manufacturing (HTM), Low-Tech Manufacturing (LTM) and Primary sectors. Table 2 presents the effect of forward GVC participation of origin MENA countries and RTAs with EPs on pollution. We include results of the interaction terms between RTAs (with and without EPs) and forward GVC participation indexes classified as in table A.2 in Appendix. The basic gravity variables yield the expected results. Interpretation of the coefficients of gravity variables are the same as in table 1.

Table 2 illustrates how RTA_noenvlaws and RTA_envlaws coefficients have a negative sign. Moreover, signing more RTAs with EPs has negative and significant effect on carbon emissions originated by MENA countries. This is in line with the findings of Baghdadi et al. (2013). They argue that countries belonging to the same RTA with environmental laws have converged CO2 emissions.

Forward indicates forward participation of origin of carbon emissions ‘countries in GVCs. Estimating with FE, forward GVC participation index is not significant for Hight-Tech Manufacturing (HTM) sectors. Forward participation in Low-Tech Manufacturing (LTM) sectors increases air pollution. High Upstreamness levels in Primary sectors (agriculture, fishing, mining and quarrying) are associated with low pollution rate. Thus, upstream tasks in GVCs do not contribute to environmental deterioration except for LTM sectors. LTM sectors include food and beverages, textiles and wearing apparel, wood and paper, metal products and recycling. Textiles and wearing apparel are known as high polluting sectors. Developing countries execute tasks in high-polluting industries (Ben-David et al., 2018). This may be explained by the fact that multinational firms headquartered in developing countries perform their polluting activities in countries with relatively weak environmental laws.

Signing more PTAs with and without EPs does not contribute to environmental quality when MENA countries are engaged in forward linkages in sectors of HTM and primary sectors. This is explained by the weak role those sectors play as polluting industries. However, participation in forward linkages in LTM industries with the presence of environmental laws has a negative and significant impact on pollution. Therefore, forward GVC participation in LTM sectors and presence of RTAs with environmental laws decreases carbon emissions.

Table 2: CO2 emissions and forward GVC participation

	(1)	(2)	(3)	(4)
VARIABLES	OLS	OLS	FE	FE
Ln distance	-0.419***	-0.416***		
	(0.00751)	(0.00772)		
Ln gdp_o	0.587***	0.584***	0.139***	0.140***
	(0.00329)	(0.00331)	(0.0111)	(0.0111)

Ln gdp_d	0.724***	0.724***	0.473***	0.473***
	(0.00239)	(0.00238)	(0.0125)	(0.0125)
Contiguity	0.870***	0.822***		
	(0.0536)	(0.0545)		
Language	0.108***	0.0472***		
	(0.0145)	(0.0141)		
Colony	0.855***	0.884***		
	(0.0842)	(0.0839)		
Forward_HTM_o	-0.0162***	-0.0177***	0.000512	-0.000741
	(0.000609)	(0.000626)	(0.00179)	(0.00180)
Forward_LTM_o	0.00428***	0.00513***	0.00362**	0.00445**
	(0.000342)	(0.000361)	(0.00172)	(0.00176)
Forward_P_o	0.0174***	0.0163***	-0.00310***	-0.00309***
	(0.000548)	(0.000560)	(0.000779)	(0.000771)
RTA_noenvlaws	-0.0704		-0.0530	
	(0.0555)		(0.0404)	
RTA_envlaws		-0.529***		-0.0583**
		(0.0370)		(0.0291)
RTA_noenvlaws ×Forward_HTM_o	0.0132***		-0.00109	
	(0.00415)		(0.00231)	
RTA_noenvlaws ×Forward_LTM_o	-0.0291***		-0.00125	
	(0.00226)		(0.00145)	
RTA_noenvlaws ×Forward_P_o	0.00618*		0.00322*	
	(0.00374)		(0.00188)	
RTA_envlaws ×Forward_HTM_o		0.0133***		0.00876***
		(0.00241)		(0.00162)
RTA_envlaws ×Forward_LTM_o		-0.0103***		-0.00269***
		(0.000941)		(0.000740)
RTA_envlaws × Forward_P_o		0.0142***		-0.00229
		(0.00219)		(0.00142)
Constant	-26.68***	-26.57***	-13.14***	-13.15***
	(0.114)	(0.114)	(0.388)	(0.389)

Observations	80,814	80,814	80,814	80,814
R-squared	0.691	0.692	0.657	0.657
Number of id			3,320	3,320
Country pair FE	NO	NO	YES	YES
Year FE	NO	NO	YES	YES

Note: (1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1

In table 3, the gravity variables (GDP, distance, contiguity, common language and colony) hold the same coefficients as previously showed in table 2 with slight changes in coefficients. Using bilateral flows of carbon emissions from origin MENA country to country of destination, we examine the environmental effect of the interaction between RTAs with environmental provisions and backward GVC participation index related to the country of origin (MENA). The third and fourth columns (Table 3) show results of the impact of RTAs (with EPs and without EPs) on CO2. RTAs without environmental regulations increase carbon dioxide flows. However, for RTAs with EPs, the coefficient is negative and insignificant.

Backward indicates backward participation in global production networks. Backward GVC participation index, linked to country of origin (MENA) and country of destination, is significant and positive. This indicates that engaging in backward linkages rises pollution. Exporting foreign value added (downstream activities) increases CO2 emissions. Participation of MENA countries in backward GVCs is linked to its environmental degradation proxied by carbon emissions.

Backward linkages in HTM and P industries are positively related to pollution. However, backward GVC participation in LTM sectors is negatively related to CO2. This means that MENA produces carbon dioxide when it imports value-added to be exported again in sectors of HTM (petroleum, chemical and non-Metallic mineral products, electrical and machinery and transport equipment) and sectors of P (agriculture, fishing, mining and quarrying).

As shown in columns 2 and 4 of Table 3, the interaction term between RTAs with environmental laws and backward participation in GVCs is negative and significant for LTM and P industries. Results are the same when RTAs do not include EPs. Signing RTAs decreases carbon emission in

LTM and primary sectors. However, the coefficients of the interaction terms between RTAs (with and without environmental laws) and backward participation of MENA countries in GVC in HTM sectors (column3 and column4) are positive and significant. This indicates that RTAs do not have an effect on pollution in HTM sectors in GVCs.

Table 3: CO2 emissions and backward GVC participation

	(1)	(2)	(3)	(4)
VARIABLES	OLS	OLS	FE	FE
Ln distance	-0.407***	-0.400***		
	(0.00740)	(0.00759)		
Ln gdp_o	0.491***	0.484***	0.186***	0.188***
	(0.00402)	(0.00405)	(0.0106)	(0.0106)
Ln gdp_d	0.739***	0.738***	0.473***	0.473***
	(0.00235)	(0.00233)	(0.0122)	(0.0122)
Contiguity	0.853***	0.735***		
	(0.0542)	(0.0553)		
Language	0.147***	0.0689***		
	(0.0142)	(0.0139)		
Colony	0.808***	0.854***		
	(0.0803)	(0.0799)		
Backward_HTM_o	0.0132***	0.00620***	0.0150***	0.0148***
	(0.000941)	(0.000963)	(0.00130)	(0.00132)
Backward_LTM_o	-0.0304***	-0.0261***	-0.0171***	-0.0169***
	(0.000766)	(0.000783)	(0.00136)	(0.00137)
Backward_P_o	0.0209***	0.0238***	0.00892***	0.00885***
	(0.000659)	(0.000673)	(0.000550)	(0.000546)
RTA_noenvlaws	-0.264***		0.0930**	

	(0.0522)		(0.0408)	
RTA_envlaws		-0.527***		-0.00844
		(0.0334)		(0.0239)
RTA_noenvlaws × Backward_HTM_o	-0.0865***		0.00564**	
	(0.00509)		(0.00282)	
RTA_noenvlaws × Backward_LTM_o	0.0778***		-0.00508**	
	(0.00431)		(0.00234)	
RTA_noenvlaws × Backward_P_o	0.0296***		-0.00894***	
	(0.00433)		(0.00170)	
RTA_envlaws × Backward_HTM_o		0.0883***		0.00856***
		(0.00457)		(0.00214)
RTA_envlaws × Backward_LTM_o		-0.0475***		-0.00468***
		(0.00319)		(0.00156)
RTA_envlaws × Backward_P_o		-0.0370***		-0.00656***
		(0.00330)		(0.00181)
Constant	-24.54***	-24.37***	-14.34***	-14.38***
	(0.125)	(0.125)	(0.379)	(0.382)
Observations	80,814	80,814	80,814	80,814
R-squared	0.705	0.705	0.667	0.667
Number of id			3,320	3,320
Country pair FE	NO	NO	YES	YES
Year FE	NO	NO	YES	YES

Note: (1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1

To conclude, environmental laws in RTAs signed by MENA countries reduce environmental degradation caused by its upstream tasks in LTM sectors and downstream business activities in LTM and P industries. Forward GVC participation in LTM sectors deteriorates the environment. However, backward trade linkages of MENA countries in LTM sectors do not harm the environment.

IV. Conclusion

The relationship between trade and environmental degradation is seen as a major concern both in research and public debates. They question the impact of trade on the environment as well as the impact of environmental policies on trade (WTO, 2004). Despite the numerous studies on trade environment nexus, the relationship between the environmental consequence of participation in GVCs is less explored. To fill this gap, this paper examines the impact of integration on global production networks on CO2 emissions when MENA countries are signing more RTAs with environmental provisions. This study links GVC participation in terms of backward linkages and forward linkages, environmental laws in RTAs and carbon footprint. We adopt a gravity model approach estimated using fixed effects for the period 1990 to 2015.

We find that government effectiveness, a proxy for institutional quality, reduces carbon emissions originated in MENA region. Thus, our results support the findings of Ibrahim and Law (2016). They analyze the impact of trade and institutional quality on pollution in Sub-Sahara Africa (SSA). They show that high levels of institutional quality make trade openness beneficial to the environment. Interestingly, signing more RTAs does not reduce CO2 emissions emitted by MENA region. Particularly, EPs in MENA does not directly contribute to environmental quality even when institutional quality is ensured. This indicates that good quality of institutions in MENA only reduces air pollution.

Moreover, this study analyzes the effects of GVC in terms of forward participation and backward participation on carbon emissions in MENA countries. Overall, we find that the participation of MENA countries in global production networks harms environmental quality proxied by carbon footprint. The impact of GVC participation on environmental quality varies depending on backward or forward engagement in GVCs in specific sectors. Furthermore, the effect of including more environmental standards in RTAs has a different impact on CO2 if the MENA country is operating in backward or forward tasks.

We find that the environment suffers deterioration when MENA countries participate in forward GVCs in Low-Tech Manufacturing sectors. It means that forward activities related to food and beverages, textiles and wearing apparel, wood and paper, metal products increase air pollution. Moreover, we find that EPs decrease the harmful impact of engaging in forward linkages (upstream tasks related to exporting indirect value added in LTM sectors) on environmental quality.

Furthermore, signing more trade agreements (with and without environmental laws) reduces carbon footprint when the region executes downstream production activities in LTM and Primary sectors. Thus, backward GVC participation in the presence of RTAs increases environmental quality in MENA countries.

Nowadays, companies all over the world start redefining their business models to overcome environmental challenges and reach sustainable goals (WTO, 2018). Drake-Brockman (2018) emphasizes on the importance of sustainable GVC-linked investments where low-carbon opportunities are identified. He says that greening GVCs could improve environmental quality with more sustainable goods and services.

To conclude, this study helps identify to which extent negotiating environmental policies in the MENA region is important for a green sustainability. Thus, environmental provisions in MENA countries decrease the negative effect of GVC participation on environmental quality in primary sectors and sectors of LTM. However, the impact of pollution is global. Consuming important quantities of CO2 or emitting important quantities of CO2, in both ways, deteriorate the environment. Thus, serious coordination between countries in terms of respecting and implementing environmental laws in investments and business activities is crucial for better and sustainable environment.

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APPENDIX

Table A.1: Data description

Variable	Description	Observation	Mean	Min	Max	Source
Ln CO2	Log of embodied flow_Gg CO2	86654	1.524	-5.383	10.238	Eora Global Supply Chain Database
Ln gdp_o	Log of origin GDP (current US$)	83166	24.231	19.93	27.348	WDID: World Development Indicators, World Bank
Ln gdp_d	Log of destination GDP (current US$)	84582	23.847	17.578	30.523	
Distance	Log of weighted distance	86840	8.452	.744	4.742	CEPII
Contiguity	1=Contiguity	86840	.02	.141	0	
Language	1=Common official or primary language	86840	.17	.376	0	
Colony	1=Pair ever in colonial relation	86840	.007	.086	0	
RTA_noenvlaws	=1 if regional trade agreement (no environmental provisions)	86840	.101	0	1	Dataset on the content of preferential trade agreements (PTAs)
RTA_envlaws	=1 if there is at least one RTA with environmental	86840	.046	0	1	

	provision mentioned in the agreement					(Hofmann et al., 2017)
Government Effectiveness-o	Percentile Rank of origin	56780	48.065	.51	91.346	Worldwide Governance Indicators (WGI) World Bank
Government Effectiveness -d	Percentile Rank of destination	56740	50.58	0	100	
Forward_HTM_o	Forward participation index in High-Tech Manufacturing	86840	22.301	0	55.102	UNCTAD-Eora Global Value Chain Database
Forward_LTM_o	Forward participation index in Low-Tech Manufacturing	86840	23.269	0	73.332	
Forward_P_o	Forward participation index in Primary sectors	86840	28.873	0	67.237	
Backward_HTM_o	Backward participation index in High-Tech Manufacturing	86840	22.364	0	72.466	
Backward_LTM_o	Backward participation index in Low-Tech Manufacturing	86840	20.067	0	85.797	
Backward_P_o	Backward participation index in Primary sectors	86840	13.598	0	54.593	

Table A.2: Sector description

Classification	Sectors (26 sectors)
Primary sectors	Agriculture Fishing Mining and Quarrying
Low-Tech Manufacturing	Food & Beverages Textiles and Wearing Apparel Wood and Paper Metal Products Other Manufacturing Recycling
High-Tech Manufacturing	Petroleum, Chemical and Non-Metallic Mineral Products Electrical and Machinery Transport Equipment
Low-Tech Services	Electricity, Gas and Water Construction Maintenance and Repair Wholesale Trade Retail Trade Hotels and Restaurants Transport Private Households Others
High-Tech Services	Post and Telecommunications Financial Intermediation and Business Activities

	Public Administration Education, Health and Other Services

Classification of sectors according to foster (2015)

Table A.3: Countries list

<u>Countries (MENA)</u>					
UAE Bahrain Djibouti Algeria Egypt	Iran Iraq Israel Jordan Kuwait	Lebanon Libya Morocco Malta Oman	Qatar Saudi Arabia Syria Tunisia Yemen		
<u>Countries (World)</u>					
Afghanistan Angola Albania Andorra Argentina Armenia Antigua Australia	Switzerland Chile China Cote dIvoire Cameroon Congo Colombia Cape Verde	Georgia Ghana Guinea Gambia Greece Guatemala Guyana Hong Kong	Lebanon Liberia Libya Sri Lanka Lesotho Lithuania Luxembourg Latvia	Pakistan Panama Peru Philippines Papua New Guinea Poland Portugal	Seychelles Syria Chad Togo Thailand Tajikistan Turkmenistan Trinidad and Tobago

Austria	Costa Rica	Honduras	Macao SAR	Paraguay	Tunisia
Azerbaijan	Cuba	Croatia	Morocco	Qatar	Turkey
Burundi	Cyprus	Haiti	Moldova	Russia	Taiwan
Belgium	Czech Republic	Hungary	Madagascar	Rwanda	Tanzania
Benin	Germany	Indonesia	Maldives	Saudi Arabia	Uganda
Burkina Faso	Djibouti	India	Mexico	South Sudan	Ukraine
Bangladesh	Denmark	Ireland	Mali	Senegal	Uruguay
Bulgaria	Dominican Republic	Iran	Malta	Singapore	USA
Bahrain	Algeria	Iraq	Mongolia	Sierra Leone	Uzbekistan
Bahamas	Ecuador	Iceland	Mozambique	El Salvador	Venezuela
Bosnia and Herzegovina	Egypt	Israel	Mauritania	Somalia	Viet Nam
Belarus	Eritrea	Italy	Mauritius	Sao Tome and Principe	Vanuatu
Belize	Spain	Jamaica	Malawi	Suriname	Samoa
Bolivia	Estonia	Jordan	Malaysia	Slovakia	Yemen
Brazil	Ethiopia	Japan	Namibia	Slovenia	South Africa
Barbados	Finland	Kazakhstan	Niger	Sweden	Zambia
Brunei	Fiji	Kenya	Nigeria	Swaziland	Zimbabwe
Bhutan	France	Kyrgyzstan	Nicaragua		UAE
Botswana	Gabon	Cambodia	Netherlands		
Central African Republic	UK	North Korea	Norway		
Canada		Kuwait	Nepal		
		Laos	New Zealand		
			Oman		