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# CO2 Emissions, Environmental Provisions and Global Value Chains: The Middle East and North Africa in a Global Context

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# CO2 Emissions, Environmental Provisions and Global Value Chains: The Middle East and North Africa in a Global Context

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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 with legally enforceable environmental provisions reduce carbon emissions. However, the impact of RTAs with no enforceable and without environmental provisions on pollution is insignificant. Participation of MENA countries in backward GVCs rises environmental degradation. Moreover, we examine the interaction effects between the number of 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 when those Environmental Provisions (EPs) are legally enforceable. From backward GVC perspective, our study proves that RTAs with environmental laws (enforceable and not enforceable) could reduce carbon emissions in MENA region. Therefore, there is a need to enforce and increase the number of environmental provisions in MENA in order to reduce pollution and contribute to sustainable upgrading in GVCs.

**JEL Classification:** F15, F18.

**Keywords:**

CO2 emissions, Global Value Chains, Environmental Provisions, panel data, gravity model, Middle East and North Africa.

# i. Introduction

The relationship between trade and environmental degradation is seen as a major research question. It consists of the impact of trade on the environment, as well as the impact of environmental policies on trade (WTO, 2004). In trade policy, environmental consequences of economic development and trade openness have been widely explored (Managi et al., 2009). Hence, trade causes harmful impacts on the environment. International transport related to moving the good from origin to destination is linked to growing carbon emissions. Therefore, international trade requires suitable environmental regulations to contribute to environmental sustainability (WTO, 2018).

After 1970, there has been growing interest in studying the impact of international trade on environmental quality (WTO, 2004). For instance, Ibrahim and Law (2016) analyze the impact of trade and institutional quality on pollution in Sub-Sahara Africa (SSA). They show that the level of institutional quality decides whether trade openness is harmful or beneficial to the environment. Trade openness in countries with high institutional reforms brings more economic development and better environment. Moreover, Ren et al. (2014) show that china's trade openness increases carbon emissions. Additionally, 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. Pao and Tsai (2011) study the impact of FDI and economic growth on environmental degradation. They argue that developing countries should increase environmental protection or be careful in attracting which FDI in order to avoid environmental damage. Although developing countries are reaping benefits from international trade, there are many environmental issues such as air pollution, overfishing and land degradation (WTO, 2018). Carbon dioxide (CO2) emissions, as indication for air pollution, were shifted from developed countries to developing countries (Kanemoto et al., 2014). This is explained by the fact that countries differently implement and enforce environmental laws. Multinationals, where their headquarters are in countries with strict environmental policies, launch their activities in countries with poor environmental laws (Ben-David et al., 2018). Similarly, Managi et al. (2009) find that the effect of trade on the environment varies depending on the country and the pollutant. They declare that trade has a positive impact on the environment in Organization for Economic Co-operation and Development (OECD) countries.

Fragmentation of production across countries leads to expansion in international trade especially after 1990. Today, the product crosses border many times before reaching its final destination. In the era of Global Value Chains (GVCs), the cost to transport a good to its destination rises leading to an increase in carbon emissions. The environmental costs of participation in GVCs due to product shipment from a country to another are higher compared to standard trade (WB, 2019). Air pollution coming from international freight transport could increase by 160 percent by 2050 (ITF, 2017). Therefore, tracing carbon footprint resulting from production and transporting is justified. The aim of this is to identify products by their carbon footprint to deal better with environmental issues (WTO, 2018).

Due to the rise of Global Value Chains (GVCs), it is important to examine the impact of trade on environmental degradation in developing countries (WB, 2019). For instance, Wang et al., (2019) examine the effect of vertical specialization on carbon emissions. They find that participation in GVCs has a U-shaped relationship with per capita carbon emissions. It means that the participation index of GVCs (sum of forward participation index and backward participation index) is positively correlated with CO2 emissions. However, GVC participation index in square is negatively correlated with per capita Carbon dioxide.

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.

Through the prevalence of global production networks, the number of Preferential Trade Agreements (PTAs) signed between countries increases. According to Berger et al. (2016), the expansion of GVCs goes hand in hand with the proliferation of deep Preferential Trade Agreements (PTAs). In this respect, Osnago et al. (2017) show that deep trade agreements increase GVC trade. In their study, Yao et al. (2019) study the impact of trade on environmental quality in the presence of trade agreements. They indicate that Free Trade Agreements (FTAs) play a fundamental role in GVCs, but they are changing envirnmental aspects as well. They apply the gravity model to examine the impact of FTAs on bilateral CO2 emissions. They find that FTA agreements positivaly affect pollution.

Recently, the focus is not only on the number of trade agreements but also on the included provisions. Provisions related to environmental laws allow analyzing their impact on pollution. 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 international trade 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). For instance, Martínez-Zarzoso (2018) empirically analyzes the effect of Environmental Provisions (EPs) in RTAs on pollution. She proxied pollution using three indicators: concentrations of suspended particulate matter less than 2.5 microns (PM2.5), Sulphur dioxide ($SO_2$) and nitrogen oxide (NOx). She finds that RTAs (with or without environmental provisions) have a positive relationship with environmental quality related to two pollutants ($SO_2$ and NOx). However, the applied empirical framework does not give enough statistical certainty.

The present paper examines the empirical relations between trade and the environment in Middle East and North Africa (MENA) region during 1990-2015. In the analysis, we focus on carbon emissions as a measure of environmental quality. Our research contributes to understanding to which extent integration in GVCs and signing more RTAs with provisions related to the environment could affect pollution in the MENA region.

This study contributes to the literature by: first, we extend the analysis of trade–environment relation to the MENA region which has received relatively little attention. Wang et al., (2019) estimate the effect of participation in GVCs on per capita carbon emissions using a panel data for 62 countries and regions. They cover the years 1995-2011. 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. We cover the period 1990-2015. Second, we analyze the impact of RTAs with and without environmental provisions on carbon emissions using the gravity model.

The organization of the paper is as follows. Section 1 introduces the paper. Section 2 reviews related studies on environmental provisions in the first part and on GVCs participation and pollution in the second part. 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. Literature review

1. RTAs with environmental laws:

The proliferation of Regional Trade Agreements (RTAs) has been noticed in the last 30 years. Recently, many RTAs include environmental provisions. In recent years, there is a considerable interest in environmental quality and provisions related to the environment (Martínez-Zarzoso, 2018; Martínez-zarzozo and Núňez-Rocha, 2018 ; Baghdadi et al., 2013). Under this new trading system, environmental protection enhances sustainable development. Although they differ in scope and enforceability, environmental provisions focus on the same issues related to environmental protection. Bringing environmental provisions into RTAs ensures that trade policy integrate environmental concerns (WTO, 2018). Figure 1 illustrates the evolution of the number of RTAs between 1960 and 2015. We notice that only a few trade agreements were signed between 1960 and 1990. The number of RTAs without EPs is higher than the number of RTAs with environmental laws. Moreover, the number of trade agreements with EPs has been steadily increasing since 2000. In addition, the number of RTAs with legally enforceable EPs increased to reach approximately the same number of trade agreements without legally enforceable EPs in 2015.

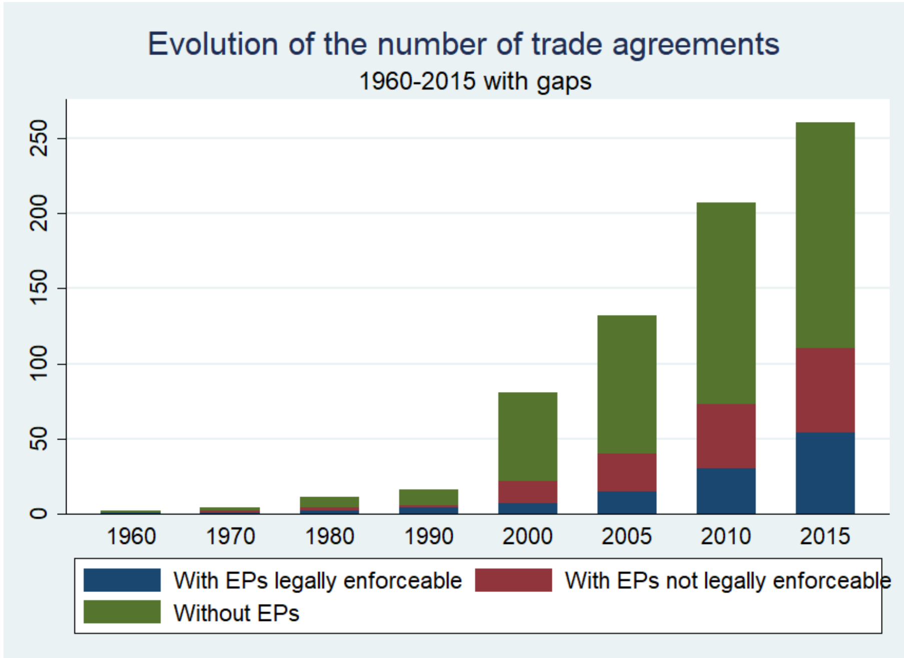


**Figure : RTAs and Environnemental Provisions (EPs)**

There is a growing body of literature about the relationship between pollution and RTAs. For instance, Cherniwchan (2017) proves that North American Free Trade Agreement (NAFTA), in its first five years, reduces emissions of pollutants by two-third in the United States (US) manufacturing sectors. Moreover, Yao et al. (2019) find a positive effect of FTAs on bilateral carbon emissions. However, this effect is sensitive to the income group of the country. FTAs are beneficial in high income countries. FTAs harm the environment in upper middle-income and lower middle-income countries. However, those previous studies did not put into consideration environmental laws included in RTAs and the possible impact they can have on the environment.

Many attempts have been made (Zhou et al., 2017; Baghdadi et al., 2013; Martínez-Zarzoso, 2018) with the purpose of assessing the impact of RTAs with and without environmental provisions on pollution. For example, 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 is linked to lower level of pollution. Contrary to Baghdadi et al. (2013) who use CO2 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.

In addition, Martínez-Zarzoso (2018) 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. Moreover, regional studies about environmental regulations in MENA region are scarce. Ramzy and Zaki (2018) 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.

Modern PTAs are deeper and cover provisions beyond the mandate of the World Trade Organization (WTO) such as environmental laws. The expansion of deep PTAs is considered a challenge for developing countries to participate and upgrade in global production networks with higher value-added activities (Berger et al., 2016). Thus, it is important to evaluate the impact of trade agreements with EPs on GVC participation of developing countries. The next section highlights the relationship between GVC participation and pollution.

2. GVC participation and pollution:

Nowadays, there is a high level of trade in parts and components than trade in final goods. Gains from GVCs are not equally shared within countries (WB, 2019). Likewise, Del Prete et al., (2018) argue that despite the low participation of North Africa (NA) in GVCs, a big part of their traded goods is parts and components. Berger et al. (2016) indicate that the number of deep PTAs increases with the rise in GVCs. This is explained by trade costs which are higher under global production networks. At the multilateral level, GVCs are affected by policies related to investment, competition and environmental laws etc. Therefore, signing deep PTAs reduces and, in some cases, eliminates those trade costs.

Enhancing social and environmental protection lead to higher participation rate in global production networks (WB, 2019). However, this is a challenge for developing countries where international trade in intermediate products rises domestic CO2 emissions. In the age of GVCs, Yao et al. (2019) argue that attention has to be paid from developing countries while setting deep agreements. Whereas FTAs could increase or decrease pollution. Lessons could be learnt from high income countries because their FTAs contribute to reducing carbon emissions.

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 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 (WB, 2019).

The GVC participation index is defined as follows:

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

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

And,

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

Balié et al. (2017) indicate that upstream activities are related to high forward participation rate. In addition, domestic production contributes by intermediates in the exports of the other importers. Furthermore, backward participation consists of importing foreign value-added to be exported again. It describes the extent of involvement in downstream activities. Cheng et al. (2013) argue that a country is upstream when its activities are related to producing raw materials, product design and research. Upstreamness is linked to early stage activities in the production process. Conversely, a country is downstream in the production process when it executes post-fabrication tasks such as customer service.

# iii. Methodology

1. Data

We investigate the effect of 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. Data are available for 19 MENA countries originating pollution for the period from 1990 to 2015. Countries considered in the empirical analysis are listed in Tables 5 in the Appendix.

We provide an overview of all used variables as well as some descriptive statistics in Table 4. 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. $CO_2$ emissions are a proxy of air quality. They report flows of embodied $CO_2$ from each origin/emitter country to each destination/consumer country. Units are Gg $CO_2$ (1 Gg = 1Kt). $CO_2$ accounts for emissions associated with imported and exported goods.

Furthermore, forward and backward GVC participation indexes are calculated from UNCTAD-Eora Global Value Chain Database. We are using bilateral data of RTAs from Mario Larch's

Regional Trade Agreements Database. This database includes all RTAs notified to the World Trade Organization (WTO).

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 (WDID) of the World Bank.

2. Model

This study discusses the impact of GVC participation and environmental laws measures on pollution in the MENA region. It highlights the effect of forward participation, backward participation and RTAs with and without environmental provisions on CO2 emissions in the region. The gravity approach is used in this study to examine if forward/backward linkages increase or decrease CO2 emissions. In other words, which (upstreamness or downstreamness) affects more the pollution in the MENA region. Moreover, we analyze the impact of deep PTAs with and without environmental provisions on pollution in MENA region. A number of empirical studies have used the gravity model to assess the impact of RTAs and environmental provisions on CO2 emissions (Yao et al., 2019; Baghdadi et al., 2013). Moreover, 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 the carbon emission 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 PPML estimated equation is as follows:

$$CO2_{odt} = \exp [ \nu_o + \phi_d + \vartheta_t + \alpha_1 \ln gdp_{ot} + \alpha_2 \ln gdp_{dt} + \alpha_3 \ln distance_{od} + \alpha_4 contiguity_{od} + \alpha_5 language_{od} + \alpha_6 colony_{od} + \alpha_7 numberRTAenv_{le_{odt}} + \alpha_8 numberRTA_{notle_{odt}} + \alpha_9 numberRTAenv_{no_{odt}} + \alpha_{10} Forward_{ot} + \alpha_{11} \; Backward_{ot} + \alpha_{12} \; Forward_{dt} + \alpha_{13} \; Backward_{dt} + \alpha_{14} (numberRTAenv_{odt} \times Forward_{ot}) + \alpha_{15} ( numberRTAenv_{odt} \times Backward_{ot}) + \alpha_{16} (numberRTAenv_{odt} \times Forward_{dt}) + \alpha_{17} (numberRTAenv_{odt} \times Backward_{dt}) ] \times \varepsilon_{odt}$$

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.

$numberRTA_{no_{odt}}$ signifies the number of RTAs without environmental provisions between countries of origin and destination at year t. $numberRTAenv_{le_{odt}}$ denotes the number of RTAs with legally enforceable environmental laws. Moreover, $numberRTAenv\_notle_{odt}$ indicates the number of RTAs with environmental provisions not legally enforceable.

Furthermore, Forward and ln Backward indicate the forward participation index and backward participation index respectively. The interaction term between the number of RTAs with legally enforceable environmental provisions and the backward participation index for origin country is given by $numberRTAenv\_le_{odt} \times ln\ Backward_{ot}$. Similarly, we have applied other sort of interaction terms in the previous equation with already defined variables.

Moreover, $\nu_o$, $\phi_d$ and $\vartheta_t$ denotes country-specific (origin and destination) and year fixed effects respectively. Finally, $\varepsilon_{odt}$ is the error term.

Following Yao et al. (2019), we implement a Poisson Pseudo-Maximum Likelihood (PPML) estimation which is suitable in estimating the gravity model. PPML deals with the heteroskedasticity in the error term. It also provides efficient estimators when flows of carbon emissions are zeros in the observations of the dependent variable. Moreover, this paper includes country-specific fixed effects (FE) and time fixed effects (FE) to control for endogeneity biases.

## iv. Estimation and results

Table 1 shows the empirical findings of the baseline equation estimated using PPML. Table 1 shows the impact of the number of RTAs (with and without environmental laws) on carbon emissions from MENA countries. The gravity variables such as gdp of destination countries, distance, colonial links and common official language have the expected signs and significance levels with slight changes in contiguity and origin country gdp. Whereas, contiguity and origin country gdp are not significant.

For MENA origin of carbon emissions, the number of RTAs with environmental provisions not legally enforceable (column 3) and the number of RTAs without environmental provisions (column 4) are not significant for carbon emissions. However, the number of legally enforceable RTAs with environmental laws (column 2) negatively affects carbon emissions from MENA region. This indicates that enforceability of RTAs which contains environmental provisions decreases pollution. In other words, a 10 percent increase in the number of RTAs with environmental provisions decreases carbon footprint by 1.79 percent.

Baghdadi et al. (2013) argue that countries belonging to the same RTA with environmental laws have converged CO2 emissions. Similarly, Zhou et al. (2017) show that RTAs without environmental provisions harm air quality. Whereas RTAs with environmental laws reduces pollution. Moreover, Low income countries suffer from pollution even after signing more FTAs due to lenient environmental standards (Yao et al., 2019). In line with this, our study proves that only RTAs with legally enforceable environmental laws could reduce carbon emissions in MENA region. Therefore, there is a need for MENA countries to set more serious environmental standards.

**Table 1 : RTAs, environnemental provisions and Carbon emissions (PPML estimation)**

| VARIABLES | (1)<br>CO2 | (2)<br>CO2 | (3)<br>CO2 | (4)<br>CO2 |
|---|---|---|---|---|
| Ln distance | -1.089*** | -1.102*** | -1.080*** | -1.091*** |
| | (0.0782) | (0.0767) | (0.0804) | (0.0785) |
| Ln gdp_o | 0.0479 | 0.0853 | 0.0345 | 0.0503 |
| | (0.0739) | (0.0809) | (0.0698) | (0.0722) |
| Ln gdp_d | 0.821*** | 0.853*** | 0.850*** | 0.814*** |
| | (0.0951) | (0.0971) | (0.0899) | (0.0929) |
| contiguity | 0.114 | 0.142 | 0.108 | 0.113 |
| | (0.168) | (0.166) | (0.170) | (0.168) |
| language | 0.619*** | 0.569*** | 0.623*** | 0.607*** |
| | (0.157) | (0.147) | (0.154) | (0.152) |
| colony | 0.261 | 0.292* | 0.257 | 0.269 |
| | (0.174) | (0.163) | (0.171) | (0.168) |
| numberRTAenv_le | | -0.179** | | |
| | | (0.0854) | | |
| numberRTAenv_notle | | | 0.177 | |
| | | | (0.243) | |
| numberRTA_no | | | | 0.0328 |
| | | | | (0.188) |
| Constant | -12.24*** | -13.80*** | -12.81*** | -12.12*** |
| | (1.986) | (2.279) | (2.106) | (2.006) |
| Observations | 8,404 | 8,404 | 8,404 | 8,404 |
| exporter | YES | YES | YES | YES |
| importer | YES | YES | YES | YES |
| year FE | YES | YES | YES | YES |

Note: (1) Robust standard errors in parentheses
(2) *** p<0.01, ** p<0.05, * p<0.1
(3) The origin country is in MENA region

The first column of Table 2 shows the estimation results for a model specification with two different independent variables indicating forward participation of origin MENA country and forward participation for destination countries. Column 2 presents the effect of forward GVC participation of origin MENA countries and RTAs with legally enforceable EPs on pollution. Column 3 shows the results of the interaction term between RTAs with legally enforceable EPs and destination forward GVC participation index. Furthermore, column 4 and column 5 present the interaction terms between the number of RTAs with environmental laws not legally enforceable and forward GVC participation index of origin countries and destination countries respectively. The basic gravity variables yield the expected results in both model specifications as in table 1 .

Forward indicates forward participation in GVCs of origin and destination countries of carbon emissions. Forward GVC participation indexes are not significant. Thus, upstream tasks in GVCs does not contribute to environmental deterioration. Participation in forward linkages with the presence of environmental laws not legally enforceable has positive and significant impact on pollution especially for countries in MENA region. In addition, forward GVC participation and the number of RTAs (RTAs include legally enforceable environmental laws) decreases carbon emissions.

To conclude, the environment suffers deterioration when countries engage to forward linkages without legally enforceable environmental provisions in RTAs. However, exports of indirect value added does not in itself rise pollution.

**Table 2: $CO_2$ emissions and forward GVC participation (PPML estimation)**

| VARIABLES | (1) CO2 | (2) CO2 | (3) CO2 | (4) CO2 | (5) CO2 |
|---|---|---|---|---|---|
| Ln distance | -1.088*** | -1.097*** | -1.109*** | -1.004*** | -1.078*** |
| | (0.0793) | (0.0771) | (0.0775) | (0.0887) | (0.0812) |
| Ln gdp_o | 0.0320 | 0.0935 | 0.0875 | -0.0166 | 0.0186 |
| | (0.0676) | (0.0888) | (0.0826) | (0.0767) | (0.0735) |
| Ln gdp_d | 0.797*** | 0.862*** | 0.873*** | 0.987*** | 0.886*** |
| | (0.0970) | (0.100) | (0.0985) | (0.0951) | (0.0945) |
| contiguity | 0.0376 | 0.124 | 0.109 | 0.102 | 0.0600 |
| | (0.179) | (0.172) | (0.167) | (0.182) | (0.172) |
| language | 0.623*** | 0.558*** | 0.560*** | 0.555*** | 0.622*** |
| | (0.155) | (0.145) | (0.145) | (0.146) | (0.150) |
| colony | 0.260 | 0.299* | 0.298* | 0.310** | 0.252 |
| | (0.172) | (0.162) | (0.160) | (0.150) | (0.160) |
| Forward_o | 0.000181 | | | | |
| | (0.00809) | | | | |
| Forward_d | 0.0102 | | | | |
| | (0.0176) | | | | |
| numberRTAenv_le × Forward_o | | -0.00636** | | | |
| | | (0.00299) | | | |
| numberRTAenv_le × Forward_d | | | -0.00665** | | |
| | | | (0.00284) | | |
| numberRTAenv_notle × Forward_o | | | | 0.0179*** | |
| | | | | (0.00552) | |
| numberRTAenv_notle ×Forward_d | | | | | 0.0121* |
| | | | | | (0.00730) |
| Constant | -10.35*** | -13.76*** | -13.52*** | -15.27*** | -12.79*** |
| | (2.181) | (2.493) | (2.445) | (2.346) | (2.290) |
| Observations | 7,202 | 7,781 | 7,766 | 7,781 | 7,766 |
| exporter | YES | YES | YES | YES | YES |
| importer | YES | YES | YES | YES | YES |
| year FE | YES | YES | YES | YES | YES |

Note: (1) Robust standard errors in parentheses
(2) *** $p<0.01$, ** $p<0.05$, * $p<0.1$
(3) The origin country is in MENA region

In table 3, the gravity variables 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 the number of RTAs with environmental provisions (enforceable and not enforceable) and backward GVC participation index related to the country of origin (MENA). To examine the interaction effects between the number of RTAs with environmental laws and participation of MENA countries in backward linkages, we include multiplicative interaction terms between the numberRTAenv_notle, numberRTAenv_le, Forward and Backward variables in the gravity equation.

Backward indicates backward participation in global production networks. Backward GVC participation index linked to country of origin (MENA) and country of destination are significant and positive. This indicates that engaging in backward linkages rises pollution. Exporting foreign value added (downstream activities) increases $CO_2$ emissions. Participation of MENA countries in backward GVCs is linked to its environmental degradation proxied by carbon emissions. 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. Moreover, Developing countries execute tasks in in high-polluting industries (Ben-David et al., 2018).

As shown in columns 3 and 5 of Table 3, the interaction term between number of RTAs with environmental laws (legally enforceable and not legally enforceable) and backward participation of countries of destination are insignificant. However, the coefficients of the interaction terms between the number of RTAs (with and without legally enforceable environmental laws) and backward participation of MENA countries in GVC (column 2 and column 4) are negative and significant. This confirms that the combination of participating in backward linkages for MENA region and signing more RTAs with environmental laws reduce pollution no matter if those environmental provisions are legally enforceable or not.

**Table 3: $CO_2$ emissions and backward GVC participation (PPML estimation)**

| VARIABLES | (1)<br>CO2 | (2)<br>CO2 | (3)<br>CO2 | (4)<br>CO2 | (5)<br>CO2 |
|---|---|---|---|---|---|
| Ln distance | -287.3*** | -1.087*** | -1.098*** | -1.088*** | -1.084*** |
| | (85.69) | (0.0780) | (0.0783) | (0.0780) | (0.0812) |
| Ln gdp_o | 83.74*** | 0.0438 | 0.0465 | 0.0108 | 0.0184 |
| | (30.44) | (0.0759) | (0.0758) | (0.0777) | (0.0721) |
| Ln gdp_d | 42.11* | 0.840*** | 0.828*** | 0.785*** | 0.888*** |
| | (24.92) | (0.0975) | (0.0958) | (0.0957) | (0.0895) |
| contiguity | -166.4 | 0.0993 | 0.0770 | 0.0760 | 0.0585 |
| | (170.0) | (0.173) | (0.170) | (0.179) | (0.173) |
| language | 246.8 | 0.602*** | 0.615*** | 0.504*** | 0.626*** |
| | (215.8) | (0.152) | (0.152) | (0.151) | (0.152) |
| colony | 1,035 | 0.274 | 0.264 | 0.366** | 0.256 |
| | (711.9) | (0.170) | (0.170) | (0.158) | (0.169) |
| Backward_o | 11.68** | | | | |
| | (5.258) | | | | |
| Backward_d | 1.195*** | | | | |
| | (0.274) | | | | |
| numberRTAenv_le × Backward_o | | -0.00429** | | | |
| | | (0.00176) | | | |
| numberRTAenv_le × Backward_d | | | -0.00236 | | |
| | | | (0.00248) | | |
| numberRTAenv_notle × Backward_o | | | | -0.0175** | |
| | | | | (0.00795) | |
| numberRTAenv_notle × Backward_d | | | | | 0.00943 |
| | | | | | (0.00613) |
| Constant | -1,051 | -12.11*** | -11.54*** | -9.540*** | -12.48*** |
| | (1,232) | (2.046) | (2.074) | (2.160) | (2.178) |
| Observations | 7,202 | 7,781 | 7,766 | 7,781 | 7,766 |
| Number of id | 547 | | | | |
| exporter | YES | YES | YES | YES | YES |
| importer | YES | YES | YES | YES | YES |
| year FE | YES | YES | YES | YES | YES |

Note: (1) Robust standard errors in parentheses
(2) *** $p<0.01$, ** $p<0.05$, * $p<0.1$
(3) The origin country is in MENA region

To conclude, environmental laws in RTAs signed by MENA countries reduces environmental degradation caused by its downstream business activities. Backward trade linkages of MENA countries in the presence of EPs (legally enforceable and not enforceable) does not harm the environment. Enforceability of EPs is not important in MENA when it participate in backward GVCs. However, legal enforceability of EPs in RTAs matters for all countries (MENA or other) so that its upstream production tasks do not deteriorate the environmental quality.

## v. Conclusions

International trade could harm environmental quality. Previous studies on the relationship between trade and the environment have been unable, to our knowledge, to empirically discuss the relationship between participation in GVCs, pollution and RTAs with environmental policies.
This paper examines the impact of integration into 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 PPML. Data cover the period 1990 to 2015. In recent years, there has been considerable interest in analyzing the effect of environmental provisions on pollution. In this respect, Baghdadi et al. (2013) and Zhou et al. (2017) show that environmental laws benefit air quality. Our results indicate that RTAs which specifically include legally enforceable environmental provisions reduces CO2 emissions. Particularly, a 10 percent increase in the number of RTAs with enforceable environmental provisions decreases carbon footprint by 1.79 percent.

As previously discussed in the literature, environmental quality is highly linked to involvement in GVCs. This study analyzes the effects of GVC participation on carbon emissions by using data for MENA countries. Ben-David et al. (2018) indicates that multinationals headquartered in developing countries perform their polluting activities in countries with weak environmental provisions. Similarly, we find that the participation of MENA countries in backward global production networks harms environmental quality proxied by carbon footprint.

Our results also show the interaction between the number of RTAs with environmental provisions (enforceable and not enforceable) and GVC participation indexes related to the country of origin (MENA) and destination countries as well. We find that the environment suffers deterioration when countries participate in forward GVCs without legally enforceable environmental provisions in RTAs. This goes in line with the findings of Yao et al., (2019). They indicate that low income countries suffer from pollution even after signing more FTAs due to lenient environmental standards. However, legally enforceable EPs decrease the harmful impact of engaging in forward linkages (upstream tasks related to exporting indirect value added) on environmental quality.

Furthermore, signing more trade agreements with environmental laws in MENA region reduces carbon footprint when the region executes downstream production activities. In this case, enforceability of EPs is not mandatory. Thus, backward GVC participation in the presence of RTAs with environmental laws (enforceable and not enforceable) increases environmental quality in MENA countries.

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 backward GVC participation on environmental quality. However, the legal enforceability of those EPs decreases the harmful impact of engaging in forward linkages on environmental quality.

# APPENDIX

**Table 4: Data description**

| Variable | Description | Obs | Mean | Min | Max | Source |
|---|---|---|---|---|---|---|
| CO2 | Embodied Flow Gg CO2 | 9163 | 203.322 | 0 | 16285.13 | Eora Global Supply Chain Database |
| Contiguity | 1=Contiguity | 9163 | .081 | 0 | 1 | CEPII |
| Language | 1=Common official or primary language | 9163 | .531 | 0 | 1 | |
| Colony | 1=Pair ever in colonial relation | 9163 | .02 | 0 | 1 | |
| Distance | weighted distance (pop-wt, km) | 9163 | 2719.724 | 131.758 | 17465.98 | |
| Gdp_o | Origin GDP (current US$) | 8667 | 8.99e+10 | 4.92e+08 | 7.54e+11 | WDID: World Development Indicators, World Bank |
| Gdp_d | Destination GDP (current US$) | 8894 | 4.10e+11 | 4.92e+08 | 1.80e+13 | |
| numberRTAenv_notle | Number of RTAs with not enforceable environmental laws | 9163 | .631 | 0 | 8 | Mario Larch's Regional Trade Agreements Database |
| numberRTAenv_le | Number of RTAs with legally enforceable environmental laws | 9163 | .291 | 0 | 8 | |
| numberRTA_no | Number of RTAs without environmental laws | 9163 | .615 | 0 | 1 | |
| Forward_o | Forward participation index of origin county | 9163 | 6290000 | 0 | 4.63e+07 | UNCTAD-Eora Global Value Chain Database |
| Backward_o | Backward participation index of origin county | 9163 | 2980000 | 0 | 2.78e+07 | |
| Forward_d | Forward participation index of destination country | 9163 | 3.53e+07 | 0 | 6.34e+08 | |
| Backward_d | Backward participation index of destination country | 9163 | 3.99e+07 | 0 | 8.75e+08 | |

**Table 5: Countries list**

Origin countries (MENA)

UAE Bahrain Djibouti Algeria Egypt Iraq Israel Jordan Kuwait Lebanon Libya Morocco Malta Oman Qatar Saudi Arabia Syria Tunisia Yemen

Destination countries (World)

Bahrain Algeria Egypt Iraq Jordan Kuwait Lebanon Libya Morocco Oman Qatar Saudi Arabia South Sudan Singapore Syria Tunisia Yemen UAE USA Angola Burundi Eritrea Ethiopia Kenya Lesotho Madagascar Mozambique Mauritius Malawi Namibia Rwanda Swaziland Seychelles Tanzania Uganda Zambia Zimbabwe Austria Belgium Bulgaria Cyprus Czech Republic Germany Denmark Spain Estonia Finland France UK Greece Croatia Hungary Ireland Italy Lithuania Luxembourg Latvia Malta Netherlands Poland Portugal Slovakia Slovenia Sweden Switzerland Djibouti Iceland Norway Turkey Canada Mexico Albania Andorra Bahamas Bosnia and Herzegovina Belize Barbados Chile Cote dIvoire Cameroon Colombia Costa Rica Dominican Republic Fiji Georgia Guatemala Guyana Honduras Israel Jamaica North Korea Moldova Nicaragua Peru Papua New Guinea El Salvador San Marino Suriname Trinidad and Tobago South Africa

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