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Environmental Regulations, Trade, and Foreign Direct Investment: Evidence from Gravity Equations

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Abstract

Since the early 90s, after the implementation of various regulatory multinational agreements, debates about the impacts of environmental policies on international trade and Foreign Direct Investment (FDI) flows have been increasingly growing. This article tackles this issue for 14 home countries and 39 host countries for 6 Regional Trade Agreements (RTAs) during the period from 1990 to 2011 by using static and dynamic gravity equations. We also used simultaneous gravity equations to invest•gate the two-way linkages between trade and FDI in the presence of environmental regulations. Our main findings suggest that the impact of the environmental regulations on trade is positive and significant for the static estimation, but insignificant in the dynamic estimation. However, the impact of the environmental regulations on FDI is positive and insignificant for both static and dynamic estimations. The results also showed the existence of unidirectional causal relationship running from trade to FDI.

*Keywords :*Environmental regulations, FDI, Trade, Gravity Equations, Simultaneous gravity equations.

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1. Introduction

In an increasingly integrated world with free capital flows, declining trade barriers, environmental regulations can have a crucial role in shaping countries' comparative advantages. However, this paradigm has been an active research area over the past few decades. The literature on international trade, FDI, and environment nexus has been rapidly increasing since the beginning of the 1980s. Trade and FDI are becoming increasingly major drivers of economic development and technology transfer (Omri and Kahouli, 2014a). The links between trade, FDI, and environment are important, multiple and complex. The extent to which environmental regulations might affect trade and FDI, or vice versa, has been the subject of considerable academic and policy debate. In a world characterized by an economic activity driven by the trade and FDI, it is argued that environmental degradation will be accelerated, unless the environment is protected by taking the necessary measures at the national and international levels.

Since the early 1990s, and after the implementation of various regulatory multinational agreements, debates about the impacts of environmental policies on international trade, technology production and FDI flows have been increasingly growing. A particular attention has been paid to the issue of whether environmental regulations influence both FDI flows and international trade. If the degree of the environmental regulations vary across countries, then the differences in the environment-related costs for firms may be sufficient to have an impact on international competitiveness and on countries' export and import patterns.

There is a vast literature on the relationship between trade and the environment, with numerous empirical studies examining the effects of environmental regulations on either trade flows or the location of industrial plants. Studies in the first category investigate whether these regulations reduce the exports of the concerned country, whilst those in the second examine whether FDI flows shift towards countries with lax regulations (See Table 1). As our study combines the two above categories, the following review of the literature focuses on the empirical research dealing with the impact of environmental regulations on both trade and FDI.

The relationship between environmental regulations, trade, and FDI has been the subject of considerable academic research (e.g. Van Beers and Van den Bergh, 1997; Jug and Mirza, 2005; Deana et al., 2009; Hanna, 2010; Elliott and Zhou, 2013). For example, Van Beers and Van den Bergh (1997) investigated the impact of environmental regulations on bilateral exports using a gravity setting with OECD[1] data. Their main finding supports the evidence of the pollution haven hypothesis, since they came up with the result that the OECD countries' exports are negatively and significantly influenced by more regulations. Similarly, they also found that imports are negatively correlated with the importing country's regulations, which does not support the pollution haven hypothesis. Using gravity equations with Europe data, Jug and Mirza (2005) showed that more environmental regulations reduce exports, when depicting a pure cost effect. They also showed that there is no significant difference in the impact of regulations on trade in case of dirty and clean sectors. More recently, Elliott and Zhou (2013) suggest that higher environmental regulations can promote capital inflows which we refer to as environmental regulations induced FDI.

[1] OECD indicates Organisation for Economic Co-operation and Development.

Table 1

Summary of empirical studies concerning the impacts of environmental regulations on trade and FDI.

No.	Author (s)	Countries	Econometric methodology		Conclusions : impact of environmental regulations
			Model	Estimation technique	
Environment-Trade studies					
1	Tobey (1990)	23 developed and developing countries	HOV model	Cross section	Positive and insignificant (3 industries). Negative and insignificant (2 industries).
2	Xu (2000)	20 developed and developing countries	Gravity model	Cross section	Positive and significant
3	Van Beers and Van den Bergh (2000)	• 23 countries OECD countries and developing countries. • 14 OECD countries	Gravity model	Cross section	Mixed results
4	Harris et al. (2002)	24 OECD countries	Gravity model	Panel Exporter, importer and time effects	Positive and insignificant
5	Ederington and Minier (2003)	U.S. industries	Imports/domestic production at industry-level	Panel and time fixed effects	Positive and significant
6	Cole and Elliott (2003)	60 developed and Developing countries	HOV model	Cross section	Positive and insignificant
7	Levinson and Taylor (2008)	U.S. imports from Canada and Mexico	Partial-equilibrium Model	Panel and time fixed effects	Positive and significant
8	Arouri et al. (2012)	20 countries	Gravity model	Panel and time fixed effects	Positive and insignificant
Environment- FDI studies					
9	Dean et al. (2009)	U.S. industries	Logit model	Cross section	Positive and significant
10	Hanna (2010)	U.S. Multinational firms	Panel firm-level	Panel and time fixed effects	Positive and significant
11	Leiter et al. (2011)	Europe industries	Dynamic panel	GMM estimation	Positive and significant
12	Kheder and Zugravu (2012)	74 countries receiving French direct investments	economic geography model	Panel	Positive and significant only for developed countries and most of emerging economies and Central and Eastern European countries.

Note: Only studies concerning the impacts of environmental regulations on trade and FDI flows are summarized in table 1. HOV indicates Heckscher–Ohlin–Vanek.

It can be seen that the past studies have never considered in a one work the impacts of environmental regulations on international trade and FDI. In this context, to evaluate the impact of environmental regulations on trade and FDI, we choose the difference in CO2 emissions per unit of GDP of both partners - or difference of their "carbon intensity." Relative to GDP, they reflect the economic and environmental requirements of sustainable development set out from the Framework Convention on Climate Change. Our environmental regulation variabe determined by CO2 emissions are closely related to the Kyoto Protocol commitments and this is, at the best of our knowledge, the only proxy variable giving an approximation of countries' efforts to respect Kyoto abatement targets (costantini and Crespi, 2008). The difference in CO2 emissions between two partners per unit of GDP represents the decarbonisation of an economy compared to another. Its decrease (increase) means that the exporting country undertakes more (less) effort than the importing countries to reduce carbon intensity. A positive (negative) coefficient reflects the negative (positive) consequences in terms of competitiveness restrictions on CO2 emissions.

In this article, we propose a novel approach to empirically address this issue for a panel of 14 home countries (with 2 RTAs)[2] and 39 host countries (with 6 RTAs)[3] using static (Fixed effect: FE, random effect: RE, and Hausman-Taylor: HT regressions) and dynamic estimators (difference GMM and system GMM). We also investigate, at the sometime, the interaction between trade and FDI using simultaneous gravity equations estimated by GMM-estimator. We are motivated by the fact that there are no studies that have investigated the two-way linkages between trade–FDI using two structural Gravity equations that allow one to simultaneously examine the impact of (i) FDI, environmental regulations and others variables on international trade; and (ii) international trade, environmental regulations and other variables on FDI.

The remainder of this article is organized as follows. Section 2 outlines the material and method. Section 3 reports and discusses the empirical results. Section 4 concludes the article and gives some policy implications.

2. Material and Methods

Empirical researches concerning the relationships between environmental regulations, trade, and FDI have increased in the last few decades. Several estimation techniques were used to empirically address this issue. In our study, we will focus on a panel data with static and dynamic gravity models to estimate the impacts of environmental regulations on trade and FDI. Moreover, we will use simultaneous gravity equations to examine the two-way linkages between trade and FDI in the presence of environmental regulations.

2.1. Gravity equations

In common with the previous literature on trade, FDI, and pollution haven hypothesis, we examine the impact of the environmental regulations on FDI and trade patterns. Specifically, using static and dynamic effects, we begin by estimating the impacts of environmental regulations on trade and FDI flows over the period 1990-2011.

The gravity model is an important and effective tool for explaining trade and FDI between the different parties. The use of this model with a huge number of observations implies more robust results than the other models since this model processes data between pairs of countries. Therefore, in this work we focus on the impacts of RTAs on trade and FDI, hence the use of a gravity model is justified. From a gravity model and among other explanatory factors, we estimate the effects on bilateral trade and FDI progress made by a country's abatement in respect of its partners. Such a model is well adapted to the determination of the causes of trade and FDI.

[2] EU (15) and NAFTA.

[3] EU (15), NAFTA (North American Free Trade Agreements), ASEAN (Association of Southeast Asian Nations), Mercosur (The Southern Common Market), EUROMED (Euro-mediterranean Free Trade Agreements), and AMU (Arab Maghreb Union).

2.1.1. Trade gravity equations

Tinbergen (1962) and Pöyhönen (1963) were the pioneers who applied the gravity equation to analyze the international trade flows. Since then, the gravity model has been successfully applied to migration and FDI flows, and more specifically, to trade (Martínez-Zarzoso et al., 2009). According to this model, trade from home country (i) to host country (j) is determined by the economic sizes of their (GDP or GNP), their population, geographical distance, and a set of dummies incorporating some type of characteristics common to specific flows.

According to the generalized gravity model of trade, the volume of trade between pairs of countries ($Trade_{ijt}$) is a function of incomes (GDPs), population, similitude index, difference in per capita GDP, real exchange rate, FDI, environmental regulations, geographical distance, and a set of dummies, as shown in the following equation:

$$\begin{aligned} \ln Trade_{ijt} = {} & \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIFGDP_{ijt} + \beta_6 \ln SIML_{ijt} + \beta_7 \ln RER_{ijt} \\ & + \beta_8 \ln FDI_{ijt} + \beta_9 \ln DIFCO2_{ijt} + \beta_{10} \ln DIST_{ij} + \beta_{11} LANG_{ij} + \beta_{10} BORD_{ij} + \beta_{11} EU(15) \\ & + \beta_{12} NAFTA + \beta_{13} ASEAN + \beta_{14} Mercour + \beta_{15} EUEOMED + \beta_{16} AMU + u_{ijt} \end{aligned} \tag{1}$$

where $Trade_{ijt}$ is the trade (exports + imports) between country i and country j in period t (constant US$). $GDP_{it}(GDP_{jt})$ is the GDP of country i (j) at period t (constant US$). $POP_{it}(POP_{jt})$ refers to the population of country i (j) in period t. $DIFGDP_{ijt}$ is the absolute value of the difference in GDP of country i and j. $SIML_{ijt}$ is an indicator of the similar size of the GDP of countries i and j. This index takes values between 0 and ½. For values close to zero, the two countries are considered very different and vice versa very similar for around ½ values. RER_{ijt} is the real exchange rate measured by the nominal exchange rate (NER) for each country vis-à-vis the dollar ($NER_{i/\$}$ value of the currency of country i of 1$) to extract data from IFS, CPI_i is the consumption price index of country i for each year from 1990 to 2011. If the CPI is not available for a country, the GDP deflator is used. FDI_{ijt} represents the inward investment stocks of country i to country j. $DIFCO2_{ijt}$ is the difference in CO_2 emissions between two partners per unit of GDP (expressed in purchasing power parity with 2005 base year). $DIST_{ij}$ is the geographical distance between i and j partners. $LANG_{ij}$ is a dummy for business partners who share a common language variable. $BORD_{ij}$ is the act of sharing a common border.

$EU(15)_{it}$, $NAFTA_{it}$, $Mercosur_{it}$, $ASEAN_{it}$, AMU_{it} and $EUROMED_{it}$: Dummy variables (to capture regional effects) of trade partners i and j in year t. It takes value 1 when the host countries are members of an FTA, and 0 otherwise. u_{ijt} is an error term.

Most of the existing gravity models are based on panel data which use static rather than dynamic specifications. The use of the dynamic model is justified for countries that traded extensively in the past. Their companies set up networks of distribution and service in the partner country, which has led to entry and exit barriers because of the irremediable costs. Furthermore, the consumers became used to the products of the partner country generating what we can call the formation of the habits (Kahouli and Maktouf, 2014). Thus, it is very likely that the bilateral commercial flows between these countries are also raised (Eichengreen and Irwin, 1998). The existence of irremediable costs supported by the traders to set up distribution networks and services in foreign markets generates persistent trade, a country trading to another country for a given year tend to continue to do so the following year. As a result, the export activity of the previous year provides a basis for the trade activities of the current year. So equation (2) is formulated dynamically:

$$\begin{aligned} \ln Trade_{ijt} = {} & \beta_0 + \lambda \ln Trade_{ij,t-1} + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIFGDP_{ijt} + \beta_6 \ln SIML_{ijt} \\ & + \beta_7 \ln RER_{ijt} + \beta_8 \ln FDI_{ijt} + \beta_9 \ln DIFCO2_{ijt} + \beta_{10} \ln DIST_{ij} + \beta_{11} LANG_{ij} + \beta_{12} BORD_{ij} + \beta_{13} EU(15) \quad (2) \\ & + \beta_{14} NAFTA + \beta_{15} ASEAN + \beta_{16} Mercour + \beta_{17} EUEOMED + \beta_{18} AMU + u_{ijt} \end{aligned}$$

where λ is the adjustment coefficient in the dynamic model. The other variables are described in the previous equation.

2.1.2. FDI gravity equations

The volume of FDI between pairs of countries (FDI_{ijt}) is a function of incomes (GDPs), per capita GDP, similitude index, real exchange rate, trade flows, environmental regulations, inflation rate, high education, internet users, geographical distance, and a set of dummies, as shown in the following equation:

$$\begin{aligned} \ln FDI_{ijt} = {} & \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln GDPpc_{it} + \beta_4 \ln GDPpc_{jt} + \beta_5 \ln SIML_{ijt} + \beta_6 \ln RER_{ijt} + \beta_7 \ln Trade_{ijt} \\ & + \beta_8 \ln DIFCO2_{ijt} + \beta_9 \ln INFL_{jt} + \beta_{10} \ln SCOLA\ III_{jt} + \beta_{11} \ln INFRA_{jt} + \beta_{12} \ln DIST_{ij} + \beta_{13} LANG_{ij} \\ & + \beta_{14} BORD_{ij} + \beta_{15} EU(15)_{it} + \beta_{16} NAFTA_{it} + \beta_{17} Mercosur_{it} + \beta_{18} ASEAN_{it} + \beta_{19} AMU_{it} \\ & + \beta_{20} EUROMED_{it} + u_{ijt} \end{aligned} \quad (3)$$

where FDI_{ijt} is the stock of FDI from country i to host country j in year t. GDP_{it} (GDP_{jt}) means the gross domestic product of country i (country j) in year t. $GDPpc_i$ ($GDPpc_j$) shows the gross domestic product per capita of country i (j) in year t. $SIML_{ijt}$ is an indicator of the size similarity of the GDP of country i and j. RER_{ijt} represents the real bilateral exchange rate. $Trade_{ijt}$ are the total imports and exports between investing partner i and host country j in year t. $DIFCO2_{ijt}$ the CO_2 emissions difference of the two partners per unit of GDP. $INFL_{jt}$ determines the inflation rate of host country j in year t. $SCOLA\ III_{jt}$ is the rate of tertiary education in the host country j. $INFRA_{jt}$ is the number of internet users in the host country j. $DIST_{ij}$ determines the geographical distance between partners i and j. $LANG_{ij}$ is the sharing of a common language. $BORD_{ij}$ is the act of sharing a common border. Increasing numbers of RTAs with historical geographical conditions were applied to the FDI model. The importance of geography provides additional justification for the consideration of the determinants of closeness and distance in explaining the FDI trend, including dummies regional groupings. The variables of regional integration are planned to examine the competitive advantage in obtaining economies of scale and to reduce the investment barriers between the member countries.

To make equation (3), we propose adding a lagged endogenous variable to account for the hysteresis in the FDI. We estimate the dynamic model using the difference GMM and system GMM estimators, mainly to compare them with the most appropriate models. The first dynamic specification is given by:

$$\begin{aligned} \ln FDI_{ijt} = {} & \beta_0 + \lambda \ln FDI_{ij,\,t-1} + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln GDPpc_{it} + \beta_4 \ln GDPpc_{jt} + \beta_5 \ln SIML_{ijt} + \beta_6 \ln RER_{ijt} \\ & + \beta_7 \ln Trade_{ijt} + \beta_8 \ln DIFCO2_{ijt} + \beta_9 \ln INFL_{jt} + \beta_{10} \ln SCOLA\ III_{jt} + \beta_{11} \ln INFRA_{jt} + \beta_{12} \ln DIST_{ij} \\ & + \beta_{13} LANG_{ij} + \beta_{14} BORD_{ij} + \beta_{15} EU(15)_{it} + \beta_{16} NAFTA_{it} + \beta_{17} Mercosur_{it} + \beta_{18} ASEAN_{it} + \beta_{19} AMU_{it} \\ & + \beta_{20} EUROMED_{it} + u_{ijt} \end{aligned} \qquad (4)$$

where λ is the adjustment coefficient in the dynamic model. The other variables are described in the previous section. Equation (4) is a better version of equation (3).

2.2. Simultaneous gravity equations

In this part, we try to analyze the two-way linkages between trade-FDI in the presence of environmental regulations variable. We are motivated by the fact that there are no studies that investigated the two-way linkages between trade–FDI using two dynamic structural gravity-equations that allow one to simultaneously examine the impact of (i) FDI, environmental regulations and other variables on international trade; and (ii) international trade, environmental regulations and other variables on FDI. As mentioned earlier, most theses studies generally opines that trade is an important determinant of the country's FDI (Dunning et al., 2001; Anwar and Nguyen, 2010). On the other hand, however, a number of other studies indicate that FDI promotes trade flows (Fukasaku et al., 2000; Rose and Spiegel, 2004; and Driffield and Love, 2007). This implies the existence of an interrelationship between trade and FDI. Increased FDI promotes trade, and rising trade may, in turn, raise FDI (Aizenman and Noy, 2006; Beugelsdijk et al., 2008).

It is well known that trade depends on FDI as well as on other variables. Then, it can be argued that FDI depends on trade and on other variables. Consequently, trade and FDI variables are in fact endogenous. In this sense, we believe that simultaneous gravity equations can be very appropriate to consider trade and FDI endogenous. On this basis, the two-way linkages between trade and FDI are empirically examined by making use of the two following equations:

$$\begin{cases} \ln Trade_{ijt} = \beta_0 + \lambda \ln Trade_{ij,t-1} + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIFGDP_{ijt} + \beta_6 \ln SIML_{ijt} \\ \qquad + \beta_7 \ln RER_{ijt} + \beta_8 \ln FDI_{ijt} + \beta_9 \ln DIFCO2_{ijt} + \beta_{10} \ln DIST_{ij} + \beta_{11} LANG_{ij} + \beta_{12} BORD_{ij} + \beta_{13} EU(15)_{it} \\ \qquad + \beta_{14} NAFTA_{it} + \beta_{15} Mercosur_{it} + \beta_{16} ASEAN_{it} + \beta_{17} AMU_{it} + \beta_{18} EUROMED_{it} + u_{ijt} \\ \\ \ln FDI_{ijt} = \beta_0 + \lambda \ln FDI_{ij,\,t-1} + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln GDPpc_{it} + \beta_4 \ln GDPpc_{jt} + \beta_5 \ln SIML_{ijt} + \beta_6 \ln RER_{ijt} \\ \qquad + \beta_7 \ln Trade_{ijt} + \beta_8 \ln DIFCO2_{ijt} + \beta_9 \ln INFL_{jt} + \beta_{10} \ln SCOLA\ III_{jt} + \beta_{11} \ln INFRA_{jt} + \beta_{12} \ln DIST_{ij} \\ \qquad + \beta_{13} LANG_{ij} + \beta_{14} BORD_{ij} + \beta_{15} EU(15)_{it} + \beta_{16} NAFTA_{it} + \beta_{17} Mercosur_{it} + \beta_{18} ASEAN_{it} + \beta_{19} AMU_{it} \\ \qquad + \beta_{20} EUROMED_{it} + u_{ijt} \end{cases}$$

2.4. Data and estimation techniques

The following development presents our database and the used estimation techniques. We will estimate the aggregate trade and FDI between 14 home countries and 39 host countries for 6 RTAs (EU(15), NAFTA, ASEAN, Mercosur, AMU and EUROMED) during the period from 1990 to 2011 (see appendix 1-3). Our database is a unbalanced panel with a maximum of 12.870 observations (14 × 39 × 22). The gravity model using panel data can be estimated by fixed effects (FE), random effects (RE), Hausman-Taylor (HT) and GMM methods.

The FE method introduces the country's specific effect considering different intersections for each group of the member countries. The FE approaches are not sufficient for models including invariant variables in time, such as distance, which is one of the fundamental variables (Cheng and Wall, 2005). The RE method, which takes into account the time series and the cross-transversal dimension of the data, treats interception as a random variables through common member countries. In this context, it can provide efficient estimates, especially when there is little variation in time series. However, the biased and inconsistent estimates are likely to occur if the specific effect is correlated with some explanatory variables. Therefore, Hausman test is necessary to test the presence of this bias. The dummy variable of the common language and the distance variable (which does not vary over time), as shown in equations (3) and (4), can be estimated by the FE method, as it will be dropped by the transformation of the FE. Furthermore, the RE approach requires a zero correlation between the individual effects and the independent variables in the model. As an alternative to FE and RE estimators, we propose the HT estimator by using instrumental variables instead of invariant variables, and may include some instruments of the explanatory variables in the model. According to Busse and Gröning (2011), the HT method can produce consistent and efficient estimates for the time-invariant if the FE are not correlated with the explanatory variables.

Very few studies based on a panel estimation of gravity equations have considered the possibility of controlling the statistical significance of both FDI and trade lagged variables. The introduction of the dynamic panel data model can help avoid avoids certain econometric problems due to the incompatibility of the estimators cited above. For the dynamic panel, we present the results for the difference GMM and the system GMM estimators. The difference GMM estimator suggested by Arellano and Bond (1991) has been widely used in the literature of the dynamic panel. However, if the data are very persistent, as in the case of trade and FDI, Blundell and Bond (1998) argued that this procedure can be improved by using the system GMM estimator, which complements the difference GMM estimator. There are two conditions that must be met to ensure the validity of the system GMM estimator (Roodman, 2011). First, there should be no autocorrelation in the error term. This condition is tested by examining the autocorrelation of first and second order residues in first differences. The first difference residuals should have a negative and significant autocorrelation of the first order, but no autocorrelation of second order. Second, the instruments must be correlated with the error term. This condition can be tested using a Hansen test of over-identifying restrictions. In other words, over-identified instruments should not be correlated with the error term. The null hypothesis in Hansen test is that there is no correlation between the instruments and the error term.

We have also a dynamic panel data model in a simultaneous-equation where lagged levels of trade and FDI are taken into account. The GMM is the estimation method most commonly used in dynamic models with panel data and a lagged dependent variable. This method uses a set of instrumental variables to solve the endogeneity problem of the regressors.

3. Results and discussions

Our objective in this study is to examine, on the one hand, the impacts of the environmental regulations on trade and FDI, and on the other hand, the two-way linkages between trade and FDI.

We begin the results by performing the panel unit root test proposed by Levin et al. (2002) and Im et al. (2003). The unit root test rejected the null hypothesis for each variable. The result shows that the variables are stationary. The results about the impacts of environmental regulations on trade and FDI are reported in Table 2 and 3, respectively. These tables present the results of the POLS, FE, RE, HT, Difference GMM, and two step GMM system estimators.

The results for trade flows are given in Table 2. According to HT estimator, as expected, the findings about the static estimations reveal that most of the market size variables (GDP_i, GDP_j, POP_i, POP_j, DIFGDP, and SIML) have significant impacts on trade flows. The results are consistent with the recent studies on this subject, e.g. Medvedev (2012), Kuznetsova, (2013), and Kahouli and Maktouf (2014). The coefficient of the environmental regulations has a positive and significant impact on trade flows. The magnitude of 0.018 implies that a 1% increase in the environmental regulations increases trade by around 0.02%. This result implies that stricter environmental regulations decrease trade between partner countries. It follows that the results are consistent with those of Robson (1988), Van Beers and Van den Bergh (1997), and Jug and Mirza (2005). However, FDI has a negative and significant effect on trade flows at 10% level. The magnitude of 0.001 implies that a 1% increase in FDI decreases trade by 0.001%. This result indicates that FDI and trade are substitutable, rather than complementary. This finding is consistent with those of Mohan and Watson (2012), Goh et al. (2013). In the same context, the RER coefficient is negative and significant at 5% level. This suggests that the countries' currency appreciation against the countries j currencies discourage the trade flows (Carrère, 2006; Roy, 2013; Kahouli and Maktouf, 2013). Distance has a negative and significant effect on trade flows. This implies that trade flows between two partners is negatively correlated with geographical distance (Baier and Bergstrand, 2009; Lin and Sim, 2012; Goh et al., 2013).

The coeifficient of the qualitative variables (common border and language), are significant and positive. These results confirm that sharing the same border and language increases trade flows between partners (Siliverstovs and Schumacher, 2009; Egger and Lassmann, 2012). The coefficients of the regional dummy variables such as EU (15), NAFTA, and ASEAN, have positive and significant impacts on trade flows, while the impacts of AMU and EUROMED are negative and significant. The member countries can take advantage of RTAs to promote their opportunities for trade between them by reducing transaction costs and increasing potential markets. Countries may choose members of the same RTAs or other agreements, as they give them free access to their markets and even in their neighboring markets (Kahouli and Maktouf, 2013).

For the dynamic estimations, the *system-GMM* estimator provides better results in terms of standard deviations compared to *difference-GMM* estimator, meaning that the fitted values are more precise. The system-GMM estimator includes not only the previous instruments, but also the lagged differences of the variables (Arellano and Bover, 1995; Blundell and Bond, 1998). We present the most reasonable results, which behave favorably in terms of the diagnostic tests of over identification (Hansen-J test) and the absence of a 2nd order autocorrelation AR(2).

Table 2 Trade gravity model estimations.

Independent	Dependent : Trade											
	Static estimations								Dynamic estimations			
	POLS		FE		RE		HT		DIFF-GMM		SYS-GMM	
$Trade_{ij,t-1}$	-		-		-		-		.420	(8.86)***	.730	(16.42)***
GDP_i	.671	(10.28) ***	-.105	(-0.37)	.878	(4.62)***	.172	(1.68)*	-2.328	(-4.64)***	.244	(1.94)*
GDP_j	.673	(38.50) ***	1.943	(8.73)***	1.079	(16.55)***	1.911	(21.81)***	4.128	(7.08)***	.289	(2.74)***
POP_i	.173	(2.72) ***	3.176	(4.93)***	.004	(0.02)	.960	(5.81)***	.650	(1.48)	-.058	(-0.55)
POP_j	-.0176	(-1.01)	-1.583	(-3.22)***	-.411	(-5.38)***	-1.207	(-11.14)***	-2.588	(-7.42)***	-.100	(-1.49)
DIFGDP	-.394	(-4.67) ***	.256	(4.00)***	.340	(5.46)****	.294	(4.50)***	.238	(5.48)***	.207	(1.26)
SIML	-.043	(-3.24)***	-.647	(-3.07)***	-.059	(-0.82)	-.584	(-6.12)***	-2.838	(-5.06)***	-.053	(-1.01)
RER	.010	(1.53)	-.031	(-0.56)	-.045	(-1.46)	-.054	(-2.47)**	-.264	(-4.23)***	-.025	(-1.46)
FDI	.002	(1.81)*	-.001	(-0.96)	-.000	(-0.19)	-.001	(-1.68)*	.002	(1.40)	.006	(3.10)***
DIFCO2	-.016	(-1.59)	-.014	(-1.24)	-.022	(-1.75)*	.018	(-2.88)***	.008	(0.93)	-.000	(-0.04)
DIST	-.684	(-38.92)***	-	-	-.422	(-5.42)***	-.063	(-0.33)	-		-.154	(-3.87)***
LANG	.567	(12.34)***	-	-	.516	(2.70)***	-.074	(-0.13)	-		.127	(1.62)
BORD	.320	(7.32)***	-	-	.433	(2.25)**	.691	(0.80)	-		.117	(1.34)
EU(15)	.054	(1.52)	.053	(0.85)	.002	(0.06)	.918	(2.43)**	-.074	(-1.21)	.003	(0.05)
NAFTA	.024	(0.46)	.469	(3.81)***	.300	(2.93)***	.434	(5.99)***	.147	(1.17)	-.127	(-1.32)
Mercosur	.099	(1.70)*	-.393	(-3.55)***	-.319	(-2.94)***	-.379	(-6.45)***	-.015	(0.72)	.020	(0.24)
ASEAN	.843	(14.53)***	.069	(1.10)	.041	(0.77)	.088	(2.82)***	.177	(3.96)***	.146	(1.63)
EUROMED	-.120	(-3.64)***	-.132	(-2.62)***	-.135	(-2.94)***	-.127	(-6.89)***	-.042	(-1.62)	-.005	(-0.23)
AMU	-.682	(-12.54)***	-.712	(-10.37)***	-.343	(-1.76)*	-1.575	(-11.06)*	.071	(-0.62)	-.044	(-0.45)
Constant	-11.19	(-12.74)***	-55.660	(-7.13) ***	-21.600	(-11.29)***	-30.521	(-12.04)***	-		-5.251	(-3.74)***
-	0.712		0.389		0.712		-		-			
N/ Group number	10505		532/10505		532/10505		532/10505		532/9438		532/9971	
F-Statistique	(1643.29)***		(141.78)***		(3335.19)***		(6551.84)***		(201.36)***		(842.34)***	
Hausman Test	-		(238.64)***		(316.59)***		-		-		-	
AR(2)	-		-		-		-		(1.48)		(1.47)	
Hansen Test	-		-		-		-		(409.40)		(423.46)	

*, **, *** Indicate significance levels at 10%, 5% and 1%, respectively. The values in parentheses are the t-student.
Columns (5): 1-step difference GMM, with robust standard errors and the options "collapse" and "lag (1 to 9)".
Column (6): 2-step system GMM, with robust standard errors and the options "collapse" and "lag (1 to 7)".
Hansen J-test — overidentification test of restrictions in GMM estimation.
AR(2) test — Arellano–Bond's test to analyse the existence of 2nd order autocorrelation.

The adjustment coefficient (lagged trade) is positive and statistically significant at 1% level, indicates that the adjustment costs play a crucial role and confirm that the trade gravity model should be estimated dynamically. This result is consistent with the findings of Martinez-Zarzoso et al. (2009), Kahouli and Maktouf (2014), who indicate that the lagged trade has a positive and significant effect on trade flows. Besides, the estimated coefficients are almost significant and have the expected theoretical signs. The GDP appears to be an important determinant of trade flows between partners. The FDI has a positive and significant impact on trade. This means that trade and FDI are complementary (Dur et al., 2013). The variable related to the environmental regulations has a negative and insignificant impact on trade flows. Thus, the environmental regulations appear to play a marginal role and do not affect trade significantly. This confirms the results showed by Tobey (1990).

Next, we focus on the impact of the environmental regulations on FDI. The results are presented in Table 3. For the static estimations, and according to HT estimator, the GDP is included in the estimation to capture the effect of the economic size; it is positive and statistically significant in all the models. This suggests that the income investment partners and host countries strongly influence FDI stocks (Hejazi, 2009; Martinez et al., 2012; Cuong, 2013). In addition, the coefficient on the GDPpc is positive and statistically significant for the home country, but negative and significant for the host country. The estimated coefficients of per capita GDP indicate that the host countries are intensive in labor, and simultaneously home countries are intensive in capital (García-Herrero and Santabárbara, 2007; Mitze et al., 2008). In the same context, the estimated coefficients of the similarity index are negative and not significant. The elasticity index of similarity is very important in the HT estimator compared with the estimated RE models. This result is consistent with that of Egger and Pfaffermayr (2004); Antonucci and Manzocchi (2006) who showed that the similarity index between countries is less sensitive to changes in FDI stocks. The coefficient sign is negative because the sample studied is heterogeneous. The estimated coefficient of the real exchange rate is positive and statistically significant. This suggests that the depreciation of currencies of the home country against the currency of the host country encourages the FDI stock (Martinez et al., 2012; Cuong, 2013).

Similarly, the coefficient of trade variable is positive and significant. The results indicate that FDI and trade are complementary rather than substitutable (Neary, 2009; Mohan and Watson, 2012; Kristjansdottir, 2013). However, the coefficient of inflation is negative and statistically significant. High inflation in the home country decreases FDI in host countries. This means that investors can increase investment abroad with lower inflation rate to maintain price competitiveness on the world market as it is in their domestic markets (Kleinert and Tubal, 2010; Medvedev, 2012; Cuong, 2013). Thus, the coefficient of tertiary education is positive and statistically significant at 1%. Foreign investors assess the education level of the human capital in the host country to ensure a successful implementation of MNCs. Therefore, a high tertiary enrollment increases FDI of the host country (Hejazi, 2009; Bhavan et al., 2011; Martínez et al., 2012). Similarly, the coefficients of the INFRA variable proxy for the number of internet users is positive and statistically significant at a 1% level. Investors may well choose the country with greater availability of the Internet. This result confirms the findings of Raudonen and Freytag (2012); Castellani et al. (2013). The use of the Internet can play a role equivalent to the reduction of geographical distances between the two countries by inducing the FDI. Changing geographical distance between two countries is impossible. The Internet, however, is expected to increase rapidly in the near future. The distance in our models reflects the cost of information.

According to Table 3, the distance has not contributed much to the stock of inward FDI in host countries between 1990 and 2011. This finding reinforces the principles of Braconier et al. (2005) and Zwinkels Beugelsdijk (2010) saying that distance does not affect

FDI. On qualitative dummies, the coefficient of dummy for a common language is negative and insignificant in the HT model. The results contradict our intuition that countries sharing the same language invest more with each other than a pair that does not use the same language, because the cost of information and communication is lower (Buch et al., 2003; Mohan and Watson, 2012). The results show that sharing the same land border has no impact on the stocks of the FDI (Mitze et al., 2008; Cuong, 2013). Finally, the coefficients of the regional dummy variables are positive and statistically significant at 1% for the EU(15), NAFTA and ASEAN. By joining larger RTAs, a country could reassure investors that its reforms are irreversible, thus enhancing the confidence of potential investors. Foreign investors can take advantage of these RTAs to increase their investment opportunities and / or trade between members by reducing the costs information and increasing the market potential (Balasubramanyam et al., 2002; Martinez et al., 2012). However, the coefficients of Mercosur variables are negative and insignificant in all models. This implies that members of the region have a low level of investment between one another (Bengoa and Sanchez-Robles, 2003). In addition, membership in the host country in EUROMED and AMU negatively and significantly influences the inward FDI stocks. In this context, Brenton et al. (1999) showed a negative sign on integration variables suggesting that membership in RTAs negatively affects FDI.

For the dynamic estimations, the FDI lagged variable (adjustment coefficient) is positive and statistically significant. The result shows that the adjustment costs play a significant role and confirm our view that the FDI gravity model should be estimated dynamically (Bhavan et al., 2011; Mina, 2012). The existence of sunk costs incurred by investors to set up distribution networks and services in foreign markets generates persistent FDI to a country that invests in another country for a given year and tends to continue to do so the following year. In addition, the estimated coefficient of GDP is positive and statistically significant at 1% level. This highlights the importance of investment partners and the capacity of the host countries by encouraging inward FDI in these countries (Bevan and Estrin, 2004; Bhavan et al., 2011). In the same way, the coefficient on GDP per capita (proxy for labor costs and competitiveness) is positive and statistically significant at 1 % level for the country of origin, but negative and significant at 1% level for the host country. The host countries are intensive in labor and simultaneously, home countries are intensive in capital (Demekas et al., 2005; Bellak et al., 2009).

Therefore, the estimated coefficient of the similarity index is positive and insignificant for the system GMM estimator. Regarding the difference GMM estimator, the coefficient is negative and insignificant. Moreover, this index is low, therefore, the more the two countries are different in terms of GDP , the higher the share of intra-industry trade is low (Carr et al., 2001 ; Bergstrand and Egger, 2007). The coefficient of the RER is negative and statistically significant in the GMM-Sys. This result confirms the findings of Chakrabarti (2001), Di Giovanni (2005), and Bhavan et al. (2011) who state that the depreciation of currencies of the investment partners against the currency of the host country encourages the inward FDI in the host countries.

In the same order, the coefficient of trade is positive and statistically significant for the GMM-Diff, however, negative and insignificant for the GMM-Sys. Hence, FDI and trade between investing partners and host countries are complementary for GMM-Diff. Several previous studies have shown a positive and significant coefficient on the variable measuring trade, for example, Bhavan et al. (2011); Mina (2012). Thereafter, the coefficient of inflation is negative and statistically significant. The results show that the high inflation rate in the host country may discourage investors and reduce FDI in the host country. The results support the hypothesis that inflation rates have a negative impact on FDI in both home and host countries (Mina, 2012; Ngouhouo, 2013). As for the tertiary education variable, it is positive and statistically significant at 1% level. The results confirm the hypothesis that the increase in tertiary education will promote production and reduce its cost. It has a positive impact on FDI stock to the host country (Hejazi, 2009; Cazzavillan and Olszewski, 2012).

The coefficient of the variable INFRA is positive and statistically significant at 1% level. This implies that a large number of internet users has a positive effect on the stock of the FDI (Mateev and Tsekov, 2013). However, it is obvious that the distance does not play an important role in the investment decisions by MNCs. (Bevan and Estrin, 2004; Bhavan al., 2011). Regarding the qualitative dummies, contiguity is not significant and has a positive sign. This result shows that sharing the same border has no impact on trade flows between members (Stein and Daude, 2007; Vicard and Desbordes, 2009).

The coefficient of the dummy variables for common language is significant and positive. The results support the idea that a pair of countries with the same official language will invest more with each other than a pair that does not use the same language as the information and communication costs decrease (Bergstrand and Egger, 2007; Vicard and Desbordes, 2009). Finally, the dummy coefficients of EU(15) and NAFTA are positive and statistically significant at 1% level. The results indicate that the adhesion of partners who invest in the EU and NAFTA has a significant influence on FDI in the host countries. This is because the host country can provide an entry for investment partners and other economic integration and closer economic relations with the host member countries. Many host countries (usually developing countries) have announced the agreement on the promotion and protection of investments to protect foreign investors in order to encourage and promote the FDI stock in the country.

In addition, several host countries have signed FTAs with several other countries to stimulate technology development and private investment among members. Thus, investors choose their partner host country as a production base to get a better position in the global competitiveness after the removal of barriers to investment and trade between members. However, regional variables ASEAN, Mercosur, EUROMED are statistically insignificant. This suggests that membership of the host countries in these groups did not significantly affect the stock of FDI. Moreover, AMU dummy is negative and statistically significant. Regional integration efforts could create additional unexpected barriers to FDI (e.g., unnecessary administrative burdens, bureaucratization and over-regulation that regional integration efforts could carry).

Finally, we focus on the two-way linkages between trade and FDI. Table 4 reports the estimated results of the simultaneous gravity equations of trade (Model 1) and FDI (Model 2). In Model 1, the trade lagged variable has a positive and significant effect on trade. This indicates that the adjustment costs play a crucial role and confirm that the trade gravity model should be estimated dynamically (Mullen and Williams, 2011). Trade in the previous year promotes the trade in the current year. FDI has a positive and insignificant impact on trade. $DIFCO_2$ has also a positive and significant impact on trade at 5% level. The magnitude of 0.095 implies that a 1% rise in environmental restriction raises trade by around 0.1%. The positive result of its coefficient generates negative consequences in terms of competitiveness restrictions of the CO_2 emissions (Cole, 2006; Sbia et al., 2014; and Omri, 2013). Regarding the market size variables, only the GDP export, GDP import, POP export, and SIML have a positive and significant impact on trade (Mullen and Williams, 2011 ; Goh et al., 2013). According to the dummy variables, only contiguity, EU(15), NAFTA, and EUROMED have a positive and significant impact on trade, while the effect of Mercosur on trade is negative and significant.

Table 3 FDI gravity model Estimations.

Independent	Dependent : Foreign Direct Investment (FDI)											
	Static estmations								Dynamic estimations			
	POLS		FE		RE		HT		DIFF-GMM		SYS-GMM	
$FDI_{ij,t-1}$	-		-		-		-		.498	(12.43)***	.669	(17.33)***
GDP_i	2.450	(20.36)***	1.526	(0.35)	2.592	(8.00)***	2.719	(2.12)**	-12.024	(-1.26)	2.527	(2.84)***
GDP_j	1.043	(10.14)***	5.901	(1.50)	1.399	(4.66)***	2.998	(3.90)***	12.685	(1.27)	-.511	(-0.69)
$GDPpc_i$	6.576	(20.63)***	4.752	(1.88)*	5.517	(7.21)***	4.944	(9.03)***	3.668	(0.96)	1.480	(3.95)***
$GDPpc_j$	-1.969	(-10.99)***	-2.302	(-0.94)	-2.002	(-5.34)***	-2.079	(-4.58)***	-5.505	(-1.29)	-.755	(-2.42)**
SIML	-.018	(-0.14)	-5.348	(-1.51)	-.061	(-0.17)	-1.333	(-1.26)	-8.664	(-1.28)	1.420	(1.56)
RER	-.124	(2.44)**	-1.368	(0.57)	-.321	(2.32)**	-.981	(2.42)**	-2.234	(0.61)	-.186	(1.94)*
Trade	.066	(0.72)	.314	(1.08)	.218	(1.10)	.386	(1.98)**	1.988	(1.92)*	-.236	(-0.60)
DIFCO2	-.409	(-4.87)***	-.063	(-0.40)	-.188	(-1.26)	-.107	(-1.14)	.050	(0.31)	-.191	(-1.56)
SCOLIII	-.076	(-0.23)	2.111	(2.51)**	1.059	(1.56)	1.476	(3.29)***	1.145	(1.62)	.876	(1.27)
$INFL_j$	-.184	(-1.68)*	-.278	(-1.86)*	-.307	(-2.15)**	-.317	(-3.10)***	-.163	(-1.42)	-.072	(-0.73)
INFRA	.625	(8.89)***	.404	(2.49)**	.591	(5.94)***	.487	(6.50)***	.347	(1.85)*	.037	(0.46)*
DIST	-.660	(-3.98)***	-		.209	(0.44)	.309	(0.42)	-		-.508	(-1.41)
LANG	.583	(1.53)*	-		.474	(0.43)	.948	(0.47)**	-		.055	(0.09)*
BORD	-.916	(-1.89)*	-		-124	(0.08)	1.394	(0.46)	-		-.564	(-0.58)
EU(15)	7.990	(26.09)***	1.801	(1.45)	3.742	(4.10)***	2.227	(4.16)***	-1.946	(-1.08)	3.058	(3.49)***
NAFTA	8.319	(16.55)***	1.245	(0.64)	3.312	(2.55)**	1.419	(1.32)	-.334	(-0.18)	4.993	(3.34)***
Mercosur	.939	(1.72)*	1.041	(0.66)	-.362	(-0.35)	.054	(0.05)	.416	(0.21)	.528	(0.65)
ASEAN	1.941	(3.60)***	-2.759	(-2.50)**	-1.811	(-1.84)*	-2.380	(-4.03)***	.222	(0.58)	1.128	(1.55)
EUROMED	-.697	(-1.72)*	-.437	(-0.75)	-.778	(-1.42)	-.479	(-1.49)	-1.042	(-1.53)	-.176	(-0.48)
AMU	-4.236	(-8.53)***	-		-4.317	(-3.41)***	-4.272	(-2.06)**	-2.624	(-4.16)**	-1.955	(-2.31)**
Constant	-130.172	(-29.63)***	-231.786	(-2.66)***	-143.340	(-12.65)***	-188.920	(-6.83)***	-		-52.110	(-3.74)***
R^2	0.418		0.229		0.487		-		-		-	
N/ Group number	7089		500/7089		500/7089		500/7089		482/5894		500/6934	
F-Statistique	(400.24)***		(23.26)***		(963.36)***		(2119.52)***		(27.27)***		(138.66)***	
Hausman Test	-		(308.11)***		(197.44)***		-		-		-	
AR(2)	-		-		-		-		0.70		1.04	
Hansen Test	-		-		-		-		172.43		186.98	

*, **, *** Indicate significance levels at 10%, 5% and 1%, respectively. The values in parentheses are the t-student.
Columns (5): 1-step difference GMM, with robust standard errors and the options "collapse" and "lag (1 to 8)".
Column (6): 2-step system GMM, with robust standard errors and the options "collapse" and "lag (1 to 5)".
Hansen J-test — overidentification test of restrictions in GMM estimation.
AR(2) test — Arellano–Bond's test to analyse the existence of 2nd order autocorrelation.

In Model 2, the FDI lagged variable has a positive and significant effect on FDI at 1% level. This suggests that higher FDI in the previeous year does send positive signals to prospective foreign investors. Trade has a positive and significant impact on FDI at 1% level. The magnitude of 0.103 implies that a 1% increase in trade increases FDI by around 0.10%, indicating that trade and FDI are complementary. This result is consistent with the finding of Wang et al. (2010); Zwinkels and Beugelsdijk (2010); and Anwar and Nguyen (2011). In contrast, DIFCO2 has a negative and significant effect on FDI at 1% level. The magnitude of 1.48 implies that a 1% rise in environmental restriction decreases FDI by around 1.5%. The negative result of its coefficient generates positive consequences in terms of competitiveness restrictions of the CO2 emissions (Lee, 2013; Sbia et al., 2014; Omri and Kahouli, 2014b.). Regarding the market size variables, only the GDP export, GDP import, and GDP_{pc} export have a positive and significant impact on FDI (Mitze et al., 2010). INF and RER have an insignificant effect on FDI. In this context, inflation rate and exchange rate, as indicators of macro-economic stability, are not affecting FDI (Frenkel et al., 2004). However, INFRA and SCOLIII have a positive and significant effect on FDI. For example, the magnitude of 0.065 and 0.151 implies that a 1% rise in internet users and high school education raises FDI by around 0.06% and 0.15%, respectively (Hejazi, 2009). According to the dummy variables, only contiguity, EU(15), NAFTA, and AMU have a significant impact on FDI, while the effect of ASEAN, Mercosur, and EUROMED on FDI is insignificant (Kreinin and Plummer, 2008).

Table 4

GMM regressions of simultaneous gravity equations**.**

Independent variables	Dependent variables			
	Trade (Model 1)		FDI (Model 2)	
$Trade_{ij,t-1}$	.981	(183.71)***	-	
$FDI_{ij,t-1}$	-		.788	(74.89)***
GDP_i	.285	(2.57)**	.316	(3.92)***
GDP_j	.183	(0.55)**	.278	(3.94)***
POP_i	.080	(2.84)***	-	
POP_j	-.003	(-0.53)	-	
$GDPpc_i$	-		1.041	(5.31)***
$GDPpc_j$	-		-.450	(-4.09)***
DIFGDP	.013	(0.58)	-	
SIML	.008	(2.38)**	-.104	(-1.14)
RER	-.000	(-0.32)	.033	(1.08)
Trade	-		.103	(4.08)***
FDI	.039	(0.91)	-	
DIFCO2	.095	(1.93)**	-.148	(-2.67)***
SCOLIII	-		.065	(0.35)*
$INFL_j$	-		-.025	(-0.40)
INFRA	-		.151	(3.42)***
DIST	-.004	(-0.54)***	-.128	(-1.31)
LANG	.006	0.51	.150	0.74
BORD	.022	(1.99)**	-.235	-0.86
EU(15)	.075	(3.73)***	1.597	(7.37)***
NAFTA	.069	(2.44)**	1.425	(4.47)***
Mercosur	-.028	(-1.88)*	-.136	(-0.44)
ASEAN	-.026	(-1.47)	.156	(0.50)
EUROMED	.016	(1.66)*	-.321	-1.28
AMU	.011	(0.59)	-.772	(-2.49)**
Constant	1.294	(2.83)***	-19.563	(-6.76)***
N	6933		6934	
F-Statistique	(17354.29)***		(1376.15)***	
Hansen Test	(50.328)***		(7.825)**	

*, **, *** Indicate significance at 10%, 5% and 1% levels, respectively. The values in parentheses are the t-student.

Models 1 and 2 : Simultaneous equation with robust standard errors and the command “ivreg2”.

Hansen J-test: overidentification test of restrictions in simultaneous equation estimation.

The overall findings show the evidence of a unidirectional causal relationship running from FDI to trade, indicating that FDI and trade are complementary. This confirms the results showed by Anwar and Nguyen (2011).

4. Conclusion and policy implications

The impact of the environmental regulations on trade and FDI has been extensively investigated in the past literature. Little is however known about their dynamic interactions using gravity equations. This article investigates this issue using static estimations (Fixed effect: FE, random effect: RE, and Hausman-Taylor : HT regressions) and dynamic estimations (difference GMM and system GMM). We empirically also proposed to examine the simultaneous causal relationships between trade and FDI by using simultaneous gravity equations. We tackle this issue empirically between 14 origin countries and 39 host countries for 6 RTAs (EU(15), NAFTA, ASEAN, Mercosur, AMU and EUROMED). We are motivated by the fact that there are no studies that investigated the two-way linkages between trade and FDI using two structural Gravity equations that helps simultaneously examine the impact of (i) FDI, environmental regulations and other variables on international trade; and (ii) international trade, environmental regulations and other variables on FDI.

The main findings over the period 1990–2011 show that the impact of the environmental regulations on trade is positive and significant for the static estimations, but insignificant for the dynamic estimations. The positive impact of environmental regulations on trade implies that stricter environmental regulations increases trade between partner countries. It also indicates that parallel regional groups established or consolidated in the 90s stimulate trade flows between partners, which reflects an open regionalism. The Porter hypothesis applied to trade competitiveness is confirmed more clearly with a sample consisting of all intra-regional flows. However, the impact of the environmental regulations on FDI is negative and insignificant for both static and dynamic estimations. The results also show the existence of unidirectional causal relationship running from trade to FDI. Accordingly, for rapid expansion of exports, trade liberalization policies have to encourage the sectors that will trigger FDI. More precisely, the sectors which are able to exploit exporting capabilities built on local suppliers. This approach must take into account the way to break poor ties among MNCs and local company; as past study reveals that technology transfers remain poor in the host country. In addition, the policy makers of the host countries should promote activities as potential exports which make use of our comparative advantage. Thus, the FDI should be seen as a complement and not as a substitute for local capital resources.

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