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Impact of Trade in Environmentally Preferable Products and Clean Technologies on Economic Growth and Environmental Quality : Empirical Analysis in Developing Countries and in OECD countries

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***Abstract*— The aim of this paper is to estimate the indirect and the direct effects of trade in Environmentally Preferable Products and Clean Technologies (called "Class B" lists) on air quality for a number of developed and developing during the period 1996-2015 and 2005-2015 (through environmental policy and income). Empirically, the study relies on the Two-Stage Least Squares (2SLS) and Three Stage Least Squares regression analysis. For both "Class B" lists of preferable goods, OECD countries are encouraged to market EPP (Environmentally Preferable Products) because they have a negative overall effect on carbon emissions, which is not the case for developing countries (no effects have been identified). Trade intensity in clean technologies (CT) contributes to the reduction of CO2 emissions in the case of OECD countries. For developing countries, trade in these products does not bring any benefits to the quality of the environment, hence the importance of focusing on trade in other types of products.**

***Keywords*— Trade; environmental-goods; clean-technologies; air-pollution; economic-growth.**
JEL Classification: F18; Q5; Q55; Q53; O4

I. INTRODUCTION

The World Trade Organization (WTO) emphasizes the necessity of environmental goods trade liberalization in rich countries as well as in developing countries. For all these countries, there is a way to encourage environmental protection through the use of ecological goods and the strengthening of the economic fabric. In developing countries, domestic and foreign companies benefit from a cheaper production cost based on a cheaper labor. The WTO's incentive to reduce import tariffs for environmental goods can play a significant role in encouraging business to protect the environmental quality. The reduction of tariffs encourages the imports of environmental goods and services, which in turn encourages firms to reduce pollution by benefiting from low production costs.

Reducing the costs of environmental protection products, services and technologies would encourage the governments to set up measures and programs in favour of the environmental protection.The promotion of the trade liberalization of new technologies and environmental goods favors the creation of new companies as well as new job opportunities in the domain of industrial ecology. The leading exporters of ecological goods are developed countries. They can also strengthen their economies and maintain a sustainable economic growth as far as low costs are only applicable in these countries. As stated in the work of [12], the advantages in the trade of environmental goods and services are more favorable in rich countries than in poor countries. In their work, they emphasize the importance of developed countries' membership to the World Trade Organization. All these countries benefit from gains and profits realized through trade in environmental goods. This advantage can be explained by the easy access of WTO countries to all environmental goods and services, including in poor countries.

The environmental damages are largely related to the type of usage of environmental goods as well as to their recycling and to final waste disposal. Certain countries in transition are characterized by their pollution degree. Environmental degradation can be explained by the consumption process of goods and their elimination in the environment. The question now being asked is: what needs to be liberalized in developing countries in order to preserve the quality of the environment?

This paper will be presented as follows: the first part includes a short review of the literature on environmental goods. It will consist of a presentation of environmental goods. The second part will deal with the presentation of our theoretical model which is based on a specification of three simultaneous equations. The variables of this study will be defined, followed by an estimation approach. Finally, the results of the estimations will be the subject of the third part in which the results will be analyzed and discussed. The paper will conclude with some recommendations.

II. REVIEW OF THE LITERATURE

According to the World Trade Organization (WTO), there are two broad categories of goods: the first is defined as "traditional environmental goods" and the second as "environmentally preferable products", ([14]). Excluding their specificities and physical properties, these products have the ability to solve environmental problems as any good having the capacity to store a large amount of carbon. The second category

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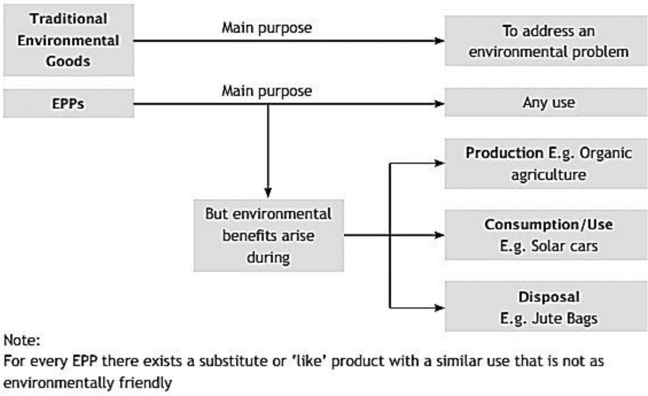
which is known as "environmentally preferable products" includes different goods and products that provide benefits for the environment. These benefits depend on the fabrication process of a product and its consumption, which should not hinder the quality of the environment. Similarly, one of the criteria that is important for a product in order to be classified in the list of environmentally preferable goods concerns the way a product is destroyed and recycled ([14]).



Source: [4]

Fig. 1 Distinction between Traditional Environmental Goods and Environmentally Preferable Products (EPP)

For this reason, we need to distinguish between traditional environmental goods (Class A) and environmentally preferable products (Class B) by relying on the distinctive criteria cited below. Environmentally preferable goods are useful in several processes. In fact, they can be consumed on a personal daily basis in wide production industries. Their specificity can also be explained by the nature of their fabrication which follows a non-polluting process using eco-friendly primary products. These goods are also distinguishable by their specificity of use, as for example solar-powered cars. Some products are specialized in the recovery of other goods and in final waste disposal. Fig. 1 above draws a comparison between traditional environmental goods and environmentally preferable products.

A. « Class A » Environmental Goods

This class is relative to the set of traditional goods that encompass the different products and goods used in the process of environmental protection. As an example, it can include chemical goods and goods that are necessary for the transformation of raw materials into finished products. More specifically, these are goods whose activity is intended to maintain all the degraded waters, the products capable of managing the residues that cannot be re-used, and the goods needed to control pollution, and other products. It is worth noting that certain goods and products which are related to industrial production are categorized in "Class A" environmental goods to protect the quality of the environment. We can mention mechanical devices such as valves, but also machines used to compress gases or fluids.

B. Class B » Environmental Goods

« Class B » environmental goods are different from "class A" environmental goods in the sense that they are characterized by a special production process and by their consumption and destruction that do not hinder the environment. These consumption goods are used in the industrial sector and are not intended to solve environmental problems. However, their specific characteristics lie in their nature of production, their use, and their recycling which "possess positive environmental characteristics compared to other substitutable goods" ([17]). In this context, we can mention the different types of clothing whose production was based on natural fiber and on hightech equipment.

In the same way, this list integrates the various necessary equipments which do not require a lot of energy as well as low intensity production tools which are polluting or not-polluting and less energy-consuming. For the production of electrical energy, this includes all industrial equipment whose production is carried out through renewable energy sources ([17]). We extracted examples of environmentally preferable goods from "Class B" environmental goods.

Specifically, we identify "chlorine-free papers, natural and biodegradable fibers such as jute, sisal, natural dyes, organic soaps free of phosphate, water-based paints, natural rubber, gums and adhesives, tools and equipment needed to produce renewable energy, ethanol, and other lighting products that save energy, etc" ([17]). In the appendix, a detailed list of classification of environmental goods and their definitions proposed by the UNCTAD is exposed.

Despite the efforts of several global organizations to provide a clear and accurate list of environmental goods, the works of the WTO are mainly based on environmental goods defined by the "Class A" list belonging to the OECD and the APEC. As an example, we can cite the attempt of the UNCTAD which presented a new list named "EPP-core" whose products are similar to those categorized in the list of goods preferable for the environment (or Environmentally Preferable Product (EPP)) (Class B). All the goods in the "EPP-core" list consist of products designed for industrial use and individual consumption. It is the WTO, after few debates on the trade of environmental goods, which designated the products of this list as preferable goods for the environment according to their usage and their specific consumptions.

The goods in the "EPP-core" list are not qualified according to their production process or to the processes used in the respect of the quality of the environment. These are specific products for the environment due to the nature of their use, their destruction and even their recycling. In this list there are several goods which were already mentioned above in the list of environmentally preferable products (EPP). For all the goods of the EPP-core list, we did not identify any good related to green technologies, named "CT" (clean technologies) or related to "CT-fuels" (clean fuel technologies). These include two specific lists that are not included in the "EPP-core" list. Moreover, it is worth noting that these three different lists are not considered as definitive, and for this reason their approval by the WTO is not yet guaranteed. An exact definition of environmental goods is not yet obvious and depends on technological developments and the emergence of new products including the interest of countries in demanding goods that are beneficial for exports. The requirements of particular goods and their integration into existing lists vary from country to country. Thus, several countries ensure the protection of their markets by setting relatively expensive tariffs on some goods.

In what follows, we try to estimate the impact of "Class B" environmental goods (classified by the WTO) on the quality of the environment.

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C. Previous Studies

No research has been conducted yet on the causal relationship between trade liberalization in environmental goods and services and their effects on countries' economic growth and environmental quality. However, in her study, [19] developed a framework of analysis that will serve as a model for the present study. The results of my study will then be compared to the results of her analysis.

On the subject of trade liberalization, some studies addressed how trade in environmental goods and services influences the implementation of policies protecting the environment (e.g. [8], [9], [6], [11] – [3]). However, the effects of trade in environmental goods and services on countries' economic growth and environmental quality have been disregarded

References [8], [9], [6], [11] and [3] focused on the influence of trade in environmental goods and services on the implementation of environmental protection policy.

In their analysis, [2] justified the importance of the liberalization of environmental goods. In fact, trade in this type of goods increases the energy efficiency of importing and exporting countries and allows them to reduce pollutant emissions.

Such a result consolidates the idea presented by the WTO which attests to the importance of trade in this type of goods. The reduction of pollution can be explained by the right use of all environmental goods and the existence of other constitutive elements with indirect effects influencing the relationship between air pollution and the use of products reducing environmental pollution. Among the indirect factors influencing the reduction of polluting emissions, we can mention the importance of the environmental policy to be implemented. Since all economic activity creates pollution, the strengthening of environmental policy could reduce emissions. It is therefore considered as a fundamental element as it indirectly plays a significant role in the reduction of polluting emissions subsequent to the use and marketing of environmental goods.

The role of policy-makers consists in setting the right environmental policy while taking into consideration countries' entry into international markets and the need to reduce environmental damage. Countries' development and economic growth also have considerable mitigating effects on pollution. Developed countries are famous for their advanced techniques and technologies, which are available to increase social welfare and develop the industrial sector. For this reason, it goes without saying that technical progress plays an important role in offsetting the scale effect.

Any pollution generated as a result of the increase in the scale of production is reduced through the improvement of production processes and techniques ensuring a better quality of the environment. In addition, economic development contributes to reducing environmental damage through stable and effective environmental policies. In this context, the effectiveness of the environmental policy is a key element for the technical effect to lead to environmental improvement.

Technical effect is realized through the increase of income level through the accumulation of wealth. Raising the level of income therefore leads individuals to make some sacrifices in order to protect their environment and consume goods and services that do not cause environmental damage. In view of the fact that development is based on the level of income, any tax exemption in countries whose business activity is based on imports of environmental goods and services causes a decline in the level of income. For this reason, the environmental component cannot be made a priority.

We will try to focus on the effects that trade in environmental goods and services can have on the quality of the environment while taking into account the different elements influencing the improvement of the quality of the environment.

The commercial movements of environmental goods can be determined and influenced by various factors such as the effectiveness of the environmental policy and its sustainability, the obstacles in the economic environment, the evolution of people's needs and their demand for biological goods called "green" products and the new direction of companies towards new ecological technologies.

In the following sections, we will make an estimate of the direct and indirect effects of the trade liberalization of environmental goods on the quality of the environment according to a model based on three specific simultaneous equations. Such an estimate will take into consideration the previously mentioned elements that have an indirect influence on the trade of environmental goods. The indicator of environmental degradation chosen in this study is analyzed and explained in the first equation. We then focus on the theoretical framework developed in the work of [12] as well as [5].

In the second equation, we explain the environmental policy that is implemented and its effect on the sustainability and stability of the environment by focusing on some theoretical frameworks emphasizing the importance of such an indicator. Finally, for the third equation which aims to explain the variable of wealth expressed in terms of the per capita income variable, we rely on some theoretical analyses within the scope of the endogenous growth theory (See [13]).

III. EMPIRICAL VALIDATION

A. Estimation Model and Methodology

For a country "p" during a period (t), pollution is determined below by several factors presented as follows:

$$P_{ept} = f\left(VA_{pt}, va_{pt}, i_{(gross)\,pt}, PE_{pt}, Trade_{pt}\right)(1)$$

The added value achieved by each specific sector (vapt) depends in particular on the factors of production (capital endowments), labor and capital (capital stock) on which the composition effect depends. The labor factor is related to the entire working population, also called labor force. The added value (VApt) is relative to the overall added value for the whole economy. The variable (PE) expresses the demand for clean products to ensure the clean-up process. The variable (Trade) relates to a country's openness to international trade, and is expressed in terms of open rate.

The level of gross intensity of polluting emissions (i(gross)p) is expressed in terms of the production tools used (various Environmentally Preferable Product, EPP–core) products and Clean Production Technologies (CTP)). It also depends on the severity of the environmental policy implemented and the income level reached in an economy. Below is the specification of the gross pollutant intensity for a country "p" during a period of time (t), illustrated as follows:

$$i_{(gross)\,pt} = f\left(EPP\_core_{pt}, P_{env(pt)}, Rev_{pt}\right)(2)$$

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In this specification, the factor (EPP–core) refers to the trade intensity in Environmentally Preferable Product. We also emphasize the effectiveness and importance of environmental protection policy (Penv). (Revpt) refers to the per capita income level achieved in the economy which determines the capacity, the awareness of individuals and their commitment to protect the environment.

The technical effect is justified by considerable efforts made to reduce pollution and by the demand for clean technologies (CT) to ensure the clean-up process, as specified below:

$$PE_{pt} = f\left(CT_{pt}, Penv_{pt}, Rev_{pt}\right) \quad (3)$$

The demand for depollution is expressed in terms of trade intensity in clean technologies.

Based on theoretical assumptions, the coefficient of the parameters expressing the composition effect and the scale effect are expected to have a positive effect on pollution. However, given their importance in improving the environment, we expect the coefficients of the variables that express the technical effect to be negatively correlated with the level of pollution.

- The environmental equation

According to [11], the application of a rigid and strict environmental policy is not beneficial for industries exporting environmentally preferable goods and clean technologies. Similarly, for companies whose production activities are highly polluting, strict policies are likely to hinder their activities. In this sense, several companies are encouraged to relocate their activities to countries where environmental regulations are not rigid. The effect of trade intensity in Environmentally Preferable Product (EPP–core) as well as clean technologies (CT) on pollution is still ambiguous.

The specification of the environmental policy (Pevn) function and its key determinants are illustrated as follows:

$$P_{env(pt)} = f\begin{pmatrix} Freed\_index_{pt}, Corrup\_Cntr_{pt}, \\ POLITstab_{pt}, EPP\_core_{pt}, CT_{pt}, Trade_{pt} \end{pmatrix} \quad (4)$$

The term (Freed_index) is an indicator of democracy; (Corrup_Cntr) refers to corruption, and (POLITstab) expresses the political stability of a country. The other terms have been previously defined as (EPP–core), which is related to Environmentally Preferable Product; (CT) which expresses clean technologies. Finally, (Trade) is related to trade openness.

- The income equation

In order to define and clarify the various factors and determinants of the income function, we rely on an endogenous growth analysis found in the literature. Production depends on the capital stock and labor as well as countries' level of development. According to [15], the studies of [1] and [16] focused on the "institutional" and "geographic" factors and the importance of "international trade" in determining the factors of income level. This factor is considered crucial to the development and the growth of income in comparison with the geographical and international trade factor , ([17]).

In our analysis, we only focus on the institutional factor and the role of trade liberalization in the development of nations. In fact, the establishment of better institutions and the effectiveness of a country's political structure lead to its social and economic development ([15]. All these points have been developed thoroughly following a rich literature which justifies the role of all these factors in the economic development. International trade is seen as a factor of economic growth because of its positive and significant contribution to improving income level ([10]).

In our case study, the different determinants for a country (p) on which income (Rev) depends are illustrated as follows:

$$Rev_{pt} = f\begin{pmatrix} K_{pt}, L_{pt}, Freed\_index_{pt}, EPP\_core_{pt} \\ CT_{pt}, Trade_{pt} \end{pmatrix} \quad (5)$$

The terms K and L refer to the factors of production: the stock of available capital and labor. The quality of the institutions in this case is expressed in terms of the nature of the democratic regime that has been adopted. It is represented by the variable of civil liberties and political rights.

Our empirical validation will valorize the different effects of trade intensity in environmental goods on the quality of the environment. It is developed through a system of three simultaneous equations. Trade in environmental goods has a direct effect on the level of pollution and will be illustrated in the first equation. However, the second equation highlights the indirect effect that trade in environmental goods can have through environmental regulation and policy implementation. Finally, the third equation serves to test the indirect effect of trade in environmental goods through income.

Since the sum of the added values of the different production sectors represents the scale of the economy expressed as a function of the Gross Domestic Product (GDP), our final structural model is presented as follows (Pe is relative to pollution level):

$$P_{ept} = f\left(GDP_{pt}, Rev_{pt}, Penv_{pt}, EPP-core_{pt}, CT_{pt}, Trade_{pt}\right) \quad (6)$$

$$P_{env(pt)} = f\begin{pmatrix} Rev_{pt}, Freed\_index_{pt}, Corrup\_Cntr_{pt}, \\ POLITstab_{pt}, EPP\_core_{pt}, CT_{pt}, Trade_{pt} \end{pmatrix} \quad (7)$$

$$Rev_{pt} = f\begin{pmatrix} K_{pt}, L_{pt}, Freed\_index_{pt}, EPP\_core_{pt} \\ CT_{pt}, Trade_{pt} \end{pmatrix} \quad (8)$$

In this model, the variables of pollution, environmental policy and realized income are dependent variables.

B. Variables of the Model

The sample of developing countries in this study includes 21 low-income countries and 37 middle-income countries (see the appendix). Our estimate will cover the period 2005 to 2012 insofar as the indicator of environmental sustainability, which is expressed according to the effectiveness of the adopted environmental policy, is only available during this period. For OECD countries (21 countries), the estimate is made during the period between 1996 and 2015 since the variable of the environmental policy stringency index is available during this period for all these countries.

In order to estimate our model, we prepared a database that illustrates the different factors influencing the quality of the environment. In this sense, we presented a theoretical model based on three key dependent variables: pollution, environmental policy stringency and income level. The definition of the variables and the sources of data extraction are presented in Table 1.

TABLE I

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DEFINITION OF THE VARIABLES

Variables	Definition	Sources
PECO₂	CO_2 emissions (Metric tons per person) during the period 1995 – 2011.	*Energy Information Administration (2016)*
	For the year 2012, we relied on CO_2 emissions series in million tons after dividing each value by each country's population. (data is not available for some countries).	*Created and calculated by the author, based on the data of the BP Statistical Review of World Energy2016)*
Total population	Variable of the total population used to calculate CO_2 emissions per capita for the year 2012.	*World Bank (2016)*
GDP	GDP at constant prices ($US constant 2005).	*World Bank (2016), (WDI, (2016)) United Nation Statistics Division (2016) (National Accounts)*
TradeINT _ EPP / B	Trade Intensity in environmentally preferable products appearing on the EPP-core list. It is defined as a function of the share of exports and imports of EPP-core products in the overall exports and imports of goods.	*Created and calculated by the author, based on the data presented in UNComtrade Database (2016).*
TradeINT _ CT / B	Trade Intensity in clean technologies and Class B products. It is defined as a function of the share of exports and imports of "green" or clean technologies and products in the overall exports and imports of goods.	*Created and calculated by the author, based on the data presented in UNComtrade Database (2016).*
Trade_ICT	Trade in Information and Communication Technologies. This variable is calculated as a function of the sum of ICT goods imports (as a percentage of the total imports of goods) and ICT goods exports (as a percentage of the total exports of goods).	*Created and calculated by the author, based on the data presented in World Bank (2016), (WDI, (2016))*
Trade_SERV	Trade in services as a percentage of GDP. This variable is defined by imports and exports as a percentage of GDP (in US $).	*World Bank (2016), (WDI, (2016))*
GNP$_p$	Gross national income per capita, PPP (current international $).	*World Bank (2016), (WDI, (2016))))*
ISEP	Index of the severity of environmental policy. This index varies from « 0 » (low degree of environmental policy stringency) to « 6 » (high degree of environmental policy stringency) and it takes into consideration a set of 14 measures and instruments focusing on the quality of the environment and pollution	*OECD, (2016)*
	In the case of developing countries, the index is expressed as « CPIA policy and institutions for environmental sustainability rating". The classification varies between "0" (low) and "6" (high).	*World Bank (2016), (WDI, (2016))*
GFCF	Gross Fixed Capital Formation ($US constant 2005). This variable is used to calculate the capital stock.	*World Bank (2016)*
L	The labor factor is expressed as a function of the total working population.	*World Bank (2016), (WDI, (2016))*
K	The capital stock is calculated according to gross fixed capital ($US constant 2005). Method of calculation: we used a depreciation rate of 5%, fixed for most types of installations and equipments (Organisation de coopération et de développement économiques, (2001). Mesurer la productivité). *Capital stock = fixed capital (of the year (t)) + capital stock created (of the year (t-1)) - (5% of the capital stock created (of the year (t-1)).*	*Created and calculated by the author, based on the data presented in World Bank (2016), (WDI, (2016))*
K / L	Relative endowments in capital and labor. This variable is expressed as the quotient of the division of capital stock by labor (working population).	*Created and calculated by the author.*
Trade	The intensity of international openness is expressed as a function of The sum of exports and imports divided by the GDP (constant).	*World Bank (2016)); World Trade Organisation (2016), (WTO)* ▪ *UNCTAD Statistics Database (2016).* ▪ *Created and calculated by the author.*
Freed_Index	Democracy is measured by the civil liberty index and is calculated by a simple average of the political rights and the civil liberty index of each country (DP + IL) / 2.	*Created and calculated by the author, based on the data presented in Freedom House Organisation (2016)*
POLITstab	Indicator of political stability	*Kaufmann et al. (2006) Worldwide Governance Indicators (WGI), (2016)*
IC_imp	The concentration index on imports.	*UNCTAD Statistics Database (2016).*

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IC_exp	The concentration index on export.	*UNCTAD Statistics Database (2016).*
IDiv_imp	The import diversification index.	*UNCTAD Statistics Database (2016).*
IDiv_exp	The export diversification index.	*UNCTAD Statistics Database (2016).*

C. Estimation Technique

If we need to identify the direct and indirect effect of liberalization on the quality of the environment, we should opt for estimation methods that can clearly identify these effects. If we use the OLS method (Ordinary Least Square), the estimated results would only show a partial effect. In order to choose the adequate estimation method and valorize the different trade effects on the quality of the environment, we do estimations through Two-Stage Least Squares (2SLS) and Three Stage Least Squares regression analysis. For a more adequate method of estimation, we rely on the Hausman test results which are illustrated in the estimation tables

D. Estimation Results

In this part, we proceeded to the estimation of the three simultaneous equations previously developed by studying the impact of "Class B" environmentally preferable products on pollution. The choice of these two variables was based on the importance of the comparative advantage held by the majority of developing countries and all developed countries in the production of these goods.

We rely on two variables previously defined: trade intensity in the environmentally preferable products of the EPP-core list named (TradeINT_EPP/B) and trade intensity in "green" products, which are necessary to electricity production named (TradeINT_CT/B). The results of the estimates are presented in Tables 2, 3 and 4 and the results of the global effect which has been calculated are presented in Table 5 below.

In OECD countries, the intensity of trade in EPP-core environmentally preferable products has a direct negative effect with a negative and significant coefficient at the 5% level. This result is in line with theoretical assumptions since all these products are defined by a low polluting production process. The trade intensity in Class B EPP-core has a beneficial direct technical effect (negative sign (-0.23564), see Table 2) for the environment. In developing countries, the intensity of trade in EPPcore products has no significant direct effect on the level of pollution.

TABLE II
ESTIMATION OF THE DIRECT EFFECT OF TRADE INTENSITY IN CLASS B ENVIRONMENTALLY PREFERABLE PRODUCTS ON CO2 EMISSIONS USING THE TWO-STAGE LEAST SQUARES AND THREE-STAGE LEAST SQUARES METHODS.

Equation (1) : **Estimation of the direct effect on environmental quality**	**OECD countries (advanced economies)**	**Developing countries (middle-income and low income countries)**
	TMC	**TMC**
	Ln(ECO_2p)	**Ln(ECO_2p)**
ln(GDP)	1.70e-03 (0.77)	7.94e-04** (2.31)
ln(K/L)	-0.24838* (-1.90)	-0.03369 (-1.40)
ln(GNPp)	1.69363*** (4.40)	1.35189*** (16.72)
ln(ISEP)	-0.10059* (-2.30)	2.02728** (2.55)
ln(TradeINT _ EPP / B)	-0.23564** (-2.57)	-0.03010 (-0.64)
ln(TradeINT _ CT / B)	-0.55184*** (-3.44)	-0.10821 (-1.46)
ln(Trade_ICT)	0.10264*** (1.99)	-0.42548 (-5.02)
ln(Trade_SERV)	-0.72149*** (-4.84)	-0.51644*** (-2.61)
ln(Trade)	0.89648*** (6.18)	0.99587*** (5.12)
IC_imp	5.56835*** (3.84)	2.61798*** (2.95)
IC_exp	0.30326 (0.31)	-1.24982*** (-3.13)
IDiv_imp	-1.49293 (-1.42)	-2.81714*** (-2.67)
IDiv_exp	-0.30749 (-0.50)	0.74438 (0.75)
Constant	-15.33097*** (-5.16)	-14.37803*** (-9.52)
Hausman test : Prob>Chi2	0.9997	0.8636
Observations number	171	205

Notes: (***): Significance at the 1% level; (**): significance at the 5% level and (*): significance at the 10% level. Values in parentheses are relative to « t » of student. DMC: Two-stage Least Squares Technique. TMC: Three-stage Least Squares Technique

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TABLE III
ESTIMATION OF THE INDIRECT EFFECT OF TRADE INTENSITY IN CLASS B ENVIRONMENTALLY PREFERABLE PRODUCTS ON CO2 EMISSIONS VIA ENVIRONMENTAL POLICY, USING THE TWO-STAGE LEAST SQUARES AND THREE-STAGE LEAST SQUARES METHODS.

Equation of the environmental policy (2) : Estimation of the indirect effect via environmental policy	**OECD countries (advanced economies)**	**Developing countries (middle-income and low income countries)**
	TMC	**TMC**
	Dependant variable	
	ln(ISEP)	**ln(ISEP)**
ln(GNP_p)	0.31657** (2.27)	0.04407** (1.97)
POLITstab	0.04570 (0.56)	0.03672** (2.15)
Freed_index	0.00439 (0.05)	0.03352*** (3.40)
Corrup_Cntr	0.00167 (0.82)	0.12549*** (4.71)
ln(TradeINT _ EPP / B)	0.16496*** (3.51)	-0.01687 (-1.51)
ln(TradeINT _ CT / B)	0.44482*** (6.00)	0.00617 (0.30)
ln(Trade_ICT)	-0.00596 (-0.17)	0.06549*** (2.98)
ln(Trade_SERV)	-0.01409 (-0.13)	0.14414*** (5.11)
ln(Trade)	0.18023 (1.48)	-0.22297*** (-6.25)
IC_imp	1.88341** (1.99)	0.00071 (0.00)
IC_exp	1.55769*** (2.88)	0.27510*** (3.42)
IDiv_imp	-2.37408*** (-3.25)	0.05948 (0.21)
IDiv_exp	-0.68026* (-1.74)	-0.42667** (-2.03)
Constant	-1.92907 (-1.12)	1.11596*** (3.72)
Hausman test : Prob>Chi2	0.9997	0.8636
Observations number	171	205

Notes: (***): Significance at the 1% level; (**): significance at the 5% level and (*): significance at the 10% level. Values in parentheses are relative to « t » of student. DMC: Two-stage Least Squares Technique. TMC: Three-stage Least Squares Technique

TABLE IV
ESTIMATION OF THE INDIRECT EFFECT OF TRADE INTENSITY IN CLASS B ENVIRONMENTALLY PREFERABLE PRODUCTS ON CO2 EMISSIONS VIA INCOME, USING THE TWO-STAGE LEAST SQUARES AND THREE-STAGE LEAST SQUARES METHODS.

Equation of income (3) : Estimation of the indirect effect via income level	**OECD countries (advanced economies)**	**Developing countries (middle-income and low income countries)**
	TMC	**TMC**
	Dependant variable	
	ln(GNP_p)	**ln(GNP_p)**
ln(K)	0.33296*** (16.79)	0.74662*** (21.26)
ln(L)	-0.43581*** (-11.64)	-0.67154*** (-18.67)
Freed_index	0.00060 (0.77)	-0.231711*** (-4.04)
ln(TradeINT _ EPP / B)	0.10799*** (4.53)	-0.01848 (-0.77)
ln(TradeINT _ CT / B)	0.01283 (0.33)	0.09313** (2.18)
ln(Trade_ICT)	-0.06866*** (-3.81)	-0.02553 (-0.55)
ln(Trade_SERV)	0.13905** (2.42)	-0.00507 (-0.07)
ln(Trade)	-0.35910*** (-5.99)	0.21613*** (3.04)
IC_imp	1.61800*** (3.06)	-0.96090* (-1.95)
IC_exp	0.93480*** (3.42)	0.04448 (0.27)
IDiv_imp	-0.10404 (-0.29)	-0.97493* (-1.68)
IDiv_exp	-0.88636*** (-3.90)	0.30539 (0.64)
Constant	8.99067*** (16.90)	1.80627** (1.97)
Hausman test : Prob>Chi2	0.9997	0.8636
Observations number	171	205

Notes: (***): Significance at the 1% level; (**): significance at the 5% level and (*): significance at the 10% level. Values in parentheses are relative to « t » of student. DMC: Two-stage Least Squares Technique. TMC: Three-stage Least Squares Technique

At the level of the environmental regulation equation, the trade intensity in EPP-core increases the environmental severity. At the level of the environmental regulation equation, trade intensity in EPP-core increases the environmental severity. Thus, the increase in trade intensity in EPP-core has an indirect positive effect (0.01759) on pollution via environmental policy (which influences the level of income). For developing countries, trade intensity in EPP-core has no significant direct effect on the severity of environmental policy and the level of wealth achieved.

OECD countries are encouraged to market Environmentally Preferable Products (EPP) in order to reduce pollution. For developing countries, trade in these products does not bring any benefit to the preservation of the environment.

In the income equation, we observe that any increase in the trade intensity of EPP-core contributes to income growth, which explains that all OECD countries have a comparative

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advantage in the production of environmentally preferable products.

Since income increases pollution (direct effect) (see Table 2), trade intensity in EPP-core has therefore an indirect positive effect (0.18289) (Table (5)) on CO2 emissions via income. This results in an overall negative effect (-0.03516) generated by trade intensity in Environmentally Preferable Product (EPP) on CO2 emissions. The indirect positive effect on polluting emissions via income is offset by the direct technical effect of EPP-core intensity.

In OECD countries, trade intensity in clean technologies (CT) contributes to the reduction of CO2 emissions. It therefore has a direct negative effect (-0.55184). However, it has no direct effect on the environment in developing countries. For environmental regulation, trade intensity in CT has a positive effect on the severity of environmental policy in OECD countries and has no effect on income. As a result, trade intensity in these products has a negative total effect (-0.59658) consolidated by a direct technical effect and a negative indirect effect (-0.04474) via environmental policy (see Table 5).

TABLE V

GLOBAL EFFECT OF TRADE INTENSITY IN CLASS B ENVIRONMENTALLY PREFERABLE GOODS IN OECD COUNTRIES AND DEVELOPING COUNTRIES

Trade intensity	Direct effect	Air pollution : ECO_2p Indirect effect via : ISPE	GNPp	Global effect (direct effect + indirects effects)
OECD countries				
ln(TradeINT _ EPP / B)	-0.23564 (-)	ISPE → EPP (0.16496x-0.10059) + ISPE → GNPp → EPP (0.10799x0.31657) =0.01759 (+)	(0.10799x1.69363) =0.18289 (+)	(-0.03516) (-)
ln(TradeINT _ CT / B)	-0.55184 (-)	ISPE → EPP (0.44482x-0.10059) + ISPE→GNPp →CT pas d'effet =-0.04474 (-)	–	(-0.59658) (-)
Developing countries				
ln(TradeINT _ EPP / B)	–	–	–	–
ln(TradeINT _ CT / B)	–	ISPE→ CT pas d'effet + ISPE → GNPp → CT (0.09313x0.04407) =0.00410 (+)	(0.09313x1.35189) =0.12590 (+)	(0.13000) (+)

Note: For developing countries, the effects are calculated through the coefficients identified in the estimates of the three simultaneous equations based only on the significant coefficients of trade intensity in the following "Class B" environmental goods: TradeINT_EPP/B, TradeINT_CT/B, PSI variables and income variables.

Similarly, for all variables (EPP_core ans CT), the calculation method [19] of the total effect is as follows:

- Coeff(TradeINT_EPP/B)Eq(1)→Direct effect(1)
- [Coeff(TradeINT_EPP/B)Eq(2)*Coeff(ISEP)Eq(1)+Coeff (TradeINT_EPP/B)Eq(3)*Coeff(GNPp)Eq(2)]→Indirect effect via the policy of the environment (2)
- [Coeff(TradeINT_EPP/B)Eq(3)*Coeff(GNPp)Eq(1)]→ Indirect effect via income (3)

→ (1) + (2) + (3) = Total effect

For developing countries, trade intensity in CT has no effect on the severity of environmental policy, but has a positive effect on income. Similarly, increased wealth leads to increased pollution in developing countries. Trade in "green" technologies increases pollution with a positive overall effect resulting from a positive indirect effect (0.00410) generated by the environmental policy and amplified by a positive indirect effect through income. It is therefore not recommended for developing countries to focus on the trade liberalization of "green" technologies. Investment in research and development should be encouraged to reduce pollution caused by increased wealth.

Total trade openness, on the other hand, has a positive and significant direct effect in OECD and developing countries (Table 2)). Trade openness causes a negative scale-composition effect on the quality of the environment. It has no effect on the severity of environmental policy in OECD countries. However, it reduces the severity of environmental policy in developing countries, which justifies the "race to the bottom" phenomenon. In addition, it has a negative effect on income in OECD countries and increases wealth in developing countries.

In our study, we did not identify any technical effect in regards to the intensity of trade liberalization on the level of pollution in OECD and developing countries (see Table 2). Our results are contradictory to those illustrated in [5] and Dean (2002) who proved the existence of the technical effect which is generated by an increase in wealth (by offsetting the effect of scale). In OECD countries, trade openness does not contribute to increase the wealth of nations, unlike in developing countries (see Table 4).

IV. CONCLUSIONS

For both "Class B" lists of preferable goods, OECD countries are encouraged to market EPP (Environmentally Preferable Products) because they have a negative overall effect on carbon emissions, which is not the case for developing countries (no effects have been identified). Trade intensity in clean technologies (CT) contributes to the reduction of CO2 emissions in the case of OECD countries. For developing countries, trade in these products does not bring any benefits to the quality of the environment, hence the importance of focusing on trade in other types of products.

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In our study, we emphasized the importance of regulating the institutional environment through the severity of environmental policy which ensures the efficiency and the proper functioning of norms and standards. The high intensity marketing of environmentally friendly goods manifests itself in countries with effective regulations that contribute to reducing pollution.

By focusing on environmental regulation, it turned out that a marketing effect of environmental goods can be beneficial in countries possessing an effective regulation. In OECD countries, it is necessary to strengthen the institutional environment, the political stability and the control of corruption to increase the severity of regulations. In developing countries, a strict policy can affect the quality of the environment. For this reason, it is preferable to opt for more flexible policies that promote measures to reduce pollution.

In what concerns the liberalization of trade exchanges, the establishment of a workstream in favor of trading facilities in these types of goods seems necessary. It is important to opt for a decision allowing the removal of tariffs and barriers on environmental goods to enable all countries to benefit from their advantages.

It is recommended to encourage trade in environmental goods to stimulate economic growth and sustainable development. This will encourage the use of environmental technologies, which in turn can stimulate innovation and technology transfer.

Trade increase in clean goods and trade movements increases the demand for labor through the transfer of new technologies and skills which enables to create new jobs and reduce the level of unemployment. With regard to the World Trade Organization's negotiations on the subject of trade liberalization and its relation to the environment, future discussions should take into consideration the means necessary for the dissemination and ease of access to the environmental goods market.

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