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Territorial attractiveness, trade liberalization, and pollution: Evidence from Morocco between 1975 and 2015

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Abstract

The impact of trade liberalization on the environment has generated a heated debate recently. With rising concern over environmental quality, an investigation of the consequences of trade openness on the environment has become unavoidable. In this paper, we estimate an input-output structural decomposition analysis model to examine whether Morocco benefited from trade liberalization in terms of CO2 emissions. Particularly, we test whether Morocco can be regarded as a pollution haven before and after joining the World Trade Organization and implementing multiple multilateral and bilateral trade agreements (i.e., during 1975-1995 and 1995-2015). Results provide evidence that Morocco can be characterized as a pollution haven. An increase in trade for Morocco implies extra pollution. CO2 emissions embodied in exports become more important than emissions avoided by imports after trade liberalization, which can be explained partly by lax environmental regulations. Results also revealed that exports is among the most important final demand categories contributing to CO2 emissions growth in the Moroccan economy. France, Singapore, Spain, Italy, UK, the USA, Germany, and the Netherlands are among the top 10 export destinations with the highest emissions embodied in exports. Thus, the possible policy implications that one might draw is that some caution is needed in the future when further liberalizing trade. Trade liberalization has certainly its benefits in terms of economic growth. Nevertheless, the economic growth it produces is far from sustainable. Therefore, attempting to avoid such pollution haven phenomenon through legal and institutional infrastructure improvements has become a necessity. Since pollution is a global problem, cooperation among the various trading partners would assist in the advancement of technological innovation and sustainable growth which would improve environmental quality on a global scale.

Keywords: Territorial attractiveness; Pollution haven hypothesis; International trade; World trade organization; Input-output Structural decomposition analysis.
JEL Classification : C67; F18; Q01; Q27; Q56; Q58
Paper type: Empirical research

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1. Introduction

The dominant trend in the world economy in the last decades was towards liberalization of trade. This considerable expansion in international trade has raised among scholars and policy-makers serious concerns about trade's environmental consequences. It is in this vein that we investigate in this paper how trade liberalization affects pollution in Morocco. More specifically, we analyze the Pollution Haven Hypothesis (PHH) for Morocco. The PHH suggests that countries with laxer environmental standards have a comparative advantage in pollution-intensive industries and therefore they provide pollution-intensive products for the rest of the world (Cole 2004; Cole and Elliott 2003; Copeland and Taylor 2004). Compared with its major trading partners, Morocco can be considered as a developing country for which the assumption of low environmental standards does apply, especially because Morocco's main trading partners have binding emissions targets under the Kyoto protocol while Morocco does not (United Nations 1998).

We use carbon dioxide (CO2) emissions as a proxy for environmental pollution as CO2 is typically considered as the key driver of pollution (Tiba and Omri 2017). This study seeks to contribute to the literature by using an input-output (IO) structural decomposition analysis in order to provide insights and policy implications to help address sustainable economic growth policies for Morocco and developing countries in general. To the best of our knowledge, except for the study conducted by Achraf et al. (2020) on water footprint for Morocco, no previous (IO) structural decomposition analysis studies investigating particularly CO2 emissions were performed for this country. This paper aims to answer the following questions: (1) Is Morocco an attractive territory from the PHH perspective? (2) To which extent emissions embodied in exports are important compared to other final demand categories in the Moroccan economy? (3) What are Morocco's main trading partners in terms of emissions embodied in exports?

The rest of the paper is structured as follows. Section 2 discusses the literature review. Section 3 presents our empirical strategy. Section 4 reports the empirical results. Section 5 discusses these results and provides some relevant policy implications. Section 6 concludes the paper.

2. Literature Review

Extensive empirical studies have been conducted on the relationship between trade openness and environmental pollution. However, the debate has generated more heat than light since it still relics controversies. The empirical studies have reached mixed findings. Using different econometrics techniques, some studies have found that expansion in international trade volume intensified environmental pollution (Akomolafe, Danladi, and Oseni 2015; Balsalobre-Lorente et al. 2017; Dean 2002; He 2006; Jiang 2014; Kasman and Duman 2015; Kurniawan and Managi 2018; Managi and Kumar 2009; Ozturk and Acaravci 2013; Tamazian and Bhaskara Rao 2010; Tayebi and Younespour 2012; Wang, Liu, and Wang 2019). Some studies have found that expansion in trade volume improved environmental quality (Faiz-Ur-Rehman, Ali, and Nasir 2007; Frankel and Rose 2002; Kohler 2013; Shahbaz, Lean, and Shabbir 2012; Sousa, Hering, and Poncet 2015). Other studies found that the impact of international trade on the environment depends on the countries studied (Balsalobre-Lorente et al. 2017; Choi, Heshmati, and Cho 2010; Kim, Suen, and Lin 2018; Le, Chang, and Park 2016; Managi, Hibiki, and Tsurumi 2009).

The main reason behind the inconsistent results in the literature is the difference in the level of development of the countries investigated. Most studies agree that for developing countries international trade exacerbates pollution problems, while for developed countries it improves environmental quality. That is typically explained by the PHH. Thus, environmental pollution will be worst in developing countries with trade liberalization. Many papers tested the PHH in

different contexts and periods (Antweiler, Copeland, and Taylor 2001; Cole and Elliott 2005; Eskeland and Harrison 2003; He 2006; Hoffmann et al. 2005; Levinson and Taylor 2008; Neumayer 2001; Rezza 2013; Tang 2015). In this regard, a growing body of literature started adopting IO Structural Decomposition Analysis (SDA) models to analyze the PHH (Dietzenbacher and Mukhopadhyay 2007; Su and Ang 2013, 2014; Zhang, Guo, and Hewings 2014). For instance, the difference amid emissions embodied in exports and imports were used to calculate the emissions balance of trade and to test therefore the PHH (Chen and Chen 2011; Dietzenbacher and Mukhopadhyay 2007; Wilting, Hoekstra, and Schenau 2006).

The alternative for the PHH in the literature is the factor endowment hypothesis which suggests that developed countries specialize in exporting capital-intensive (dirty) products (Umed Temurshoev 2006). Decidedly, the debate on the relationship between international trade and pollution have stayed inconclusive, which calls for more empirical research.

3. Methodology

3.1. Environmentally-extended input-output model

The development of the CO2 emissions-extended IO model used in this paper entailed the construction of a basic IO model. CO2 emissions satellite accounts were integrated with this model. The standard Leontief IO model used (see Miller and Blair (2009) for an overview) can be expressed in matrix notation as:

$$\mathbf{x} = \mathbf{ax} + \mathbf{y} \tag{1}$$

Where :
(**x**): The gross output vector;
(**y**): The final demand vector;
(**a**): The technical coefficient matrix.
By solving for (**x**), we get:

$$\mathbf{x} = (\mathbf{i} - \mathbf{a})^{-\mathbf{1}}\mathbf{y} = \mathbf{ly} \tag{2}$$

Where:
(**i**): The identity matrix;
($\mathbf{l} = (\mathbf{i} - \mathbf{a})^{-\mathbf{1}}$): The Leontief inverse matrix, which shows the total sectoral production required to satisfy the final demand in the economy.

To quantify the CO2 emissions released to satisfy the final demand, we consider that each dollar sold by a given sector to other sectors corresponds to a fixed volume of CO2 emissions, which is known in literature as the homogeneity assumption. Therefore, the CO2 emissions-extended IO model can be expressed as:

$$\mathbf{P} = \mathbf{e}(\mathbf{I} - \mathbf{a})^{-\mathbf{1}}\mathbf{y} = \mathbf{ely} \tag{3}$$

Where:
(**P**) : The vector of CO2 emissions generated in the economic system directly or indirectly (i.e., Gigagram CO2);
($\boldsymbol{e}$): The diagonalized CO2 emissions vector depicting CO2 emissions intensity as the volume of CO2 emissions per unit of gross output (i.e., Gg per US dollar).
Vector **e** can be obtained by the following equation:

$$\mathbf{e} = \frac{e_j}{x_j} \tag{4}$$

Where:
(e_j): The volume of CO2 emissions in the sector (j);

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(x_j): The total economic output of sector (j).

3.2. Structural decomposition analysis models

The SDA performed in this study can be given as:

$$\Delta \mathbf{P} = \Delta \mathbf{elY} + \mathbf{e}\Delta \mathbf{ly} + \mathbf{el}\Delta \mathbf{y} \quad (5)$$

Each of the three terms in the right-hand side of the equation (5) represents the contribution of a contributing factor to the CO2 emissions changes ($\Delta \mathbf{P}$), other things held constant. More specifically, ($\Delta \mathbf{elY}$) represents the technological effect, ($\mathbf{e}\Delta \mathbf{ly}$) depicts the economic system efficiency effect, and ($\mathbf{el}\Delta \mathbf{y}$) represents the final demand effect. The latter reflects the CO2 emissions changes arising from changes in the final demand composition of different final demand categories. Final demand categories considered included Household final consumption, non-profit institutions serving households, government final consumption, Gross fixed capital formation, changes in inventories, acquisitions less disposals of valuables, and exports.

When analyzing the imports effect, we replaced ($\mathbf{el}\Delta \mathbf{y}$) by ($\mathbf{el}\Delta \boldsymbol{y_m}$), where $\boldsymbol{y_m}$ represents total final demand including imports. We calculated the imports effect by subtracting the total final demand without including the imports effect from the total final demand including the imports effect.

After calculating the exports and imports effects we verified whether the difference between emissions embodied in exports and emissions avoided by imports is positive. For a pollution haven, the exports effect is larger than the imports effect. The PHH tested in his paper does not mean that trade flows are only determined by pollution considerations. This study implies that there are other important factors taken into account, primarily factor endowment considerations.

When decomposing the change in CO2 emissions from a base time 0 to current time 1, the three drivers adopted in this paper have six first-order possible decomposition forms (Dietzenbacher and Los 1998). That is the non-uniqueness issue in SDA. With three drivers, the results would differ significantly depending on the adopted decomposition form (Dietzenbacher and Los 1998). Consequently, it is necessary to address the non-uniqueness problem. There are several methods for solving it. We average the polar decomposition forms as suggested by Dietzenbacher and Los (1998). This method is widely accepted in the literature (Arto and Dietzenbacher 2014) (see Hoekstra and Van Den Bergh (2002) for a detailed discussion). Accordingly, the final demand's contribution ($\Delta \mathbf{Y}$) to the CO2 emissions changes can be represented by:

$$\Delta \mathbf{Y} = \frac{\mathbf{1}}{\mathbf{2}}(\mathbf{f_0 l_0 \Delta y} + \mathbf{f_1 l_1 \Delta y}) \quad (11)$$

3.3. Data

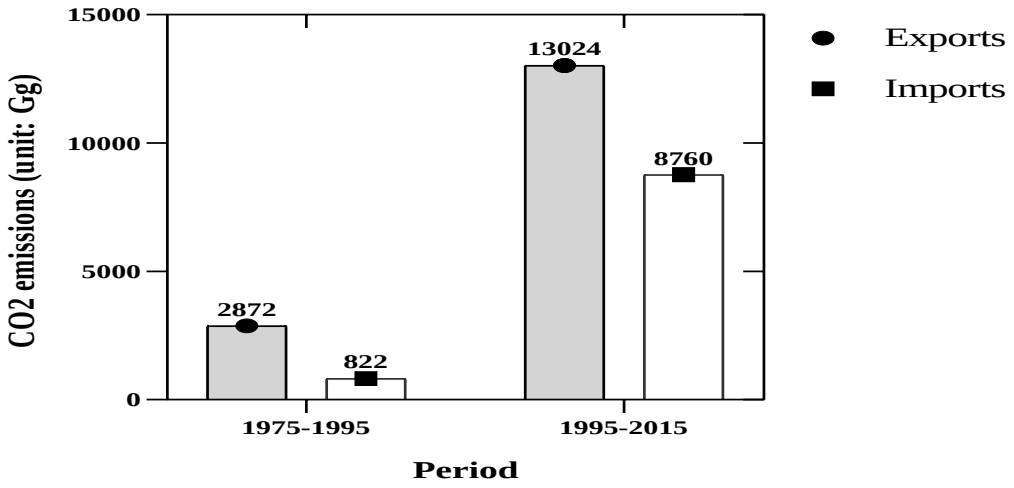
This study required three main datasets: IO tables and the corresponding CO2 emissions data for 1975, 1995, and 2015. In the same vein, the choice made by Morocco in the 1990s to liberalize its international trade through its tariff policy was a turning point in its development strategy. This trade policy reform was accomplished through adhesion to the World Trade Organization (WTO) in 1995 and the establishment of multiple bilateral and multilateral trade agreements. Tariffs were subsequently reduced significantly after 1995 (Berahab and Dadush 2020). Since the most recent published IO table for Morocco was 2015, our study used the period 1975-2015 and split it into two subperiods: 1975-1995 (Before Morocco's WTO membership) and 1997-2015 (After Morocco's WTO membership) to analyze the CO2 emission trends during the two subperiods in order to compare them. The datasets used in this paper were obtained from the Eora global MRIO database (Lenzen et al. 2012, 2013) which consists of time series data aggregated to 26 economic sectors and also provides CO2 emissions satellite accounts. To ensure consistency among IO tables, we converted the datasets into 2010

constant prices using implicit GDP price deflators as appropriate price indices do not exist. We divided the nominal GDP by real GDP in 2010 constant dollars extracted from the world bank's world development indicators database to obtain implicit GDP price deflators. The CO2 emissions satellite accounts contained in the Eora global MRIO database used in this study were primarily extracted from the Emission Database for Global Atmospheric Research (EDGAR).

4. Results

4.1. Pollution haven hypothesis test

Figure 1: Pollution haven hypothesis test results



Source: *Authors*

As aforementioned, our objective in this paper is to verify whether the difference between emissions embodied in exports and imports is positive. If the exports effect is larger than the imports effect, then we are in presence of a pollution haven. Figure 1 provides an overview of CO2 emissions embodied in exports and those avoided by imports between 1975 and 2015. During the 1975-1995 subperiod, CO2 emissions embodied in exports exceed emissions avoided by imports by 2050.3 Gg. During 1995-2015, CO2 emissions embodied in exports outbalances emissions avoided by imports by 4263.27 Gg. Results indicate that the trade effect increased by 2212.94 Gg in the 1995-2015 subperiod compared to 1975-1995, which is equivalent to a 107.93% growth rate.

4.2. Structural decomposition analysis of CO2 emissions from the final demand destination perspective

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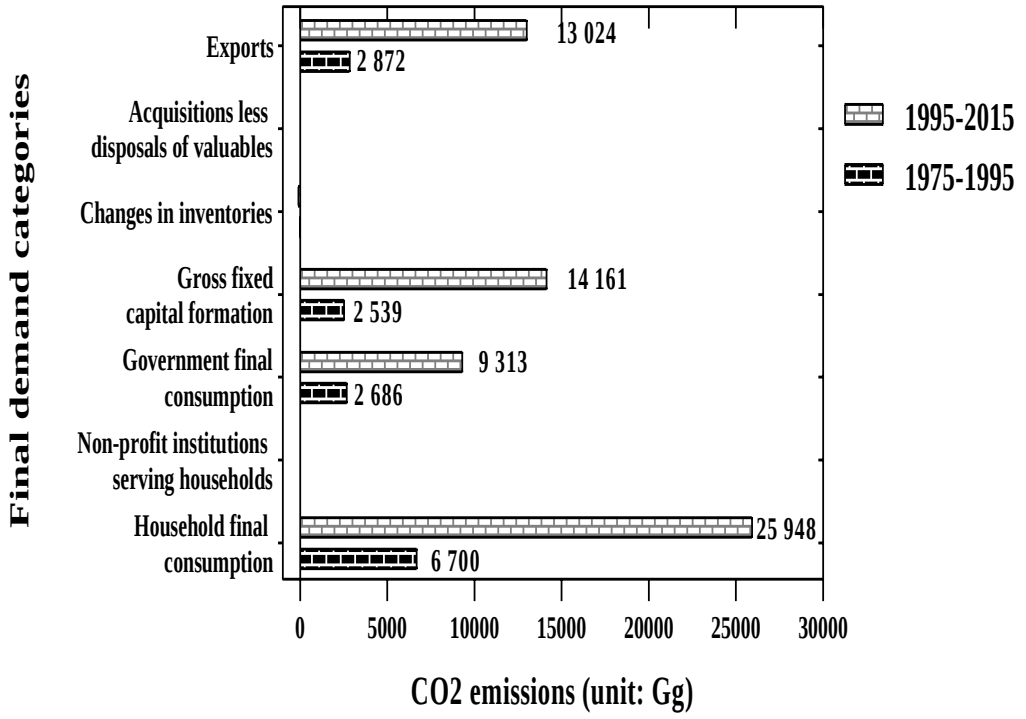
***Figure 2**:* Structural decomposition analysis of CO2 emissions from the final demand destination perspective



Source: *Authors*

In order to gain an overview of emissions embodied in exports compared to other final demand categories in the economy, we examined the sources of changes in CO2 emissions from the final demand destination perspective as shown in Figure 2. From 1975 to 1995, household final consumption followed by exports, government final consumption, and gross fixed capital formation played the most critical role in CO2 emissions growth. Changes in inventories followed by non-profit institutions serving households were the only categories contributing to CO2 emissions reduction, but their contribution was insignificant.

Between 1995 and 2015, household final consumption followed by gross fixed capital formation, exports, and government final consumption were the most important drivers behind the CO2 emissions growth as shown in figure 2. The contribution of changes in inventories, which was the only final demand category offsetting CO2 emissions, was too small to be significant.

4.3. Structural decomposition analysis of CO2 emissions from export destination perspective

Table 1: Structural decomposition analysis of CO2 emissions from export destination perspective results

1975-1995		1995-2015	
Country	CO2 emissions embodied in exports (Gg)	Country	CO2 emissions embodied in exports (Gg)
France	868.97	France	2581
USA	310.52	Singapore	1974.6
Spain	287.79	Spain	1457.29
Germany	258.65	Italy	801.66

Italy	233.03	UK	744.1
UK	179.52	USA	715.3
Japan	138.28	Germany	645.11
Netherlands	129.92	China	517.28
Belgium	94.92	Netherlands	404.43
Rest of World	341.75	Rest of World	3066.38

Source: *Authors*

Analysis of CO2 emissions changes from the final demand destination perspective reported in figure 2 indicated that exports is among the most important final demand categories contributing to CO2 emissions during the entire investigation period. A closer inspection of emissions embodied in exports in terms of countries of destinations revealed that France is the most important trading partner in this regard during both investigated subperiods as shown in table 1. The USA was the second most important trading partner in this respect during 1975-1995 and was replaced by Singapore during 1995-2015. The latter was not even a part of the 10 most important Morocco's trading partners in terms of CO2 emissions embodied in exports during the first subperiod. Spain, Italy, UK, the USA, Germany, and the Netherlands were among the top 10 trading partners during both subperiods.

5. Discussion

A positive trade effects during the entire investigation period indicates that Morocco can be regarded as a pollution haven. In this regard, after joining the WTO and implementing several bilateral and multilateral trade agreements with various countries including the European Union, the gap has widened between the exports and imports effects in terms of CO2 emissions. CO2 emissions embodied in exports has become to a greater extent more important than emissions avoided by imports after trade liberalization measures implemented by Morocco after 1995. Even if the effect of exports on pollution is partly offset by the effect of emissions avoided by imports, we can fairly say that trade openness is associated to an increase in pollution and comply with the pollution haven hypothesis in Morocco. These results are consistent with the aforementioned studies showing that increasing trade leads to an increase in pollution. The positive trade effect can be explained largely by an absence of eco-friendly technology, aging energy infrastructure, and lax environmental regulations (Apergis and Payne 2010; Tamazian and Bhaskara Rao 2010).

The findings of the study imply several policy implications in order to benefit from trade openness without aggravating pollution problems. The most important suggestion in this regard is the improvement of environmental quality in exports since these latter are vital for economic growth but involve extra pollution. The higher value-added and lower carbon-intense exports should be encouraged in this respect. Thus, efforts such as introducing eco-friendly technologies are urgently needed. Massive investment in research and development is crucial to overcome this. Harmonization of environmental standards in trade agreements in a way that responds to both profit and environmental concerns could be an ideal solution to mitigate the negative environmental impacts of trade openness, especially with countries found to be in the top 10 trading partners in terms of CO2 emissions embodied in exports (viz. France, Singapore, Spain, Italy, UK, the USA, Germany, and the Netherlands). It is also essential to implement energy policies that aim at encouraging the usage of renewable energy which will have a sustainable effect on economic growth.

6. Conclusion

This paper is designed to investigate the relationship between trade liberalization and pollution for Morocco for the period between 1975 and 2015. Particularly, the study attempts

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to test the pollution haven hypothesis (PHH) in Morocco using an input-output structural decomposition analysis model.

The results support the (PHH) for Morocco and verify the existence of a relationship amid trade openness and pollution in a way that extra trade exacerbates CO2 emissions. This could be explained partly by lax environmental regulations in Morocco compared to its major trading partners. These results do not imply that the (PHH) is the only factor that determines trade patterns. The (PHH) is only one factor among others. Benefiting from trade liberalization without exacerbating environmental problems is what Morocco's policies should seek in the future. The higher value-added and lower carbon-intense exports should be encouraged in this respect, especially exports to France, Singapore, Spain, Italy, UK, the USA, Germany, and the Netherlands.

So, is trade liberalization bad or good for the environment? Answering this question requires more careful empirical work. Future work should be seeking to improve the methods used and investigate a much broader spectrum of environmental indicators.

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