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# Assessing the Economic, Social and Environmental Effects of Trade Openness: An OECD Analysis

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**Abstract.** This study aims to examine the effects of trade liberalization on economic growth, income inequality, and $CO_2$ emissions, while also testing for the existence of both social and environmental Kuznets curves. To this end, three econometric models are employed. The first model analyzes the impact of trade openness on economic growth, the second investigates its effect on income inequality, and the third focuses on the relationship between trade openness and $CO_2$ emissions. The analysis is conducted using panel data for 24 OECD countries over the period 2005–2022. The methodological approach relies on panel data techniques, with estimations carried out using the fixed effects method. The empirical findings indicate that greater openness to international trade has a positive and statistically significant impact on economic growth by expanding markets, generating economies of scale, and enhancing productive efficiency in the countries studied. Furthermore, trade liberalization appears to increase income inequality, particularly between skilled and unskilled workers. From an environmental perspective, trade openness promotes the adoption of cleaner technologies, thereby contributing to a reduction in $CO_2$ emissions. Finally, the results confirm the existence of the Kuznets curve, revealing both U-shaped and inverted U-shaped relationships between GDP, income inequality, and $CO_2$ emissions within the estimated models.

## 1. INTRODUCTION

Following the oil shocks of 1973 and 1979, and the outbreak of the debt crisis in the early 80s, most countries implemented open-door policies and liberalized their trade under the aegis of the IMF and World Bank. The liberalization of trade and investment flows is of decisive importance in contributing to economic growth in OECD member countries, and these countries have seen a vast area of free trade in goods, and increased income and growth. In theory, classical economists such as A. Smith, Ricardo, Eli Heckscher, Berthil Ohlin and Paul A. Samuelson theorized that trade had a positive impact on growth. Samuelson put forward theories showing that trade have a positive impact on growth. The policy of free trade was defined by A. Smith, who explained the theory of international trade by reducing customs restrictions, and demonstrated the importance of foreign trade by confirming that “exchange is favorable to every country; every country finds absolute advantage in it while Ricardo, Eli Heckscher, Berthil Ohlin and Paul A. Samuelson were interested in comparative advantage,

However, the theories of Michael Posner (1961) and Raymond Vernon (1966) advocated a relationship between technological progress and trade liberalization policies, thanks to which developing countries could achieve high growth rates and catch up.A gravity model establishes a relationship between trade flows and the economic and geographical factors of countries, and is based on the principle of physical gravitation (Hummels and Levinsohn, 1995; Evenett and Keller, 1998),Wei Shang-Jin (1996),Harrigan (2001).

However, while this policy of trade openness has been beneficial for OECD countries, it has also been characterized by an increase in inequalities, particularly between skilled and unskilled workers. Similarly, while the driving role of trade in the economies of OECD member countries via the increase in demand for goods and services and productivity in exporting sectors, leading to serious effects, particularly on air quality and climate change, this pushes these countries to see a balance between economic growth, inequality and the environment. Although OECD countries are making efforts to minimize the environmental impact of their economic growth, pressures remain high due to unsustainable production and consumption patterns.

Despite progress in reducing pollutant emissions and introducing environmental regulations, international trade continues to play a major role in pollution and climate change.Wage inequalities within OECD countries have been exacerbated by economic globalization and trade openness, notably through international outsourcing and technological advances.Due to the off shoring of jobs to low-wage countries and increased automation, manufacturing jobs have shrunk and wages have become polarized, favoring highly-skilled workers to the detriment of the less-skilled. According to the hypothesis that trade liberalization stimulates growth, we can have this hypothesis verified and contribute to the reduction of inequalities, American economist Simon Kuznets 1955 shows that income inequality is a function of a country's degree of development, by means of an inverted U-shaped curve, In 1991, Grossman and Krueger proposed reproducing this idea in the environmental field. The terminology Environmental Kuznets Curve (EKC) did not appear, however, until Panayotou's 1993 article.

Empirical studies focus on the impact of international trade on the “growth-inequality-environment” triangle.Today, this issue is at the heart of global economic concerns, most studies show that openness is a real catalyst for growth, making the economy more responsive to external shocks (Sach and Warner (1995), Harrison (1996), Edwards (1998), Dollar (1992), Ben-David (1993)).While the correlation between inequality and trade openness is unclear, many studies suggest that openness worsens inequality (Barro, 1999; Spilimbergo and al. (1999); Lundberg and Squire, 2003) and other studies have concluded that trade openness can reduce inequality (Dollar, 2000; Dollar and Kraay, 2001).

Empirical studies of the impact of openness on the environment show that international trade liberalization can have a variety of consequences, with some studies finding that trade positively affects environmental quality, Antweiler and al. (2001), EL

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Moummy, C, Salmi, Y. & Baddih, H. (2021),Coulibaly, S. & Cissoko, A. (2024) etc. Other studies highlight the importance of integrating environmental measures and regulations into trade agreements, in order to promote sustainable development Dean (1998), Baghdadi and al (2013), Michieka and al. (2013) etc.

In this article, a key question is posed: “How does trade openness influence economic growth, internal income inequality and $CO_2$ emissions within OECD member countries?”

Our empirical study covers 24 OECD countries from 2005 to 2022. It is based on the fixed-effects method, which enables us to analyze the direct economic, social and environmental impacts of trade liberalization.

This study analyzes the effects of trade openness on economic growth, income inequality, and $CO_2$ emissions in 24 OECD countries from 2005 to 2022, within the historical and theoretical context of trade liberalization. Section 2: Literature Review. Section 3: Methodology. Section 4: Results and discussion. Finally, Section 5: Results and Conclusion.

## 2. LITERATURE REVIEW

The aim of these empirical studies is to examine the impact of international trade on the “growth-inequality-environment” triangle, a subject that is currently of prime interest to all economists. Empirical studies aim to test whether or not trade openness has a negligible effect on internal income inequality, economic growth and the environment. Trade openness and economic growth have attracted considerable interest since the 1990. Sachs and Warner (1995) show that countries with open policies achieve higher growth (4.5% per year) than those with protectionist policies (0.7%), although the relationship is difficult to prove robustly. Baldwin and Seghezza (1996) emphasize the role of openness-induced investment and technology as drivers of growth, supported by the work of Coe and Moghadam (1993)and Coe and Helpman (1995).Harrison (1996) confirms a positive correlation between openness and growth using different estimation methods. Edwards (1998), analyzing 93 countries over the period 1960-1990, concludes that openness boosts total factor productivity and favors long-term growth. Frankel and Romer (1999) use an instrumental variable method to demonstrate a significant effect of foreign trade on growth. Studies on trade openness and economic growth show varied results across regions and contexts.Abdouni and Hanchane (2006) used an endogenous growth model on 47 developing countries (1980-1997) and concluded that trade openness stimulates growth via access to foreign knowledge, despite a non-significant effect of human capital. Mansouri (2009), studying Morocco (1970-2005), found that FDI alone had no significant effect, but combined with trade liberalization, it had a positive impact. Bechtini and Hassen (2018) confirmed a bidirectional relationship between openness and growth in Tunisia (1980-2014), with a key role for FDI via technological externalities. Sekkach (2021) observed that trade openness has had a major effect on growth in sub-Saharan Africa (1981-2019), mainly influenced by physical capital and population growth. The work of Mtiraoui A. (2015) highlights trade openness as a key driver of economic growth, through market expansion, economies of scale, and improved productive efficiency. Spilimbergo, Londono and Szekely (1999) analyzed the impact of trade openness on income distribution as a function of factor endowments. They conclude that capital- and land-intensive countries have a more egalitarian income distribution, while labor-abundant countries have more inequality. The effect of openness varies according to a country's comparative advantage: it reduces inequality in countries rich in physical capital, but accentuates it in those abundant in skilled labor. Feenstra and Hanson (1996) show that openness mainly benefits skilled workers in developing countries, accentuating internal inequalities.

Similarly, Harrison and Hanson (1999), studying Mexico, find that trade reforms favor skilled workers over unskilled, widening wage differentials. Dollar and Kraay (2001) point out that the opening up of trade since the 1980s has enabled developing countries to catch up with richer countries, highlighting a strong correlation between trade and economic growth, with an indirect effect on poverty reduction. Finally, using the Gini index, Kahai and Simmons (2005) show that economic openness accentuates inequalities in developing countries, while its effect remains negligible in industrialized countries. Panel data analyses carried out by a number of researchers highlight the contrasting effects of trade liberalization on income inequality, depending on countries' level of development.Yenipazarli and Kucukkaya (2016) conclude that trade liberalization has no significant impact on low-income countries but increases inequality in middle-income countries, while the effects in rich countries remain complex. Muzammil et al (2018) show that trade openness, combined with education and the ratio of skilled to unskilled workers, reduces income disparities, although technology transfer exacerbates inequality in developing countries.D'Elia and De Santis (2019) find that openness promotes economic growth, particularly for low-income OECD countries, but its effect on inequality remains insignificant. Wade (2020) emphasizes the key role of trade and finance in reducing poverty and inequality, while highlighting the vulnerability of developing countries to external shocks. ElAlaoui et al (2023) , Woulkam and al (2023) show that the COVID-19 crisis has exacerbated income disparities and increased unemployment, particularly in Africa. Finally, the study by Elbejnouni and L. Zouiri (2024) analyzes the impact of openness and economic growth on income inequality in 30 developing countries between 1980 and 2017, using a fixed-effects specification.

The results show a significant relationship between GDP per capita and income growth among the wealthier classes, to the detriment of other segments of the population. However, the effect of trade and financial openness remains statistically insignificant. On the other hand, education appears to be a decisive factor in reducing income inequality.With regard to the environment Empirical studies on the impact of trade liberalization on the environment show contrasting results. Antweiler and al (2001) analyzed the impact of trade openness on $SO_2$ concentrations in 44 countries and found that a 1% increase in GDP due to liberalization leads to an equivalent reduction in emissions, highlighting the importance of incorporating environmental measures into trade agreements. Cole and al (1998) examined the effect of the Uruguay Round on various air pollutants between 1990 and 2000 and found an increase in $NO_2$ emissions in all regions studied, while other pollutants decreased in developed countries but increased in developing countries, illustrating the environmental disparities between these groups.

Dean (1998) studied the effect of liberalization on chemical oxygen demand in China, revealing a deterioration in water quality and underlining the need for appropriate environmental policies. Jalil and Mahmud (2009) confirmed the Environmental Kuznets Curve (EKC) for China, showing a quadratic relationship between income and CO2 emissions, while Baghdadi et al. (2013) demonstrated that CO2 emissions converge in free trade agreements incorporating environmental clauses. Michieka et al. (2013) revealed a causal relationship between Chinese export growth and rising CO2 emissions, suggesting that policies to reduce coal consumption could mitigate these effects. Haq et al. (2016) observed that trade openness in Morocco failed to verify the EKC curve, while Dogan and Turkekul (2016) found that in the US, energy consumption and urbanization increased pollution, but trade could improve environmental quality. Geoffroy et al. (2019) studied Cameroon and confirmed that economic growth has a negative short-term impact on the environment, but positive in the long term, although trade openness has a detrimental effect.

In Morocco, El Moummy and al. (2021) have shown that renewable electricity generation does not yet have a significant impact on growth, but that trade openness plays a key role in the technology transfer necessary for clean energy development. Coulibaly

and Cissoko (2024) found a positive relationship between trade and pollution in Mali, both in the short and long term. Gharnit et al (2020) validated the pollution paradise hypothesis in Morocco, showing that foreign direct investment reduces CO2 emissions in the short term but increases them in the long term.

Senzele (2022) confirmed the EKC curve hypothesis in Côte d'Ivoire, where emissions are mainly influenced by energy, urbanization and industry, and recommended a transition to green growth. Lastly, Alfidi and Machrafi (2024) have highlighted the importance of policy reforms accompanying trade liberalization in Morocco to meet the challenges of climate change, particularly in the agricultural sector.

Mtiraoui; A. et al. (2024)[1] extends the analysis to the environmental dimension, emphasizing the role of economic openness and technological progress in promoting the energy transition and reducing pollutant emissions for MENA region. This study builds on these contributions by jointly examining the effects of trade openness on economic growth and environmental outcomes. These studies show that the impact of trade on the environment depends on the policies adopted and the economic specificities of each country.

## 3. RESEARCH METHODOLOGY

We begin by presenting the methodology used for our study, before analyzing the estimates and discussing the conclusions, while recalling the variables and models of our study and the data we used. Our analysis covers 24 OECD member countries(Argentina, Armenia, Austria, Belgium, Brazil, Colombia, Costa Rica, Denmark, Ecuador, Finland, France, Germany, Greece, Italy, Luxembourg, Netherlands, Panama, Paraguay, Peru, Poland, Portugal, Spain, Sweden, United Kingdom) covers the period from 2005 to 2022.

This study aims to empirically analyze the existing effects between trade openness - economic growth, openness, inequality and openness, environment and to answer specific hypotheses seem relevant:

*$H_1$: The policy of openness has a significant impact on economic growth in OECD countries.*

*$H_2$: Trade openness is a key factor explaining the increase in inequalities.*

*$H_3$: Trade openness has either a positive or negative impact on the environment.*

*$H_4$: The Kuznets curve hypothesis remains valid in both social and environmental terms.*

To do this, we'll take three models based on the fixed-effects method for the economic, social and environmental impact of trade liberalization.

$$Ln(Pib)_{it} = \alpha_0 + \alpha_1 ov_{it} + \alpha_2 pop_{it} + \alpha_3 tech_{it} + \alpha_4 infl_{it} + \alpha_5 ln(urbn)_{it} + \alpha_6 \ln(co2)_{it} + \alpha_7 Gini_{it} + \varepsilon_{it} \quad (1)$$

$$\ln(co2)_{it} = \alpha_0 + \alpha_1 ov_{it} + \alpha_2 \ln(urbn)_{it} + \alpha_3 rsn_{it} + \alpha_4 Ln(Pib)_{it} + \alpha_5 (pib_{it})^2 + \alpha_6 (pib_{it})^3 + \varepsilon_{it} \quad (2)$$

$$Gini_{it} = \alpha_0 + \alpha_1 ov_{it} + \alpha_2 educ_{it} + \alpha_3 Ln(Pib)_{it} + \alpha_4 (pib_{it})^2 + \varepsilon_{it} \quad (3)$$

Where “i” represents each country and “t” represents each time period (with t = 1, 2,.....T),

α: Coefficients of the explanatory variables in the model, ε is the error term.

$\varepsilon_{it}$ : Error term specific to country i and period t.

These three equations form a simultaneous equations model inspired by Mtiraoui A, (2025) capturing the interdependent relationships between economic growth, $CO_2$ emissions, and income inequality. The empirical analysis requires tests of endogeneity and simultaneity (Hausman, Durbin–Wu–Hausman), as well as identification and validity tests of the system, followed by appropriate estimation methods (such as fixed effects or instrumental variables).

Table 1. Variables used in the models.

| List of Abbreviations | Variables | Source |
|---|---|---|
| Ln(Pib):gdp log | Economic growth: GDP per capita (constant 2015 US$) | |
| Ov | Trade (% of GDP): | |
| pop | Population growth (annual %) | |
| tech | Individuals using the Internet (% of population) | |
| infl | Inflation, GDP deflator (annual %) | |
| ln(urbn):urbnization log | Urban population (% of total population). | |
| ln( co2): co2 log | emissions (metric tons per capita) | The World Development Bank (WDI) |
| Gini | The Gini index | |
| rsn | Total natural resources rents (% of GDP | |
| educ | School enrollment, secondary (% gross) | |
| $(pib)^2$ | GDP squared: The level of GDP per capita | |
| $(pib)^3$ | GDP cube: The level of GDP per capita | |

Note:** Using the natural logarithm improves estimation quality by making relationships more linear, stabilizing variance, simplifying interpretation and reducing the influence of extreme values.

**: *$(pib)^2$, $(pib)^3$* we will empirically verify the threshold effect. We will also verify the existence of the U-inverted environmental and social Kuznets curve.

This sample was chosen according to data availability (WDI) to enable us to estimate each of the trade openness-growth, openness-environment and openness-inequality effects for a period spanning 2005-2022, so our three models seem relevant in this respect.Our methodological approach is essentially based on panel data analysis, and estimation using the “static panel” method seemed the most effective for all three models, in order to address the direct influence of trade openness on economic growth, the environment and inequalities.Standard OLS estimators are no longer optimal, and the standard methods for estimating the so-called “Static Panel” are fixed effects or random effects. When both fixed- and random-effects models are validated, the Hausman test is generally used to discriminate between them. The Hausman (1978) specification test can be used as a means

[1] Mtiraoui, A., et. al. (2024). Institutional quality and economic growth in the energy transition of MENA countries. *International Journal of Energy Economics and Policy* 14 (6), p.p. 605 - 613.

of evaluation. The null hypothesis of this test is the presence of random effects, but in each case for the three models, we rejected the null hypothesis and accepted the Withen estimator (existence of fixed effect) from the 10% threshold. The method we will adopt is inspired by the work of Guillerm, M. (2017), Quamar, T., Maniani, A., & Fawzi, S. (2020), Berthélemy, J. C., Dessus, S., & Varoudakis, A. (1997) ,Tsafack Nanfosso, R., & Nguena, C. L. (2015) and others.

## 4. ANALYSIS OF RESULTS

In this section, we present the results of our estimations and their interpretations. We then begin our study with preliminary analyses of descriptive statistics and correlation.

Table 2. Descriptive statistics.

| Variables | Observations | Mean | Std. dev. | Min. | Max. |
|---|---|---|---|---|---|
| Ln(pib) | 432 | 9.89392 | 0.9257686 | 7.746293 | 11.62998 |
| Gini | 432 | 37.10833 | 8.938209 | 25.1 | 56.3 |
| Ln(co2) | 432 | 1.467044 | 0.7570718 | -0.4071472 | 3.243 |
| ov | 432 | 87.76657 | 61.20644 | 22.10598 | 393.1412 |
| pop | 432 | 0.6634186 | 0.7069181 | -2.482061 | 2.430976 |
| tech | 432 | 66.74355 | 23.76905 | 5.252983 | 98.86585 |
| infl | 432 | 4.127569 | 6.941694 | -2.491021 | 69.47124 |
| educ | 432 | 106.9053 | 19.07354 | 60.55744 | 164.0798 |
| rsn | 432 | 1.811755 | 3.151215 | 0.0047514 | 18.96187 |
| Ln(urbn) | 432 | 4.328726 | 0.1506835 | 4.045067 | 4.586527 |

Note** :This part of the panel data generates a statistical summary of the specified variables, displaying the mean, standard deviation, minimum and maximum values, as well as the sum total of the values. It also shows the number of non-missing observations, helping to understand the distribution and quality of the data.

The descriptive statistics show that GDP per capita and urbanization levels are relatively high and stable across OECD countries, while trade openness, $CO_2$ emissions, and income inequality vary considerably. Population growth is generally low, and technology adoption is widespread but uneven across countries. Inflation and natural resource dependence display high variability, indicating differences in economic conditions and resource reliance. Overall, these variations justify the use of panel data analysis to study the effects of trade openness on growth, inequality, and environmental outcomes.

Table 3. Correlations between variables.

| | Ln(pib) | Gini | ln(co2) | ov | pop | tech | infl | educ | rsn | ln(urbn) |
|---|---|---|---|---|---|---|---|---|---|---|
| Ln(pib) | 1.0000 | | | | | | | | | |
| Gini | -0.7324 | 1.0000 | | | | | | | | |
| Ln(co2) | 0.8589 | -0.7778 | 1.0000 | | | | | | | |
| Ov | 0.5316 | -0.3416 | 0.5197 | 1.0000 | | | | | | |
| Pop | -0.0884 | 0.5045 | -0.2396 | 0.2762 | 1.0000 | | | | | |
| Tech | 0.7621 | -0.6597 | 0.6163 | 0.3625 | -0.1637 | 1.0000 | | | | |
| Infl | -0.2317 | 0.2916 | -0.1963 | -0.1839 | 0.2025 | -0.1455 | 1.0000 | | | |
| Educ | 0.5294 | -0.5597 | 0.4591 | 0.1487 | -0.2381 | 0.6054 | -0.1263 | 1.0000 | | |
| Rsn | -0.5851 | 0.5385 | -0.4891 | -0.2892 | 0.3045 | -0.4723 | 0.1680 | -0.3212 | 1.0000 | |
| Ln(urbn) | 0.4636 | -0.2223 | 0.3262 | 0.2234 | 0.1319 | 0.4732 | 0.1761 | 0.5892 | -0.1302 | 1.0000 |

Note**: Correlations between variables are below 0.8, meaning that they are moderately related. This reduces the risk of high multicollinearity and enables clearer interpretation of individual effects in statistical analyses.

Table 4. The openness on economic growth, the environment using the fixed-effects method: OECD case.

| **Model 1** | | | |
|---|---|---|---|
| ***Ln(pib)*** | **Coefficient** | **Std. Erreur.** | **P>\|z\|** |
| *ov* | 0.0006756 | 0.0002969 | 0.023*** |
| *tech* | 0.0033081 | 0.0003486 | 0.000*** |
| *pop* | 0.0231287 | 0.0108774 | 0.034*** |
| *infl* | -0.0016241 | 0.0009621 | 0.092*** |
| *Ln(urbn)* | 0.482273 | 0.2183402 | 0.028*** |
| *Ln(co2)* | 0.2028762 | 0.0283019 | 0.000*** |
| *Gini* | -0.0122795 | 0.0026617 | 0.000*** |
| *Constant* | 7.675601 | 0.9668988 | 0.000*** |
| Model 2 | | | |
| *Ln(co2)* | | | |
| *ov* | -0.0032033 | 0.0005083 | 0.000*** |
| *Ln(urbn)* | -3.072137 | 0.2689749 | 0.000*** |
| *rsn* | 0.0036203 | 0.0037192 | 0.331 |
| *Ln(pib)* | -21.38259 | 7.861438 | 0.007*** |
| $(pib_{it})^2$ | 2.707431 | 0.8496931 | 0.002*** |
| $(pib_{it})^3$ | -0.1088375 | 0.0304602 | 0.000*** |
| *constant* | 67.40478 | 24.26339 | 0.006*** |
| Model 3 | | | |
| *Gini* | | | |
| ***Ov*** | 0.0126511 | 0.0063247 | 0.046*** |
| ***éduc*** | -0.0167354 | 0.0085305 | 0.051*** |
| ***Ln(pib)*** | -43.58027 | 8.884563 | 0.000*** |
| $(pib_{it})^2$ | 1.928199 | 0.4930497 | 0.000*** |
| ***Constant*** | 278.5607 | 39.68611 | 0.000*** |

**Note**: *** indicates significance at the 10% level.

Our first model results, presented in the table, show that our variables have globally positive and significant coefficients on economic growth, except for inflation and the Gini index, which have negative coefficients and affect growth negatively in OECD member countries. Openness to trade and foreign direct investment (FDI) is a key driver of economic growth in OECD countries. Trade and investment stimulate economic growth, employment and development by improving resource allocation and competition, and facilitating the spread of technology and knowledge. Since the 1990s, OECD countries have engaged in more open international trade, and have seen an increase in their economic growth and an improvement in their standard of living. Open trade give OECD countries access to larger markets, stimulating demand for their products. It fosters innovation and competitiveness by encouraging companies to improve their efficiency in response to increased competition. What's more, importing goods and services at lower prices reduces costs for consumers and businesses alike, and therefore mutual benefits (collective welfare). By facilitating foreign investment, trade openness also strengthens infrastructure and productive capacity. Together, these factors contribute to sustained economic growth.. This result is interpreted in line with the theoretical prediction as A. Smith, Ricardo, and Eli Heckscher, Berthil Ohlin and Paul A. Samuelson implemented theories showing that trade has a favorable impact on growth. These results coincide with the empirical work of (Baldwin and Seghezza, 1996) (Coe and Moghadam, 1993), (Coe and Helpman, 1995) and (Brecher, Choudhri and Schembri, 1996*).* Technology has an expected sign for our estimation. It seems positive and significant for OECD economies. Research and development has a positive impact on growth and benefits trading partners through technology spillovers, which in turn increases total factor productivity (TFP) and GDP growth. In other words, technology has direct positive effects on production (productivity gains, value added) and on the modernization of production equipment. In recent years, OECD countries have witnessed the development of new information and communication technologies (NICTs), with strong communication links between trading partners fostering the transmission of knowledge, the invention of new manufacturing methods and more efficient work reorganization. Technology plays a crucial role in economic growth in OECD countries, boosting efficiency and productivity in various sectors. Technological innovation enables companies to automate processes, thereby reducing production costs and increasing output. It also encourages the development of new products and services, opening up markets and creating jobs. In addition, advanced technologies improve the quality of goods and services, stimulating domestic and international demand.

In addition, they facilitate access to information and knowledge, boosting business competitiveness. Digitization and information technologies improve infrastructures, making services more efficient and accessible. Finally, technology encourages foreign investment by creating more attractive business environments. These combined effects contribute to sustainable, robust economic growth in OECD countries. Demographic growth can stimulate economic growth in OECD countries by increasing the size of the workforce, thereby boosting production and consumption. A growing population generates greater demand for goods and services, encouraging companies to invest and expand. It can also lead to a greater diversity of skills and innovations, enriching human capital. A young and growing population also encourages entrepreneurship and the creation of new businesses. In addition, a growing working population can boost tax revenues, enabling more investment in infrastructure and public services. High inflation can have a significant negative impact on economic growth in OECD countries. It threatens consumers' purchasing power, reducing their ability to buy goods and services, which can dampen aggregate demand. Companies are faced with high production costs, accompanied by falling added value and profits, which can lead them to raise prices, reducing their competitiveness in international competition. In addition, inflation can lead to higher interest rates, increasing the cost of credit and curbing investment and consumption. Finally, it can destabilize financial markets and lead to economic instability, complicating planning and decision-making for businesses and households.

In general, OECD countries are characterized by relatively moderate inflation rates compared with other regions of the world. However, periods of high inflation can occur in response to various economic factors, such as the COVID-19 pandemic, energy crises, supply chain disruptions or expansive monetary policies. Central banks in OECD countries carefully monitor inflation and adjust monetary policies to maintain price stability and support economic growth. Urbanization can stimulate economic growth in OECD countries by concentrating human, financial and material resources in densely populated areas. This promotes efficiency and innovation by facilitating interaction between companies, workers and consumers. Cities become dynamic economic centers, attracting foreign and local investment. Urbanization also improves infrastructure, such as transport and communications, increasing productivity and connectivity between different economic agents. It enables economic specialization and the creation of new business sectors thanks to a greater concentration of knowledge and skills. In addition, urban areas foster the development of modern services and infrastructure, improving quality of life and attracting more investment. Finally, well-planned urbanization can generate economies of scale, making services more efficient and accessible.CO2 emissions, while having negative environmental effects, have historically been associated with economic growth in OECD countries, due to their link with industrial development and increased production. During the period of industrialization, CO2 emissions accompanied infrastructure expansion, job creation and improved living standards thanks to the increased production of energy and goods. Fossil fuel-based industries contributed to rapid economic growth by fuelling the expansion of the manufacturing and transport sectors. Moreover, abundant, inexpensive energy has enabled investment in modern infrastructure and technology, further stimulating growth. However, it is essential to note that the positive effects of these emissions are accompanied by negative effects on climate and health, prompting OECD countries to continually seek more sustainable measures to support economic growth while reducing carbon emissions. In our estimation, the Gini index, which measures internal income inequality, is represented by Gini coefficients and has an expected impact on economic growth. Internal income inequality can hamper economic growth in OECD countries by limiting consumption and development opportunities for a significant proportion of the population. When incomes are unequally distributed among workers, this can lead to low demand for goods, as people with low incomes have a more limited capacity to consume. This reduces overall demand for goods and services, which can slow business growth and investment. Inequality also creates barriers to education and training, and so can stifle innovation. In addition, it can lead to social and political conflict, accompanied by instability that can discourage foreign investment. High levels of inequality can also drive substantial public spending towards social support programs, reducing the resources available for productive investment. In short, income inequality can create economic and social imbalances that hinder healthy, sustainable economic growth. With regard to the second model, the first thing to conclude is that all the coefficients of the variables explained are statistically significant, except for natural resources.

In our estimation, we note that the impact of the implementation of open policies is negative and significant on CO2 emissions. Estimation using the fixed-effects method on a sample of 24 OECD member countries reveals a coefficient of -0.0032033 for the trade openness variable (ov). This coefficient indicates that a one-unit increase in the level of trade openness is accompanied by a 0.32% decrease in CO2 emissions, so this relationship can be explained by several factors. Trade openness promotes the adoption of cleaner technologies by exporting companies, greater resource efficiency thanks to greater competition, and

specialization in less polluting industries, all of which help to reduce co2 emissions. In addition, OECD countries have introduced strict environmental regulations and performance standards for industry and transport to limit the negative effects of CO2 emissions (such as the Pen market in European countries).They are also committed to encouraging sustainable trade and reducing the carbon footprint of business activities.

Open markets facilitate access to new technologies that improve production processes by reducing the massive use of energy, water and substances that have threatened the environment. Trade openness can also catalyze environmental innovation, as international competition drives companies to adopt cleaner technologies (otherwise known as clean energy) and invest in sustainable practices to remain competitive. Trade agreements, especially those with binding environmental clauses, play a crucial role in regulating the environmental impact of international trade. They encourage nations to adopt higher environmental standards in order to participate in international trade. This result is in line with empirical studies by Dogan and Turkekul (2016), Baghdadi and al. (2013), and El Mounny and al. (2021).

Estimation using the fixed effects method, on a sample of 24 OECD member countries, reveals that every 1% increase in the level of urbanization is associated with a 3.07% reduction in CO2 emissions. This shows that urbanization helps to reduce CO2 emissions in these countries. This relationship can be explained by several factors.Firstly, cities often adopt new technologies and more modern infrastructures, such as public transport and green buildings, thereby reducing carbon emissions.

Secondly, urban environments facilitate access to technological innovations and sustainable practices, which are less prevalent in rural areas (which have more traditional habits and practices).In addition, public policies from the state is still being applied in urban areas also tend to promote sustainability, with stricter environmental regulations to improve energy efficiency. Finally, cities, as economic centers, are under pressure to adopt environmentally practices and reduce emissions, in response to the expectations of citizens and businesses alike. These results are in line with studies by McGranahan and al (2010) and Poumanyvong and Kaneko (2010*),* which show that urbanization helps reduce CO2 emissions through better infrastructure and more efficient policies.

The theory of ecological modernization, applied to OECD countries, confirms that improving urban quality and wealth can reduce environmental problems through improved technologies, restructured policies and better compliance with environmental regulations. Furthermore, our results show that natural resources have a slightly positive effect on CO2 emissions. However, this effect is not statistically significant, which explains why it is not strong enough to be considered reliable. In other words, the quantity of natural resources does not clearly explain variations in CO2 emissions in OECD countries. This suggests that the direct impact observed may not be sufficiently robust, depending on the method used. Our estimation also addresses the effect of economic growth on CO2 emissions, and tests the presence of the Environmental Kuznets Curve (EKC) hypothesis.

Firstly, the results show a significant and negative effect of economic growth on CO2 emissions in the short term. This suggests that a slight increase in GDP (in the early stages of production) is associated with a reduction in CO2 emissions in the short term. Secondly, the positive coefficient of $(pib)^2$ indicates that the effect of economic growth on CO2 emissions increases in the medium term, which could mean that emissions tend to rise as economic growth intensifies. Thirdly, the negative coefficient of $(pib)^3$ shows that, in the long term, higher economic growth is associated with lower CO2 emissions. This is consistent with the idea that more developed economies adopt cleaner technologies and stricter environmental policies (as per our sample: 24 OECD countries). These results confirm the Kuznets environmental curve for OECD countries. In the short term, economic growth reduces CO2 emissions, but in the medium term, the effect may increase before decreasing in the long term, illustrating an inverted U-shaped relationship between economic growth and CO2 emissions.

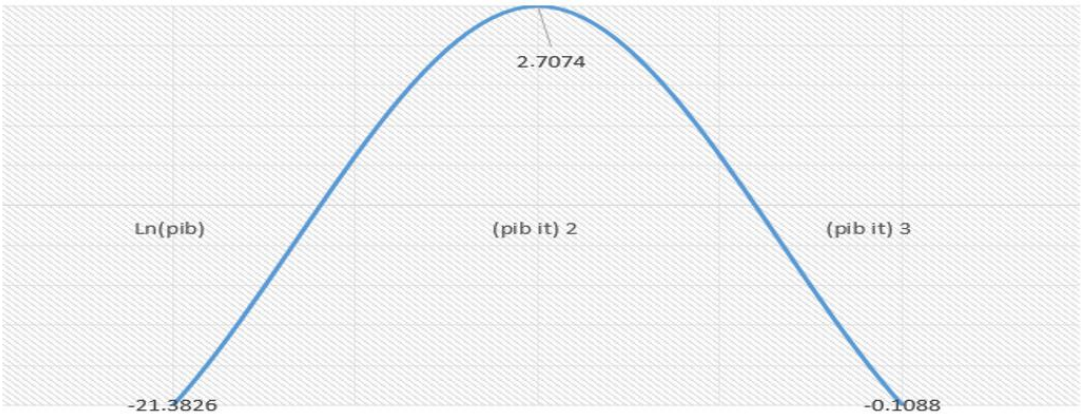


Figure 1. The presence of the Environmental Kuznets Curve (EKC) hypothesis in OECD countries

In summary, our studies confirm that for OECD member countries, economic growth can worsen the environment in the medium term, but above a certain level of growth, it encourages the adoption of cleaner technologies and improves environmental quality. Moreover, the negative coefficient of GDP per cube suggests that, once this level is reached, environmental problems can be resolved through stricter measures, innovation and changes in production patterns. As Ulucak and Bilgili (2018) point out, high economic growth can reduce environmental degradation through more stringent regulations and technological advances from research and development. These findings are consistent with studies by Senzele, J. (2022), NNP Geoffroy, NNY Daniel and KF Hervé in 2019.

Although trade openness can stimulate economic growth and create opportunities, it also appears to intensify income inequality in OECD countries, as the results of the third model (expected result) indicate. Indeed, there is a positive and statistically significant relationship between trade openness and the Gini coefficient. This means that an increase in trade openness is accompanied by a rise in internal income inequalities measured by the Gini coefficient. In other words, greater openness to international trade tends to increase domestic income disparities in these countries. This estimate can be explained by the fact that trade openness encourages international competition, favoring the most competitive exporting companies and increasing their market share. As a result, income gaps appear between workers in exporting sectors and those in sectors facing increased competition, leading to their decline.

In addition, technological progress and globalization are changing the structure of labor markets in OECD countries. This is leading to a polarization of jobs, with a sharp disparity between low-skilled, poorly-paid jobs and higher-skilled, better-paid ones (known as wage inequality). This can generate anxiety among workers in OECD countries, due to job losses (especially in non-exporting sectors), rising inequality and a shrinking middle class. These results are consistent with studies by Feenstra and Hanson (1996) ,Harrison and Hanson (1999) Lustig (1998)Autor, Dorn and Hanson (2013) Goldberg, P. K., & Pavcnik, N. (2016).

The education variable, measured by the gross enrolment ratio, has an expected coefficient and exerts a negative effect on the Gini coefficient in OECD countries. Indeed, an increase in the level of education leads to a reduction in income inequality, as a better distribution of income is observed in countries with higher levels of education. Education plays an essential role in reducing income disparities by providing individuals with skills and qualifications that are in demand on the job market. This improvement in educational levels enables workers to access better-paid, more stable jobs, thus promoting a more equitable distribution of income. In addition, education stimulates innovation (research and development) and productivity, contributing to high economic growth and job creation in all skill-intensive sectors, reducing the gap between skilled and less-skilled workers.

A positive relationship between development (long-term growth: squared GDP/capita) and income inequality was found for 24 OECD economies. Confirmation of the existence of the ordinary U-shaped Kuznets curve appeared in our estimation, with the coefficient of GDP/capita indicating growth being negative and highly significant. Growth therefore plays an important role in determining inequality.

Inequality and growth are negatively correlated, and the positive sign of the square of growth (GDP/capita) confirms the existence of a threshold effect. The existence of the Kuznets curve for the growth-inequality relationship is confirmed, but inverted into an ordinary U-shape. Income inequality decreases in the early phases of growth, then stabilizes and finally increases in later phases (see figure).

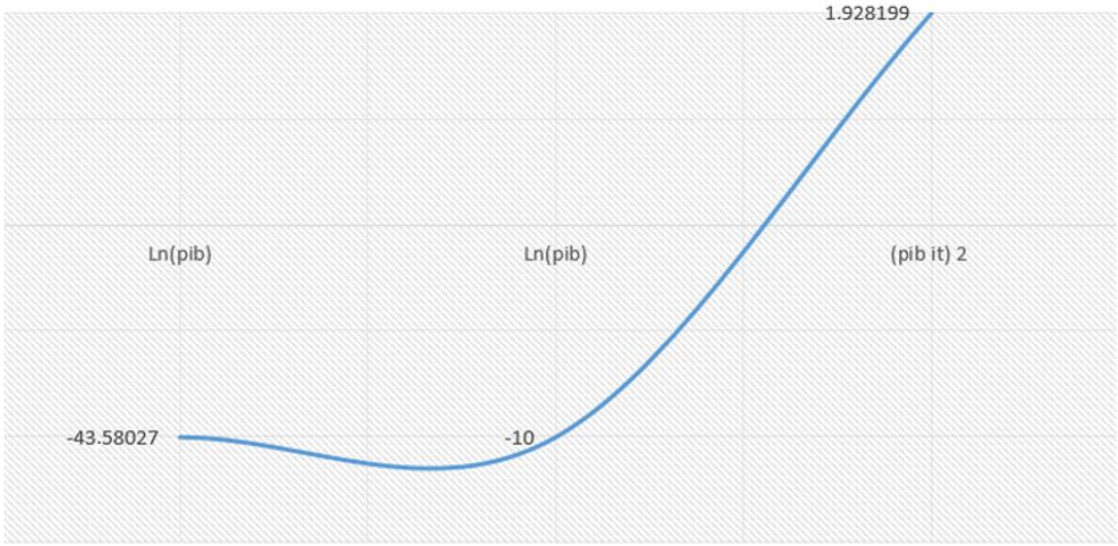


Figure 2. The presence of the Kuznets social curve hypothesis in OECD countries (Fixed effects method).

In recent years, technical progress and growth have led to a considerable rise in living standards, with gross domestic product improving in several OECD countries. We have witnessed the emergence of New Technologies. These are seen as a catalyst for economic growth, and we can say that they are causing a great deal of inequality. This inequality can be seen in the worsening situation of unskilled workers in these countries. OECD countries are seen as technology producers, and this is accompanied by an increase in inequality due to the rising demand for skills, to the detriment of the low-skilled, which can lead to wage differentials in the long term. These results coincide with the work of Tinbergen, J. (1974), Spilimbergo and al. (1999).

**Research implications*

Our results point to a number of economic implications: OECD countries that opened their borders in the 90s can now continue along this path, strengthening their growth sectors by relying on technology - in other words, encouraging those sectors that are responsible for generating higher export revenues. The advantages of this approach are, first and foremost, higher productivity and earnings in sectors in which each member country specializes. However, the aggravation of inequalities, as shown in our estimation in these countries due to technological advance, can be resolved by improving modes of governance in order to highlight a redistribution of income between skilled and unskilled workers. As trade openness also has a positive impact on the environment, helping to reduce CO2 emissions, we need to improve strategies and measures, and include more stringent regulations to protect the environmental aspect of international trade practices.

## 5. CONCLUSION

The findings of this study highlight the multifaceted effects of trade openness on economic, social, and environmental outcomes in 24 OECD countries over the period 2005–2022, estimated using the fixed effects method. The results show that trade liberalization, measured by the ratio of exports and imports to GDP, fosters economic growth by enhancing innovation, expanding access to international markets, and improving productive efficiency.

At the same time, trade openness appears to exacerbate income inequalities, as technologically advanced exporting sectors benefit disproportionately, leading to wider wage gaps between skilled and unskilled workers. On the environmental side, trade liberalization encourages the adoption of cleaner technologies, higher resource efficiency due to increased competition, and specialization in less polluting industries, contributing to a reduction in $CO_2$ emissions. These effects are further reinforced by the stringent environmental regulations and performance standards implemented in OECD countries.

Finally, the results support the existence of the Kuznets curve, revealing both ordinary and inverted U-shaped relationships between GDP, income inequality, and $CO_2$ emissions, confirming that economic growth, social equity, and environmental

sustainability are interlinked in complex but predictable ways.

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