Rethinking the Impact of Trade Openness on Global Economic Productivity: A Cross-Country Analysis

Hasan Alp Özel[1] Hüseyin Utku Demir[2]

Received: 26/11/2024 Online Published: 20/04/2025
Accepted: 17/02/2025

Abstract

This study investigates the relationship between trade openness and economic productivity across 147 countries using World Bank data. We construct novel proxy measures for productivity by normalizing each country's GDP relative to global totals. To estimate the causal effect of openness on productivity, we use the number of trade partners as an instrument for openness, controlling for regional and income-level factors. Our regression analysis reveals no significant relationship between trade openness and economic performance over the last two decades, challenging the conventional belief that increased trade liberalization drives economic growth. These findings suggest a more complex dynamic at play and underscore the need for further research to better understand the intricate link between openness and productivity, with important implications for policy design and global economic strategy.

Keywords: Trade openness, Economic Growth, Productivity, Trade Liberalization, Development.

JEL Classification: F41, F43, O47

1. Introduction

The complex relationship between trade openness and economic efficiency has long been a key area of focus in both economic research and policy discussions. Traditionally, it has been assumed that greater openness to trade promotes economic growth and efficiency. However, recent empirical studies have begun to challenge this widely held view, prompting a need to reevaluate the mechanisms involved. Unlike most previous studies that focus primarily on aggregate measures of trade openness, this study introduces the number of trade partners as an instrumental variable, offering a novel way to isolate exogenous variation in openness and its impact on productivity.

In this paper, we construct proxy measures for productivity by normalizing each country's GDP relative to global totals. This allows us to create efficiency metrics that reflect each nation's contribution to global production and population. To assess the impact of openness on economic performance, we require exogenous variation in openness. We propose a theory based on differences in the number of trade partners among countries and utilize this as a potential source of exogenous variation. The theory is grounded in three key assumptions:

The number of trade partners does not directly affect productivity, as it primarily influences trade volume and ease rather than internal productivity drivers.

Countries with more trade partners are likely to engage in higher levels of exports, imports, and overall trade.

Trade partners are shaped by historical and geopolitical relationships rather than domestic

[1] Prof. Dr., Karabuk University, Faculty of Business, Karabük, Turkey, alpozel@karabuk.edu.tr, ORCID: https://orcid.org/0000-0001-7435-7641
[2] Assist. Prof. Dr. Karabuk University, Faculty of Business, Karabük, Turkey, utkudemir@karabuk.edu.tr, ORCID: https://orcid.org/0000-0002-9140-0362.

policies or productivity-enhancing factors.

Based on these premises, we employ the number of trade partners as an instrumental variable for openness. We construct a novel productivity measure by normalizing GDP and population, allowing us to assess economic efficiency relative to global totals. For openness, we calculate the export and import ratios, dividing each country's average trade activity by its population ratio. Additionally, we incorporate the number of regional trade agreements (RTAs), finding a strong first-stage relationship where RTAs explain about 27% of the variation in openness. However, despite RTAs significantly influencing openness, our results suggest that openness has not been a major determinant of productivity. The findings of this study have important implications for trade policy. As global trade dynamics continue to evolve, understanding the nuanced effects of openness on productivity can help policymakers design more targeted and effective strategies for fostering economic efficiency

In our two-stage least-squares analysis, we find no significant relationship between openness and productivity in recent years. Figure 1 demonstrates a weak positive correlation between productivity and the number of trade partners across 147 countries, though this pattern does not hold for Europe. We hypothesize that the number of trade partners influences productivity through increased trade activity. To validate this, we regress productivity on openness, using the number of trade partners as an instrument.

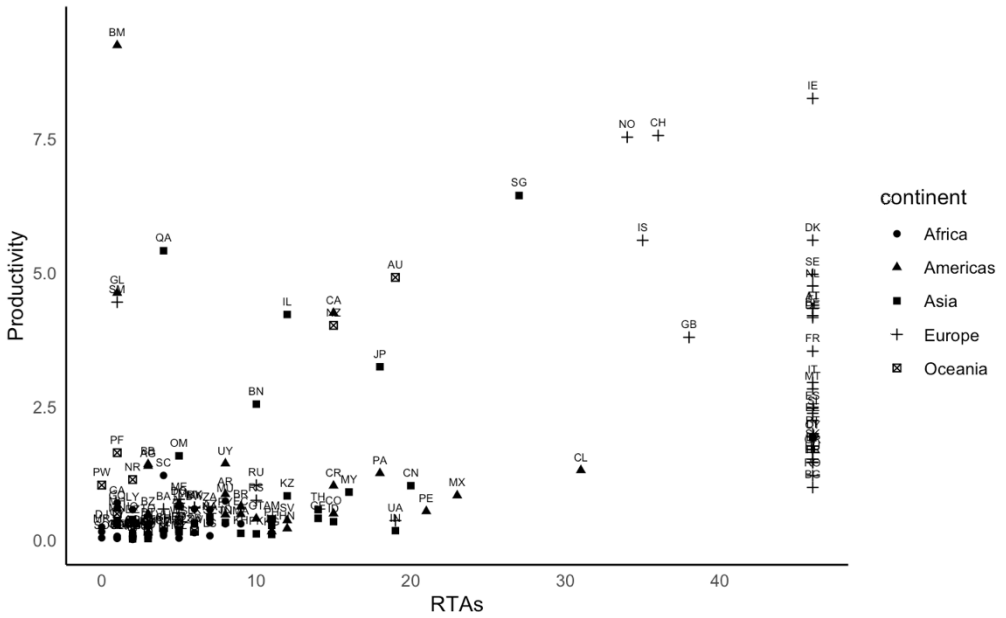

Figure 1 Reduced Form Relationship Between Productivity and Number of Trade Partners

A key assumption of our instrumental variable approach is that RTAs, conditional on controls, affect productivity only through openness. The main concern with this assumption is the potential correlation between RTAs and wealth, which could directly influence productivity. To address this, we control for income levels, ensuring that the number of trade partners affects productivity primarily through openness. Our robustness checks confirm the validity of this instrument, even when controlling for income, indicating that the relationship between trade partners and productivity is driven by openness.

We also explore the possibility of omitted variables by controlling for geographical factors such as longitude and regional dummies, accounting for differences in trade opportunities and economic performance across regions. For example, the European Union significantly impacts trade

openness for its member countries, while African nations may face distinct trade challenges.

While it is impossible to account for every variable correlated with RTAs and productivity, we conduct overidentification tests using polynomial RTAs to ensure the validity of our instrument. The results support our hypothesis that RTAs do not directly influence productivity outside of their effect on openness. Furthermore, by using the number of trade partners as an instrument, we mitigate concerns of reverse causality between productivity and openness, isolating the exogenous variation in openness for our estimates.

Despite the potential for measurement error in calculating openness, the instrumental variable approach helps alleviate this concern. We introduce the trade openness measure by dividing a country's export and import ratios by its population ratio. Our findings reveal a complex relationship between openness and productivity, with no significant association observed over much of the study period.

These results challenge conventional assumptions, raising important questions about how openness interacts with economic performance. While traditional economic theory posits that trade liberalization spurs growth, our analysis points to a more nuanced and multifaceted dynamic. This highlights the need for ongoing research to better understand these interactions and inform more effective policy strategies.

A vast body of literature has extensively explored the implications of trade openness. Strong associations between trade openness and economic growth have been documented in various studies. While previous studies have extensively examined the relationship between trade openness and economic growth, the specific role of the number of trade partners in shaping productivity remains underexplored. This paper seeks to fill that gap by employing an innovative instrumental variable approach. Additionally, trade openness is often viewed as complementary to financial development (Sghaier, 2023). Notably, while trade openness may support carbon neutrality in wealthy nations, this correlation is not evident in poorer countries. Consequently, achieving carbon neutrality necessitates free trade and equitable benefits across different income groups (Wang et al., 2023).

Moreover, the impact of trade openness on environmental degradation has emerged as a prominent area of study in recent years. While trade openness tends to impede environmental quality for high-income, middle-income, and low-income groups, the magnitude of this effect varies across different country groups. Notably, in middle-income countries, a feedback loop between trade openness and carbon emissions is highlighted, whereas trade openness contributes to CO2 emissions in high-income and low-income countries. Furthermore, research indicates heterogeneous effects of free trade on renewable energy across different income levels, with positive impacts observed in higher-income and upper-middle-income countries but adverse effects in lower-income countries (Wang and Zhang, 2021).

Existing literature offers extensive evidence of the positive relationship between trade openness and economic growth. Studies have shown that openness complements financial development and may support carbon neutrality, although this relationship varies across income groups. While previous findings suggest strong links between openness and economic performance, our results deviate from this norm, revealing a lack of significant correlation between openness and productivity in recent years. This divergence emphasizes the need for further investigation into the drivers of economic efficiency in the context of global trade.

Given the ongoing changes in global trade dynamics, such as rising protectionism and shifting geopolitical alliances, understanding the effects of openness on productivity is more important than ever. By uncovering the nuanced relationship between trade openness and productivity, our study provides critical insights that could reshape how economists and policymakers approach

global trade strategy

The remainder of this paper is organized as follows: Section II reviews relevant literature, Section III presents our empirical analysis, Section IV discusses the results, Section V outlines limitations and future research directions, and Section VI concludes with a summary of findings and implications.

2. Literature Review

The relationship between trade openness and economic growth has long been a subject of debate and investigation in economic literature. Concepts such as globalization and trade liberalization, especially with the proliferation of advanced technologies, have deepened the connections between world economies. Trade openness is a critical factor determining the role of a country's external trade activities in its economy and is widely regarded as a significant driver of economic growth.

Numerous studies have identified a positive relationship between trade openness and economic growth. For instance, research by Frankel and Romer (1999), Balassa (1978), Harrison (1996), Alberto and Wacziarg (1999), and Romer (1990) has consistently demonstrated that trade openness promotes economic growth. It has been noted that trade openness enables firms to enter diverse markets, become more competitive, and consequently expand market sizes.

However, our study challenges this conventional wisdom, particularly for recent years. This divergence from previous findings raises important questions about the changing nature of global trade and its impacts on economic performance.

Recent research has added nuance to our understanding of the trade openness-growth relationship. Namahoro et al. (2023) found that while trade openness has a significant positive effect on growth in terms of total exports across a panel of 48 African countries, the impact varies across regions and economic levels. This regional variation aligns with our findings and underscores the importance of considering geographic and economic context when analyzing trade impacts.

Pata et al. (2023) observed that real income and trade openness reduce environmental degradation in ASEAN countries, but this effect is statistically insignificant in high-income countries. This finding suggests that the benefits of trade openness may not be uniform across different income levels, a theme that our study explores in depth.

Okafor et al. (2023) found that trade openness stimulates tourism flows in low-income countries, while its effect is statistically insignificant in high-income countries. This differential impact across income levels resonates with our findings and highlights the complex interplay between trade openness and various economic sectors.

Interestingly, Jiang and Liu (2023) found contrasting effects of trade openness on carbon emissions between BRICS and G7 countries. This study, along with our findings, suggests that the impacts of trade openness may be contingent on a country's level of economic development and industrial structure.

However, not all studies have found uniformly positive effects of trade openness. Some studies have found results that more directly challenge the trade openness-growth orthodoxy. For example, Baliamoune-Lutz and Ndikumana (2007) demonstrated a negative effect of trade openness on economic growth in African countries. Similarly, Rodriguez and Rodrik (2000) and Levine and Renelt (1992) found negative or uncertain relationships between trade openness and growth.

The relationship between trade openness and income inequality has also been a subject of recent research. Dorn et al. (2022) argue that increasing trade openness particularly exacerbates inequality in less developed countries. This finding adds another layer of complexity to our

understanding of the impacts of trade openness, suggesting that its effects may not be uniformly beneficial across all segments of society.

Sakyia et al. (2015) found a two-way positive relationship between trade openness and income level in the long run, suggesting that trade openness is both a cause and a consequence of income level. Short-term results indicate that the connection between export-led growth and economic growth progresses in the same direction. This bidirectional relationship highlights the complex dynamics at play in the trade openness-growth nexus.

The technological impact of trade openness is another crucial aspect to consider. Trade openness often involves the transfer of production technologies from other countries. This technological diffusion can be a significant driver of productivity improvements and economic growth. However, as our study suggests, the relationship between trade openness and productivity may be changing in recent years.

From the perspective of endogenous growth theory, technology imports can enhance local firms' experiences and accelerate their innovation, thereby increasing their human capital. The positive externalities of trade on society, such as technology and knowledge spillovers, can promote long-term growth (Romer, 1986; Coe & Helpman, 1995; Sala-i-Martin, 1996). However, developing countries may not fully benefit from these positive externalities due to low human capital investment. Romer (1986) suggests that countries with low human capital investment cannot enter a successful growth path.

Our study contributes to this ongoing debate by providing a comprehensive analysis across a large number of countries over an extended period. Unlike many previous studies, we observe a shift in the relationship between trade openness and economic performance over time, with a negative relationship emerging in recent years. This temporal dimension adds a crucial perspective to the existing literature and suggests that the dynamics of global trade may be evolving.

3. Empirical Investigation and Analysis

3.1. Data Description and Model

This study utilizes the World Bank's World Development Indicators (WDI) dataset, encompassing 147 countries from 2000 to 2021. This dataset offers an extensive view of global economic trends over two decades, providing annual data on key economic indicators for a thorough year-by-year regression analysis. To ensure consistency and comparability across all regressions, the same 147 countries are analyzed throughout.

The primary variables are Gross Domestic Product (GDP) and population for each country. To account for each country's relative size in the global economy, we calculated the GDP ratio, defined as a country's GDP divided by the total global GDP. This measure reflects each country's share of global economic output. Similarly, we computed a population ratio, capturing each country's proportion of the world's population. These ratios form the basis for our productivity measure, defined as a country's GDP ratio divided by its population ratio, representing productivity as economic output per capita relative to the global average.

$$GDP\ Ratio_j = \frac{GDP_j}{\sum_{i=1}^{N} GDP_i}$$

$$Population\ Ratio_j = \frac{Population_j}{\sum_{i=1}^{N} Population_i}$$

$$Y_j = \frac{GDP\ Ratio_j}{Population\ Ratio_j}$$

The key independent variable is trade openness, which measures the extent to which a country participates in global trade. Openness is calculated as the average of export openness and import openness ratios, where each country's exports and imports are expressed as a percentage of the global totals divided by its population ratios. This provides a standardized measure of a country's trade activity relative to the rest of the world.

$$Export\ Ratio_j = \frac{Export_j}{\sum_{i=1}^{N} Export_i}$$

$$Import\ Ratio_j = \frac{Import_j}{\sum_{i=1}^{N} Import_i}$$

$$Open\_Ex_j = \frac{Export\ Ratio_j}{Population\ Ratio_j}$$

$$Open\_Im_j = \frac{Import\ Ratio_j}{Population\ Ratio_j}$$

$$Openness_j = \frac{Open\_Ex_j + Open\_Im_j}{2}$$

Table 1 provides a summary of the key descriptive statistics for productivity and openness from 2000 to 2021, showcasing their mean, median, standard deviation, and range across different years. These statistics highlight variations across countries and years, which are critical for understanding the dynamics at play. For instance, the mean productivity ranges from 1.6 in 2007 to 1.41 in 2021, while the openness variable shows an increase from 2.9 in 2007 to 3.2 in 2021. These statistics highlight the decrease of the productivity measure and the increasing trend in openness during the period.

Table 1 Descriptive Statistics

Productivity	2017	2018	2019	2020	2021
Mean (SD)	1.42 (1.99)	1.44 (2.00)	1.41 (1.95)	1.39 (1.98)	1.41 (2.02)
Median	0.57	0.56	0.56	0.52	0.53
(Q1, Q3)	(0.18, 1.64)	(0.17, 1.69)	(0.17, 1.69)	(0.17, 1.58)	(0.17, 1.61)
Min, Max	0.02, 10.39	0.02, 10.32	0.02, 10.23	0.02, 10.68	0.02, 10.82
Openness	2017	2018	2019	2020	2021
Mean (SD)	3.0 (7.0)	3.1 (7.0)	3.1 (7.4)	3.2 (8.2)	3.2 (8.0)
Median	0.7	0.7	0.7	0.6	0.7
(Q1, Q3)	(0.2, 3.1)	(0.2, 3.1)	(0.2, 3.1)	(0.2, 2.8)	(0.2, 2.7)

Min, Max	0.0, 64.8	0.0, 64.9	0.0, 67.7	0.0, 76.6	0.0, 74.8
Productivity	2012	2013	2014	2015	2016
Mean (SD)	1.47 (2.11)	1.49 (2.13)	1.48 (2.10)	1.40 (1.98)	1.40 (1.99)
Median	0.57	0.58	0.59	0.57	0.56
(Q1, Q3)	(0.16, 1.6)	(0.17, 1.66)	(0.16, 1.61)	(0.16, 1.63)	(0.17, 1.66)
Min, Max	0.02, 10.63	0.02, 11.16	0.02, 11.33	0.03, 10.36	0.02, 10.46
Openness	2012	2013	2014	2015	2016
Mean (SD)	2.8 (6.1)	2.8 (6.4)	2.8 (6.6)	3.0 (7.0)	3.1 (7.2)
Median	0.8	0.8	0.7	0.7	0.7
(Q1, Q3)	(0.3, 2.8)	(0.2, 2.8)	(0.2, 2.9)	(0.2, 3.0)	(0.2, 3.1)
Min, Max	0.0, 55.5	0.0, 60.0	0.0, 63.8	0.0, 65.1	0.0, 67.5
Productivity	2007	2008	2009	2010	2011
Mean (SD)	1.60 (2.44)	1.63 (2.42)	1.55 (2.29)	1.50 (2.19)	1.51 (2.18)
Median	0.45	0.47	0.49	0.51	0.55
(Q1, Q3)	(0.15, 1.8)	(0.16, 1.95)	(0.16, 1.76)	(0.16, 1.57)	(0.16, 1.64)
Min, Max	0.02, 12.38	0.02, 12.78	0.02, 12.41	0.02, 11.62	0.02, 11.35
Openness	2007	2008	2009	2010	2011
Mean (SD)	2.9 (6.7)	2.9 (6.4)	2.9 (6.6)	2.9 (6.5)	2.9 (6.3)
Median	0.7	0.7	0.8	0.8	0.8
(Q1, Q3)	(0.2, 3.1)	(0.2, 3.1)	(0.3, 3.1)	(0.3, 2.8)	(0.2, 2.7)
Min, Max	0.0, 64.6	0.0, 60.9	0.0, 62.6	0.0, 60.3	0.0, 58.2

Table 2 Descriptive Statistics for 2021

Continent	Africa N = 43	Americas N = 23	Asia N = 32	Europe N = 38	Oceania N = 12
Productivity					
Mean (SD)	0.23 (0.25)	1.42 (2.05)	1.06 (1.61)	3.09 (2.47)	1.24 (1.58)
Median	0.13	0.69	0.38	2.31	0.44
(Q1, Q3)	(0.07, 0.31)	(0.48, 1.39)	(0.17, 0.96)	(1.21, 4.33)	(0.28, 1.39)
Min, Max	0.02, 1.21	0.15, 9.24	0.03, 6.44	0.37, 10.82	0.17, 4.91
Openness					

Continent	Africa	Americas	Asia	Europe	Oceania
	N = 43	N = 23	N = 32	N = 38	N = 12
Mean (SD)	0.4 (0.7)	1.8 (2.7)	2.5 (6.7)	8.4 (13.1)	1.3 (1.2)
Median	0.1	0.6	0.4	4.1	0.8
(Q1, Q3)	(0.1, 0.5)	(0.4, 1.7)	(0.2, 1.6)	(2.1, 8.5)	(0.3, 1.9)
Min, Max	0.0, 3.9	0.1, 11.7	0.0, 37.3	0.5, 74.8	0.2, 3.4
RTA					
Mean (SD)	3 (2)	11 (8)	11 (9)	36 (17)	5 (6)
Median	2	9	10	46	4
(Q1, Q3)	(1, 4)	(3, 15)	(5, 14)	(34, 46)	(2, 6)
Min, Max	0, 9	1, 31	1, 46	1, 46	0, 19
Income	High income	Low income	Lower middle income	Upper middle income	
	N = 49	N = 20	N = 39	N = 40	
Productivity					
Mean (SD)	3.56 (2.31)	0.06 (0.02)	0.21 (0.09)	0.63 (0.21)	
Median	2.95	0.06	0.18	0.59	
(Q1, Q3)	(1.64, 4.62)	(0.04, 0.07)	(0.13, 0.31)	(0.49, 0.76)	
Min, Max	1.13, 10.82	0.02, 0.10	0.07, 0.37	0.34, 1.03	
Openness					
Mean (SD)	8.6 (12.2)	0.1 (0.0)	0.3 (0.2)	0.9 (0.5)	
Median	4.7	0.1	0.2	0.8	
(Q1, Q3)	(2.9, 8.5)	(0.0, 0.1)	(0.1, 0.4)	(0.5, 1.2)	
Min, Max	1.4, 74.8	0.0, 0.2	0.0, 1.2	0.4, 2.1	
RTA					
Mean (SD)	30 (18)	2 (1)	6 (5)	9 (8)	
Median	46	2	5	8	
(Q1, Q3)	(12, 46)	(1, 2)	(3, 9)	(5, 12)	
Min, Max	1, 46	0, 5	0, 19	0, 46	

Table 2 presents a more granular view of productivity, openness, and the number of Regional Trade Agreements (RTA) by continent and income groups for the year 2021. Europe leads in productivity with a mean of 3.09, followed by the Americas at 1.42, while Africa has the lowest mean productivity at 0.23. This reflects the significant disparity in economic output per capita across regions. Europe also shows the highest mean openness at 8.4, compared to Africa's 0.4, indicating

the continent's higher engagement in global trade. The min-max ranges further underscore the variation within each continent, with Europe's openness spanning from 0.5 to 74.8, suggesting that some countries are far more globally integrated than others. When examining productivity by income group, high-income countries show a significantly higher mean productivity (3.56) compared to low-income countries (0.06). Similarly, high-income countries have the highest openness at 8.6, while low-income countries are much less open, with an average of 0.1. This suggests that higher-income countries are not only more productive but also more engaged in international trade. The number of Regional Trade Agreements (RTA) varies widely across regions and income groups. Europe has the highest mean of 36 RTAs, while Africa has the lowest at 3, suggesting that trade agreements play a significant role in enhancing trade openness, particularly in more developed regions. The income group breakdown further reveals that high-income countries have the most RTAs (mean 30), indicating that these agreements could be linked to both higher openness and productivity.

These statistics underscore the relationships between trade, productivity, and economic integration at both the regional and income-group levels. The high variability in both productivity and openness across countries, continents, and income groups suggests that differences in trade policies, regional agreements, and economic development significantly influence the observed outcomes.

3.2 Ordinary Regression

The regression model used in our analysis can be written as:

$$Y_i = \beta_0 + \beta_1 Openness_i + \beta_2 Openness_i^2 + \beta_3 IDA + \beta_4 IBRD + \beta_5 longitude + \beta_6 \log(Population) + \beta_7 \log(Population)^2 + \sum_j \beta_j Continents + \sum_k \beta_k Income + u_i$$

In this model, the dependent variable Y_i represents productivity, while the main explanatory variables are openness and its square to account for potential non-linear effects. The regression also includes several controls: income groups, regional dummies for continents, and variables for IDA and IBRD membership. Population is introduced in logarithmic form to account for potential scale effects, and the model further controls for longitude to capture geographic variation. The four continents represented are Europe, Africa, Asia, and Other, while the income groups are High income, Upper middle income, Lower middle income, and Low income.

There are certain limitations to this methodology. First, GDP, used as a proxy for productivity, may not capture all dimensions of economic output, particularly in countries with large informal sectors. Second, while openness is widely used as a measure of economic integration, it might not fully capture the complexity of global trade, such as non-tariff barriers or the composition of trade. Despite these limitations, the regression provides valuable insights into the relationship between openness and productivity.

Table 3 shows the results of OLS regressions for productivity on openness in 2021. All models show a statistically significant and robust relationship between openness and productivity. From model (2) to model (7), the inclusion of control variables (income groups, continents, etc.) does not substantially alter the main findings. Specifically, the results indicate that openness is positively associated with productivity, but the negative coefficient on $Openness_i^2$ suggests a diminishing marginal effect. The R-squared of 0.80 in model (2) indicates that the openness variables alone explain a large portion of the variation in productivity.

To further illustrate the impact of openness, consider two countries in the sample: Angola, with an openness value of 0.2 (approximately at the 25th percentile), and Poland, with an openness value of 2.88 (at the 75th percentile). According to the estimates in model (2), the productivity difference between these countries would be 1.55 points. In practice, the observed difference is 1.3 points, demonstrating the model's explanatory power.

Overall, Table 3 highlights a robust correlation between openness and productivity. However, caution is warranted when interpreting this relationship as causal, given potential issues like reverse causality and omitted variables. However, these problems could be solved if we had an instrument for openness. Such an instrument must be an important factor in accounting for the openness variation that we observe, but have no direct effect on productivity. Our discussion in Section I suggests that RTAs is a plausible instrument. Figure 2 shows this relationship diagrammatically

Table 3 OLS Regressions for 2021

	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
Productivity	Beta (SE)1,2	Beta (SE)1,2	Beta (SE)1,2	Beta (SE)1,2	Beta (SE)1,2	Beta (SE)1,2
$Openness$	0.61***	0.47***	0.47***	0.48***	0.56***	0.53***
	(0.032)	(0.050)	(0.050)	(0.050)	(0.053)	(0.055)
$Openness^2$	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Income						
Low		-0.95**	-0.95**	-0.99**	-0.91**	-0.80
		(0.306)	(0.307)	(0.305)	(0.337)	(0.438)
Lower middle		-0.89**	-0.89**	-0.91***	-0.86**	-0.76*
		(0.270)	(0.272)	(0.269)	(0.273)	(0.313)
Upper middle		-0.76**	-0.76**	-0.75**	-0.70**	-0.46
		(0.248)	(0.249)	(0.246)	(0.239)	(0.266)
longitude			0.00	0.00	0.00	0.00
			(0.001)	(0.001)	(0.001)	(0.001)
Log(Population)				1.9*	3.4***	3.2***
				(0.844)	(0.915)	(0.944)
Log(Population)²				0.41	-0.58	-0.36
				(0.828)	(0.841)	(0.845)
Continent						
Africa					-0.47*	-0.45
					(0.229)	(0.232)

	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
Productivity	Beta (SE)1,2	Beta (SE)1,2	Beta (SE)1,2	Beta (SE)1,2	Beta (SE)1,2	Beta (SE)1,2
Asia					-0.61*	-0.59*
					(0.247)	(0.247)
Europe					-0.92***	-0.88***
					(0.241)	(0.240)
IBRD_IDA						—
IBRD						-0.47*
						(0.236)
IDA						-0.33
						(0.299)
R^2	0.802	0.818	0.818	0.825	0.842	0.847
AIC	371	364	366	365	355	355
σ	0.839	0.813	0.816	0.806	0.774	0.768

1*p<0.05; **p<0.01; ***p<0.001

2SE = Standard Error

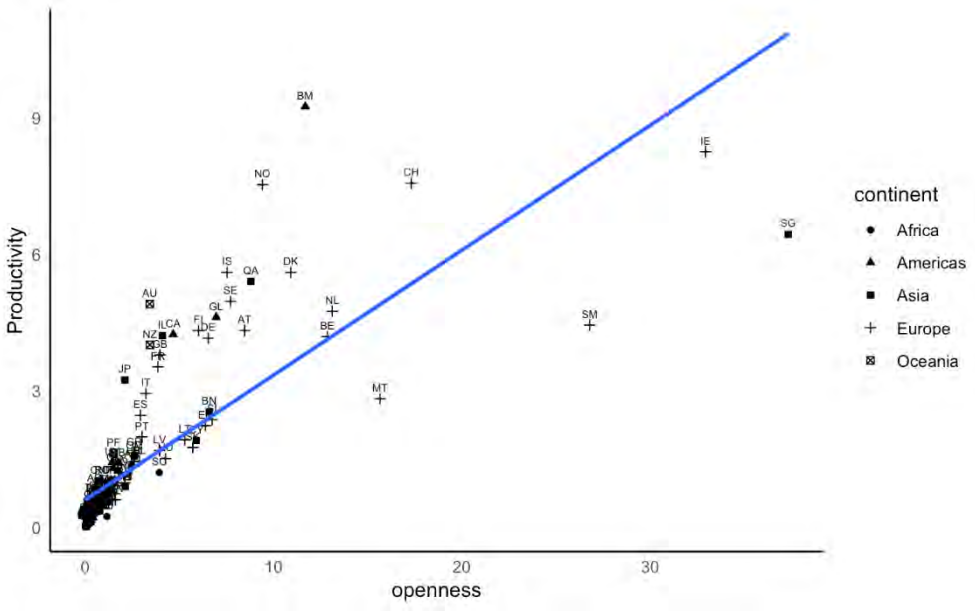

Figure 2 OLS Relationship Between Openness and Productivity in 2021

Table 4 OLS Regressions between 2014 and 2021

Productivity	2021	2020	2019	2018	2017	2016	2015	2014
Openness	0.53***	0.48***	0.59***	0.64***	0.66***	0.69***	0.72***	0.73***
	(0.055)	(0.053)	(0.056)	(0.057)	(0.059)	(0.059)	(0.057)	(0.058)
Openness	-0.01***	-0.01***	-0.01***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
income								
Low	-0.80	-0.91* (0.439)	-0.64	-0.59	-0.49	-0.43	-0.41	-0.44
	(0.438)		(0.425)	(0.424)	(0.434)	(0.425)	(0.446)	(0.472)
Lower middle	-0.76*	-0.84**	-0.60*	-0.56	-0.49	-0.40	-0.39	-0.43
	(0.313)	(0.313)	(0.303)	(0.301)	(0.308)	(0.303)	(0.317)	(0.337)
Upper middle	-0.46	-0.50	-0.32	-0.29	-0.23	-0.16	-0.12	-0.20
	(0.266)	(0.266)	(0.256)	(0.255)	(0.261)	(0.257)	(0.264)	(0.284)
Longitude	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log(Population)								
Log(Population)	3.2***	3.0**	3.5***	3.6***	3.6***	3.7***	3.9***	3.9***
	(0.944)	(0.958)	(0.915)	(0.906)	(0.924)	(0.904)	(0.925)	(0.969)
Log(Population)^2	-0.36	-0.28	-0.56	-0.65	-0.59	-0.61	-0.49	-0.38
	(0.845)	(0.861)	(0.813)	(0.810)	(0.828)	(0.810)	(0.854)	(0.899)
Continent								
Africa	-0.45	-0.39	-0.42	-0.44	-0.47*	-0.43	-0.45	-0.49*
	(0.232)	(0.234)	(0.222)	(0.222)	(0.227)	(0.221)	(0.232)	(0.245)
Asia	-0.59*	-0.53*	-0.51*	-0.53*	-0.55*	-0.52*	-0.55*	-0.60*
	(0.247)	(0.249)	(0.235)	(0.235)	(0.240)	(0.234)	(0.245)	(0.259)
Europe	-0.88***	-0.76**	-0.91***	-0.99***	-1.0***	-0.99***	-0.91***	-0.96***
	(0.240)	(0.238)	(0.224)	(0.225)	(0.228)	(0.220)	(0.231)	(0.243)
IBRD_IDA								
IBRD	-0.47*	-0.51*	-0.42	-0.41	-0.43	-0.44	-0.48*	-0.40
	(0.236)	(0.239)	(0.224)	(0.224)	(0.228)	(0.223)	(0.232)	(0.250)
IDA	-0.33	-0.36	-0.28	-0.26	-0.30	-0.27	-0.25	-0.21
	(0.299)	(0.303)	(0.286)	(0.285)	(0.291)	(0.285)	(0.296)	(0.314)

Productivity	2021	2020	2019	2018	2017	2016	2015	2014
R^2	0.847	0.837	0.855	0.862	0.853	0.859	0.861	0.853
AIC	355	358	338	337	344	338	343	357
σ	0.768	0.776	0.731	0.729	0.747	0.730	0.756	0.799

*p<0.05; **p<0.01; ***p<0.001, SE in paranthesis

Table 5 OLS Regressions between 2006 and 2013

Productivity	2013	2012	2011	2010	2009	2008	2007	2006
Openness	0.72***	0.72***	0.73***	0.71***	0.68***	0.76***	0.77***	0.75***
	(0.057)	(0.059)	(0.058)	(0.057)	(0.054)	(0.058)	(0.057)	(0.051)
Openness	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Income								
Low	-0.41	-0.49	-0.61	-0.52	-0.60	-0.52	-0.39	-0.44
	(0.446)	(0.488)	(0.482)	(0.480)	(0.412)	(0.442)	(0.432)	(0.420)
Lower middle	-0.39	-0.49	-0.56	-0.54	-0.54	-0.46	-0.33	-0.35
	(0.317)	(0.343)	(0.339)	(0.335)	(0.290)	(0.310)	(0.307)	(0.296)
Upper middle	-0.12	-0.25	-0.27	-0.31	-0.28	-0.23	-0.16	-0.16
	(0.264)	(0.289)	(0.287)	(0.283)	(0.244)	(0.261)	(0.266)	(0.257)
Longitude	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log(Population)								
Log(Population)	3.9***	3.9***	4.0***	3.6***	4.2***	4.0***	3.6***	3.7***
	(0.925)	(0.985)	(0.981)	(0.969)	(0.821)	(0.878)	(0.848)	(0.819)
Log(Population)^2	-0.49	-0.15	-0.23	0.28	-0.36	-0.29	-0.16	-0.30
	(0.854)	(0.918)	(0.915)	(0.908)	(0.775)	(0.832)	(0.794)	(0.771)
Continent								
Africa	-0.45	-0.47	-0.39	-0.42	-0.36	-0.33	-0.33	-0.30
	(0.232)	(0.253)	(0.252)	(0.250)	(0.213)	(0.229)	(0.223)	(0.218)
Asia	-0.55*	-0.57*	-0.53*	-0.50	-0.45*	-0.44	-0.46	-0.42
	(0.245)	(0.266)	(0.264)	(0.262)	(0.223)	(0.240)	(0.234)	(0.226)

Productivity	2013	2012	2011	2010	2009	2008	2007	2006
Europe	-0.9*** (0.23)	-0.98*** (0.248)	-0.88*** (0.248)	-0.79** (0.246)	-0.43* (0.213)	-0.49* (0.231)	-0.46* (0.226)	-0.45* (0.216)
IBRD_IDA								
IBRD	-0.48* (0.232)	-0.41 (0.256)	-0.42 (0.257)	-0.46 (0.255)	-0.53* (0.217)	-0.46 (0.234)	-0.44 (0.233)	-0.44 (0.225)
IDA	-0.25 (0.296)	-0.19 (0.323)	-0.15 (0.323)	-0.20 (0.320)	-0.15 (0.273)	-0.08 (0.294)	-0.09 (0.287)	-0.07 (0.280)
R^2	0.861	0.847	0.855	0.856	0.883	0.883	0.890	0.894
AIC	343	358	357	352	307	327	318	307
σ	0.756	0.817	0.813	0.806	0.687	0.737	0.720	0.697

*p<0.05; **p<0.01; ***p<0.001, SE in parenthesis

Table 6 OLS Regressions between 2001 and 2005

Productivity	2005	2004	2003	2002	2001
Openness	0.76*** (0.051)	0.76*** (0.052)	0.74*** (0.051)	0.67*** (0.050)	0.62*** (0.049)
Openness	-0.02*** (0.002)	-0.02*** (0.002)	-0.02*** (0.002)	-0.02*** (0.002)	-0.02*** (0.002)
Income					
Low	-0.42 (0.417)	-0.43 (0.417)	-0.39 (0.408)	-0.49 (0.396)	-0.63 (0.399)
Lower middle	-0.32 (0.293)	-0.31 (0.291)	-0.26 (0.285)	-0.36 (0.276)	-0.49 (0.280)
Upper middle	-0.13 (0.255)	-0.11 (0.253)	-0.06 (0.249)	-0.13 (0.241)	-0.17 (0.243)
Longitude	0.00 (0.001)	0.00 (0.001)	0.00 (0.001)	0.00 (0.001)	0.00 (0.001)
Log(Population)					
Log(Population)	4.0*** (0.816)	3.8*** (0.786)	4.0*** (0.771)	3.6*** (0.740)	3.7*** (0.744)

Productivity	2005	2004	2003	2002	2001
Log(Population)²	-0.43	-0.12	-0.28	-0.22	-0.37
	(0.769)	(0.741)	(0.727)	(0.709)	(0.719)
Continent					
Africa	-0.29	-0.24	-0.23	-0.20	-0.17
	(0.216)	(0.217)	(0.212)	(0.205)	(0.207)
Asia	-0.43	-0.46*	-0.41	-0.35	-0.35
	(0.224)	(0.222)	(0.217)	(0.211)	(0.213)
Europe	-0.38	-0.32	-0.22	-0.22	-0.31
	(0.213)	(0.210)	(0.204)	(0.197)	(0.197)
IBRD_IDA					
IBRD	-0.44*	-0.41	-0.43	-0.40	-0.41
	(0.224)	(0.225)	(0.219)	(0.212)	(0.213)
IDA	-0.04	0.02	0.03	0.03	0.02
	(0.279)	(0.278)	(0.272)	(0.266)	(0.267)
R^2	0.896	0.900	0.897	0.887	0.876
AIC	306	295	289	279	276
σ	0.693	0.682	0.667	0.647	0.649

*p<0.05; **p<0.01; ***p<0.001, SE in paranthesis

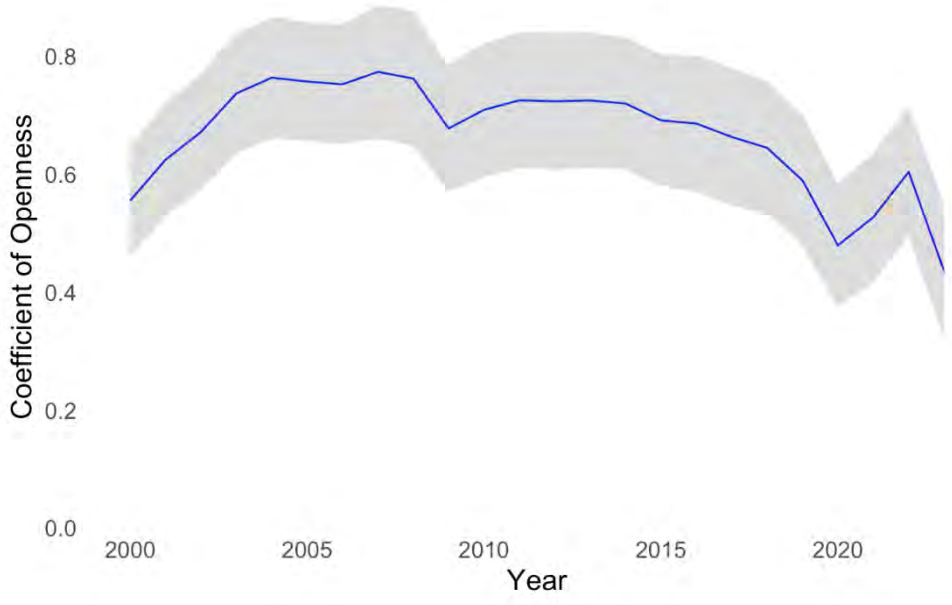

Figure 3 Coefficient of Openness between 2001 and 2021

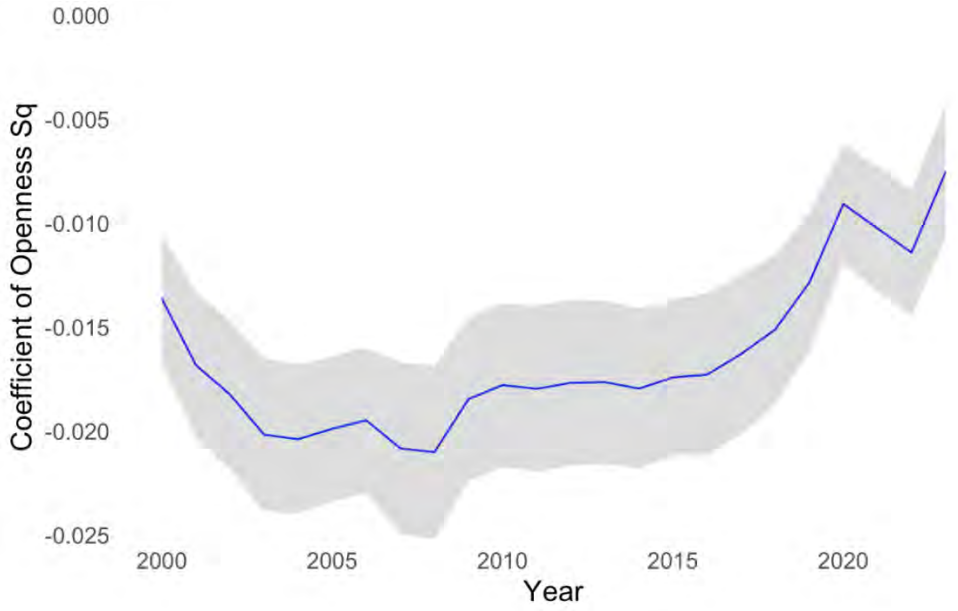

Figure 4 Coefficient of Openness Square between 2001 and 2021

Tables 4, 5, and 6, and Figures 3 and 4 provides the results of OLS regressions between 2001 and 2021, illustrating consistency in the openness-productivity relationship over time.

3.3 Openness and Productivity: IV Results

To address endogeneity concerns, we employ two-stage least squares (2SLS) to estimate the relationship between openness and productivity. The model treats openness and $Openness_i^2$ as endogenous variables, specified as:

$$Openness_i = \beta_{o0} + \beta_{o1}RTAs + \beta_{o2}RTAs^2 + \beta_{o3}RTAs^3 + \beta_{o4}RTAs^4 + X'\gamma_o + v_o$$

$$Openness_i^2 = \beta_{s0} + \beta_{s1}RTAs + \beta_{s2}RTAs^2 + \beta_{s3}RTAs^3 + \beta_{s4}RTAs^4 + X'\gamma_s + v_s$$

Where RTAs denote Regional Trade Agreements and X' represents a vector of covariates influencing all variables. The number of RTAs serves as an instrument for openness, with the exclusion restriction that RTAs do not directly affect productivity, only through their influence on openness. This identification strategy is valid if RTAs are uncorrelated with the error term u_i, and their effect on productivity is solely mediated by openness.

Table 7 reports the 2SLS estimates of openness's impact on productivity. The estimate of -0.169, with a standard error of 1.019, is not statistically significant and diverges from the OLS estimates presented in Table 3. This suggests that while openness appears to have a significant association with productivity in OLS regressions, the IV approach indicates a less clear relationship.

Table 8 and 9 displays the first-stage results, highlighting a strong relationship between RTAs and openness. The robust first-stage F-statistics support the validity of RTAs as an instrument for openness, confirming that RTAs significantly influence openness, thus validating our identification strategy.

Table 7 IV Regressions of Productivity

Productivity	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
Openness	0.372***	0.09	0.078	0.039	0.117	-0.169
	(0.0136)	(0.312)	(0.315)	(0.266)	(0.792)	(1.019)
Openness^2	0.03	0.01	0.01	0.009	0.007	0.015
	(0.007)	(0.01)	(0.01)	(0.009)	(0.023)	(0.03)
Income						
Low		-1.659	-1.697	-2.133*	-1.87	-2.152
		(1.403)	(1.407)	(1.153)	(2.509)	(2.49)
Lower middle		-1.526	-1.543	-1.945*	-1.717	-2.027
		(1.321)	(1.326)	(1.089)	(2.371)	(2.372)
Upper middle		-1.171	-1.210	-1.554	-1.411	-1.423
		(1.155)	(1.156)	(0.953)	(2.095)	(1.795)
longitude			-0.001	-0.001	0.001	0.00002
			(0.002)	(0.002)	(0.002)	(0.003)
Log(Population)				1.764	2.9	1.854
				(1.603)	(3.28)	(4.198)
Log(Population)^2				0.503	-0.116	0.552
				(1.476)	(1.761)	(2.407)
Continent						
Africa					-0.463	-0.39
					(0.521)	(0.6)
Asia					-0.75	-0.66
					(0.634)	(0.715)
Europe					-0.44	-0.057
					(1.413)	(1.667)
IBRD_IDA						
IBRD						-0.947
						(1.28)
IDA						-0.772
						(1.178)

Weak IV F-test (openness)	13.056	1.977	2.024	2.529	2.592	2.967
Weak IV p-value (openness)	0.000	0.101	0.094	0.043	0.039	0.022
Weak IV F-test (I(openness^2))	4.324	1.619	1.639	1.995	2.358	2.542
Weak IV p-value (I(openness^2))	0.002	0.173	0.168	0.099	0.057	0.043
Wu-Hausman test	9.342	10.905	11.008	10.595	4.906	6.215
Wu-Hausman p-value	0.000	0.000	0.000	0.000	0.009	0.003
Sargan test	2.165	2.094	1.994	3.510	5.450	3.501
Sargan p-value	0.339	0.351	0.369	0.173	0.066	0.174
Adj-R^2	0.298	0.298	0.286	0.419	0.518	0.31

First-Stage F-Statistic test evaluates the strength of the instrument. Although some of the values are small, we can say that the instruments are sufficiently strong and relevant for predicting the endogenous variable. Over-Identification Test (Hansen J Statistic) checks the validity of the instruments. High p-values in Table 7 indicate that the instruments are valid and uncorrelated with the error term. Endogeneity (Wu-Hausman) test assesses whether the endogenous regressor is indeed endogenous. Significant p-values in Table7 suggests that the regressor is endogenous and that IV estimation is appropriate.

Table 8 First Stage for Openness

Openness	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
$\boldsymbol{RTAs}$	29.68***	7.36*	7.45**	12.97***	4.77***	4.15***
	(4.39)***	(3.13)	(2.37)	(2.69)	(0.68)	(0.68)
$\boldsymbol{RTAs^2}$	1.68	1.04	1.17	-3.40	-8.71	-11.16*
	(9.12)	(7.17)	(6.04)	(7.03)	(5.95)	(4.60)
$\boldsymbol{RTAs^3}$	-16.03**	-12.26*	-12.44*	-11.90*	-11.09*	-10.26*
	(5.21)	(4.82)	(4.86)	(5.60)	(5.38)	(4.73)
$\boldsymbol{RTAs^4}$	-0.80***	0.11***	-0.12	0.95	3.83+	4.67
	(0.02)	(0.01)	(0.32)	(1.52)	(1.96)	(3.16)
Income						
Low		-6.5***	-6.5***	-4.85***	-4.67***	-2.81*
		(1.11)	(0.91)	(1.00)	(0.89)	(1.19)
Lower middle		-5.6***	-5.7***	-4.67***	-4.61***	-2.98**
		(1.38)	(1.19)	(1.04)	(0.96)	(1.06)
Upper middle		-4.98***	-4.94***	-4.33**	-4.50**	-2.05
		(1.23)	(1.21)	(1.32)	(1.44)	(1.51)

longitude			0.00	0.00	0.00*	-0.01*
			(0.00)	(0.00)	(0.00)	(0.00)
Log(Population)				-10.02***	-15.86***	-16.93***
				(0.63)	(4.08)	(4.31)
Log(Population)²				-2.33	0.12	1.42
				(3.73)	(2.78)	(1.63)
Continent						
Africa					2.14+	2.26
					(1.18)	(1.47)
Asia					3.31***	3.25**
					(0.80)	(1.15)
Europe					4.09***	4.10***
					(0.39)	(0.98)
IBRD_IDA						
IBRD						-3.45***
						(0.65)
IDA						-2.45***
						(0.70)
R2	0.269	0.388	0.390	0.405	0.444	0.476
R2 Adj.	0.248	0.357	0.355	0.362	0.389	0.416
AIC	877.5	857.5	858.7	859.1	855.4	850.4
BIC	895.4	884.4	888.6	895.0	900.2	901.2
RMSE	4.59	4.21	4.20	4.14	4.01	3.89

notes: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 9 First Stage for Openness²

Openness	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
RTAs	444.1***	87.57	90.45	197.97***	55.45***	38.31***
	(79.64)	(132.56)	(107.36)	(72.66)	(3.46)	(1.26)
RTAs²	-63.55	-82.86	-78.57	-186.51	-305.16	-366.08*
	(217.51)	(188.34)	(150.82)	(202.03)	(186.57)	(166.62

Openness	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
						)
$RTAs^3$	-446.90* (187.43)	-381.99* (165.95)	-388.00* (167.17)	-388.68* (177.72)	-371.39* (175.49)	-350.52* (158.09)
$RTAs^4$	57.31 (81.31)	72.97 (86.05)	65.26 (75.76)	108.04 (118.93)	169.44 (134.53)	189.65 (166.47)
Income						
Low		-102.83* (44.58)	-103.35* (38.08)	-70.48* (28.77)	-64.62* (26.64)	-30.03 (26.64)
Lower middle		-85.68+ (44.53)	-88.09* (38.06)	-66.63* (27.81)	-64.79* (26.24)	-32.21 (22.17)
Upper middle		-86.11* (41.95)	-84.88* (41.12)	-71.97+ (40.10)	-73.77+ (43.09)	-19.23 (36.13)
longitude			0.15 (0.12)	0.18 (0.12)	-0.07*** (0.01)	-0.11*** (0.00)
Log(Population)				-230.9*** (60.08)	-398.32* (166.53)	-418.28* (175.30)
Log(Population)²				-126.02+ (71.89)	-57.25 (37.49)	-25.50** (7.63)
Continent						
Africa					58.19 (37.51)	62.48 (44.76)
Asia					94.82*** (28.86)	94.40* (36.85)
Europe					93.32*** (18.99)	95.12** (32.76)
IBRD_IDA						
IBRD						-77.9*** (2.47)

Openness	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
IDA						-49***
						(7.19)
R2	0.109	0.144	0.147	0.160	0.189	0.208
R2 Adj.	0.083	0.101	0.098	0.098	0.110	0.118
AIC	3573.1	3576.2	3578.5	3582.3	3586.3	3589.0
BIC	3591.0	3603.2	3608.4	3618.2	3631.2	3639.9
RMSE	150.25	147.27	146.95	145.86	143.31	141.60

notes: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

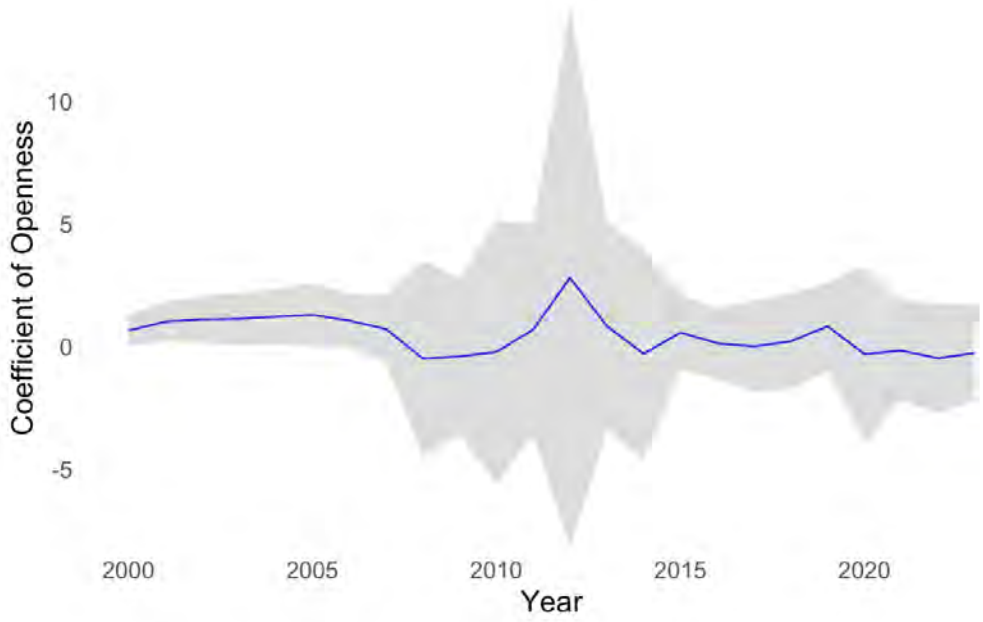

Figure 5 IV Coefficient of Openness Square between 2001 and 2021

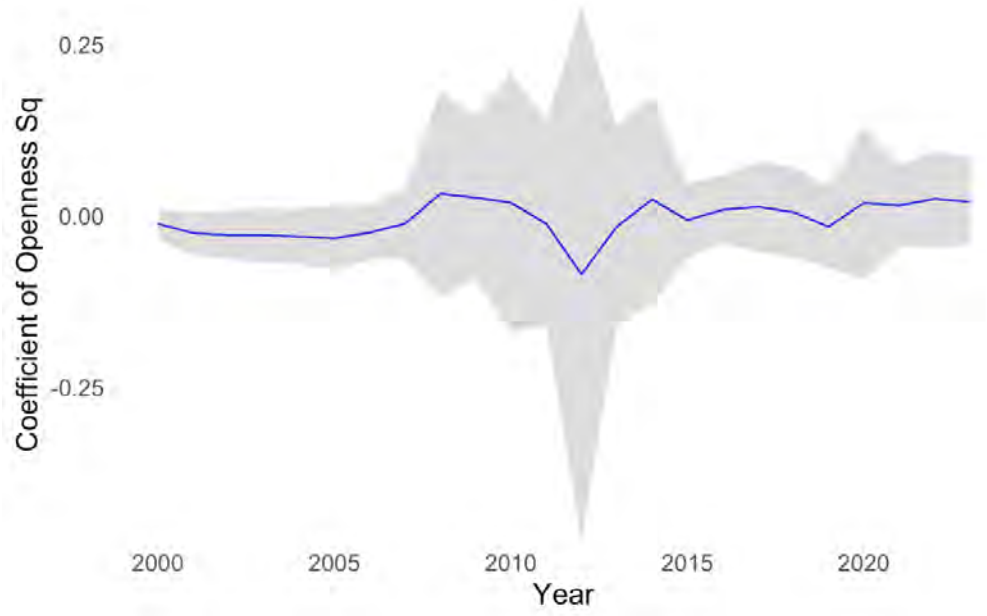

Figure 6 IV Coefficient of Openness Square between 2001 and 2021

Figures 5 and 6 provides IV Coefficient of Openness and Openness Square between 2001 and 2021, illustrating consistent insignificancy in the openness-productivity relationship over time.

Our results suggest a significant positive association between openness and productivity using OLS regressions, yet the IV approach reveals a less pronounced and statistically insignificant impact, indicating that endogeneity might obscure the true nature of this relationship. The differences between OLS and IV results underscore the importance of addressing potential endogeneity and the complexities involved in interpreting the effects of trade policies on economic productivity.

In summary, while trade openness appears beneficial for productivity in preliminary OLS results, the IV estimates suggest that this relationship may be less straightforward, warranting further investigation into the underlying mechanisms and potential confounding factors.

3.4. Additional Controls

The validity of our 2SLS results in Table 7 relies on the assumption that RTAs have no direct effect on productivity. While this assumption appears reasonable, we further test its validity by including additional controls that could potentially be correlated with both RTAs and productivity.

We introduced income dummies, longitude, log population, the square of log population, continent dummies, and IBRD and IDA dummies into our model. This approach helps us evaluate whether these controls impact our estimates of the relationship between openness and productivity. As illustrated in Table 7, the inclusion of these controls results in minimal changes to our key estimates. Notably, many variables previously highlighted in the literature become insignificant once the effect of openness is accounted for.

Additionally, we used graphical analyses in Figure 5 and Figure 6 to show time effects over the last 20 years. These figures reveal no significant deviation in results over this period.

We also assessed the validity of our instrument using overidentification tests. Our theoretical framework posits that RTAs, $RTAs^2$, $RTAs^3$, and $RTAs^4$ affect openness and its square, which in turn influence productivity. To test the exclusion restriction, we used $RTAs^2$, $RTAs^3$, and $RTAs^4$ as additional instruments. The overidentification test checks whether any of these instruments has a direct effect on productivity, assuming one of them (e.g., $RTAs^2$) is truly exogenous.

The test results suggest that the data supports our overidentifying restrictions. This implies that, while overidentification tests are subject to power issues, we can reasonably rule out direct effects of $RTAs^2$, $RTAs^3$, and $RTAs^4$ on productivity. This reinforces the validity of RTAs as an instrument and supports our IV estimation approach.

3.5 Analysis

We present a graph in Figure 7 showing total world production from 2000 to 2021. This graph includes total world exports and imports, with production depicted by a solid black line and trade activities by dashed lines. The trend indicates that total world production has been approximately 3.5 times higher than both total exports and imports. Notably, trade activity increased significantly before the 2007 economic crisis, with a subsequent slowdown and convergence in trends post-crisis.

However, following the 2007 economic crisis, we observe a shift in this trend, where the growth rate of trade slows down. Furthermore, after 2007, we notice a convergence in the trends of production growth, total exports, and total imports, suggesting a similar trajectory for these three series.

This shift in trend posts the economic crisis may indicate a change in the trajectory of trade. Despite the world moving towards a fully open economy, we observe a deceleration in its pace, signaling a period of stagnation. This graph provides valuable insights into the dynamics of global trade and production, especially in the aftermath of significant economic events such as the 2007 crisis.

Figures 8-11 provide further insights into global trade and productivity dynamics:

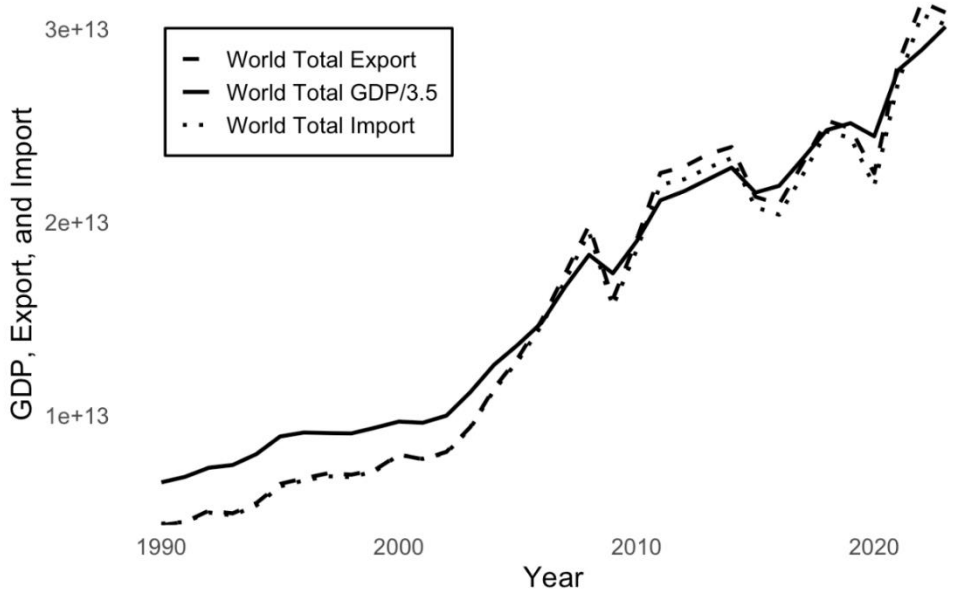

Figure 7 World Total Export, Import and GDP

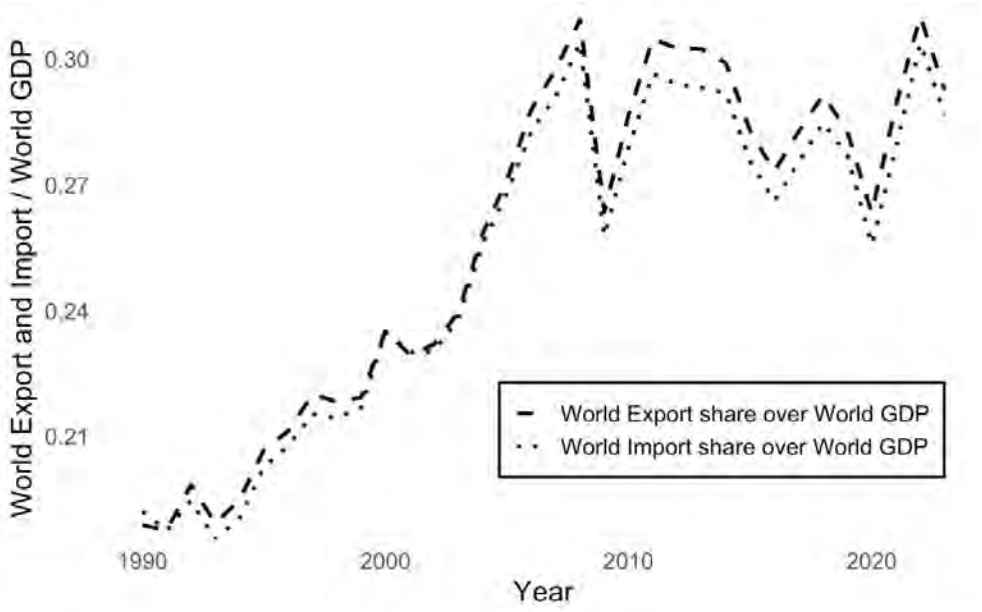

Figure 8 World Total Export, Import Share

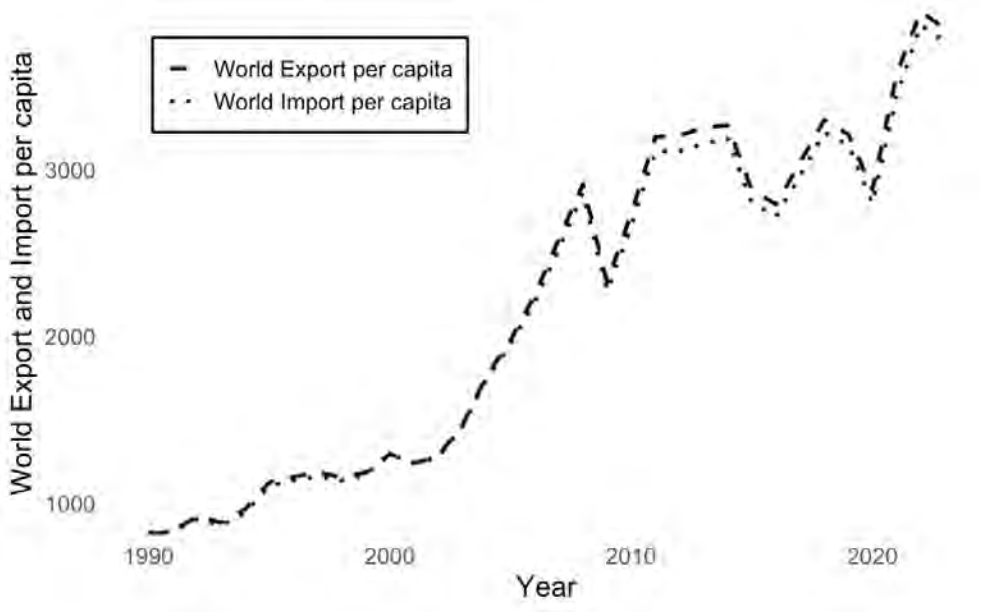

Figure 9 World Export and Import per capita

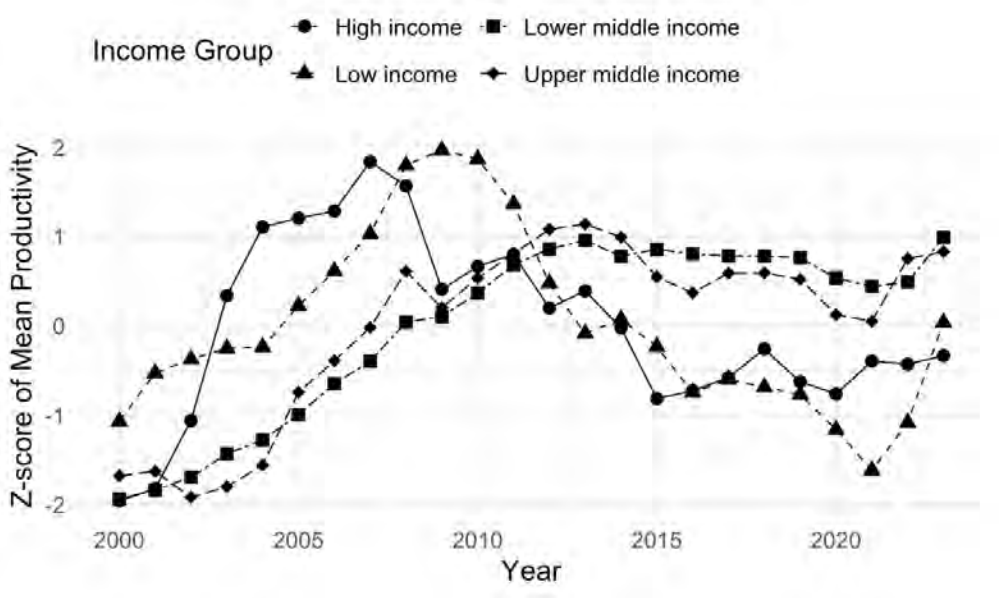

Figure 10 Z-score of Mean Productivity by Income Groups

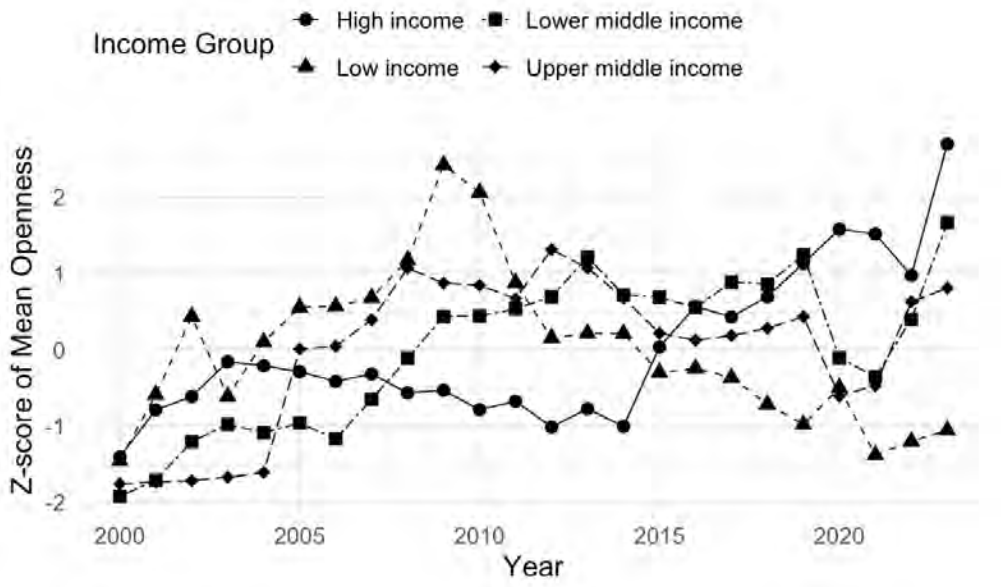

Figure 11 Z-score of Mean Openness by Income Groups

Figures 10 and 11 analyze the Z-scores of mean productivity and openness across income groups. We observe that the slowdown in openness is primarily driven by lower-income countries post-2007, while middle-income countries have shown an upward trend recently. High-income countries have demonstrated a robust recovery in openness since 2015.

In terms of productivity, high and low-income countries show similar trends post-2007, with low-income countries lagging behind. Middle-income countries, on the other hand, have not shown significant recovery in productivity since 2012. The lack of effect of openness on productivity in these graphs suggests that the expected positive relationship might be weakening.

These graphs provides valuable insights into the relationship between trade openness and income groups, shedding light on the potential shifts in economic dynamics and their implications for

productivity and development strategies.

The regression results from the previous section indicate that the coefficient for openness is consistently insignificant in recent years, contrasting with the typical positive relationship observed in the literature. The negative coefficient for openness, coupled with a positive coefficient for its squared term, points to a nonlinear relationship with diminishing returns.

Overall, these regression results suggest a complex relationship between openness, regional factors, income levels, and productivity. The negative and unsignificant coefficient for openness in last year challenges conventional wisdom and calls for further investigation into the changing dynamics of global trade and economic development.

In addition to regression results, we utilize another graph illustrating the change in the open coefficient over the period 2001-2021. The shaded area represents the confidence interval, with the open coefficient remaining statistically insignificant and close to zero. This suggests a substantial shift in the relationship between openness and the outcome variable in recent years, warranting further investigation into potential underlying factors driving this change.

4. Discussion

The findings from our analysis reveal significant insights into the evolving relationship between openness, productivity, and economic growth. Here, we explore the implications of these results and the underlying factors that may have influenced the observed trends.

The insignificant relationship between openness and productivity in our models observed in recent years may be attributed to shifts in global economic dynamics. Factors such as rapid technological advancements, geopolitical tensions, and evolving trade policies have likely altered traditional patterns of trade and economic growth. As countries adapt to these changes, the relationship between openness and productivity may evolve, reflecting new economic realities.

The aftermath of major economic crises, such as the 2007 global financial crisis, may have had lasting effects on trade patterns and economic policies. Economic downturns often lead to the implementation of protectionist measures, which can dampen the positive effects of openness on productivity. The insignificant coefficients observed in recent years may thus reflect the persistent impacts of past economic crises on global trade dynamics.

Our analysis highlights the role of income group dynamics in shaping the relationship between openness and productivity. Low-income countries, in particular, may struggle to maintain openness amid changing global economic conditions. Factors such as rising labor costs, competition from low-cost manufacturing hubs, and evolving trade agreements could contribute to a decline in openness, impacting productivity levels.

Changes in government policies related to trade, investment, and industrial development could also influence the observed relationship between openness and productivity. Protectionist policies, tariffs, and trade barriers may dampen the positive effects of openness on productivity growth. Conversely, policy initiatives promoting domestic industries or innovation could alter trade and productivity dynamics.

In conclusion, our findings underscore the need for a nuanced understanding of the factors shaping global trade dynamics. Policymakers and researchers should consider the evolving economic landscape and adopt strategies that foster sustainable and inclusive growth in an interconnected world.

5. Conclusions, Limitations and Future Research Directions

This study enhances our understanding of global economic dynamics and the relationship between trade and productivity from 2000 to 2021. The limitations of the study are as follows:

Our reliance on World Bank's World Development Indicators may involve limitations in coverage and accuracy. Future studies could explore alternative datasets or advanced data collection methodologies to address these limitations.

Regression analysis, while insightful, may overlook certain nuances in the relationship between trade openness and productivity. Future research might employ methodologies such as panel data analysis or structural equation modeling for a more comprehensive understanding.

Aggregating data at the global level may mask regional variations in the relationship between trade openness and productivity.

Our findings indicate that total world production generally exceeded total world exports and imports by approximately 3.5 times. Before the 2007 economic crisis, trade accelerated, but post-crisis, the growth rate slowed, with production growth following a similar trajectory. These observations suggest a potential shift in the trajectory of trade post-crisis.

Additionally, our analysis highlights a decline in trade openness among middle-income countries and its implications for productivity. The increasing trend of protectionism among these countries raises concerns about their ability to leverage technological advancements fully.

These findings challenge the traditional assumption that open economy policies universally enhance productivity and technological development. Future research should delve deeper into these dynamics and explore effective economic policies for middle-income countries to boost productivity and fully benefit from technological advancements.

In conclusion, this study provides valuable insights into global economic trends and informs future economic policymaking. Further research is anticipated to expand our understanding and offer new perspectives on the transformation of the global economy.

Future research should explore regional differences to provide tailored policy recommendations. In addition, while our study identifies associations between trade openness and productivity, establishing causality remains challenging. Employing quasi-experimental or longitudinal designs in future research could enhance causal inference.

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