A Global Perspective on Export Diversification: Determinants and Regional Insights from 93 Countries

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Abstract

A central structural challenge for developing economies is the diversification of their export structures. Reliance on a narrow range of commodities renders these economies susceptible to the volatility of commodity prices. This paper addresses a fundamental question: What are the key determinants of export diversification? We investigate the question using the Herfindahl-Hirschman Index (HHI) as a measure of export structure diversification, analyzing panel data from 2010 to 2019 across 93 countries. Our findings reveal that domestic credit to GDP aids in diversifying exports, whereas the presence of commercial bank branches tends to increase the concentration of exports. Exporting to high-income countries tends to decrease export diversification, while importing from such countries aids in diversifying the export structure. The spatial-lagged HHI, which accounts for the export structures of geographically proximate nations, shows significant influence in East Asia. Additionally, to support export diversification, the required level of education varies across different regions.

Keywords: *Export Diversification, Herfindahl-Hirschman Index, Spatial Lag, Natural Resource Rent, Access to Finance, Regional Difference*

Introduction

One of the persistent challenges faced by developing economies is their susceptibility to the volatility of commodity prices. Fluctuations in these prices can lead to inconsistencies in economic growth, which may affect budgetary stability and exacerbate debt concerns. A recognized solution to these challenges is the

diversification of economic and export structures. Consequently, the importance of export diversification has been a subject of long-standing debate and analysis in development research.

At the beginning of the 21st century, with the deepening of world trade, many scholars discussed the impact of trade openness on income levels (Ffrench-Davis, 2000; Frankel & Romer, 1999; Rodríguez *et al*., 2000; Rose, 2004). Some argued that exports help countries fully utilize their comparative advantages, enabling them to achieve better economic growth. This conclusion aligns with the theory proposed by Ricardo (1977)

However, when examining trade composition, other scholars found evidence to the contrary. Botta (2009) and Vera (2006) empirically claimed that changes in trade composition alter the structure of developing economies, simplifying their industrial base, and increasing their dependence on other countries.

Imbs and Wacziarg (2003) characterized the pattern of sectoral diversification along the development path. They found a U-shaped correlation between production concentration and per capita income. Cadot *et al*. (2011) extended the research of Imbs and Wacziarg (2003) and found a similar hump-shaped pattern for export diversification along the development path. For most developing countries, export diversification can significantly help in developing their economies. Take East Asian countries such as Korea and China as example, Lin and Chang (2009) and Wade (2018) found those two countries have achieved rapid economic growth by diversifying their export portfolios. Learning from the experiences of these countries, it is beneficial for developing countries to diversify their export structures.

There is a substantial body of literature discussing the driving forces behind export diversification. Klinger and Lederman (2004) and Parteka (2009) identified a U-shaped relationship between export concentration and economic development levels. Lederman and Maloney (2003) concluded that resource-dominant exports are detrimental to economic growth, particularly when controlling physical and human capital accumulation, suggesting that limited export diversification at the early stages of development is a factor in poor economic performance. Cadot *et al*. (2013) further elucidated the theoretical and empirical connections between trade diversification and economic growth.

Agosin *et al.* (2012) demonstrated that a stable real exchange rate can assist some countries in diversifying exports, though financial development does not appear to have a uniform effect. Their research also indicated that higher education levels enable countries to leverage positive terms of trade shocks for export diversification. Swathi and Sridharan (2022) expanded the sample period to 1995-2019, focusing

primarily on high-income countries. They discovered that factors such as human capital accumulation, income per capita, population size, trade openness, the proportion of manufactured output to GDP, and foreign direct investment are crucial determinants[1] of export diversification. In low-income countries, GDP per capita and population size play a more significant role, while in high-income countries, value-added in agriculture is more influential in reinforcing export structures. Gnangnon (2021) revealed that multilateral trade positively influences export diversification, with a more pronounced impact in less-developed economies. Gnangnon (2018a, 2018b, 2019, 2020, 2021) extensive studies from 2018 to 2021 also examined the effects of manufacturing export performance, aid, poverty, and tax reform, providing a rich body of references on this topic.

This paper conducts multiple regressions on a panel of 93 countries spanning from 2010 to 2019 to further verify determinants of export diversification globally and regionally, and identify factors associated with export diversification in the 21st century.

Data

To assess the extent of export diversification—or conversely, concentration—this study employs the HHI, traditionally utilized to gauge market concentration. Our trade data are sourced from the UN Comtrade database, accessible through the World Integrated Trade Solution (WITS)[2]. The dataset encompasses the period from 2010 to 2019[3] and includes information for 93 countries due to the data availability, categorized at the SITC Rev.2 two-digit level.

[1] The word, "Determinants", does not necessarily mean causality in this paper but rather indicates statistically significant association.

[2] https://wits.worldbank.org/

[3] The period from 2010 to 2019 and 93 countries for the first analysis is selected with the criteria that those countries have export data more 90% of the period. Therefore, some of the HHI data less than 10% at most are interpolated using compound growth rate between two points of time nearby the year missing data.

Table 1 Variables and Definition

Variables	Definitions	Units	Source
ATE	Access to electricity in % of population	%	WDI
NEX_yearly	Year-on-year changes in nominal exchange rate	%	IFS
CPI_yearly	Year-on-year changes in consumer price index	%	IFS
Real_EX	Real effective exchange rate index (Year 2010=100) (The higher the more appreciated)		WDI
Std_CPI	Standard deviation of annual change of monthly consumer price index		IMF
Std_EX	Standard deviation of monthly exchange rates		IMF
CBB	Commercial bank branches	per 100,000 adults	WDI
DC_GDP	Domestic credit to private sector	% of GDP	WDI
EX_high	Merchandise exports to high-income economies to total merchandise exports	% of trade	WDI
IM_high	Merchandise imports from high-income economies to total merchandise imports	% of trade	WDI
FDI	Foreign direct investment, net inflows	% of GDP	WDI
GCF	Gross Capital Formation	% of GDP	WDI
GDP_growth	Annual changes in gross domestic product at constant 2015 US$	%	WDI
HHI	Herfindahl-Hirschman Index		WITS
HHI_ST	Spatial lag of Herfindahl-Hirschman Index		WITS
MFVA	Manufacturing value added	% of GDP	WDI
ServiceVA	Service value added	% of GDP	WDI
NRR	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents	% of GDP	WDI
Open	Goods and services exports and imports	% of GDP	WDI
Pop15-64	Population ages 15-64	% of total population	WDI
Pschool	The share of primary school enrollment to gross enrollment ratio	%	WDI
Sschool	The share of secondary school enrollment to gross enrollment ratio	%	WDI
Tschool	The share of tertiary school enrollment to gross enrollment ratio	%	WDI
HEdu_labor	The share of labor with advanced education level to total labor	%	WDI
PTax	Profit tax to profit ratio	%	WDI
Tax_incomes	Taxes on income, profits, and capital gains	% of total taxes	WDI
Tariff	Tariff rate, applied, simple mean, all products	% of GDP	WDI
Pop_den	Population density	Per sq.km of land area	WDI
Pop_growth	Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage.	%	WDI
Consume	Household consumption	% of GDP	WDI
GDPpc	The natural logarithm of gross domestic production per capita	Constant international dollar	WDI
GDPpc2	The squared term of natural logarithm of gross domestic production per capita		WDI
Unemploy	Unemployment, total (National estimate)	% of total labor force	WDI

Notes: 1. High-income economies are taken from the World Bank classification of economies.

2. WDI: World Development Indicator by the World Bank, accessed as of Nov 23, 2023

3. IFS: International Financial Statistics by the International Monetary Fund as of Nov 24, 2023

4. WITS: World Integrated Trade Solution by maintained by the World Bank accessed as of Nov 23, 2023.

The *HHI* is a measure ranging from 0 to 1, where a value approaching 1 signifies a high degree of export concentration (i.e., low diversification), and a value closer to 0 indicates a more diversified export profile.

$$HHI_i = \frac{\sum_{i=1}^{n} {x_i}^2}{\left(\sum_{i=1}^{n} x_i\right)^2} \quad (1)$$

Where x is the export value of export item i and n is the total number of export items. We use spatial lag of the variables for 93 countries and 30 years from 2010 to 2019, which is computed as below:

$$HHI_{ST} = W \times HHI \quad (2)$$

Where HHI_{ST} is a matrix (93 × 10) for 93 countries and 10 years for spatial-lagged variables, *W* is a weight matrix (93 × 93) consisting of the inverse of distance between capital cities of two countries in off-diagonal elements with 0, diagonal elements. *HHI* is a matrix (93 × 10) for *HHI* variable.

Due to the nature of spatial lag computations, which involve matrix operations, complete data sets are essential as matrix multiplication cannot be executed with missing data points. Consequently, in instances where data gaps are present, up to 10% of the *HHI* series, utilized in the computation of spatial lag terms, have been subject to interpolation to maintain the integrity of the matrix. However, it should be noted that the *HHI* values used as the dependent variable in our analysis are derived exclusively from complete, non-interpolated data sets.

Regression strategy

This section elucidates the determinants and contributing factors through analysis. Table 1 enumerates the variables used. Our dataset comprises an unbalanced panel for 93 countries, spanning from 1990 to 2019, with the exclusion of years affected by Covid-19. Preliminary regressions indicate substantial data omissions during 2010 to 2019. Consequently, these gaps resulted in significant discrepancies in the availability of data across sampling periods and countries, affecting the probabilities, R-squared values, and occasionally the signs of the variables. To address this, our initial regression strategy was to delineate the period with the most comprehensive data coverage, especially for those major variables previously identified as statistically significant. After extensive testing, the analysis utilizes a panel dataset for 93 countries from the years 2010 to 2019. This subset was chosen as it presents the broadest coverage, totaling 437 samples.

The second strategy for regression focuses on selecting robust variables from numerous trials. Subsequently, we incrementally integrated variables that have been statistically significant in prior literature and some regressions within this study, illustrating that while they may hold some statistical weight, their robustness is questionable. Model 1 (in Table 2) comprises a set of variables found to be robust. Models 2 to 12 each include an additional variable that was statistically significant in

trial regressions but not deemed robust compared to those in Model 1. The results from Models 2 to 12 demonstrate a lack of robustness. All results from Model 1 to Model 12 employ both country and year fixed effects. The Hausman test in appendix 2 is applied to each outcome to verify the validity of the two-way fixed effects.

Cross-sectional independent unit root tests, which presuppose no shared factors or idiosyncratic traits among countries, were conducted for all variables, confirming stationarity. Nevertheless, spatial data, which can exhibit common spatial factors assuming closer spatial proximity, implies stronger relations, could present challenges. Thus, these tests might be more adept at identifying data stationarity. However, due to the missing data within our dataset, we could not technically perform cross-sectional independent unit root tests. This limitation necessitated alternative estimation methods to ensure the robustness of our findings.

Panel data regression

The analysis confirms the robustness of Natural Resource Rent (*NRR*) as a determinant of export structure. In this study, NRR consistently exhibits a coefficient around 0.462 (Model 1), with a positive correlation indicating that a higher share of natural resources in an economy's output is associated with increased concentration in its export structure. The direction of causality is inferred to run from *NRR* to *HHI*, given that *NRR* is typically determined by a country's factor endowments rather than by its export structure.

The number of commercial bank branches per 1000 population (*CBB*), serving as a proxy for access to finance, shows a statistically significant positive effect. This suggests that while access to finance is vital for export structure, it paradoxically favors export concentration over diversification. A plausible explanation for this positive relationship is that higher profitability from a concentrated export structure attracts more financing, with increased access to finance potentially enabling profitable firms to dominate the export landscape.[4]

[4] Concentration of export structure in fewer numbers of profitable exports such as commodity is more profitable than exporting many items, some of which may be not very profitable.

Table 2 Regression Outcomes

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
NRR	0.462***	0.551***	0.463***	0.168*	0.170*	0.463***	0.461***	0.474***	0.469***	0.450***	0.471***	0.463***
	(-0.059)	(-0.052)	(-0.059)	(-0.102)	(-0.102)	(-0.059)	(-0.059)	(-0.06)	(-0.059)	(-0.059)	(-0.059)	(-0.059)
CBB	0.095***	0.112***	0.097***	0.082**	0.089**	0.094***	0.098***	0.086***	0.085***	0.071***	0.136***	0.095***
	(-0.036)	(-0.031)	(-0.037)	(-0.036)	(-0.037)	(-0.036)	(-0.036)	(-0.038)	(-0.037)	(-0.033)	(-0.042)	(-0.037)
EX_high	0.110***	0.248***	0.107***	0.125***	0.134***	0.110***	0.116***	0.110***	0.107***	0.0994***	0.109***	0.110***
	(-0.038)	(-0.04)	(-0.038)	(-0.038)	(-0.038)	(-0.038)	(-0.038)	(-0.038)	(-0.038)	(-0.036)	(-0.038)	(-0.038)
IM_high	-0.177***	-0.287***	-0.176***	-0.161***	-0.161***	-0.177***	-0.175***	-0.173***	-0.173***	-0.164***	-0.182***	-0.177***
	(-0.042)	(-0.043)	(-0.042)	(-0.042)	(-0.042)	(-0.042)	(-0.042)	(-0.043)	(-0.042)	(-0.042)	(-0.043)	(-0.042)
Ptax	-0.212***	-0.268***	-0.213***	-0.228***	-0.231***	-0.212***	-0.211***	-0.223***	-0.210***	-0.077	-0.213***	-0.212***
	(-0.059)	(-0.053)	(-0.06)	(-0.06)	(-0.06)	(-0.06)	(-0.059)	(-0.061)	(-0.059)	(-0.059)	(-0.06)	(-0.06)
Real_EX	0.089***	0.049***	0.087***	0.124***	0.116***	0.089***	0.084***	0.090***	0.094***	0.111***	0.090***	0.089***
	(-0.019)	(-0.017)	(-0.019)	(-0.021)	(-0.021)	(-0.019)	(-0.019)	(-0.019)	(-0.02)	(-0.018)	(-0.019)	(-0.019)
Tax_income	-0.072**	0.005	-0.072**	-0.071*	-0.073**	-0.073**	-0.076**	-0.073**	-0.071*	-0.094***	-0.076**	-0.073**
	(-0.037)	(-0.032)	(-0.037)	(-0.037)	(-0.037)	(-0.037)	(-0.037)	(-0.037)	(-0.037)	(-0.036)	(-0.037)	(-0.037)
Open	0.038**	0.006	0.038**	0.054***	0.053***	0.039**	0.040**	0.042***	0.043***	0.033**	0.038**	0.038**
	(-0.016)	(-0.016)	(-0.016)	(-0.016)	(-0.016)	(-0.016)	(-0.016)	(-0.016)	(-0.016)	(-0.015)	(-0.016)	(-0.016)
DC_GDP	-0.028**	-0.021*	-0.029**	-0.018	-0.018	-0.029**	-0.029**	-0.029**	-0.027**	-0.031**	-0.036**	-0.028**
	(-0.014)	(-0.012)	(-0.014)	(-0.014)	(-0.014)	(-0.015)	(-0.014)	(-0.014)	(-0.014)	(-0.013)	(-0.015)	(-0.014)
GCF	-0.017**	-0.006	-0.018**	-0.015**	-0.015**	-0.017**	-0.018**	-0.017**	-0.018**	-0.017**	-0.018**	-0.018**
	(-0.007)	(-0.006)	(-0.007)	(-0.007)	(-0.007)	(-0.008)	(-0.007)	(-0.007)	(-0.007)	(-0.007)	(-0.007)	(-0.007)
Std_CPI	0.293*	-0.0261	0.292*	0.252*	0.381**	0.289*	0.424**	0.282*	0.304**	0.341**	0.305**	0.292*
	(-0.15)	(-0.173)	(-0.15)	(-0.15)	(-0.179)	(-0.156)	(-0.177)	(-0.151)	(-0.15)	(-0.138)	(-0.153)	(-0.151)
Pschool		-0.055*										
		(-0.030)										
HHI_st			0.065									
			(-0.091)									
EX_Yearly				-4.883								
				(-5.054)								
Std_EX					-16.390							
					(-13.240)							
GDP_growth						-0.006						
						(-0.056)						
CPI_Yearly							-0.074					
							(-0.052)					
Pop1564								0.150				
								(-0.170)				
ATE									0.067			
									(-0.054)			
Tariff										0.091		
										(-0.095)		
MFVA											-0.007	
											(-0.016)	
FDI												-0.002
												(-0.016)
Constant	8.074**	14.710***	5.175	2.781	3.265	8.118**	8.319**	-2.355	0.642	4.414	7.891*	8.095**
	(-4.075)	(-4.909)	(-5.747)	(-4.259)	(-4.245)	(-4.1)	(-4.073)	(-12.51)	(-7.287)	(-3.914)	(-4.138)	(-4.085)
Observations	437	394	437	422	421	437	437	437	437	401	427	437
R-squared	0.972	0.981	0.972	0.953	0.953	0.972	0.972	0.972	0.972	0.975	0.972	0.972
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: Indicated in Table 1

Note: Analysis by authors and standard errors in parentheses. * indicates statistical significance, * for 10%, ** for 5% and *** for 1%.

Merchandise exports to high-income economies (*EX_high*) have a statistically significant positive effect, implying that exports to wealthier economies may contribute to a concentrated export structure.

Profit tax (*Ptax*) displays a statistically significant negative relationship with *HHI*. Since the profit tax ratio to commercial profits is indicative of the effective tax rate, which is exogenously set, we infer a causal effect from profit tax to *HHI*. This suggests that higher profit tax levels encourage export diversification and inhibit concentration. This could also be interpreted as higher profit taxes diminishing firm profitability, thereby reducing export concentration.[5]

The Real Effective Exchange Rate Index (*Real_EX*) also presents a significant positive association, indicating that an appreciation of the real exchange rate aligns with greater concentration in export structures.

Taxes on Income (*Tax_income*) have a significant negative link with *HHI*, suggesting that a tax structure leaning more towards income tax is conducive to export diversification. This finding implies that increasing income taxes could support the diversification of export structures.

The Openness Index (*Open*), which measures the ratio of exports and imports to GDP, is significant and robust but yields an unexpected positive sign. This outcome indicates that higher trade dependency correlates with more concentrated export structures, contrary to the initial hypothesis that greater trade would lead to diversification.

Domestic credit as a proportion of GDP (*DC_GDP*) exhibits a significant negative sign, indicating its importance in fostering export diversification, although the causality between the two variables remains unclear. Gross Capital Formation as a percentage of GDP (*GCF*) also shows a significant negative correlation, suggesting that higher investment levels support a more diversified export structure. Finally, the standard deviation of the Consumer Price Index (*Std_CPI*) is statistically significant with a positive sign[6], while Model 7 indicates that the CPI level itself is not significant. This points to the influence of price level fluctuations, rather than inflation rate levels, on export structures.

[5] This finding also supports the relation between concentration of export structure and profitability discussed in the relation between the number of bank brunches and *HHI* above.

[6] Standard deviation of consumer price index is not found statistically significant in Case 2 with primary school enrollment ratio. This is another reason why this study does not employ primary school enrollment ratio as a robust variable.

In examining variables that occasionally show statistical significance but lack robustness, we first consider the primary school enrollment ratio (*Pschool*). While prior literature anticipated significance, our study found it to have a negative impact only in specific instances, as presented in Model 2. It was noted that among educational variables, including secondary (*Sschool*) and tertiary (*Tschool*) enrollment ratios, primary school enrollment is found to be statistically significant albeit robustness[7].

Another variable displaying intermittent significance is the spatial lag term of the *HHI* (*HHI_st*). Model 3 reveals its insignificance when combined with other variables. Nevertheless, the export structures of neighboring countries can exhibit similarities due to factors like trade relationships, production factors, and resource endowments related to geographical proximity. For instance, countries within the same global value chains may engage more in intra-industry trade, resulting in analogous *HHI* measures. While the significance of *HHI_st* was not consistently robust, further analysis in a regional context is warranted.

Concerning exchange rates, we explored two dimensions: annual changes and standard deviation (*EX_Yearly* and *Std_EX*). These were found to be sometimes significant but not consistently robust, as shown in Models 4 and Model 5.

The GDP growth rate (*GDP_growth*), including lagged GDP growth, showed occasional significance with a negative sign, indicating that a more diversified export structure may correlate with faster economic growth, as shown in Model 6. Although not robust, this relationship suggests a noteworthy trend.

The population aged 15-64 (*Pop1564*) was another variable that occasionally reached statistical significance, as observed in Model 8. Our expectation is that population structures is one of the factors that shape economic structure through its relative price between production factors such as wage and interest rates[8]. Despite the lack of

[7] Among many variables --occasionally significant but not very robust-- we found that primary school enrollment is one of the most robust variables. However, from our regression trials, other variables listed in Model 1 are found better significant. That is why primary school enrollment is grouped in Model 2.

[8] Population dividend because of higher share of working age population in the total population can mitigate upward pressures on wage while aging affects saving and therefore interest rate.

robustness, the positive sign suggests that demographic dividends may be linked to a more concentrated export structure.

Model 9 indicates that access to electricity (*ATE*), being occasionally significant, did not exhibit robustness. Tariff rates (*Tariff*) are similarly classified in Model 10; despite being exogenously determined and expected to drive export diversification, their impact was not consistently strong.

Model 11 considers the value-added by the manufacturing sector as a percentage of GDP (*MFVA*), which is sporadically significant with a negative sign, hinting that manufacturing could aid in diversifying the export structure. Finally, foreign direct investment (*FDI*) is anticipated to influence the export structure, yet it has been identified only sporadically as significant and not robust, as seen in Model 12

Regional panel data regressions

Sub-regional panel regression analyses were conducted to discern regional variances, encompassing 52 of the initial 93 countries categorized into three principal areas: Africa, East Asia, and Latin America. Appendix 1 delineates the specific country groupings. This segmentation facilitated targeted regressions and robustness checks for each region.

For the East Asian region, the dataset covered data from 14 countries over a decade. The findings, documented in Table 3, advocate for the application of both time-fixed and country-fixed effects within our analytical model based on the result of Hausman test in Appendix 2.

In this regional analysis, per capita GDP (*GDPpc*) and its squared term (*GDPpc2*) are substantiated as significant and robust, corroborating the "hump-shaped" relationship between export diversification and economic development postulated by Wacziarg and Welch (2008). Education also surfaced as a key factor; regions with a higher proportion of highly educated labor (*HEdu_labor*) demonstrated enhanced export diversification. Furthermore, *NRR* sustained its role as a robust variable within the East Asian domain. The positive coefficient of *NRR* suggests a correlation where elevated levels of natural resource rent correspond with a greater concentration in export structure.

Table 3 Regression Outcomes for East Asia

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
NRR	0.457***	0.476***	0.450***	0.416***	0.450***
	(-0.113)	(-0.113)	(-0.111)	(-0.140)	(-0.130)
GDPpc	-50.28**	-50.58**	-47.24**	-56.99*	-47.91**
	(-19.89)	(-19.76)	(-19.66)	(-0.140)	(-0.130)
GDPpc2	3.526***	3.587***	3.377***	3.914**	3.412**
	(-1.204)	(-1.197)	(-1.189)	(-0.140)	(-0.130)
HEdu_labor	-0.381***	-0.396***	-0.358***	-0.420***	-0.369***
	(-0.086)	(-0.087)	(-0.086)	(-0.140)	(-0.130)
HHI_st	-2.096***	-2.014***	-2.076***	-1.820**	-2.201***
	(-0.568)	(-0.567)	(-0.559)	(-0.140)	(-0.130)
Consume	0.782***	0.838***	0.761***	0.770***	0.804***
	(-0.170)	(-0.174)	(-0.168)	(-0.140)	(-0.130)
CPI_Year		0.201			
		(-0.147)			
GCF			-0.117*		
			(-0.067)		
Tariff				0.0413	
				(-0.365)	
Tax_income					0.0673
					(-0.104)
Constant	267.5***	259.7***	254.1***	290.9**	254.5**
	(-89.48)	(-89.07)	(-88.45)	(-132)	(-105.4)
Observations	91	91	91	69	83
R-squared	0.978	0.979	0.979	0.979	0.979
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Source: Indicated in Table 1

Note: Analysis by authors and standard errors in parentheses. * indicates statistical significance, * for 10%, ** for 5% and *** for 1%.

The ratio of consumption to GDP (*Consume*) has emerged as a crucial variable, showing a positive correlation with export concentration and an inverse relationship with export diversification.

Additionally, the spatial lag of the HHI (*HHI_st*) appears to be robust and inversely related to export concentration. This finding indicates that diversified export structures in neighboring countries are linked to increased concentration in East Asia.

Discrepancies were noted when comparing the significance and directionality of certain variables between the pooled sample regression and the region-specific analysis of East Asia. For instance, the annual change in the Consumer Price Index (*CPI_Yearly*) was significant with a negative impact on *HHI* in Table 2, but it lost significance in the East Asian analysis.

Table 4 Regression Outcomes for Latin America

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
NRR	0.673***	0.793***	0.680***	0.674***	0.712***
	(-0.178)	(-0.193)	(-0.186)	(-0.176)	(-0.179)
HEdu_labor	-1.032***	-0.925***	-1.027***	-0.980***	-1.013***
	(-0.177)	(-0.189)	(-0.18)	(-0.179)	(-0.177)
ServiceVA	-1.078***	-1.123***	-1.123***	-1.101***	-1.057***
	(-0.114)	(-0.117)	(-0.128)	(-0.114)	(-0.114)
Ptax	0.672***	0.825***	0.628***	0.657***	0.657***
	(-0.157)	(-0.186)	(-0.165)	(-0.156)	(-0.157)
Real_EX	0.160***	0.129***	0.142***	0.170***	0.158***
	(-0.035)	(-0.04)	(-0.043)	(-0.035)	(-0.035)
CPI_Yearly	-0.766***	-0.887***	-0.810***	-0.805***	-0.783***
	(-0.209)	(-0.221)	(-0.215)	(-0.209)	(-0.208)
DC_GDP		-0.0313			
		(-0.021)			
GCF			0.0579		
			(-0.137)		
Open				-0.0334	
				(-0.023)	
HHI_st					0.168
					(-0.126)
Constant	139.7***	136.0***	143.5***	138.1***	133.3***
	(-17.80)	(-17.78)	(-19.35)	(-17.67)	(-18.34)
Observations	69	69	65	69	69
R-squared	0.785	0.793	0.799	0.792	0.791
Country FE	NO	NO	NO	NO	NO
Year FE	NO	NO	NO	NO	NO

Source: Indicated in Table 1

Note: Analysis by authors and standard errors in parentheses. * indicates statistical significance, * for 10%, ** for 5% and *** for 1%.

For the Latin American dataset comprising 18 countries over a decade, a Hausman test (See Appendix 2) recommended a random effects model. The variables introduced in Models 1 through 5, summarized in Table 4, were selected for robustness checks, incorporating literature review and preliminary analyses. Random effect is used based on the result of Hausman test. Consistent with the pooled regression, natural resource rents, tax revenue, and the real effective exchange rate were significant, each exhibiting a positive relationship with *HHI*, suggesting less diversified export structures as these variables increase. Moreover, in the East Asian region, advanced educated labor (*HEdu_labor*) and the annual CPI change (*CPI_Yearly*) consistently showed significant negative correlations with export concentration, underscoring the importance of education and inflation stability in promoting diversification. The service sector's value-added (*ServiceVA*) also proved

to be significant and robust, indicating that greater service sector contributions are associated with diversified export structures.

In Latin America, however, variables such domestic credit to GDP (*DC_GDP*) and the gross capital formation ratio to GDP (*GCF*) that were significant in Table 2 did not maintain their significance, implying that openness (*Open*) is not a determinant of economic structure in this region. The spatial lag of *HHI* (*HHI_st*) does not show a significant effect within this regional context.

The regression analysis for Africa utilized data from 28 countries over a 10-year period. Due to incomplete data, the effective sample size for the regression was reduced to 75. A Hausman test (See Appendix 2) led us to select a random effects model over a fixed effects model for our analysis, with these results detailed in Table 5.

Our investigation encompassed multiple models, starting with Model 1, which includes variables identified as significant and robust. Subsequent models, Models 2 through 5, were employed to both confirm the robustness of these variables and to detect any other variables, occasionally significant, within the African dataset.

In comparison with Table 2, several variables exhibited consistent results. Natural Resource Rents (*NRR*) and the Real Effective Exchange Rate Index (*Real_EX*) both showed a positive and robust relationship with export concentration. Conversely, the profit tax-to-profit ratio (*Ptax*) and primary school enrollment ratio (*Pschool*) were negatively correlated with *HHI*. Contrastingly, certain variables show the same outcomes as Table 2. Notably, export to high-income countries (*EX_high*) was positively linked to export concentration. However, the annual change in the Consumer Price Index (*CPI_Yearly*), although not significant in Table 2, was found to be significant within the African region. On the other hand, the spatial lag of *HHI* (*HHI_st*) did not yield statistical significance in this regional analysis.

Table 5 Regression Outcomes for Africa

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
NRR	0.520**	0.488**	0.656***	0.517**	0.623**
	(-0.231)	(-0.234)	(-0.24)	(-0.234)	(-0.266)
EX_high	0.0879***	0.0915***	0.0754***	0.0882***	0.0860***
	(-0.01)	(-0.011)	(-0.011)	(-0.01)	(-0.01)
Pschool	-0.375***	-0.394***	-0.488***	-0.373***	-0.371***
	(-0.069)	(-0.073)	(-0.076)	(-0.07)	(-0.07)
Real_EX	0.448***	0.440***	0.440***	0.452***	0.445***
	(-0.09)	(-0.091)	(-0.09)	(-0.095)	(-0.09)
Ptax	-0.422***	-0.400***	-0.378***	-0.421***	-0.424***
	(-0.11)	(-0.113)	(-0.112)	(-0.111)	(-0.11)
CPI_Yearly	0.884***	0.886***	0.836***	0.873***	0.855***
	(-0.201)	(-0.201)	(-0.195)	(-0.215)	(-0.205)
HHI_st		0.0689			
		(-0.081)			
DC			-0.0313		
			(-0.033)		
FDI				0.0751	
				(-0.536)	
ServiceVA					0.117
					(-0.15)
Constant	7.265	5.991	21.86*	6.646	0.58
	-10.92	-11.04	-11.67	-11.85	-13.89
Observations	75	75	68	75	75
R-squared	0.775	0.777	0.816	0.775	0.777
Country FE	NO	NO	NO	NO	NO
Year FE	NO	NO	NO	NO	NO

Source: Indicated in Table 1

Note: Analysis by authors and standard errors in parentheses. * indicates statistical significance, * for 10%, ** for 5% and *** for 1%.

Conclusion and policy recommendations

Our study evaluated the determinants of the *HHI* across 93 countries and four regions from 2010 to 2019 through various panel data regression models. While the findings such as the significance of natural resource-related variables are consistent with previous research, we also uncovered new insights. Notably, credit availability measures—domestic credit to the private sector as a percentage of GDP and the number of commercial bank branches per 100,000 adults—were significant and robust in explaining *HHI* variations. While domestic credit to GDP is associated with export diversification, the presence of commercial bank branches tends to increase the concentration of exports. Another new finding is the impact of export market.

Exports to high-income countries is positively associated with the concentration of the export structure of exporting countries whereas imports from high-income countries is associated with the diversification of the export structure of importing countries. In terms of educational variable, we found primary school enrollment ratio is occasionally significant but not consistently robust as shown in Table 2. However, our regional analyses revealed the impact of education on export diversification varies by region, giving higher education level in East Asia regions and Latin America region, primary education level in Africa regions helps export diversification.

Surprisingly, FDI was not statistically significant in many model combinations. Similarly, population-related variables showed mixed impacts on export diversification—positively in Africa but negatively in Asia. The real effective exchange rate's significance and robustness were confirmed, suggesting that economic structure plays some roles in international competitiveness. Contrary to expectations, GDP growth rate did not show significant results. The tariff rate, expected to be a significant determinant, was not, possibly due to already low rates in many developing countries. The analysis suggests that the structure of tariffs, whether binding or not, may be more relevant for explaining export structures.

In the second part of our study, we explored the determinants of export structures in East Asia, Latin America, and Africa, finding distinct determinants across these regions. A consistent theme is the positive link between natural resource rents and export concentration. The level of education required for export diversification was notably lower in Africa than in Asia or Latin America. The "hump-shaped" relationship between *HHI* and economic development, posited by Wacziarg and Welch (2008), was particularly pertinent in Asia. This study's limitations include not employing cross-section dependent unit root tests due to the interconnected nature of countries through common global economic impacts or specific idiosyncratic factors, such as being landlocked. Employing spatial econometrics could enhance the quality of regression analyses, considering the geographical interdependence of countries. Although spatial-lagged terms for *HHI* were not significant overall in this study, it was significant in East Asia.

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Appendixes

Appendix 1 List of Countries in Each Region

Region	Number of Countries	Countries
Africa	28	Algeria; Burkina Faso; Burundi; Cameroon; Central African Republic; Cote d'Ivoire; Egypt; Arab; Ethiopia; Gambia; Ghana; Guinea; Kenya; Madagascar; Malawi; Mauritania; Morocco; Mozambique; Niger; Nigeria; Rwanda; Senegal; South Africa; Tanzania; Togo; Tunisia; Uganda; Zambia; Zimbabwe
Asia	8	Bangladesh; Cambodia; China; Indonesia; Malaysia; Mongolia; Philippines; Thailand; Vietnam
Latin America	16	Argentina; Bolivia; Brazil; Chile; Colombia; Dominican Republic; Ecuador; El Salvador; Guatemala; Honduras; Jamaica; Mexico; Nicaragua; Paraguay; Peru; Uruguay

Appendix 2 Results of Hausman Test

Tested Model	Chi2	Prob>Chi2
Table 2 Model 1	175.02	0
Table 3 Model 1	109.75	0
Table 4 Model 1	0.93	0.99
Table 5 Model 1	1.25	0.431

Note： Test of H0: Difference in coefficients not systematic, if Prob>chi2=0, H0 is rejected, model should include fixed effect, otherwise random effect should be used.