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AI Innovation AndIntellectual Property:Assessing The ImpactOfEuropeanPatentTrendsOnInternationalTrade Policies

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Abstract
This paper examines the significant impact of technological breakthroughs in artificial intelligence (AI) and European patent legislation on global competitiveness and international business strategy.The findings indicate that trade liberalization, assessed using the government's AI readiness index, substantially facilitates trade growth, especially among high-income WTO member nations. Nonetheless, specific intellectual property restrictions, including theAgreement on Trade-RelatedAspects of Intellectual Property Rights (TRIPS), may serve as trade obstacles. The rise inAI-related patents prompts intricate enquiries on intellectual property protection and the divergences between inventive nations and those that utilize this technology. These changes mayaffecttechnologytransfernormsandglobalintellectualpropertypolicies.Governmentsmust persist in diminishing trade barriers through international and bilateral agreements, emphasizing tariffreductions.Afuturestudyshouldinvestigatethedistincteffectsofregionaltradeagreements, institutional reforms, and WTO membership on various economic sectors, while also examining the long-term consequences of price volatility on trade liberalization.

Keywords: *WTO; European Patent Office; AI Technology; Government AI Readiness Index; WIPO.*

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I. Introduction

Technological advancements exert a significant influence on the evolution of international trade, with each industrial revolution bringing fundamental transformations in the fields of production, transportation, and the circulation of goods and services. For example, in the 18th century,thesteamenginerevolutionizedglobaltradebyincreasingtheefficiencyoftransportation and production systems. According to (Hobsbawm & Wrigley, 1999). At the dawn of the 21st century, we are faced with the profound consequences of the fourth industrial revolution, characterized by the advent of technologies such as artificial intelligence (AI), big data, and the Internet of Things. (IoT). These advancements have profoundly changed the sector, particularly regarding intellectual property protection, while raising new challenges and perspectives for international trade policies.

Acrucialelementofinnovationinartificialintelligenceliesinitsinteractionwithintellectual property,particularlythroughpatents.AccordingtothereportbytheEuropeanPatentOffice(EPO),patentapplicationsrelatedtoartificialintelligencehaveseenasignificantincreaseoverthe pasttenyears,andEuropehasplayedacrucialroleinthegloballandscapeofartificialintelligence patents.TheEuropeanPatentOfficemadethisstatementin2020.Thistrendreflectsthestrategies implemented to preserve Europe's leadership in the field of artificial intelligence technology development, as well as its competitiveness within the global digital economy. However, patents notonlyserveasinnovationtoolsbutalsoestablishownershipofcutting-edgetechnologies,grant rightsforcommercialandexclusiveuse,andinfluencemarketdynamics.AccordingtotheOECD (2019). This creates a delicate balance between promoting innovation and ensuring equitable access to technology.

Patents related to artificial intelligence in Europe have had a notable influence on global business strategies. With the rise of artificial intelligence integration in global supply chains and production processes, the preservation of intellectual property will become a key element of commercial competitiveness. European companies enjoy robust intellectual property protection and advanced artificial intelligence structures, allowing them to leverage these technological advancementstogainacompetitiveedgeontheinternationalstage.Thisalsohasanotableimpact on trade policy, as

nations with stronger patent protection can exert a more significant influence on the development of international trade standards. According to (Fan, X, 2021) and (Raihan, 2024), (S.-H. Chang, 2020). For example, the implementation of a more rigorous patent regime couldleadtotheemergenceofamonopolyinthefieldofessentialtechnologies,whichcouldpose trade barriers for countries that do not possess the required technological skills. According to (Mercurio, 2011).

The impact of artificial intelligence innovation on intellectual property is particularly importantinthecontextofinternationaltrade.Artificialintelligencehascontributedtoimproving logistics efficiency on a global scale, optimizing supply chain management, and reducing operational costs, resulting in an increase in productivity and competitiveness in the field of commerce. According to (Hasan & Ojala, 2024). However, the distribution of these benefits, despitetheirimportance,isnotequitable.Nationswithadvancedartificialintelligenceskills,such asEurope,arepreparingtoleadtheAI-relatedsectors,whiledevelopingcountriesmaystruggleto catch up.The inequality in the distribution of these artificial intelligence technologies is likely to exacerbate trade disparities, as nations lacking these advancements will find themselves at a disadvantage on the global stage.

Moreover, the growth in the number of patents in the field of artificial intelligence raises concerns about its long-term impact on the innovation process. Patents play a crucial role in protectingintellectualproperty;however,theycanrepresentabarriertoentryforsmallbusinesses andcountrieswithlimitedresources.Theexpansionofartificialintelligencetechnologyinvarious fields,suchasmanufacturing,healthcare,andfinance,raisesconcernsabouttheconcentrationofpatents in this area, particularly among large companies, mainly in Europe. This concentration couldpotentiallyrestrictthedisseminationofthistechnologyandhinderbroadereconomicgrowth. According to WIPO data (2020).

The goal of this study is to examine how developments in European patents in the field of artificialintelligenceaffectglobalbusinessstrategies.Bystudyingtherelationshipbetweenpatent filings in the field of artificial intelligence and the scale of international trade, we will examine how innovation in artificial intelligence stimulates global commercial competitiveness. More specifically, this research focusses on the impact of the government's artificial intelligence readiness index and the volume of patent applications in the field of artificial intelligence, based on cross-sectional data from 48 countries in 2023. The conclusions of this research shed light on the interaction between innovation in artificial intelligence, intellectual property rights, and trade policies. They emphasize the importance of a balanced regulatory framework in intellectual property, promoting innovation while ensuring equitable access to technology.

As artificial intelligence continues to revolutionize global trade, policymakers and industry stakeholders must fully understand its impact on international trade policies.This study enriches the body of knowledge on innovation in artificial intelligence and intellectual property by empirically examining the developments in European patents and theirinfluenceon international trade. This study aims to analyze the influence of European patents in the field of artificial intelligence on the competitiveness of companies, to lay the groundwork for future research exploring the interactions between technology, intellectual property, and international trade.

II. ReviewOfLiterature

TheoreticalFramework

Artificial intelligence (AI) technology has emerged as a revolutionary influence, profoundly affecting conventional international trade theories. Adam Smith’s (1776) theory of absolute advantage asserts that states ought to specialize inthe production of things in which they possess an absolute advantage and engage in trade with other countries to acquire goods and services.AI technology is changing product innovation and diversity, as well as questioning the concept of mass production. Artificial intelligence can develop competitive advantages in multiple areas simultaneously,shiftingtheimportantfactorsininternationaltradefromanaturalresource-based advantage to a focus on technological innovation. (Smith, 1776). Countries that masterAI-based technology can increase productivity, create new markets, and thus boost trade volume.

Furthermore, the interconnectivity ofAI technology promotes international cooperation and challengesthetraditional concept ofrelativeautonomy in economiccompetition betweencountries. AscountriesincreasinglyrelyonAItechnologiestopromoteeconomicgrowth,theyarebecoming interdependent and exchanging knowledge, resources, and inventions. This interconnectivity canleadtomorecoherentsupplychainswhilesimultaneouslyincreasingtheefficiencyofinternational trade, but it could also increase its complexity (Jones, 2023; OECD Trade Policy Papers, 2022; Ozturk, 2024).

Accordingto David Ricardo's theory of comparativeadvantage(1817),even ifacountryhas an absolute disadvantage in all goods, it can still benefit from trade if it focuses on goods with a relativeadvantage.AIhaschangedthisdynamicbycreatingnewindustriesthatreplacetraditional ones. Artificial

intelligence automation of manufacturing has historically weakened the competitivenessoflow-skilled,labor-intensiveindustriesinmanydevelopingcountriesthatonce hadacomparativeadvantage(Ricardo,1817).Artificialintelligenceencouragestheemergenceof new areas such as data processing and automation, which are changing trade paradigms such as digital commerce and service outsourcing (Agrawal et al., 2019).

(Heckscher et al., 1991) proposed the factor endowment theory, which emphasizes the differencesinthe relative degreeofabundance of productionfactors,mainly laborandcapital,as thebasisfortradebetweennations.However, the emergenceofartificialintelligencehas added a newdimensiontotheseproductionfactors.Countrieswithalargetechnicalworkforceandstrong research and development capabilities currently have a comparative advantage in artificial intelligence-drivenindustries.(Heckscher&Ohlin,1920).Withtheintensificationofinternational competition for artificial intelligence talent, countries with exceptional artificial intelligence capabilitiesarebecomingmorecompetitiveintheglobalmarket(Ciuriaketal.,2020).Moreover, the integration of artificial intelligence has introduced new trade barriers in international commerce. In particular, this concerns data management. The cross-border flow of data using artificial intelligence is becoming increasingly important for trade, and some countries have implementedrestrictionsondatatransferandlocaldatastorageobligationsinordertoprotectdata sovereignty (Q. Chang, 2024), (Wei & Li, 2022).

Paul Krugman proposed the new trade theory in 1980, emphasizing the role of economies of scale and differences at the firm level in international trade. In this case, artificial intelligence technologyallowsmultinationalstomoreefficientlyoptimizeproductionandresourcedistribution. By using artificial intelligence for automation and advanced analysis, companies can achieve economiesofscaleandimprovetheircompetitivenessintheinternationalmarket(Krugman,1980). However, artificial intelligence also poses a challenge to countries that have historically relied on low-wagelabortoremaincompetitiveontheglobalstage.Withautomationreplacingmanuallabor, these countries could increasingly struggle to participate in international trade. Moreover, companies can achieve product differentiation more effectively and strengthen their competitiveness in the global market through the development of personalized products andAI- targeted marketing (Mustafa Ayobami Raji et al., 2024).

TheinfluenceofAIonglobalcommerceis substantial

Artificial intelligence exerts both beneficial and detrimental effects on global commerce. From a production standpoint, AI has revolutionized the manufacturing process by automating procedures that were previously dependent on manual labor.Automated factories such asTesla's Gigafactoryand Foxconn's facilitiesexemplifythesignificant impact ofAIon the manufacturing landscape (Hasan & Ojala, 2024; Menzies et al., 2024).These breakthroughs enhance production efficiency;yet,thereareincreasingapprehensionsregardingjobdisplacementandtheconsequent escalationofunemployment,especiallyinlow-skilledsectors(Acypreste&Paraná,2022;Capraro et al., 2023;Wang et al., 2024). Certain academics assert thatAI can generate new job prospects byenhancingproductivityandaugmentingproduction (Igna&Venturini,2023).Theobjectiveis to create an educational framework that cultivates exceptionally skilled individuals equipped to assumetheseemergingresponsibilities(EtinosaIgbinenikaro&AdefolakeOlachiAdewusi,2024; Rožman et al., 2023).

AI's impact extends beyond the industrial process, affecting international trade and e- commerce logistics.AI enhances supply chain efficiency and optimizes inventory management, allowing enterprises to save costs and expedite global transactions (Albayrak Ünal et al., 2023; Atwanietal.,2022).AI-drivene-commerceplatformsimprovetheconsumerexperience,facilitate transactions through tailored product suggestions, and provide prompt after-sales support (Tiutiu& Dabija, 2023). Nonetheless, apprehensions persist thatAI may foster bias and discrimination. WemusttrainAIsystemstoconsiderculturaldiversityandpreventthereinforcementofprejudices (Akter et al., 2021; Dhabliya et al., 2024).

Artificialintelligenceandglobaltrade barriers

The impact of artificial intelligence technology on data management has particularly transformed commercial barriers. Since artificial intelligence systems heavily rely on data, managing and regulating cross-border data flows becomes crucial. Many countries have already adopted laws mandating local data storage from the perspective of privacy protection and data security,whichcouldhindermarketaccessformultinationalcompanies(Tay,2021).Furthermore, the emergence of artificial intelligence technology in the financial services sector has optimized cross-border payments, reduced trade barriers, and improved international trade (Maple et al.,

2023).However,theapplicationofartificialintelligenceinthefinancialsystemisraisingconcerns. Misuse of artificial intelligence-based tools can lead to illegal activities like money laundering (Chitimira& Ncube, 2021).

Despite these limitations, artificial intelligence continues to promote the potential for international cooperation.This is particularly true in the realm of research and development.The uneven distribution of artificial intelligence capabilities among major countries risks deepening existing commercial disparities and providing technologically advanced countries with a competitiveedgeoverthosethatadoptAImoreslowly(Goldfarb&Trefler,2018).Peoplearegrowing increasingly concerned about the monopolization ofAItechnology and the formation of new trade barriers due to the concentration of intellectual property rights in the field of artificial intelligence held by certain governments and companies (Parteka&Kordalska, 2023).

Overall, artificial intelligence technology has influenced production methods, trade barriers, and competitiveness, significantly changing international trade. Artificial intelligence brings significant advantages in improving efficiency and creating new businesses, but it also causes issues such as job displacement, inequality, and data management. This study complements the relevant literature by empirically examining the impact of artificial intelligence on international trade using the government's Artificial Intelligence Readiness Index and artificial intelligence- related patent application data.Therefore, we studied the complex relationship between artificial intelligence innovation and world trade.

III. Methodology

Model

This study employs cross-sectional data from 47 countries in 2023, sourced from the World Bank, the World Trade Organization, the World Intellectual Property Organization (WIPO), the European Patent Office, and the Oxford Insights Research Group.Areview of previous literature reveals that scholars often use the number ofAI-related patent applications in different countries as a proxy for measuring their AI capabilities. However, this approach has been frequently questioned.Themainconcernisthat,withoutclearliteratureanddatasupportontheimpactofAI technology on specific economic factors, it's uncertain whether various aspects of AI-related technologies have a uniform effect on these factors. Our findings corroborate this skepticism, showing that different AI technology-related patent applications have varying impacts on international trade.

As a result, this paper adopts the GovernmentAI Readiness Index as an alternative indicator to assess the AI level of each country. This index, based on six input indicators, provides a comprehensiveestimateofanationalgovernment'spreparednesstoimplementAIinpublicservice delivery, offering a more holistic evaluation of a country's ability to applyAI technology.

However, in 2020, the calculation method of this index was modified, making it challenging to establish apanel databaseforbuilding amultipleregression model. Sincetheoriginal dataand calculationmethodsarenotpubliclyavailable,datapriorto2020cannotbedirectlycomparedwith dataafter2020.Additionally,duetoincompletedataforcontrolvariablesin2022acrosscountries, thisstudyalsoexcludesdatafromthatyear.Forthesereasons,weutilizecross-sectionaldatafrom 2023 to conduct our empirical research. The simple Ordinary Least Squares (OLS) method is employed for analysis, using STATA version 18.0 software. The basic regression model is as follows:

$$Y_i = \beta_0 + \beta_1 ait + \beta_2 pt_i + ControleVar + \varepsilon_i \qquad (1)$$

In this regression model, Y_i represents the dependent variable for country i, β_0 is the intercept term, and β_1 through β_2 are the coefficients for the independent variables. The independent variables include X_{1i} (for $i = 1,2,3,\ldots n$), which is the Government AI Readiness Index for country i, and X_{2i} (for $i = 1,2,3,\ldots n$), which denotes the total number of AI-related patent applications in country i. The control variables in this study are GDP_i, $LandArea_i$, and Pop_i, collectively referred to as accounting for the economic size, geographic size, and population of each country—standard factors that influence trade.

The purpose of this regression model is to evaluate how AI readiness and innovation, measured by European patent applications across various fields, impact international trade. By incorporating these control variables, the model aims to isolate the specific effects ofAI-related factors from other country-specific

characteristics. To enhance the interpretability and statistical robustnessofourregressionmodel,weapplylogarithmictransformationstocertainvariables.This approach helps to linearize relationships, reduce skewness, and stabilize variances, thereby improving the model's overall performance and goodness of fit.

Table1VariablesExplanation

Variables		Description	Data Source
Dependent variables	lnImpi	Thelogarithmofimportsin country i	WorldBankDatabank WorldTrade Organization
	lnExpi	Thelogarithmofexportsin country i. (USD)	
	lnTrade	The logarithm of total importandexportvolume incountryi.(InUSD)	
	aiti	TheGovernmentAI readiness index Overallscoreincountryi	OxfordInsightsResearch Group
	ait2i	ScoreoftheTechnology SectorPillarincountry i	
	ait3i	ScoreoftheDataand Infrastructure	
	pti	Thenumberofpatents applications aboutAIincountry i.	
	p1i	Thenumberofpatents applications aboutElectrical	
Independent Variables		engineering	World Intellectual PropertyOrganization (WIPO),theEuropean Patent Office
	p2i	Thenumberofpatents applications aboutInstruments	
	p3i	Thenumberofpatents applications aboutChemistry	
	p4i	Thenumberofpatents applications aboutMechanical engineering	
	p5i	Thenumberofpatents applications about other fields (Furniture, games Otherconsumergoods Civil engineering)	
	p6i	Thenumberofpatents Applications about Unclassified	
Control Variables	GDP_i	Accounting for the economicsizeeachcountry	WorldBankDatabank World Trade Organization
	$LandArea_i$	Geographicsizeeach country	
	Pop_i	Populationofeachcountry	

IV. ResultsAndDiscussions

DescriptiveStatisticsandCorrelationsResults

Table2DescriptionStatistics

	Mean	Max	Min	SD	Kurtosis	Skewness
lnimp$_i$	25.614	28.974	19.895	1.954	3.509	-.812
lnexp$_i$	25.636	28.888	19.134	2.034	3.99	-.982
lnTrade$_i$	26.323	29.56	20.279	1.985	3.671	-.879
ait$_i$	65.258	84.796	43.262	9.842	2.506	-.493
pt$_i$	4150.936	48155	0.000	8806.966	15.207	3.323
lnGDP$_i$	26.33	30.94	21.338	2.117	2.642	-.171
lnLandArea$_i$	11.04	16.055	0.734	2.906	5.74	-1.173
lnPop$_i$	15.803	21.067	10.424	2.19	3.69	-.465

Thistablepresentsthedescriptivestatisticsforseveraleconomicvariables,includingimports (lnimp),exports(lnexp),trade(lnTrade),andotherslikeaiti(TheGovernmentAIreadinessindex), pti(Thenumberofpatentapplications),GDPi(GrossDomesticProduct),LandAreai(Landarea),andPopi(Population). Whenmentioned,variablesareexpressedinnaturallogarithms,takinginto account central tendency (mean), variance (standard deviation) and distribution characteristics (skewness, kurtosis). Most of the variables have negative skewness, indicating a left-trending distribution, and high kurtosis, indicating that land area (lnLandArea) and population (lnPopulation) in particular are likely to be extreme. It should be noted that variables such as population and GDP have moderate standard deviations, reflecting the variability of the results observed. pti (number of patent applications) and other variables show considerable variability (mean 4150.936, standard deviation 8806.966), indicating large differences between data points fortheseeconomicindicators.Thissuggeststheexistenceofthecharacteristicsofthedistribution suggest that there are potential asymmetries and outliers in the data set.

Table3Matrixofcorrelations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)lnimp$_i$	1.000							
(2)lnexp$_i$	0.996	1.000						
(3)lnTrade$_i$	0.999	0.999	1.000					
(4)ait$_i$	0.775	0.780	0.779	1.000				
(5)pt$_i$	0.560	0.531	0.547	0.529	1.000			
(6)lnGDP$_i$	0.968	0.959	0.965	0.771	0.646	1.000		
(7)lnLandArea$_i$	0.781	0.771	0.776	0.591	0.415	0.796	1.000	
(8)lnPop$_i$	0.921	0.902	0.912	0.593	0.572	0.940	0.856	1.000

The correlation matrix indicates a strong correlation between trade variables, including imports (lnimp), exports (lnexp), total trade (lnTrade), and GDP (lnGDP), with a correlation coefficient of approximately 0.95. This suggests that substantial economies generally encourage anincreaseintrade,whichencompassesbothimportsandexports.TheGovernmentAI readiness index(aiti)exhibitsamoderatecorrelationwiththesefactors(about0.77),suggestingthatnations withreducedtariffsareinclinedtoengageingreatertrade.Thenumberofpatentapplications(pti) exhibits diminished correlations with trade variables, particularly imports, exports, and GDP (about 0.53-0.65), indicating its lesser significance in influencing trade volumes. The population and area have a modest correlation with GDP and trade, indicating that countries with greater geographicalanddemographicdimensionsgenerallypossessahigherGDPandtradevolume.The matrix illustrates the correlation among economic magnitude, trade dynamics, and trade liberalization.

RegressionAnalysisResults

Table4RegressionwithImports,Exports,andTradeasDependentvariables

	(1)	(2)	(3)
VARIABLES	lnimp	lnexp	lnTrade
ait$_i$	0.0379**	0.0391**	0.0378**
	(0.0142)	(0.0167)	(0.0151)
pt$_i$	-2.60e-05**	-3.70e-05***	-3.11e-05***
	(1.01e-05)	(1.18e-05)	(1.07e-05)
lnGDP$_i$	0.585***	0.717***	0.658***
	(0.156)	(0.183)	(0.166)
lnLandarea$_i$	-0.0665	-0.0575	-0.0614
	(0.0480)	(0.0563)	(0.0510)
lnPop$_i$	0.324**	0.232	0.269*
	(0.139)	(0.163)	(0.148)
Constant	3.450*	1.314	3.078
	(1.770)	(2.078)	(1.883)
Observations	47	47	47
R-squared	0.953	0.941	0.949

Standarderrorsinparentheses

***p<0.01, **p<0.05, *p<0.1

Table 4 presents the results of a regression with imports (lnimp), exports (lnexp), and total trade(lnTrade)asdependentvariables.Inregressions1,2,and3,thecoefficientsoftheaitivariable are all significant at 5% intervals, indicating that greater trade openness reduces tariffs and leads to an increase in imports, exports, and total trade. On the other hand, it is noteworthy that the number of patent applications (pti) shows negative and significant coefficients at the 1% and 5% levels, suggesting that an increase in the number of patent applications leads to a decrease in imports, exports, and overall trade. The logarithm of GDP (lnGDPi) exerts a positive and significant impact (p<0.01)on all dependent variables, indicating that nations with ahigherGDP are characterized by higher levels of imports, exports, and commercial activities.The area of the territory (lnLandareai) is not significant, which suggests that geographical size does not play a decisive role in these models.At the 5% confidence level, the size of the population (lnPopi) has a positive and significant effect on imports. However, the impact is not significant for exports or overall trade. Finally, the high coefficient of determination (0.941 to 0.953) indicates that the model represents a significant portion of the variation in the dependent variable.

The overall results reveal general trends, such as the positive impacts of the government's Artificial Intelligence Readiness Index (aiti) and the logarithm of the Gross Domestic Product (GDPi), as well as the negative effects of the number of patent applications (pti). However, these indicators can mask significant country-to-country differences. For example, the positive effects oftradeopennessontrademaybegreaterinsomecountriesthaninothers,duetovariousstructural factorssuchasthelevel

ofdevelopment,diversityofeconomicsectorsor dependenceonspecific industries. Population differences only in imports and not found in exports or international trade indicatethatlargercountriescanimportmoretomeetdomesticneeds,withoutensuringthatthereshould be equity in the country.This highlights the importance of investigating the physiological processes underlying these relationships. The insignificance of the geographical dimension (lnLandareai)mayindicatethatthementionedvariablehasnodirecteffectonthelevelofimports and exports. However, this may be the result of underlying factors related to regional conditions, suchasaccesstowaterways,infrastructureorsoftwarecosts,whichvaryfromcountrytocountry. The model includes 47 samples, among which are 2 non-WTO member countries. Subsequently, a regression is conducted to analyze the impact of WTO member states on the model.

Table5Regressionof WTOMembersStatusonModelRegression

lnTrade	Coef.	St.Err.	t-value	p-value	[95%Conf	Interval]	Sig
aiti	.023	.012	1.93	.061	-.001	.048	*
pti	0	0	-2.66	.011	0	0	**
lnGDP	.836	.137	6.09	0	.558	1.113	***
lnLandarea	-.133	.043	-3.11	.003	-.22	-.047	***
lnPopulation	.112	.119	0.94	.352	-.129	.353	
Constant	2.672	1.522	1.76	.087	-.407	5.75	*
Meandependentvar		26.555		SDdependentvar		1.673	
R-squared		0.957		Numberofobs		45	
F-test		174.547		Prob >F		0.000	
Akaikecrit. (AIC)		43.184		Bayesiancrit. (BIC)		54.024	
****p<.01,**p<.05,* p<.1*							

Regression4inTable5istheresultoftheregressionwhenthesampleincludesonlytheWTO members(45countries)ofthisstudy.Regression5istheresultoftheregressionwhenthesample doesnotincludeWTOmemberstatesomitteddue tolimitedobservation(2countries).Theresults of the regression analysis indicate that GDP(lnGDP) exerts the most pronounced and significant influenceontotaltrade(lnTrade),withacoefficientof0.836andasignificancelevelof1%.This clearlydemonstratestheheavyinvolvementofnationswithahighGDPiincommercialactivities. The government AI readiness index (aiti) reveals a moderately significant positive effect (p = 0.061),indicatingamoderatelinkbetweentradegrowthandincreasedtradeopenness.Conversely, the number of patent applications (pti) exhibits a significant negative effect of 5% (p = 0.011), implyingthattariffpricedistortionnegativelyimpactstrade.Thelandareavariable(lnLandareai) exhibits a significant negative effect of 1% (-0.133), suggesting a tendency for nations with vast geographical expanses to engage in fewer trade exchanges, potentially due to a self-sufficiency policy.Ultimately,thisstudyrevealedthatthepopulationvariable(lnPopulation)doesnothavea significant correlation with the volume of trade exchanges. This model shows a satisfactory fit, withacoefficientofdeterminationR²of0.957,whichmeansitexplains95.7%ofthevariationin total sales, and it is overall statistically significant (F-test = 174.547, p = 0.000).

Tofurtherstudytheimpactofartificialintelligenceoncommerce,thisdocumentreplacesthe variable aiti with its components ait1, ait2, and ait3. In a similar manner, we replace the variable pti with its constituent variables p1, p2,...p6.The regression results can also be influenced by the income groups of this country. Therefore, in the following regression analysis, the countries are divided into two different samples (high-income group and middle-income group) based on their incomegroup.Next, we perform aregressionanalysisonceagain.Duetothemulticollinearityof the samples from middle-income countries, we did not analyze the regression results for these samples.

Table6RegressionofComponentvariablesofeachcorevariablebyincomegroups(Members and no members of WTO)

lnTrade	Coef.	St.Err.	t-value	p-value	[95%Conf	Interval]	Sig
ai1i	.062	.022	2.79	.009	.017	.108	***
ai2i	-.037	.018	-2.13	.04	-.073	-.002	**
ai3i	-.007	.024	-0.31	.76	-.055	.041	
p1i	0	0	-2.03	.05	0	0	*
p2i	0	0	0.20	.845	-.001	.001	
p3i	0	0	-0.07	.945	-.001	.001	
p4i	0	0	-1.15	.258	-.001	0	
p5i	.001	0	1.50	.142	0	.002	
p6i	-.002	.005	-0.34	.739	-.012	.009	

$lnGDP_i$	.782	.208	3.76	.001	.36	1.204	***
$lnLandArea_i$	-.056	.056	-1.00	.323	-.17	.058	
$lnPop_i$	.177	.187	0.94	.351	-.203	.557	
Constant	2.001	2.243	0.89	.379	-2.557	6.559	
Meandependentvar		26.323		SDdependentvar		1.985	
R-squared			0.959	Numberofobs		47	
F-test		65.972		Prob >F		0.000	
Akaikecrit. (AIC)		72.906		Bayesiancrit. (BIC)		96.958	
****p<.01,**p<.05,* p<.1*							

We carry out Regression 6 by substituting the variables aiti and pti with their respective components. The regression study shows that the ai1i component's coefficient is statistically significant at the 1% level, indicating a positive effect on overall trade (lnTradei) (coefficient of 0.062,p=0.009).Thisimpliesthatincreasedtradeliberalizationpromotescommercialexchanges. Furthermore, asignificant negativeimpact ofai2iis observed at the 5%level (coefficient -0.037, p=0.04).Thisimpliesthatcertainrestrictionshindertrade.Theai3icomponentisnotsignificant. Among the components of number of patent applications, only the variable p1i showed a significant negative marginal effect (p = 0.05), leading to a decrease in the volume of exchanges. Thenaturallogarithm ofGDP(lnGDPi)showsa significant positive impact,with a coefficientof0.782 and a p-value of 0.001. These results demonstrate that nations with a higher GDPare more involvedintradeexchanges,whileneithergeographicalarea(lnLandAreai)norpopulation(lnPopi) showstatisticalsignificance.Thismodelexplains95.9%ofthevariationsobservedinthecommercialdata(R^2=0.959)an dshowsoverallstatisticalsignificance(F-test=65.972,p=0.000).

Toanalyzeinmoredetailtheimpactofthecomponentsoftheaitivariable(ai1i,ai2i,andai3i)and the components of the pt variable (p1i, p2i, ..., p6i) in the different pricing groups, regression 7 is performed for the samples ofWTO member countries. Due to the limitations of the observations, we omit regression 8 for the samples from non-WTO member countries (2 Countries).

Table7Regressionofcomponentvariablesofeachcorevariableof WTOMembersbyincome groups

lnTrade	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
$ai1_i$	.045	.018	2.55	.016	.009	.082	**
$ai2_i$	-.033	.015	-2.22	.034	-.063	-.003	**
$ai3_i$	-.008	.019	-0.42	.68	-.046	.03	
$p1_i$	0	0	-1.51	.14	0	0	
$p2_i$	0	0	0.23	.818	-.001	.001	
$p3_i$	0	0	-0.17	.865	-.001	.001	
$p4_i$	0	0	-1.07	.294	0	0	
$p5_i$	.001	0	1.44	.158	0	.001	
$p6_i$	0	.004	-0.03	.974	-.008	.008	
$lnGDP_i$	.974	.177	5.50	0	.613	1.335	***
$lnLandArea_i$	-.125	.048	-2.61	.014	-.222	-.027	**
$lnPop_i$	.002	.153	0.02	.987	-.309	.314	
Constant	1.404	1.958	0.72	.478	-2.583	5.392	
Meandependentvar		26.555	SDdependentvar			1.673	
R-squared		0.965	Numberofobs			45	
F-test		73.785	Prob >F			0.000	
Akaikecrit. (AIC)		48.003	Bayesiancrit. (BIC)			71.489	
****p<.01,**p<.05,* p<.1*							

Table 7 presents the results of regression 7. These regression results relate to the main components of the variables of WTO members classified by income group, revealing several important aspects.The ai1i component has asignificant positiveeffect on overall trade (lnTrade) (coefficient 0.045, p = 0.016). This shows that trade liberalization is beneficial for trade. Conversely, ai2i has a significant negative effect (coefficient -0.033, p = 0.034), indicating that certain trade restrictions hinderexchanges.Theai3i component has no notableeffect.Among the price and tariff variables (from p1i to p6i), none have a significant effect on trade. The GDP (lnGDPi)hasastrongpositiveandsignificantimpact(coefficient0.974,p=0.000).Thisshowsthat countries with a high GDP engage in more trade. Geographical size (lnLandAreai) has a significant negative effect (coefficient -0.125, p = 0.014), indicating that countries with large geographical sizes have less trade. The population is not significantly affected. (lnPopi). This model fits well, with an R^2 of 0.965, explaining 96.5% of the variations in transactions, and is statistically significant (F-test = 73.785, p = 0.000).

Table8RegressionofcomponentvariablesofeachcorevariableofWTOMembersinHight Income

lnTrade	Coef.	St.Err.	t-value	p-value	[95%Conf	Interval]	Sig
Ai1i	.058	.022	2.65	.013	.013	.102	**
ai2i	-.039	.016	-2.49	.019	-.072	-.007	**
ai3i	-.019	.024	-0.78	.443	-.069	.031	
p1i	0	0	-1.47	.152	0	0	
p2i	0	0	0.41	.682	-.001	.001	
p3i	0	0	-0.37	.714	-.001	.001	
p4i	0	0	-0.99	.331	0	0	
p5i	.001	0	1.40	.171	0	.001	
p6i	-.001	.004	-0.13	.895	-.009	.008	
lnGDPi	1.101	.205	5.37	0	.681	1.521	***
lnLandAreai	-.138	.051	-2.72	.011	-.241	-.034	**
lnPopi	-.079	.167	-0.47	.639	-.42	.262	
Constant	-.136	2.405	-0.06	.955	-5.054	4.783	
Meandependentvar		26.736		SDdependentvar		1.559	
R-squared			0.960	Numberofobs		42	
F-test		57.899		Prob >F		0.000	
Akaikecrit. (AIC)		46.359		Bayesiancrit. (BIC)		68.949	
****p<.01,**p<.05,* p<.1*							

Table8presentstheresultsoftheregressionofthecomponentvariablesofeachmainvariable of the high-incomeWTO Members. Due to limited observations, we have excluded the results of the regression of the component variables of each main variable for WTO members with intermediateincome.(3observations).Theresultsoftheregressionanalysisforthesehigh-income WTOmembersshowthatseveralfactorshaveasignificantimpactonoveralltrade.(lnTrade).The ai1icomponenthasasignificantpositiveeffect(coefficient0.058,p=0.013),indicatingthattrade liberalization stimulates trade in high-income countries. On the other hand, ai2i has a significant negative effect (coefficient -0.039, p = 0.019). This shows that there are certain restrictions that hindertradeinthesecountries.ai3ihasnonotableeffect.Thevariablesrelatedtopricesandtariffs (p1i to p6i) do not have a significant effect on trade. GDP(lnGDPi) has a strong positive impact and shows a significant influence (coefficient 1.101, p = 0.000). This shows that countries with high GDP engage in more trade. The geographical area (lnLandAreai) has a significant negative effect(coefficient-0.138,p=0.011).Thisshowsthatlargecountrieshavealowertradevolume,andthatthereisnosignificanteffectonthepopulation.(lnPopi).Thismodelexplains96%ofthe commercial variations (R^2 = 0.960) and is globally significant (F-test = 57.899, p = 0.000).

V. Conclusions

Technological advancements in artificial intelligence (AI) are critical for global competitiveness, and legislative developments regarding patents in Europe directly impact internationalbusinessstrategies.ThestrengtheningofpatentprotectionsrelatedtoAIconsolidates Europe'sstrategicpositionontheglobalstage.Regressionanalysisshowsthattradeliberalization, measured by the average tariff index (ait*i*), significantly influences trade expansion, especially among high-income countries that are members of the World Trade Organization (WTO). Conversely, certain tariff restrictions, such as those imposed by theAgreement onTrade-Related AspectsofIntellectualPropertyRights(TRIPS),canactastradebarriers.GrossDomesticProduct (GDP) has a significant and positive effect on trade, emphasizing that larger and wealthier economies are more actively engaged in international commerce.Additionally, the geographical size of a country has a negative impact on trade, suggesting that larger nations may be less dependent on international trade. The analyzed model indicates that population size does not significantly affect trade.

However, the surge in AI-related patents raises complex issues concerning intellectual property (IP) protection and highlights disparities between nations that innovate and those that utilizethesetechnologies.Theincreaseinpatentfilingsmayenhancetheprotectionofinnovation and influence the standards governing technology transfer and IP transactions.

Consideringthesefindings,itisrecommendedthatgovernmentauthoritiescontinueto promote the reduction of trade barriers through multilateral or bilateral agreements. It is crucial forWTOmemberstatestocommittoreducingtariffstomaximizeeconomicbenefits.Developing countries should implement economic policies aimed at stimulating GDP growth. Additionally, accessiontotheWTOcanoffersignificanttradeadvantagestocountriesthatarenotyetmembers. This research has certain limitations. The analysis focuses on global variables such as GDP, population, and geographical size, without considering institutional or political factors that could affect trade exchanges. Moreover, the study's

ability to observe dynamic developments in trade policies is limited due to the lack of consideration for the temporal variability of data and study periods.Accesstomoredetaileddatawouldallowforabetterunderstandingoftheinfluenceofspecificfactorslikeprice variables.

Futurestudiescouldexaminetheimpactofspecificregionaltradeagreementsandinstitutional reformsoninternationaltrade.Itwouldalsobepertinenttoanalyzetheeffectof WTOmembership on various economic sectors, particularly those oriented towards exports.Acomparative analysis between WTOmemberandnon-membercountries,consideringincomeanddevelopmentlevels,would provide deeper insights into the benefits associated with membership. Furthermore, a comprehensiveexaminationoftherepercussionsofpricefluctuationscouldoffervaluableinsights into the long-term consequences of trade liberalization.

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