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Reconstruction and interpretable analysis of international digital trade development level measurement based on machine learning and SHAP algorithm

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Abstract. The purpose of this paper is to evaluate the performance of machine learning model and put forward an interpretable prediction framework for the development of international digital trade. Based on the digital trade data of 55 countries from 2010 to 2023, the evaluation index system of international digital trade development level is constructed from seven dimensions, including digital trade potential. Through XGBoost and SHAP machine learning models, the importance of different variables to the development level of international digital trade is identified. The results show that: 1) from 2010 to 2023, the development trend of international digital trade is relatively fast, and the overall score has increased from 0.079 in 2010 to 0.122 in 2023, with an increase of 54.4%; 2) From the comprehensive score of each dimension, the score of digital trade infrastructure is always ahead and the overall score shows a steady and slight upward trend, and the score of digital trade barriers is low, which is the weak link in the development of digital trade. Based on this, in order to improve the development efficiency of international digital trade, this paper puts forward five suggestions, including strengthening the cultivation and transformation of effective patents.

Keywords: development level of international digital trade; Machine learning; XGBoost algorithm; SHAP value analysis.

Introduction

Trade, as one of the troika driving economic development, is an important pillar of economic development. Digital trade is an important part of digital economy, which has become a new trend of international trade development and a new growth point of economy. According to the Global Digital Trade Development Report 2024, from 2021 to 2023, the global digital trade volume rose from 6.02 trillion US dollars to 7.13 trillion US dollars, with an average annual growth rate of 8.8%, accounting for 19.6% of the total international trade scale. From the top ten economies in the world, the digital trade scale of the European Union, the United States and China ranks the top three in the world, and maintains a steady growth trend. Under the problems of information asymmetry in international trade, conflict between data sovereignty and

cross-border flow, technical ethics and security threats, it is of great strategic significance to scientifically measure the level of international digital trade and systematically analyze its influencing factors^[1].

The concept of international digital trade has been continuously enriched and evolved into a comprehensive representation system. In 2010, Weber put forward the concept of "digital trade" for the first time, and defined digital trade as products or services transmitted electronically and delivered in digital form Weber^[2]. In 2013, the United States International Trade Commission (USITC) defined digital trade as the commerce of products and services provided by the Internet. In 2014, the United States International Trade Commission (USITC) defined digital trade as domestic commerce and international trade in ordering, producing or delivering products and services through the Internet and Internet-based technologies, covering cross-border e-commerce platform goods market transactions. After 2018, the digital trade measurement manual of WTO-OECD-IMF divides digital trade into three dimensions to measure. The first dimension is market transaction, which is divided into goods (G), services (S) and information (I). The second dimension is the market transaction link, which is divided into whether it is digitally ordered, whether it is enabled by a third-party platform, and whether it is digitally delivered. These three are "OR" relationships; The third dimension is the identity relationship between the seller and the buyer, namely B2B, B2C, C2C, etc^[3]. China scholars such as Feng Zhongxian (2022) borrowed from China. After years of research, a comprehensive evaluation system of international digital trade has been formed in terms of digital trade potential, digital skills, digital innovation, digital trade scale, digital infrastructure, digital trust risk and digital trade barriers, which provides an important reference for the development of international digital trade^[4].

The existing research focuses on trade potential, digital innovation, digital trade structure, digital infrastructure, digital trade barriers and other dimensions, and commonly uses grey relational analysis, analytic hierarchy process, entropy method and so on to measure the indicators^{[4][5][6]}. With the wide application of machine learning and the increasing importance of digital economy, it is urgent to re-examine the evaluation index system of international digital trade and further explore the important factors that affect the development level of digital trade. Under this background, this study combines the underlying logic of digital economy and trade development, constructs an evaluation index system of international digital trade, and uses machine learning method and SHAP algorithm to identify key influencing factors, which provides effective decision support for making digital trade policies scientifically and improving the development level of international digital trade.

Method selection and model construction

1.1 XGBoost Algorithm

XGBoost is a high-performance machine learning algorithm that integrates multiple regularized decision trees through gradient lifting framework, and integrates engineering technologies such as parallel computing and sparse optimization. Its core value lies in achieving the balance between prediction accuracy and generalization ability with extreme efficiency, and it is the core engine of data-driven decision-making. XGBoost supports multi-thread parallel split point search, and its training speed is 5-10 times higher than that of traditional GBDT. Its sparse sensing optimization greatly reduces the computational overhead of high-dimensional features, and has strong anti-noise. Moreover, the gradient lifting framework iteratively corrects the residual error, and the regularization term ($L1/L2$) is combined to explicitly control the model complexity,

effectively suppressing over-fitting, providing feature importance analysis, and linking the visual decision logic of SHAP value. XGBoost algorithm model is as follows:

$$\hat{y} = \sum_{k=1}^n f_k(x_i), f_k \in F \quad (1)$$

In the formula, $\hat{y}$ is the predicted value; n is the number of trees; F is the set of all classification and regression trees; f_k is a tree in specific regression; k is the number of regression trees. The objective function of XGBoost model is as follows:

$$X_{obj} = \sum_{i=1}^n l(y_i, \hat{y}) + \sum_{k=1}^k \gamma T + \frac{1}{2} \lambda \sum_{k=1}^k \sum_{j=1}^T w_j^2 \quad (2)$$

In the formula, $\sum_{i=1}^n l(y_i, \hat{y})$ is used to measure the difference between the predicted value and the real value; T is the number of leaf nodes of the decision tree; w_j is the score of the j th leaf node; γ is the depth control parameter of leaf nodes; λ is the weight control parameter of leaf nodes. In order to solve the optimal weight w_j on leaf nodes, the objective function is expanded by second-order Taylor expansion at $f_i=0$, and the objective function is approximately:

$$X_{obj} \approx \sum_{j=1}^T \left[\left(\sum_{i \in I_j} g_i \right) w_j + \frac{1}{2} \left(\sum_{i \in I_j} h_i + \lambda \right) w_j^2 \right] + \lambda T \quad (3)$$

In the formula, X_{obj} is the objective function; $g_i = \partial \hat{y}^{j-1} l(y, \hat{y}^{j-1})$, is the first derivative (gradient) of $f_k(x_i)$; $h_i = \partial^2 \hat{y}^{j-1} l(y, \hat{y}^{j-1})$, is the second derivative of $f_k(x_i)$; $I_j = \{i \mid q(x_i) = j\}$ is the sample group on the leaf j of the decision tree. The formula (4) is brought into the formula (3), and the optimal w_j and optimal target values obtained by solving are shown in the following formulas respectively:

$$w_j^* = \frac{G_j}{H_j + \lambda} \quad (4)$$

$$X_{obj} = -\frac{1}{2} \sum_{j=1}^T \frac{G_j^2}{H_j + \lambda} + \lambda T \quad (5)$$

In the formula, the sum of gradients of $G_i = \sum_{i \in I_j} g_i$, leaf nodes; $H_j = \sum_{i \in I_j} h_i$, is the sum of the second derivatives of the j -th leaf node. Divide the leaf nodes into subtrees, and each split starts from the node with the largest information gain. The formula for calculating the information gain of the leaf nodes is as follows:

$$G = \frac{1}{2} \left[\frac{G_L^2}{H_L + \lambda} + \frac{G_R^2}{H_R + \lambda} - \frac{(G_L + G_R)^2}{H_L + H_R + \lambda} \right] - \gamma \quad (6)$$

1.2 SHAP interpretable analysis

Shap (Shapley Additional Explanations) is a machine learning interpretation framework based on Shapley value of game theory, which aims to quantify the specific contribution of each feature in the model to a single prediction. Its core advantage lies in the theoretical rigor-following the axioms of consistency, local accuracy and lack, ensuring that the interpretation results are mathematically reliable and without contradiction; At the

same time, it has both global and local perspectives, which can not only reveal the overall law of the model through feature importance ranking and dependency graph, but also accurately locate the key influencing factors of single sample prediction. SHAP can transform complex characteristic effects into operational insights with the help of visualization tools such as heat map and abstract map. It is the cornerstone technology to break through the black box of algorithm and provide quantifiable, verifiable and auditable explanation basis for decision-making, which significantly improves the transparency and reliability of AI system.

$$\Phi_i = \sum_{S \subseteq N \setminus \{i\}} \frac{|S|!(|N|-|S|-1)!}{|N|!} (v(S \cup \{i\}) - v(S)) \quad (7)$$

In the formula, N is the set of all features; S is a set that does not contain the i -th influencing factor; $|S|$ is the number of features in the set S ; $v(S)$ is the contribution of set S to the prediction output of the model; $v(S \cup \{i\})$ is the contribution of the set $S \cup \{i\}$ containing the i -th influencing factor to the prediction output of the model.

Index system and data description

2.1 Index system

Based on the research of scholars at home and abroad, the digital trade development index system is established according to the principles of systematicness, objectivity, scientificity, comparability, comprehensiveness, hierarchy and feasibility. Seven dimensions of digital trade potential, digital innovation, digital skills, digital scale, digital infrastructure, digital trust risk and digital trade barriers are taken as the first-level indicators, and the comprehensive evaluation index system corresponding to 14 second-level indicators and 26 third-level indicators comprehensively measures the development level of digital trade in various countries. The specific index system is shown in Table 1.

First-level Indicators	weight	Second-level Indicators	weight	Specific Indicators	weight	Indicator direction
Digital trade potential	0.142	Consumption expenditure	0.088	Domestic Final Consumption Expenditure	0.088	Positive
		Trade scale	0.054	Total Merchandise Trade	0.054	Positive
				Gross Domestic Expenditure on R&D as a Percentage of GDP	0.019	Positive
Digital innovation	0.408	Innovation investment	0.152	Charges for the Use of Intellectual Property, Imports	0.133	Positive
				Charges for the Use of Intellectual Property, Exports	0.080	Positive
		Innovative output	0.256	Patents in Force	0.098	Positive
				Scientific and Technical Journal Articles	0.078	Positive
Digital skills	0.035	Talent input	0.035	Researchers in R&D	0.024	Positive
				Mean Years of	0.004	Positive

				Schooling		
				Gross Tertiary Enrollment Ratio	0.007	Positive
Digital trade scale	0.105	Digital trade scale	0.105	ICT Goods Exports as a Percentage of Total Goods Exports	0.047	Positive
				ICT Goods Imports as a Percentage of Total Goods Imports	0.023	Positive
				ICT Services Exports as a Percentage of Total Services Exports	0.024	Positive
				Digitally Deliverable Services Exports	0.011	Positive
Digital trade infrastructure	0.204	Physical infrastructure	0.029	Logistics Performance Index (LPI)	0.004	Positive
				Electric Power Consumption	0.025	Positive
		Network facilities	0.140	Internet Penetration Rate	0.005	Positive
				International Internet Bandwidth per Internet User	0.135	Positive
				Fixed Telephone Subscriptions per 100 Inhabitants	0.014	Positive
		Communication facilities	0.018	Mobile Telephone Subscriptions per 100 Inhabitants	0.004	Positive
				Fixed Broadband Subscriptions per 100 Inhabitants	0.011	Positive
				Mobile Broadband Subscriptions per 100 Inhabitants	0.010	Positive
Digital trust risk	0.100	Safety devices	0.089	Secure Internet Servers	0.089	Positive
		Network security	0.007	Global Cybersecurity Index	0.007	Positive
		Digital government	0.004	E-Government Development Index	0.004	Positive
Digital trade barrier	0.002	Digital trade restrictions	0.002	Digital Trade Restrictiveness Index (DTRI)	0.002	Negative

Source: The author made it through the official open database.

Table 1. Comprehensive evaluation index system and weight of digital trade

2.1.1 Digital trade potential

The potential of digital trade is the basic support of digital trade. As the starting point of the development of digital trade, the potential of digital trade is the core foundation to ensure market demand and trade volume, and provides the original kinetic energy for the balance between supply and demand of digital products and services. The sustainable growth of digital trade depends on the double radiation of domestic market consumption capacity and overall trade activities, which is not only the power source of digital economy, but also the key guarantee to cope with global competition and consumption upgrading. Research shows that the

strong domestic demand can directly stimulate the innovation of digital products, while the expansion of trade scale promotes the integration of cross-border data flow and value chain, thus injecting long-term vitality into digital trade^[7-8]. Therefore, this dimension focuses on two secondary indicators: consumption expenditure and trade scale, quantifies the demand capacity of domestic market for digital services through "Domestic Final Consumption Expenditure", reflects consumers' purchasing power and market potential, and measures the spillover effect of overall trade activities on the digital field with "total trade volume", reflecting the driving role of external market expansion, and anchoring the growth foundation of digital trade from both supply and demand sides.

2.1.2 Digital innovation

Digital innovation is the core engine of digital trade. As the driving force of the development of digital trade, digital innovation is the central mechanism of technology and knowledge transformation, which provides the source of technology empowerment and competitiveness for trade upgrading. By optimizing R&D investment and promoting the industrial application of knowledge output, digital innovation enables enterprises to maintain technological leadership and achieve sustainability in digital trade. At the same time, digital trade also provides a broad market space and technical application scenarios for digital innovation, forming a virtuous circle of innovation and trade. The development of global digital economy shows that the innovation intensity directly determines the added value of trade, and high R&D investment can accelerate the commercialization of cutting-edge technologies such as artificial intelligence and block chain, while patents and academic achievements are transformed into tools for breaking trade barriers^[9-11]. Therefore, this dimension is divided into two secondary indicators: innovation input and innovation output. Innovation input evaluates the allocation efficiency of innovation resources in the whole society through "Gross Domestic Expenditure on R&D as a Percentage of GDP", reflecting the intensity of national strategic input, while observing the activity of knowledge cross-border flow with "Charges for the Use of Intellectual Property, Imports and Charges for the Use of Intellectual Property, Exports", depicting the depth of global innovation cooperation. The innovation output measures the potential of technology commercialization with "Patents in Force" to ensure that innovation results can be transformed into trade advantages, and evaluates the density of basic research results with "Scientific and Technical Journal Articles" to provide cutting-edge technical reserves for digital trade. These indicators build a closed loop from the input end to the output end, highlighting the empowering effect of innovation on trade efficiency and sustainability.

2.1.3 Digital skills

Digital skills empower digital trade for a long time. As the cornerstone of human capital in the development of digital trade, digital skills are the key guarantee to cultivate high-quality labor force and ensure the efficient operation of trade activities in a technology-intensive environment. Digital skills are not only related to the direct reserve of R&D talents, but also to the social foundation of the education system, providing sustainable intellectual support for digital trade. Empirical analysis shows that skills shortage will restrict the export of digital services, while education investment will improve the adaptability of the labor force^[12-13]. Therefore, this dimension takes talent investment as the core secondary indicator, and quantifies the supply level of high-end talents through "Researchers in R&D" and direct observation of the human reserve of digital technology R&D. At the same time, it measures the social foundation of skills training from the perspective of national

education with "Mean Years of Schooling" and "Gross Tertiary Enrollment Ratio". The former reflects the popularity of digital literacy among the whole people, while the latter evaluates the systematic training of professional talents, and the above indicators jointly anchor the supporting effectiveness of human capital to digital trade.

2.1.4 Digital trade scale

Digital scale is the direct quantification of digital trade. As the embodiment of the competitiveness of digital trade development, digital scale is the core quantitative index of industrial performance, which directly reflects the share and influence of digital products and services in the global market. Digital scale not only measures the absolute value of trade volume, but also reveals the degree of structural optimization, ensuring that the evaluation framework focuses on actual output rather than potential capacity. The pattern of international competition shows that the trade proportion of ICT products and services is a barometer of digital sovereignty and economic resilience, high export proportion symbolizes technological advantages, while import balance shows market openness^[14]. To this end, this dimension focuses on the secondary indicators of digital trade scale, and quantifies the global division of labor status of digital hardware trade through "ICT Goods Exports as a Percentage of Total Goods Exports and ICT Goods Imports as a Percentage of Total Goods Imports", for example, the high proportion of exports reflects the status of manufacturing power; At the same time, it accurately depicts the international competitiveness of digital service trade, such as the export capacity of cloud computing or data services, with "ICT Services Exports as a Percentage of Total Services Exports and Digitally Deliverable Services Exports". These indicators show the weight of digital trade in the overall trade at multiple levels from products to services, and provide direct evidence for diagnosing regional competitiveness.

2.1.5 Digital infrastructure

Digital infrastructure is the bottom guarantee of digital trade. As the hard power foundation of digital trade development, digital infrastructure is the core element of physical bearing system, which ensures the efficient transmission and processing of data flow, commodity flow and service flow. Digital infrastructure covers not only physical logistics and energy support, but also comprehensive coverage of network, communication and terminal equipment, providing a seamless connection environment for trade activities. Global cases show that infrastructure shortcomings will raise the cost of digital trade, while broadband popularization will accelerate the growth of cross-border e-commerce^[15]. Therefore, this dimension is subdivided into four secondary indicators: physical infrastructure, network facilities, communication facilities and terminal equipment. The physical infrastructure uses the "Logistics Performance Index (LPI)" to evaluate the supporting efficiency of physical logistics for digital goods delivery to ensure timeliness; And "Electric Power Consumption" reflects the energy security of digital economy operation and quantifies the stability of digital trade. Network facilities measure coverage and transmission capacity through "Internet Penetration Rate and International Internet Bandwidth per Internet User" to support cross-border data flow. Communication facilities reflect the popularity of basic communication with "Fixed Telephone Subscriptions per 100 Inhabitants and Mobile Telephone Subscriptions per 100 Inhabitants" to ensure the reliability of trade communication. The terminal equipment observes the reach depth of the equipment through "Fixed Broadband Subscriptions per 100 Inhabitants and Mobile Broadband Subscriptions per 100 Inhabitants", for example, the number of broadband users is directly

related to the accessibility of digital services. These indicators build a comprehensive evaluation system from the hardware level and strengthen the physical resilience of trade.

2.1.6 Digital trust risk

Digital trust risk is the environmental constraint of digital trade. As a security and governance barrier for the development of digital trade, digital trust risk is the core mechanism to reduce transaction uncertainty, ensure data privacy, and create a reliable ecology for trade activities. Trust risk involves the technical protection of network security, and also includes the institutional guarantee of government digital governance to ensure that trade reduces friction costs in a compliance environment. Industry research pointed out that security vulnerabilities can lead to cross-border data interruption, while efficient government affairs can enhance trade facilitation ^[16]. Therefore, this dimension includes two secondary indicators: security facilities and digital government: security facilities evaluate the level of cyberspace protection with "Secure Internet Servers and Global Cybersecurity Index", and high security density can prevent data leakage and build the bottom line of digital trade. Digital government observes the degree of digitalization of government affairs through the "E-Government Development Index", reflecting the transparency of policies and the efficiency of supervision, such as the ability of online service to simplify the trade approval process. These indicators cut in from technology to system, systematically reduce the cost of trust and provide a scientific yardstick for evaluating environmental constraints.

2.1.7 Digital trade barriers

Digital trade barrier is the external constraint of digital trade. As the policy and legal restrictions of digital trade development, digital trade barriers are the quantitative embodiment of market access and regulatory barriers, which directly affect the integration degree of trade liberalization and globalization. Trade barriers not only reflect policy discrimination, but also measure institutional costs to ensure that external environmental variables are included in the evaluation framework. Economic analysis confirms that too high barriers will inhibit the cross-border flow of digital services, while low restrictive index will promote the diffusion of innovation ^[17]. To this end, this dimension takes digital trade restrictions as the core secondary indicator, and quantifies the restraint intensity of institutional factors such as policies and regulations and market access on digital trade through the "Digital Trade Restrictiveness Index (DTRI)" system. For example, the index covers data localization requirements or foreign investment restrictions, which directly maps the openness of the trading environment. This index provides a key basis for diagnosing the freedom of trade, helps policy makers identify the key points of reform, and promotes the optimization and upgrading of the digital trade ecology.

2.2 Data sources

In this paper, 55 countries from 2010 to 2023 are selected as research objects, and the data used are from the world's major public databases, including the International Monetary Fund (IMF), the World Economic Forum (WEF), the World Intellectual Property Organization (WIPO), the United Nations Trade Development Committee (UNCTAD), the Organization for Economic Cooperation and Development (OECD), the International Telecommunication Union (ITU) and the World Development Indicators Database (WDI). See Table 1 for the weight coefficient of the evaluation index of the development level of international digital trade using entropy method.

Results and analysis

3.1 Descriptive statistical analysis

The development level of digital trade in 55 countries from 2010 to 2023 is shown in Table 2, ranking from 1st to 55th. First of all, the development level of international digital trade is generally increasing, and the overall score has increased from 0.079 in 2010 to 0.122 in 2023, an increase of 54.4%, which shows that the development level of international digital trade is also increasing under the background of sustainable development of digital economy. Secondly, in the period of 2010—2023, from the average score of the development level of digital trade, the top ten countries in the development level of international digital trade are the United States (0.381), China (0.270), Japan (0.201), Luxembourg (0.201), Singapore (0.193) and Germany (0.173). Thirdly, there is a big gap between the development level of digital trade in developed and developing countries. Among the top 20 countries in the development level of digital trade in 55 countries, only two developing countries. Finally, after years of economic development in Asia, the development level of digital trade has been ranked in the forefront of the world. From the perspective of continents, the average development index of digital trade score in Asia, North America, Europe, Oceania, South America and Africa is 0.129, 0.117, 0.101, 0.092, 0.059 and 0.048.

Country	Year														Average score	Ran- king
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023		
United States of America	0.303	0.313	0.319	0.326	0.335	0.341	0.349	0.368	0.384	0.405	0.415	0.430	0.571	0.479	0.381	1
China	0.167	0.180	0.194	0.210	0.223	0.240	0.256	0.278	0.306	0.325	0.349	0.345	0.352	0.352	0.270	2
Japan	0.175	0.180	0.185	0.191	0.195	0.195	0.197	0.204	0.209	0.213	0.218	0.220	0.217	0.219	0.201	3

Luxembourg	0.116	0.126	0.140	0.171	0.180	0.186	0.206	0.224	0.234	0.243	0.250	0.240	0.252	0.248	0.201	4
Singapore	0.131	0.128	0.131	0.138	0.141	0.150	0.163	0.190	0.204	0.235	0.261	0.262	0.281	0.285	0.193	5
Germany	0.142	0.147	0.148	0.150	0.153	0.154	0.158	0.171	0.182	0.190	0.199	0.206	0.209	0.214	0.173	6
South Korea	0.140	0.142	0.145	0.152	0.158	0.164	0.168	0.175	0.181	0.185	0.195	0.198	0.193	0.196	0.171	7
Ireland	0.110	0.111	0.113	0.116	0.124	0.132	0.141	0.147	0.161	0.177	0.187	0.193	0.267	0.224	0.157	8
Netherlands	0.112	0.115	0.118	0.120	0.125	0.132	0.132	0.149	0.161	0.174	0.179	0.186	0.187	0.195	0.149	9
United Kingdom	0.127	0.129	0.132	0.135	0.138	0.139	0.142	0.148	0.155	0.162	0.165	0.167	0.163	0.165	0.148	10
France	0.117	0.121	0.122	0.124	0.126	0.127	0.130	0.135	0.140	0.143	0.146	0.148	0.150	0.151	0.148	11
Denmark	0.087	0.089	0.091	0.090	0.091	0.092	0.100	0.107	0.135	0.185	0.187	0.179	0.176	0.181	0.134	12
Israel	0.101	0.106	0.110	0.110	0.113	0.122	0.124	0.127	0.132	0.134	0.145	0.154	0.151	0.154	0.128	13
Sweden	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.127	14
Finland	0.106	0.106	0.107	0.103	0.105	0.106	0.107	0.110	0.115	0.127	0.140	0.150	0.151	0.158	0.122	15
Canada	0.106	0.108	0.108	0.108	0.109	0.109	0.111	0.117	0.120	0.123	0.125	0.129	0.129	0.126	0.121	16
Iceland	0.099	0.098	0.096	0.095	0.100	0.105	0.115	0.121	0.122	0.128	0.136	0.133	0.129	0.130	0.116	17
Malaysia	0.094	0.089	0.089	0.092	0.094	0.100	0.102	0.108	0.112	0.111	0.122	0.126	0.125	0.122	0.115	18
Australia	0.091	0.094	0.095	0.097	0.097	0.097	0.100	0.105	0.110	0.112	0.113	0.119	0.118	0.116	0.106	19
Czech Republic	0.079	0.082	0.083	0.083	0.086	0.088	0.091	0.098	0.107	0.117	0.130	0.129	0.132	0.131	0.104	20
Italy	0.088	0.089	0.089	0.089	0.091	0.092	0.093	0.098	0.103	0.104	0.109	0.112	0.113	0.113	0.103	21
Austria	0.085	0.083	0.087	0.088	0.090	0.091	0.093	0.094	0.101	0.105	0.109	0.117	0.115	0.114	0.099	22
Estonia	0.071	0.078	0.078	0.079	0.083	0.083	0.089	0.093	0.100	0.111	0.117	0.127	0.126	0.131	0.098	23
Belgium	0.077	0.080	0.082	0.086	0.089	0.090	0.092	0.097	0.102	0.107	0.110	0.115	0.115	0.115	0.098	24
Norway	0.086	0.085	0.086	0.085	0.086	0.087	0.088	0.091	0.094	0.099	0.101	0.104	0.103	0.101	0.097	25
Spain	0.081	0.081	0.081	0.081	0.083	0.083	0.086	0.089	0.093	0.101	0.107	0.106	0.106	0.107	0.093	26
Hungary	0.094	0.089	0.085	0.082	0.078	0.078	0.079	0.084	0.090	0.097	0.104	0.106	0.104	0.108	0.092	27
Philippines	0.074	0.059	0.076	0.074	0.081	0.095	0.096	0.087	0.092	0.103	0.110	0.110	0.110	0.108	0.091	28
Russia	0.069	0.071	0.074	0.077	0.081	0.082	0.083	0.089	0.093	0.097	0.101	0.104	0.107	0.104	0.091	29
Poland	0.065	0.063	0.066	0.068	0.074	0.075	0.078	0.083	0.091	0.094	0.101	0.104	0.105	0.107	0.088	30
Slovakia	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.084	31
New Zealand	0.069	0.070	0.071	0.072	0.074	0.078	0.079	0.084	0.084	0.086	0.089	0.091	0.088	0.087	0.084	32
India	0.059	0.063	0.065	0.067	0.069	0.072	0.075	0.077	0.082	0.088	0.093	0.092	0.095	0.094	0.080	33
Slovenia	0.057	0.059	0.061	0.061	0.063	0.064	0.066	0.072	0.080	0.085	0.092	0.095	0.096	0.097	0.078	34
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Salvador	0.021	0.022	0.022	0.023	0.024	0.024	0.026	0.029	0.027	0.030	0.033	0.037	0.038	0.036	0.029	55
Average score	0.079	0.080	0.083	0.085	0.088	0.090	0.093	0.099	0.104	0.110	0.117	0.119	0.124	0.122	—	—

Table 2. Development level of digital trade in various countries from 2010 to 2023

From 2010 to 2023, the evolution trend of the scores of seven comprehensive evaluation indicators of international digital trade, including digital trade potential, digital innovation, digital skills, digital trade scale, digital trade infrastructure, digital trust risk and digital trade barriers, vitae (Fig 1).

Digital trade infrastructure has always been leading in the 7-dimensional digital trade evaluation system, and the overall score shows a steady and slight upward trend, which proves that it, as the foundation of digital

trade, has maintained a high score and sustained growth trend. The scale of digital trade has a high score, and the overall trend of fluctuation is rising, which may be mainly due to geopolitical conflicts and the rise of unilateralism. Digital innovation increased by 55.8%, mainly due to the development of digital R&D and patents, indicating that countries have paid attention to innovative R&D in recent 14 years. The risk of digital trust has increased significantly after 2016, and the development speed is relatively fast, which may benefit from the achievements of international 5G infrastructure and standardization of cross-border e-commerce rules. The scores of digital skills and digital trade potential tend to be stable, with a small change and a slight increase in the later period. The score of digital trade barriers is low and the level of development is relatively low, which shows that tariff barriers still exist in various countries in recent 14 years, which has hindered the development of international trade.

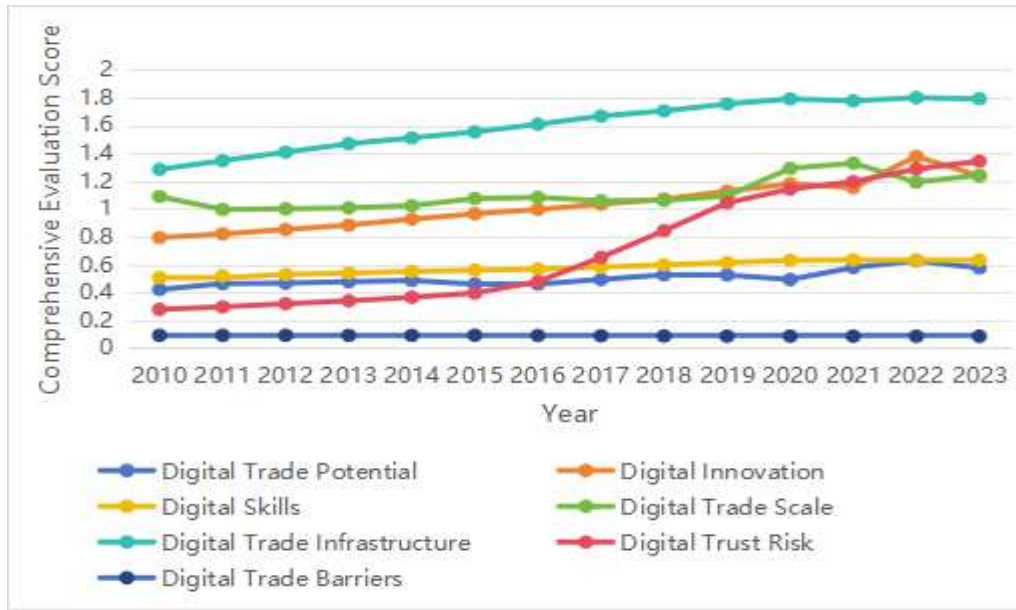


Figure 1. Evolution trend of international digital trade indicators from 2010 to 2023

3.2 Model prediction effect evaluation based on different methods

The index system of digital trade development level in various countries from 2010 to 2023 is divided into test set and training set according to the ratio of 2:8, and the parameters are optimized by grid search and 5-fold cross-validated parameter optimization. After parameter optimization, the prediction effects of seven machine learning models are shown in Table 3. From Table 3, it can be seen that XGBoost is excellent at 0.975, RMSE is excellent at 0.09, and MAE is excellent at 0.005, and its comprehensive prediction effect is excellent as a whole. At the same time, considering the high compatibility between XGBoost and SHAP model, XGBoost model is chosen as the main analysis model.

Machine Learning Method	R ²	RMSE	MAE
XGBoost	0.975	0.009	0.005
LightGBM	0.986	0.007	0.005
GBDT	0.985	0.007	0.005
KNN	0.984	0.007	0.004

Random Forest	0.982	0.008	0.004
AdaBoost	0.916	0.017	0.015
Decision Tree	0.910	0.018	0.013

Table 3. Prediction Performance of Seven Machine Learning Models

3.3 Interpretable analysis based on SHAP

In order to solve the black box problem of machine learning, this paper quantitatively evaluates the influence of 26 indicators on the development level of international digital trade, and makes explanatory analysis by using SHAP to rank the importance of different indicators, vitae (Fig 2). Figure 2 reflects the importance of the first 20 variables to the model prediction. The number of Patents in Force, “Researchers in R&D”, “Secure Internet Servers”, “Charges for the Use of Intellectual Property”, “Exports”, “Domestic Final Consumption Expenditure” and other factors have a positive impact on the development level of international digital trade, indicating that the development of these indicators has a significant positive impact on the development level of international digital trade. Research shows that countries with more effective patents often have advantages in the innovation and application of digital technology, which can promote the development of digital trade. The availability index of scientists and engineers has a significant positive effect on the development of digital trade. Intellectual property protection has a significant positive effect on digital service trade^[18-19].

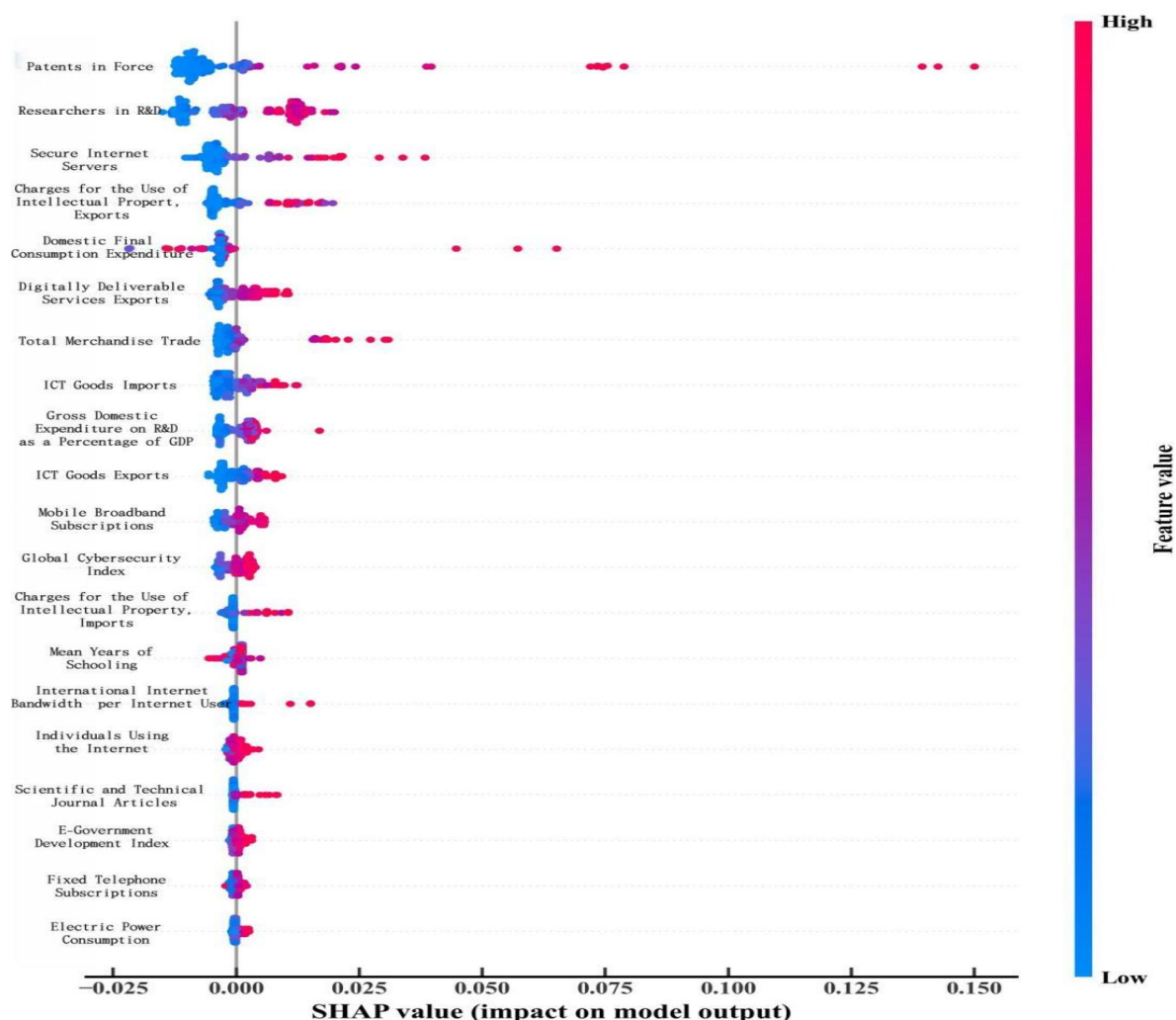


Figure 2. Overview of SHAP feature analysis

3.4 Evaluation of the development level of international digital trade based on Xgboost reconstruction

Re-evaluate the development level of international digital trade through the weight calculated by XGBoost, and the results are shown in Table 4. From 2010 to 2023, the top ten international digital trade development scores are the United States, Japan, China, South Korea, Germany, Israel, Britain, the Netherlands, Luxembourg and France. In 2023, Score of the top ten countries in the development level of international digital trade are the United States (0.835), China (0.548), Japan (0.472), South Korea (0.375), Israel (0.36), Germany (0.349), Ireland (0.324) and the Netherlands (0.309). Compared with multiple linear regression, in the evaluation of international digital trade development level reconstructed by XGBoost, its evolution trend is more reasonable, and the dynamic evolution process of international digital trade development level of different countries can be clearly seen, which provides an important reference for countries to formulate digital trade development policies and factor inputs.

Country	Year														Average	Ranking
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Score	
United States	0.552	0.574	0.590	0.612	0.636	0.653	0.673	0.711	0.734	0.761	0.790	0.796	0.903	0.835	0.701	1
Japan	0.362	0.380	0.399	0.420	0.441	0.441	0.448	0.458	0.470	0.477	0.477	0.483	0.456	0.472	0.442	2
China	0.172	0.204	0.234	0.263	0.290	0.322	0.358	0.407	0.457	0.496	0.542	0.537	0.561	0.548	0.385	3
Korea	0.232	0.249	0.265	0.277	0.296	0.304	0.311	0.325	0.341	0.357	0.373	0.373	0.375	0.375	0.318	4
Germany	0.224	0.236	0.240	0.248	0.254	0.262	0.272	0.290	0.311	0.326	0.338	0.350	0.339	0.349	0.289	5
Israel	0.171	0.190	0.208	0.222	0.242	0.260	0.281	0.300	0.319	0.342	0.367	0.359	0.351	0.360	0.284	6
United Kingdom	0.211	0.211	0.214	0.223	0.232	0.239	0.246	0.256	0.273	0.293	0.302	0.294	0.272	0.290	0.254	7
Netherlands	0.165	0.176	0.190	0.196	0.208	0.221	0.210	0.228	0.257	0.283	0.304	0.303	0.295	0.309	0.239	8
Luxembourg	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	9
France	0.195	0.204	0.206	0.211	0.218	0.223	0.230	0.240	0.251	0.257	0.265	0.265	0.259	0.266	0.235	10
Sweden	0.178	0.178	0.187	0.215	0.226	0.231	0.233	0.238	0.239	0.251	0.258	0.261	0.278	0.269	0.232	11
Ireland	0.128	0.144	0.173	0.185	0.201	0.216	0.226	0.243	0.262	0.260	0.274	0.293	0.312	0.324	0.232	12
Denmark	0.175	0.183	0.186	0.186	0.191	0.196	0.211	0.222	0.250	0.290	0.302	0.278	0.267	0.282	0.230	13
Singapore	0.170	0.176	0.178	0.188	0.191	0.212	0.214	0.226	0.231	0.242	0.248	0.261	0.283	0.276	0.221	14
Finland	0.208	0.210	0.216	0.213	0.202	0.204	0.209	0.211	0.219	0.231	0.238	0.253	0.224	0.249	0.221	15
Iceland	0.182	0.165	0.145	0.138	0.155	0.174	0.179	0.195	0.183	0.208	0.239	0.190	0.179	0.202	0.181	16
Canada	0.158	0.163	0.163	0.166	0.166	0.166	0.167	0.172	0.177	0.180	0.182	0.184	0.194	0.187	0.173	17
Austria	0.137	0.133	0.142	0.143	0.150	0.151	0.159	0.164	0.178	0.188	0.196	0.198	0.197	0.198	0.167	18
Belgium	0.115	0.122	0.128	0.134	0.142	0.146	0.151	0.158	0.172	0.185	0.194	0.211	0.201	0.203	0.162	19
Australia	0.141	0.144	0.147	0.149	0.151	0.150	0.154	0.160	0.166	0.168	0.170	0.179	0.184	0.178	0.160	20
Norway	0.135	0.136	0.139	0.139	0.144	0.149	0.155	0.164	0.169	0.174	0.178	0.186	0.184	0.182	0.160	21
New Zealand	0.103	0.107	0.109	0.112	0.125	0.142	0.147	0.151	0.156	0.160	0.163	0.157	0.158	0.158	0.139	22
Italy	0.111	0.115	0.117	0.119	0.121	0.125	0.130	0.138	0.146	0.149	0.151	0.160	0.161	0.159	0.136	23
Russian federation	0.108	0.113	0.117	0.120	0.124	0.124	0.123	0.128	0.132	0.135	0.135	0.140	0.156	0.146	0.129	24
Spain	0.109	0.109	0.108	0.107	0.108	0.107	0.111	0.117	0.124	0.145	0.149	0.146	0.152	0.150	0.124	25
Czech Republic	0.082	0.088	0.094	0.098	0.104	0.108	0.109	0.118	0.127	0.138	0.148	0.153	0.155	0.153	0.120	26
Estonia	0.086	0.094	0.096	0.094	0.096	0.095	0.101	0.111	0.121	0.134	0.141	0.155	0.145	0.152	0.116	27
Slovenia	0.082	0.093	0.095	0.096	0.097	0.093	0.098	0.111	0.126	0.137	0.147	0.143	0.148	0.148	0.115	28
Hungary	0.095	0.095	0.096	0.098	0.098	0.095	0.097	0.103	0.116	0.123	0.132	0.142	0.135	0.139	0.112	29
Portugal	0.087	0.091	0.090	0.085	0.088	0.091	0.099	0.110	0.119	0.125	0.132	0.143	0.153	0.144	0.111	30
poland	0.063	0.064	0.069	0.073	0.081	0.083	0.091	0.109	0.120	0.126	0.135	0.140	0.145	0.142	0.103	31
Slovak Republic	0.084	0.083	0.083	0.082	0.082	0.081	0.072	0.077	0.095	0.107	0.120	0.106	0.118	0.117	0.093	32
Lithuania	0.065	0.067	0.066	0.072	0.078	0.075	0.080	0.085	0.096	0.104	0.111	0.120	0.125	0.129	0.091	33
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
El Salvador	0.003	0.003	0.006	0.008	0.008	0.010	0.015	0.017	0.009	0.013	0.016	0.012	0.021	0.016	0.011	55
均值	0.107	0.112	0.117	0.121	0.127	0.132	0.136	0.144	0.153	0.162	0.170	0.171	0.176	0.175	——	—

Table 4. Evaluation of the development level of international digital trade based on XGBoost reconstruction

Robustness test

In order to ensure the robustness of the results, this paper compares the feature importance of XGBoost and SHAP algorithms. The results show in Table5 that among the top 10 features of feature importance of XGBoost and SHAP algorithms, the number of effective patents and talents in R&D fields rank in the top 2 in the same order, and four of the top 5 feature values are the same, so the prediction results are still valid, which shows the robustness of the empirical results of this study.

Rank	XGBoost model		SHAP model		Entropy method	
	Feature	Value	Feature	Value	Feature	Value
1	Patents in Force	0.276	Patents in Force	0.211	ICT Goods Exports	0.064
2	Researchers in R&D	0.276	Researchers in R&D	0.132	Patents in Force	0.062
3	Charges for the Use of Intellectual Property, Exports	0.169	Secure Internet Servers	0.088	Fixed Broadband Subscriptions	0.056
4	Domestic Final Consumption Expenditure	0.084	Charges for the Use of Intellectual Property, Exports	0.081	Secure Internet Servers	0.055
5	Total Merchandise Trade	0.070	Domestic Final Consumption Expenditure	0.070	Fixed Telephone Subscriptions	0.055
6	Secure Internet Servers	0.041	Digitally Deliverable Services Exports	0.051	Gross Domestic Expenditure on R&D as a Percentage of GDP	0.049
7	Charges for the Use of Intellectual Property, Imports	0.028	Total Merchandise Trade	0.051	Researchers in R&D	0.048
8	Gross Domestic Expenditure on R&D as a Percentage of GDP	0.026	ICT Goods Imports	0.048	Total Merchandise Trade	0.048
9	Global Cybersecurity Index	0.019	Gross Domestic Expenditure on R&D as a Percentage of GDP	0.042	ICT Goods Imports	0.048
10	International Internet Bandwidth per Internet User	0.016	ICT Goods Exports	0.041	Scientific and Technical Journal Articles	0.048

Table 5. Comparison of feature importance between XG Boost and SHAP algorithms

Conclusions and suggestions

5.1 Conclusion

The evaluation index system of international digital trade level from 2010 to 2023 based on entropy method was established. After evaluating the effects of seven machine models, such as XGBoost, LightGBM, SVR and KNN, XGBoost with excellent prediction effect and high compatibility with SHAP algorithm was selected as the main prediction model in this paper. Further, in order to deeply explore the importance and effect of various influencing factors on the development level of international digital trade, SHAP is used for in-depth analysis, and the conclusions are as follows:

1) According to the entropy method, the development level of international digital trade in 2010—2023 showed a sustainable development trend. In 2023, the top 10 countries in international digital trade are the United States, China, Singapore, Luxemburg, Ireland, Japan, Germany, South Korea, the Netherlands and Denmark. From 2010 to 2016, the development of international digital trade was relatively flat, with an average growth rate of 2.0%. From 2017 to 2020, the development of international digital trade was obviously accelerated, with an average growth rate of 4.6%. From the perspective of continents, in 2023, the development level of digital trade from high to low is Asia, North America, Europe, Oceania, South America and Africa.

2) The XGBoost model is used to estimate the development level of international digital trade, and the top 10 countries in 2023 are the United States, China, Japan, South Korea, Israel, Germany, Ireland, the Netherlands, Britain and Denmark. From the perspective of continents, the development level of digital trade from high to low is Asia, North America, Europe, Oceania, South America and Africa.

3) From the value of SHAP contribution, the top 10 indicators are the number of “Patents in Force”, which have the greatest impact on the development of international digital trade, followed by “Researchers in R&D” and “Secure Internet Servers”. “Researchers in R&D” promote digital technology iteration and reduce transaction costs and time and space constraints. “Secure Internet Servers” is the infrastructure of digital trade, which can reduce the trust risk of digital trade.

4) From the related factors of international digital trade, The key factors affecting the development level of international digital trade are Patents in Force, Researchers in R&D , Secure Internet Servers, Charges for the use of intellectual property, Exports, Domestic Final Consumption Expenditure, Digitally Deliverable Services Exports, Total Merchandise Trade, ICT Goods Imports as a Percentage of Total Goods Imports, Gross Domestic Expenditure on R&D as a Percentage of GDP, Charges for the Use of Intellectual Property, Exports, Among them, Patents in Force and Researchers in R&D are always in the top 2, and the number of effective patents is the most important factor for the development level of international digital trade.

5.2 Suggestions

Based on the conclusion of the paper, the key factors affecting the development level of international digital trade “Patents in Force”, “Researchers in R&D”, “Secure Internet Servers”, “Charges for the Use of Intellectual Property, Exports” and “Domestic Final Consumption Expenditure”. In order to enhance the competitiveness of global digital trade, this proposal combines the results of empirical analysis and puts forward the following targeted countermeasures.

1) Strengthen the cultivation and transformation of effective patents and lay a solid foundation for digital

trade innovation. “Patents in Force” is the primary factor in the development of international digital trade, which directly drives technological innovation and industrial upgrading. We should increase R&D investment through policy guidance, optimize the intellectual property protection system, establish national patent funds, support universities and enterprises to jointly develop digital technology patents, and simplify the patent transformation process. At the same time, promote the patent sharing platform, encourage transnational cooperation, and promote the application of patent achievements in digital services, artificial intelligence and other fields. Strengthen intellectual property education and law enforcement, crack down on infringement, and improve patent quality and internationalization level. Thereby reducing the transaction cost of digital trade, enhancing the national innovation competitiveness and promoting the sustainable growth of digital trade.

2) Optimize the training and incentive mechanism of R&D talents and accelerate the iteration of digital technology. “Researchers in R&D” are the core force to promote the update of digital technology and reduce the time and space restrictions of trade. We should expand the scale of STEM (Science, Technology, Engineering and Mathematics) education through education reform and talent introduction policies, set up special scholarships to attract high-end talents from all over the world, build an integrated platform in Industry-University-Research, and encourage enterprises to cooperate with research institutions to develop digital solutions. At the same time, improve the talent incentive mechanism, such as providing tax incentives and entrepreneurial support, and promote talent innovation in frontier fields such as cloud computing and blockchain. In addition, strengthen international talent exchange, reduce visa barriers, and build a global R&D talent network. Improve the iterative efficiency of digital technology, reduce trade friction and shorten the technology transformation cycle.

3) Improve the density and reliability of secure Internet servers and build a digital trade infrastructure. As a key infrastructure, “Secure Internet Servers” can significantly reduce the trust risk and data leakage of digital trade. Through public investment and public-private cooperation, we should expand the coverage of server networks, deploy high-density server clusters in key cities and trade hubs, and promote 5G and quantum encryption technologies to enhance security. At the same time, formulate international standardized network security protocols, strengthen cross-border data supervision and cooperation, and crack down on cybercrime. Encourage enterprises to adopt green server technology to reduce energy consumption and environmental impact. Enhance the trust and efficiency of digital trade, increase the density of servers and support the development of digital trade.

4) Expand the export share of intellectual property royalties and enhance the advantages of digital trade value chain. “Charges for the Use of Intellectual Property, Exports” is the core of the related factors affecting digital trade, which reflects a country's global competitiveness in the field of digital content and services. We should encourage the creation and export of digital content through policy support and market-oriented mechanism, such as setting up export subsidies for intellectual property rights and supporting the internationalization of cultural creativity, software and digital media industries. At the same time, simplify the export process, promote electronic payment and blockchain technology to ensure the transparency of transactions, and strengthen international negotiations to strive for intellectual property protection clauses in bilateral trade agreements. Cultivate local brands and high-end services to enhance the added value of intellectual property rights. Optimize the trade structure, increase foreign exchange income, and promote the increase of exports in the total service.

5) Stimulate domestic final consumption expenditure and activate the endogenous power of digital trade.

As an important correlation factor, “Domestic Final Consumption Expenditure” can stimulate the demand for digital services and market scale. Residents should be encouraged to increase their spending on digital products and services through economic stimulus policies, tax reduction and fee reduction, and consumer voucher programs, and e-commerce and digital payment platforms should be promoted to enhance consumer convenience. At the same time, strengthen consumer protection and education, crack down on false propaganda and enhance market confidence. Combined with regional development strategy, support the construction of digital infrastructure in underdeveloped areas and narrow the consumption gap. Expand the domestic demand market, provide a stable foundation for digital trade, promote the average annual growth of domestic consumption expenditure, and help the balanced development of global trade.

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Author contributions

Jingyi Lao conceived this study and was responsible for conceptualization, funding acquisition, data curation, data analysis and paper writing. Liurong Pan was responsible for overseeing the article funding acquisition and quality control. Wei LI assisted in statistical analysis using python and performed data collection. Weiye Liang was responsible for data collection and investigation. Jiali Xie was responsible for data interpretation and software.

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Data availability statement

The data used are from the world's major public databases, and the above data are from the International Monetary Fund (IMF), the World Economic Forum (WEF), the World Intellectual Property Organization (WIPO), the United Nations Trade Development Committee (UNCTAD), the Organization for Economic Cooperation and Development (OECD), the International Telecommunication Union (ITU), the World Development Indicators Database (WDI) and the UNESCO Institute for Statistics (UIS). All the authors of this study declare that there is no conflict of interest of financial, professional or personal nature, and there is no relationship that may affect the objectivity of the results of this study or the fairness of interpretation.

Additional Information

Competing Interests Statement: The authors declare that they have no competing interests. This includes

no financial, personal, or professional relationships that could be perceived as influencing the research or its outcomes. All authors have reviewed this statement and confirm its accuracy.

Figure legends

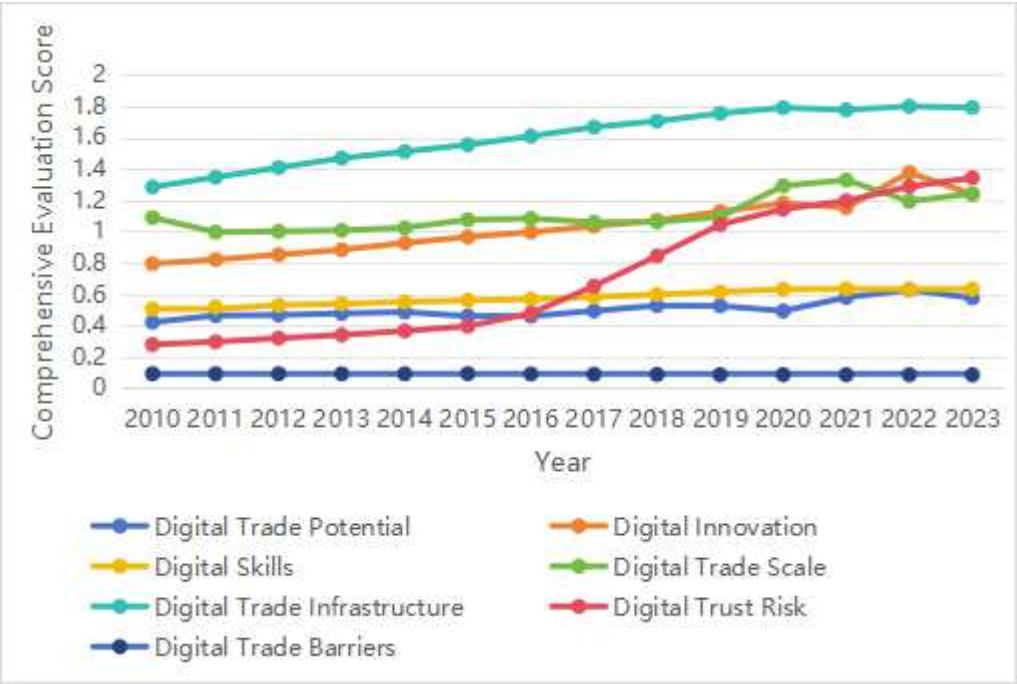


Figure 1. Evolution trend of international digital trade indicators from 2010 to 2023

From 2010 to 2023, the evolution trend of the scores of seven comprehensive evaluation indicators of international digital trade, including digital trade potential, digital innovation, digital skills, digital trade scale, digital trade infrastructure, digital trust risk and digital trade barriers, is shown in Figure 1.

Digital trade infrastructure has always been leading in the 7-dimensional digital trade evaluation system, and the overall score shows a steady and slight upward trend, which proves that it, as the foundation of digital trade, has maintained a high score and sustained growth trend. The scale of digital trade has a high score, and the overall trend of fluctuation is rising, which may be mainly due to geopolitical conflicts and the rise of unilateralism. Digital innovation increased by 55.8%, mainly due to the development of digital R&D and patents, indicating that countries have paid attention to innovative R&D in recent 14 years. The risk of digital trust has increased significantly after 2016, and the development speed is relatively fast, which may benefit from the achievements of international 5G infrastructure and standardization of cross-border e-commerce rules. The scores of digital skills and digital trade potential tend to be stable, with a small change and a slight increase in the later period. The score of digital trade barriers is low and the level of development is relatively low, which shows that tariff barriers still exist in various countries in recent 14 years, which has hindered the development of international trade.

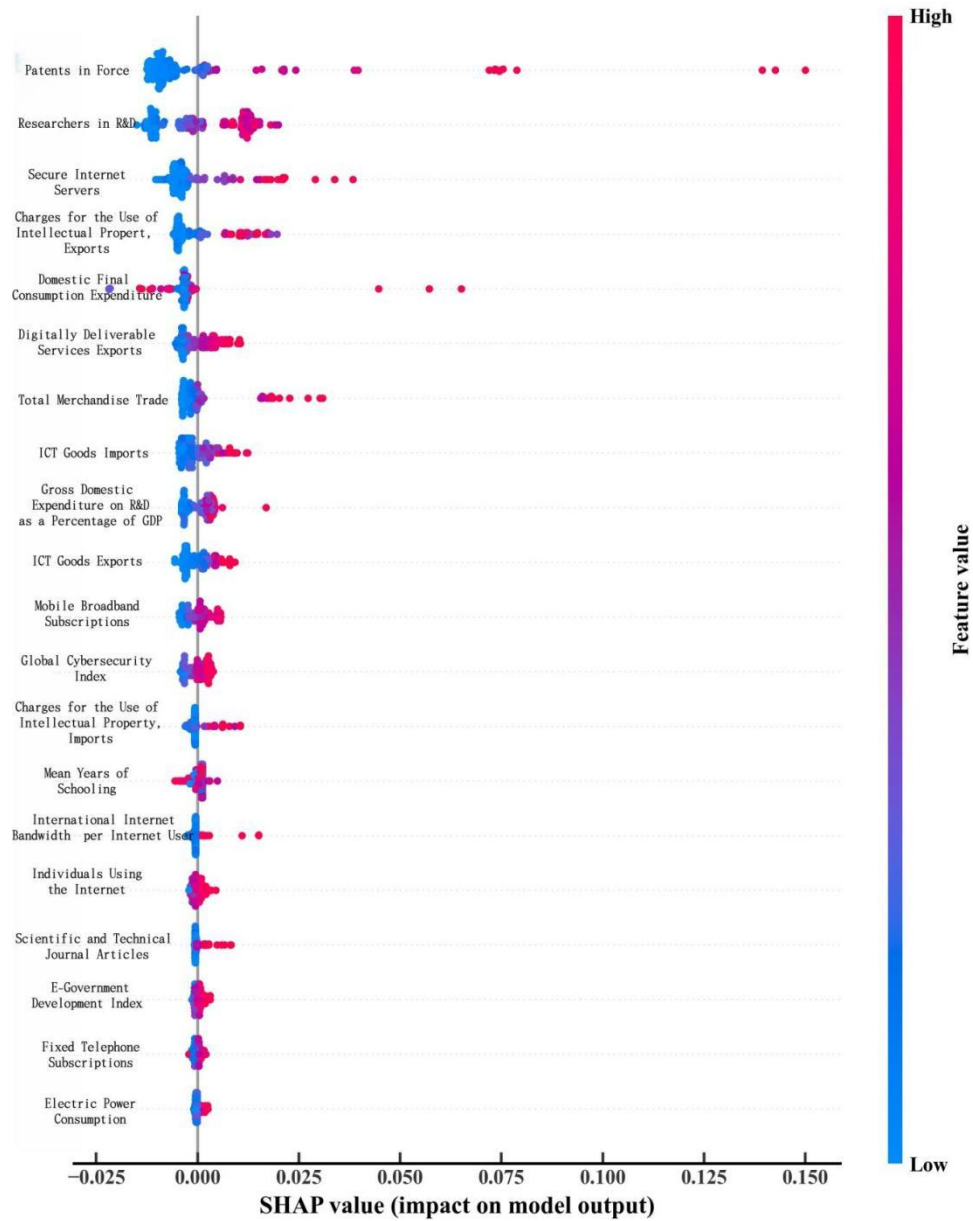


Figure 2. Overview of SHAP feature analysis

In order to solve the black box problem of machine learning, this paper quantitatively evaluates the influence of 26 indicators on the development level of international digital trade, and makes explanatory analysis by using SHAP to rank the importance of different indicators. Figure 2 reflects the importance of the first 20 variables to the model prediction. The number of

Patents in Force, “Researchers in R&D”, “Secure Internet Servers”, “Charges for the Use of Intellectual Property, Exports”, “Domestic Final Consumption Expenditure” and other factors have a positive impact on the development level of international digital trade, indicating that the development of these indicators has a significant positive impact on the development level of international digital trade. Research shows that countries with more effective patents often have advantages in the innovation and application of digital technology, which

can promote the development of digital trade. The availability index of scientists and engineers has a significant positive effect on the development of digital trade. Intellectual property protection has a significant positive effect on digital service trade (Ou et al., 2024).

Tables

Based on the research of scholars at home and abroad, the digital trade development index system is established according to the principles of systematicness, objectivity, scientificity, comparability, comprehensiveness, hierarchy and feasibility. Seven dimensions of digital trade potential, digital innovation, digital skills, digital scale, digital infrastructure, digital trust risk and digital trade barriers are taken as the first-level indicators, and the comprehensive evaluation index system corresponding to 14 second-level indicators and 26 third-level indicators comprehensively measures the development level of digital trade in various countries. The specific index system is shown in Table 1.

Table 1. Comprehensive evaluation index system and weight of digital trade

First-level Indicators	weight	Second-level Indicators	weight	Specific Indicators	weight	Indicator direction
Digital trade potential	0.142	Consumption expenditure	0.088	Domestic Final Consumption Expenditure	0.088	Positive
		Trade scale	0.054	Total Merchandise Trade	0.054	Positive
				Gross Domestic Expenditure on R&D as a Percentage of GDP	0.019	Positive
Digital innovation	0.408	Innovation investment	0.152	Charges for the Use of Intellectual Property, Imports	0.133	Positive
				Charges for the Use of Intellectual Property, Exports	0.080	Positive
				Patents in Force	0.098	Positive
		Innovative output	0.256	Scientific and Technical Journal Articles	0.078	Positive
				Researchers in R&D	0.024	Positive
				Mean Years of Schooling	0.004	Positive
Digital skills	0.035	Talent input	0.035	Gross Tertiary Enrollment Ratio	0.007	Positive
				ICT Goods Exports as a Percentage of Total Goods Exports	0.047	Positive
				ICT Goods Imports as a Percentage of Total Goods Imports	0.023	Positive
Digital trade scale	0.105	Digital trade scale	0.105	ICT Services Exports as a Percentage of Total Services Exports	0.024	Positive
				Digitally Deliverable Services Exports	0.011	Positive
				Logistics Performance Index (LPI)	0.004	Positive
Digital trade	0.204	Physical	0.029			

infrastructure	infrastructure	Electric Power Consumption	0.025	Positive
Digital trust risk	0.100	Network facilities	0.140	Positive
Digital trade barrier	0.002	Communication facilities	0.018	Positive
Digital trade barrier	0.002	Terminal device	0.021	Positive
Digital trade barrier	0.002	Safety devices	0.089	Positive
Digital trade barrier	0.002	Network security	0.007	Positive
Digital trade barrier	0.002	Digital government	0.004	Positive
Digital trade barrier	0.002	Digital trade restrictions	0.002	Negative

Source: The author made it through the official open database.

The development level of digital trade in 55 countries from 2010 to 2023 is shown in Table 2, ranking from 1st to 55th. First of all, the development level of international digital trade is generally increasing, and the overall score has increased from 0.079 in 2010 to 0.122 in 2023, an increase of 54.4%, which shows that the development level of international digital trade is also increasing under the background of sustainable development of digital economy. Secondly, in the period of 2010—2023, from the average score of the development level of digital trade, the top ten countries in the development level of international digital trade are the United States (0.381), China (0.270), Japan (0.201), Luxembourg (0.201), Singapore (0.193) and Germany (0.173). Thirdly, there is a big gap between the development level of digital trade in developed and developing countries. Among the top 20 countries in the development level of digital trade in 55 countries, only two developing countries. Finally, after years of economic development in Asia, the development level of digital trade has been ranked in the forefront of the world. From the perspective of continents, the average development index of digital trade score in Asia, North America, Europe, Oceania, South America and Africa is 0.129, 0.117, 0.101, 0.092, 0.059 and 0.048.

Table 2. Development level of digital trade in various countries from 2010 to 2023

Country	Year														Average score	Ranking
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023		
United States of America	0.303	0.313	0.319	0.326	0.335	0.341	0.349	0.368	0.384	0.405	0.415	0.430	0.571	0.479	0.381	1
China	0.167	0.180	0.194	0.210	0.223	0.240	0.256	0.278	0.306	0.325	0.349	0.345	0.352	0.352	0.270	2
Japan	0.175	0.180	0.185	0.191	0.195	0.195	0.197	0.204	0.209	0.213	0.218	0.220	0.217	0.219	0.201	3
Luxembourg	0.116	0.126	0.140	0.171	0.180	0.186	0.206	0.224	0.234	0.243	0.250	0.240	0.252	0.248	0.201	4
Singapore	0.131	0.128	0.131	0.138	0.141	0.150	0.163	0.190	0.204	0.235	0.261	0.262	0.281	0.285	0.193	5
Germany	0.142	0.147	0.148	0.150	0.153	0.154	0.158	0.171	0.182	0.190	0.199	0.206	0.209	0.214	0.173	6
South Korea	0.140	0.142	0.145	0.152	0.158	0.164	0.168	0.175	0.181	0.185	0.195	0.198	0.193	0.196	0.171	7
Ireland	0.110	0.111	0.113	0.116	0.124	0.132	0.141	0.147	0.161	0.177	0.187	0.193	0.267	0.224	0.157	8
Netherlands	0.112	0.115	0.118	0.120	0.125	0.132	0.132	0.149	0.161	0.174	0.179	0.186	0.187	0.195	0.149	9
United Kingdom	0.127	0.129	0.132	0.135	0.138	0.139	0.142	0.148	0.155	0.162	0.165	0.167	0.163	0.165	0.148	10
France	0.117	0.121	0.122	0.124	0.126	0.127	0.130	0.135	0.140	0.143	0.146	0.148	0.150	0.151	0.148	11
Denmark	0.087	0.089	0.091	0.090	0.091	0.092	0.100	0.107	0.135	0.185	0.187	0.179	0.176	0.181	0.134	12
Israel	0.101	0.106	0.110	0.110	0.113	0.122	0.124	0.127	0.132	0.134	0.145	0.154	0.151	0.154	0.128	13
Sweden	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.127	14
Finland	0.106	0.106	0.107	0.103	0.105	0.106	0.107	0.110	0.115	0.127	0.140	0.150	0.151	0.158	0.122	15
Canada	0.106	0.108	0.108	0.108	0.109	0.109	0.111	0.117	0.120	0.123	0.125	0.129	0.129	0.126	0.121	16
Iceland	0.099	0.098	0.096	0.095	0.100	0.105	0.115	0.121	0.122	0.128	0.136	0.133	0.129	0.130	0.116	17
Malaysia	0.094	0.089	0.089	0.092	0.094	0.100	0.102	0.108	0.112	0.111	0.122	0.126	0.125	0.122	0.115	18
Australia	0.091	0.094	0.095	0.097	0.097	0.097	0.100	0.105	0.110	0.112	0.113	0.119	0.118	0.116	0.106	19
Czech Republic	0.079	0.082	0.083	0.083	0.086	0.088	0.091	0.098	0.107	0.117	0.130	0.129	0.132	0.131	0.104	20
Italy	0.088	0.089	0.089	0.089	0.091	0.092	0.093	0.098	0.103	0.104	0.109	0.112	0.113	0.113	0.103	21
Austria	0.085	0.083	0.087	0.088	0.090	0.091	0.093	0.094	0.101	0.105	0.109	0.117	0.115	0.114	0.099	22
Estonia	0.071	0.078	0.078	0.079	0.083	0.083	0.089	0.093	0.100	0.111	0.117	0.127	0.126	0.131	0.098	23
Belgium	0.077	0.080	0.082	0.086	0.089	0.090	0.092	0.097	0.102	0.107	0.110	0.115	0.115	0.115	0.098	24

Norway	0.086	0.085	0.086	0.085	0.086	0.087	0.088	0.091	0.094	0.099	0.101	0.104	0.103	0.101	0.097	25
Spain	0.081	0.081	0.081	0.081	0.083	0.083	0.086	0.089	0.093	0.101	0.107	0.106	0.106	0.107	0.093	26
Hungary	0.094	0.089	0.085	0.082	0.078	0.078	0.079	0.084	0.090	0.097	0.104	0.106	0.104	0.108	0.092	27
Philippines	0.074	0.059	0.076	0.074	0.081	0.095	0.096	0.087	0.092	0.103	0.110	0.110	0.110	0.108	0.091	28
Russia	0.069	0.071	0.074	0.077	0.081	0.082	0.083	0.089	0.093	0.097	0.101	0.104	0.107	0.104	0.091	29
Poland	0.065	0.063	0.066	0.068	0.074	0.075	0.078	0.083	0.091	0.094	0.101	0.104	0.105	0.107	0.088	30
Slovakia	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.084	31
New Zealand	0.069	0.070	0.071	0.072	0.074	0.078	0.079	0.084	0.084	0.086	0.089	0.091	0.088	0.087	0.084	32
India	0.059	0.063	0.065	0.067	0.069	0.072	0.075	0.077	0.082	0.088	0.093	0.092	0.095	0.094	0.080	33
Slovenia	0.057	0.059	0.061	0.061	0.063	0.064	0.066	0.072	0.080	0.085	0.092	0.095	0.096	0.097	0.078	34
Portugal	0.057	0.058	0.058	0.058	0.061	0.063	0.068	0.074	0.079	0.083	0.091	0.094	0.094	0.094	0.075	35
Mexico	0.063	0.061	0.063	0.064	0.065	0.070	0.073	0.074	0.075	0.077	0.079	0.082	0.082	0.082	0.074	36
Brazil	0.058	0.061	0.063	0.065	0.068	0.069	0.068	0.071	0.072	0.074	0.079	0.079	0.082	0.083	0.072	37
Latvia	0.054	0.054	0.057	0.061	0.064	0.068	0.070	0.073	0.074	0.078	0.085	0.083	0.081	0.084	0.071	38
Lithuania	0.047	0.049	0.049	0.051	0.054	0.057	0.061	0.066	0.071	0.078	0.088	0.090	0.096	0.106	0.070	39
Thailand	0.051	0.048	0.051	0.054	0.059	0.062	0.066	0.071	0.072	0.074	0.083	0.083	0.084	0.082	0.069	40
Greece	0.050	0.052	0.053	0.055	0.058	0.062	0.064	0.068	0.071	0.075	0.082	0.080	0.081	0.083	0.067	41
Serbia	0.044	0.046	0.049	0.050	0.050	0.053	0.055	0.058	0.062	0.066	0.073	0.076	0.078	0.080	0.067	42
Argentina	0.048	0.050	0.052	0.055	0.054	0.058	0.059	0.062	0.060	0.060	0.065	0.071	0.066	0.064	0.060	43
Costa Rica	0.062	0.065	0.068	0.072	0.066	0.050	0.048	0.050	0.051	0.054	0.058	0.057	0.060	0.058	0.059	44
Türkiye	0.043	0.045	0.046	0.050	0.051	0.052	0.055	0.057	0.061	0.062	0.067	0.069	0.076	0.072	0.058	45
Uruguay	0.039	0.039	0.044	0.047	0.051	0.053	0.055	0.057	0.059	0.062	0.067	0.069	0.068	0.066	0.058	46
Chile	0.038	0.040	0.042	0.044	0.046	0.049	0.052	0.053	0.056	0.059	0.063	0.063	0.060	0.060	0.056	47
South Africa	0.036	0.037	0.038	0.042	0.040	0.043	0.044	0.048	0.052	0.054	0.057	0.059	0.059	0.059	0.052	48
Indonesia	0.037	0.037	0.037	0.036	0.037	0.036	0.037	0.043	0.047	0.050	0.062	0.068	0.068	0.067	0.048	49
Montenegro	0.033	0.033	0.034	0.036	0.039	0.042	0.043	0.045	0.054	0.056	0.062	0.060	0.061	0.060	0.047	50
Panama	0.039	0.038	0.039	0.038	0.040	0.042	0.045	0.048	0.051	0.051	0.053	0.053	0.053	0.053	0.047	51
North Macedonia	0.032	0.029	0.033	0.033	0.035	0.037	0.040	0.041	0.045	0.048	0.051	0.056	0.058	0.057	0.046	52
Kazakhstan	0.029	0.034	0.037	0.039	0.040	0.039	0.040	0.041	0.043	0.045	0.048	0.051	0.053	0.053	0.043	53
Pakistan	0.013	0.015	0.016	0.022	0.022	0.023	0.027	0.027	0.029	0.033	0.041	0.044	0.044	0.044	0.042	54
Salvador	0.021	0.022	0.022	0.023	0.024	0.024	0.026	0.029	0.027	0.030	0.033	0.037	0.038	0.036	0.029	55
Average score	0.079	0.080	0.083	0.085	0.088	0.090	0.093	0.099	0.104	0.110	0.117	0.119	0.124	0.122	—	—

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The index system of digital trade development level in various countries from 2010 to 2023 is divided into test set and training set according to the ratio of 2:8, and the parameters are optimized by grid search and 5-fold cross-validated parameter optimization. After parameter optimization, the prediction effects of seven machine learning models are shown in Table 3. From Table 3, it can be seen that XGBoost is excellent at 0.975, RMSE is excellent at 0.09, and MAE is excellent at 0.005, and its comprehensive prediction effect is excellent as a whole. At the same time, considering the high compatibility between XGBoost and SHAP model, XGBoost model is chosen as the main analysis model.

Table 3. Prediction Performance of Seven Machine Learning Models

Machine Learning Method	R ²	RMSE	MAE
XGBoost	0.975	0.009	0.005
LightGBM	0.986	0.007	0.005
GBDT	0.985	0.007	0.005
KNN	0.984	0.007	0.004
Random Forest	0.982	0.008	0.004
AdaBoost	0.916	0.017	0.015
Decision Tree	0.910	0.018	0.013

Re-evaluate the development level of international digital trade through the weight calculated by XGBoost, and the results are shown in Table 4. From 2010 to 2023, the top ten international digital trade development scores are the United States, Japan, China, South Korea, Germany, Israel, Britain, the Netherlands, Luxembourg and France. In 2023, Score of the top ten countries in the development level of international digital trade are the United States (0.835), China (0.548), Japan (0.472), South Korea (0.375), Israel (0.36), Germany (0.349), Ireland (0.324) and the Netherlands (0.309). Compared with multiple linear regression, in the evaluation of international digital trade development level reconstructed by XGBoost, its evolution trend is more reasonable, and the dynamic evolution process of international digital trade development level of different countries can be clearly seen, which provides an important reference for countries to formulate digital trade development policies and factor inputs.

Table 4. Evaluation of the development level of international digital trade based on XGBoost reconstruction

Country	Year														Average	Ranking
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Score	
United States	0.552	0.574	0.590	0.612	0.636	0.653	0.673	0.711	0.734	0.761	0.790	0.796	0.903	0.835	0.701	1
Japan	0.362	0.380	0.399	0.420	0.441	0.441	0.448	0.458	0.470	0.477	0.477	0.483	0.456	0.472	0.442	2
China	0.172	0.204	0.234	0.263	0.290	0.322	0.358	0.407	0.457	0.496	0.542	0.537	0.561	0.548	0.385	3
Korea	0.232	0.249	0.265	0.277	0.296	0.304	0.311	0.325	0.341	0.357	0.373	0.373	0.375	0.375	0.318	4
Germany	0.224	0.236	0.240	0.248	0.254	0.262	0.272	0.290	0.311	0.326	0.338	0.350	0.339	0.349	0.289	5
Israel	0.171	0.190	0.208	0.222	0.242	0.260	0.281	0.300	0.319	0.342	0.367	0.359	0.351	0.360	0.284	6
United Kingdom	0.211	0.211	0.214	0.223	0.232	0.239	0.246	0.256	0.273	0.293	0.302	0.294	0.272	0.290	0.254	7
Netherlands	0.165	0.176	0.190	0.196	0.208	0.221	0.210	0.228	0.257	0.283	0.304	0.303	0.295	0.309	0.239	8
Luxembourg	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	9
France	0.195	0.204	0.206	0.211	0.218	0.223	0.230	0.240	0.251	0.257	0.265	0.265	0.259	0.266	0.235	10
Sweden	0.178	0.178	0.187	0.215	0.226	0.231	0.233	0.238	0.239	0.251	0.258	0.261	0.278	0.269	0.232	11
Ireland	0.128	0.144	0.173	0.185	0.201	0.216	0.226	0.243	0.262	0.260	0.274	0.293	0.312	0.324	0.232	12
Denmark	0.175	0.183	0.186	0.186	0.191	0.196	0.211	0.222	0.250	0.290	0.302	0.278	0.267	0.282	0.230	13
Singapore	0.170	0.176	0.178	0.188	0.191	0.212	0.214	0.226	0.231	0.242	0.248	0.261	0.283	0.276	0.221	14
Finland	0.208	0.210	0.216	0.213	0.202	0.204	0.209	0.211	0.219	0.231	0.238	0.253	0.224	0.249	0.221	15
Iceland	0.182	0.165	0.145	0.138	0.155	0.174	0.179	0.195	0.183	0.208	0.239	0.190	0.179	0.202	0.181	16
Canada	0.158	0.163	0.163	0.166	0.166	0.166	0.167	0.172	0.177	0.180	0.182	0.184	0.194	0.187	0.173	17
Austria	0.137	0.133	0.142	0.143	0.150	0.151	0.159	0.164	0.178	0.188	0.196	0.198	0.197	0.198	0.167	18
Belgium	0.115	0.122	0.128	0.134	0.142	0.146	0.151	0.158	0.172	0.185	0.194	0.211	0.201	0.203	0.162	19
Australia	0.141	0.144	0.147	0.149	0.151	0.150	0.154	0.160	0.166	0.168	0.170	0.179	0.184	0.178	0.160	20
Norway	0.135	0.136	0.139	0.139	0.144	0.149	0.155	0.164	0.169	0.174	0.178	0.186	0.184	0.182	0.160	21
New Zealand	0.103	0.107	0.109	0.112	0.125	0.142	0.147	0.151	0.156	0.160	0.163	0.157	0.158	0.158	0.139	22
Italy	0.111	0.115	0.117	0.119	0.121	0.125	0.130	0.138	0.146	0.149	0.151	0.160	0.161	0.159	0.136	23
Russian federation	0.108	0.113	0.117	0.120	0.124	0.124	0.123	0.128	0.132	0.135	0.135	0.140	0.156	0.146	0.129	24
Spain	0.109	0.109	0.108	0.107	0.108	0.107	0.111	0.117	0.124	0.145	0.149	0.146	0.152	0.150	0.124	25
Czech Republic	0.082	0.088	0.094	0.098	0.104	0.108	0.109	0.118	0.127	0.138	0.148	0.153	0.155	0.153	0.120	26
Estonia	0.086	0.094	0.096	0.094	0.096	0.095	0.101	0.111	0.121	0.134	0.141	0.155	0.145	0.152	0.116	27

Slovenia	0.082	0.093	0.095	0.096	0.097	0.093	0.098	0.111	0.126	0.137	0.147	0.143	0.148	0.148	0.115	28
Hungary	0.095	0.095	0.096	0.098	0.098	0.095	0.097	0.103	0.116	0.123	0.132	0.142	0.135	0.139	0.112	29
Portugal	0.087	0.091	0.090	0.085	0.088	0.091	0.099	0.110	0.119	0.125	0.132	0.143	0.153	0.144	0.111	30
poland	0.063	0.064	0.069	0.073	0.081	0.083	0.091	0.109	0.120	0.126	0.135	0.140	0.145	0.142	0.103	31
Slovak Republic	0.084	0.083	0.083	0.082	0.082	0.081	0.072	0.077	0.095	0.107	0.120	0.106	0.118	0.117	0.093	32
Lithuania	0.065	0.067	0.066	0.072	0.078	0.075	0.080	0.085	0.096	0.104	0.111	0.120	0.125	0.129	0.091	33
Malaysia	0.066	0.070	0.073	0.079	0.083	0.090	0.094	0.096	0.096	0.094	0.096	0.102	0.108	0.101	0.089	34
Greece	0.055	0.056	0.058	0.066	0.070	0.080	0.074	0.087	0.094	0.100	0.108	0.115	0.111	0.112	0.085	35
Brazil	0.056	0.060	0.062	0.064	0.066	0.067	0.067	0.069	0.072	0.077	0.083	0.080	0.101	0.089	0.072	36
Latvia	0.058	0.059	0.061	0.060	0.062	0.062	0.059	0.067	0.070	0.075	0.079	0.087	0.081	0.083	0.069	37
Turkey	0.042	0.046	0.050	0.053	0.055	0.057	0.060	0.065	0.074	0.078	0.084	0.091	0.101	0.095	0.068	38
Serbia	0.040	0.044	0.046	0.047	0.051	0.058	0.061	0.062	0.069	0.073	0.079	0.080	0.091	0.084	0.063	39
Mexico	0.038	0.041	0.043	0.046	0.050	0.055	0.060	0.065	0.067	0.069	0.070	0.073	0.082	0.076	0.060	40
India	0.041	0.045	0.047	0.050	0.052	0.053	0.055	0.061	0.066	0.071	0.075	0.065	0.080	0.071	0.059	41
Thailand	0.023	0.027	0.033	0.039	0.045	0.047	0.056	0.062	0.069	0.074	0.082	0.080	0.095	0.085	0.058	42
Argentina	0.042	0.045	0.047	0.050	0.051	0.054	0.056	0.059	0.057	0.057	0.058	0.061	0.074	0.064	0.055	43
South Africa	0.027	0.030	0.032	0.036	0.037	0.040	0.042	0.047	0.054	0.058	0.061	0.060	0.068	0.063	0.047	44
Uruguay	0.028	0.028	0.035	0.036	0.039	0.039	0.041	0.043	0.045	0.043	0.046	0.049	0.056	0.049	0.041	45
Chile	0.025	0.027	0.029	0.029	0.032	0.034	0.036	0.038	0.041	0.044	0.048	0.046	0.056	0.049	0.038	46
Indonesia	0.021	0.023	0.024	0.025	0.026	0.027	0.028	0.033	0.040	0.039	0.051	0.059	0.068	0.063	0.038	47
Philippines	0.022	0.019	0.027	0.030	0.032	0.038	0.038	0.038	0.042	0.044	0.047	0.048	0.051	0.048	0.037	48
Kazakhstan	0.015	0.019	0.024	0.028	0.031	0.031	0.031	0.032	0.040	0.043	0.045	0.044	0.051	0.048	0.034	49
Costa Rica	0.025	0.028	0.029	0.032	0.034	0.030	0.030	0.029	0.027	0.030	0.035	0.033	0.062	0.043	0.033	50
Montenegro	0.026	0.022	0.025	0.026	0.028	0.033	0.032	0.032	0.038	0.039	0.040	0.040	0.041	0.040	0.033	51
North Macedonia	0.014	0.012	0.018	0.019	0.026	0.029	0.033	0.033	0.040	0.042	0.046	0.043	0.049	0.047	0.032	52
Panama	0.011	0.011	0.012	0.012	0.014	0.017	0.018	0.022	0.023	0.023	0.021	0.022	0.023	0.021	0.018	53
Pakistan	0.001	0.001	0.002	0.004	0.007	0.010	0.014	0.016	0.017	0.021	0.025	0.025	0.027	0.027	0.014	54
El Salvador	0.003	0.003	0.006	0.008	0.008	0.010	0.015	0.017	0.009	0.013	0.016	0.012	0.021	0.016	0.011	55
均值	0.107	0.112	0.117	0.121	0.127	0.132	0.136	0.144	0.153	0.162	0.170	0.171	0.176	0.175	——	—

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In order to ensure the robustness of the results, this paper compares the feature importance of XGBoost and SHAP algorithms. The results show that among the top 10 features of feature importance of XGBoost and SHAP algorithms, the number of effective patents and talents in R&D fields rank in the top 2 in the same order, and four of the top 5 feature values are the same, so the prediction results are still valid, which shows the robustness of the empirical results of this study.

Table 5. Comparison of feature importance between XG Boost and SHAP algorithms

Rank	XGBoost model		SHAP model		Entropy method	
	Feature	Value	Feature	Value	Feature	Value
1	Patents in Force	0.276	Patents in Force	0.211	ICT Goods Exports	0.064
2	Researchers in R&D	0.276	Researchers in R&D	0.132	Patents in Force	0.062
3	Charges for the Use of Intellectual Property, Exports	0.169	Secure Internet Servers	0.088	Fixed Broadband Subscriptions	0.056
4	Domestic Final Consumption Expenditure	0.084	Charges for the Use of Intellectual Property, Exports	0.081	Secure Internet Servers	0.055
5	Total Merchandise Trade	0.070	Domestic Final Consumption Expenditure	0.070	Fixed Telephone Subscriptions	0.055
6	Secure Internet Servers	0.041	Digitally Deliverable Services Exports	0.051	Gross Domestic Expenditure on R&D as a Percentage of GDP	0.049
7	Charges for the Use of Intellectual Property, Imports	0.028	Total Merchandise Trade	0.051	Researchers in R&D	0.048
8	Gross Domestic Expenditure on R&D as a Percentage of GDP	0.026	ICT Goods Imports	0.048	Total Merchandise Trade	0.048
9	Global Cybersecurity Index	0.019	Gross Domestic Expenditure on R&D as a Percentage of GDP	0.042	ICT Goods Imports	0.048
10	International Internet Bandwidth per Internet User	0.016	ICT Goods Exports	0.041	Scientific and Technical Journal Articles	0.048

Supplementary Files

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