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RESEARCH ARTICLE

The Role of Digital Economy in Shaping Economic Growth in Belt and Road Initiative Countries

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Abstract
Global trade dynamics have been re-shaped by the rapid development of digital technologies, but the role played by these changes in economic growth in countries is poorly understood. The study considers 149 developing countries that are engaged in the Belt and Road Initiative to explore the relationship between the digital economy, international trade and economic growth. Using data between the years 2000 and 2024 and dynamic panel models, results demonstrate that international trade helps the growth of economic growth significantly while the overall digital economy has a negative impact, which may indicate existing digital infrastructure is a barrier. The interplay between trade and the digital economy drives the need for policies that unite both trade and the digital initiative approach. The study suggests that digital capabilities must be improved in the sample countries for the maximum trade benefits to be generated and for growth to be stimulated. Policymakers should look into improving digital infrastructure and digital literacy in order to make international trade more efficient and facilitate higher economic growth.

Keywords: Digital economy; international trade; economic growth

Introduction

Raising economic growth has been placed at the center of many countries in the world (Bei, 2018; Zhang et al., 2022; Luo et al., 2024). This concept also emphasizes on the integration of technological innovations in addition to openness and coordinated development (Dai et al., 2025; Pan et al., 2021; Zhou et al., 2020). The speed up of the global economy highlights the importance of identifying radical drivers that can be effective for increasing growth. In this era of fast technology development, digitalization has become one of the major forces, changing the conventional economic system and promoting the adjustment of the structure for sustainable long-term growth. The digital economy has taken over a fast-growing set of industries, such as digital infrastructure, internet-based services, digital platforms, digital finance, and ICTs (Zhang & Zhao, 2024). By introducing broadband internet and mobile networks as well as digitized business processes, digitalization has been able to significantly improve efficiency and productivity. These technologies have revolutionized many industries such as finance, manufacturing, and logistics, as they have allowed businesses to optimize their operations, reduce costs and access global markets (Li et al., 2017; 2020). The evidence shows that digital tools change the traditional economy resulting in higher growth. Theories of what a healthy digital economy implies is that it spurs new innovations,

aligns the asymmetries of information, disseminates knowledge, and new business models (Huang et al., 2023; Razzaq et al., 2023). Digitalization is also a key driver for the spread of technology so that small and medium sized enterprises can be included in global value chains and economies can be diversified. These processes are essential for growth (Dai, 2025) and they are only possible through the transformation of the traditional paradigms. Advanced economies have invested in the digitized infrastructure extensively to realize higher growth rates whereas, in comparison, developing countries, due to affordability issues, face complications in adopting digital technologies in trade and economic activities and, as such, are left behind creating a digital divide for greater growth opportunities. The international trade has been a core pillar of economic growth, allowing exchange between countries of whatever goods and services globally (Rodriguez & Rodrik, 2000). In today's digital era, however, digital technologies and infrastructure are key to competing in the trade arena and without these assets, trade will never be effective. Thus, the inclusion of digital platforms and online services in trade presents new problems for developing countries (particularly those without affordability). There is a weak understanding of how Belt and Road Initiative (BRI) countries can use digital technologies to hasten growth through international trade. Studying the extent of business digitalization in these economies is important in terms of promoting such trade and boosting growth. Many studies have analyzed the trade-growth relationship, but very few have considered the influence of digital infrastructure, which has become the main part of trade transactions. While some research has examined the impact of the digital economy on growth, often it has used one single proxy. Digitalization has different components and those are digital access, usage, and skills which are essential to enabling trade and economic activity. This work is addressing this gap by examining how digital access, use and skills and the digital economy in general affect growth considering the implications for international trade in BRI developing economies. The findings offer policy recommendations for BRI economies to grow to reap the benefit of digital tools to boost global trade and economic growth. This paper is structured as follows: part 2 is methodology, part 3 is results and discussions and part 5 is discussion and policy suggestions.

Methodology

Data and empirical models

Taking economic growth as the dependent variable, we focus on the impact of digital economy indicators (digital access, digital usage and digital skills) on growth, when international trade is incorporated. We are also looking at the trade-X interaction with these digital factors and examine the contribution of each factor to growth. The interaction effects are analysed for 149 countries that are part of the Belt and Road initiative between 2000 and 2024. Data is derived from known databases such as the World Development Indicators and World governance indicators. We make four regression equations to explore deep relationship between digital factors, trade and economic growth. Many previous studies have used various indicators to proxy the digital economy, but none has divided the digital economy into digital access, digital usage and digital skills as we do. Chen and Xing (2025) also incorporated measures of digital economy, but they have different indicators and have not split the categories, digital access, use and skills. Equation 1 shows the impact of these three categories of digital as well as trade on GDP growth, which can be used to component-wise measure the contribution of the digital economy.

$$GDP_{it} = \beta_0 + \beta_1 GDP_{it-1} + \beta_2 TRD_{it} + \beta_3 Digacc_{it} + \beta_4 Digusg_{it} + \beta_5 Digsk_{it} + \beta_6 CTR_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots (1$$

In equation 1, GDP is the economic growth, TRD is the trade, Digacc is the digital access, Digusg is the digital usage and Digsk is the digital skills. CTR represents control variables which consist of financial development, consumer price index, foreign direct investment, exchange rate, population, government expenditure, labor force

and fixed capital formation. eit is the error term. Equation 2 expands equation 1 by adding interaction terms between trade and one of each of the digital indicators. These interactions - Digacc x TRD, Digusg x TRD and Digsk x TRD, are represented by INT1, INT2 and INT3, respectively.

$$GDP_{it} = \beta_0 + \beta_1 GDP_{it-1} + \beta_2 TRD_{it} + \beta_3 Digall_{it} + \beta_4 CTR_{it} + \beta_5(INT1) + \beta_6(INT2) + \beta_7(INT3) + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots (2$$

Equation3 aggregates the digital economy into one index (Digall) whilst retaining the structure of equation1. Equation 4 includes the aggregate digital index and its interaction with trade (INT4).

$$GDP_{it} = \beta_0 + \beta_1 GDP_{it-1} + \beta_2 TRD_{it} + \beta_3 Digall_{it} + \beta_4 CTR_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots (3$$

$$GDP_{it} = \beta_0 + \beta_1 GDP_{it-1} + \beta_2 TRD_{it} + \beta_3 Digall_{it} + \beta_4 CTR_{it} + \beta_5(INT4) + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots (4$$

Variables explanation

GDP per capita is used as a measure of growth and trade as a percentage of GDP. The digital economy is summed up by three indicators: Digital access proxied as fixed telephone subscriptions/100 inhabitants, mobile cellular subscriptions/100 inhabitants, Secure Internet servers/million people. Digital usage is the percentage of people using the internet and fixed broadband subscriptions per 100 inhabitants while digital skills is taken as the duration compulsory education. Control variables include financial development measured as domestic credit to private sector as income percent of GDP, Consumer price index, Foreign direct investment net inflow % of GDP, Exchange rate which is measured as official rate as it is set by national authorities. Population growth taken as annual percentage increase in population, Government expenditure taken as expenditure on education as a percent of GDP, Labor force measured as the overall workforce and Fixed capital formation % of GDP. Table 1 summarizes descriptions of the variables. Table of correlations is shown in Table 2 and Figure 1 effects of each variable on economic growth.

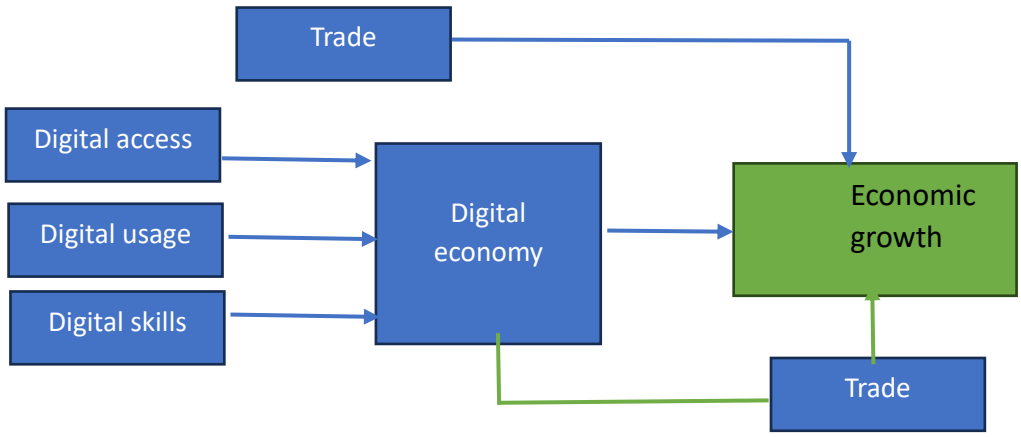

Figure 1: The effect of digital economy on economic growth via trade

Econometric Models

To examine how nexus factors between economic growth, trade, and digital economy in this research uses static and dynamic panel models. The static models include Ordinary Least Squares (OLS) and Fixed Effect Estimators

and the dynamic model employed is the Two Step Generalized Method of Moments (GMM). The OLS estimator is a preliminary estimator to give a foundation knowledge of the variable relationships and is known for its efficiency in providing estimates of linear relationships (Wooldridge, 2010). Controlling for unobserved heterogeneity across countries, the study further uses a fixed effect regression model to control for time and invariant characteristics. This model separates the influence of independent variables on economic growth. In the case of panel data analysis, a fixed effect model is regarded as useful in addressing individual-specific traits that can possibly cause biased OLS estimates (Baltagi, 2005). Consequently, the difference GMM and the two-step system GMM are respectively deployed in order to overcome the problem of endogeneity, in this study. The difference GMM controls unobserved effects by data transformation while the two step system GMM deals with the equation in level and difference level resulting in efficient estimation (Arellano & Bover, 1995). The importance of this method is in the presence of dynamic panel data and lagged dependent variables (Blundell & Bond, 1998). By using the above methods, the research proves its results and states the validity of the results as well as reducing the biases caused by omitted variables and errors in the analysis. These methods have been also supported by the prior studies of e.g. Roodman (2009) which emphasizes the effectiveness of the GMM estimator when analyzing the panel data.

Table 1. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
GDP	1.067	1.017	-5.932	4.013
TRD	4.357	.509	0.792	5.080
FTS	1.693	1.657	-6.570	5.144
MCS	3.608	1.785	-4.035	4.399
SIS	3.743	3.1348	-3.907	10.484
ITU	2.504	1.708	-8.148	5.605
FBBS	-.0005	2.743	-10.79	4.819
CED	2.179	0.270	1.386	2.833
FD	3.275	1.33	-6.429	5.539
CPI	4.663	0.568	1.067	10.56
FDI	1.013	1.319	-6.684	6.107
EXR	3.266	2.823	-3.112	22.62
POP	0.317	0.978	-5.490	2.963
GOVEXP	1.367	0.438	-2.062	2.808
LBF	14.99	1.640	10.49	20.47
FCF	3.059	0.378	-.1615	4.356

Table 2. Correlation

	GDP	TRD	FTS	MCS	SIS	ITU	FBBS	CED	FDPVT	CPI	FDI	EXR	POP	GOVEXP	LBF	FCF
GDP	1.000															
TRD	0.010	1.000														
FTS	-0.042	0.308	1.000													
MCS	-0.033	0.404	0.625	1.000												
SIS	-0.078	0.537	0.658	0.661	1.000											
ITU	-0.048	0.479	0.774	0.750	0.846	1.000										
FBBS	-0.014	0.474	0.864	0.668	0.803	0.869	1.000									
CED	0.027	-0.119	0.324	0.252	0.214	0.319	0.312	1.000								
FDPVT	0.033	0.352	0.693	0.555	0.632	0.646	0.746	0.135	1.000							
CPI	-0.110	-0.191	-0.21	-0.007	0.111	0.054	-0.029	0.022	-0.225	1.000						
FDI	0.024	0.571	0.226	0.201	0.239	0.173	0.183	0.009	0.129	-0.15	1.000					
EXR	0.061	-0.402	-0.41	-0.339	-0.412	-0.41	-0.373	-0.204	-0.322	0.255	-0.214	1.000				
POP	0.040	-0.196	-0.54	-0.415	-0.509	-0.52	-0.590	-0.147	-0.411	0.059	0.017	0.344	1.000			
GOVEXP	-0.043	0.255	0.276	0.250	0.217	0.306	0.216	0.315	0.189	-0.08	0.128	-0.276	-0.126	1.000		
LBF	0.168	-0.509	-0.05	0.033	-0.119	-0.04	0.049	-0.092	0.144	0.201	-0.396	0.313	-0.028	-0.232	1.000	
FCF	0.22	0.048	-0.06	0.033	-0.055	-0.00	0.009	-0.194	0.114	0.107	0.046	0.130	0.103	-0.012	0.174	1.000

Results and discussions

Table 3 shows the results of the impact of international trade and the digital economy on economic growth. Column 1 contains variables, column 2 are the results of the two-step system GMM model using the digital economy indicators and column 3 the results of the same model but using the digital economy index as a variable. In both of the models social and economic development, we have a positive and significant coefficient of international trade, which mean that international trade has positive effect in economic growth. Prior studies also find that trade leads to growth, by stimulating market access, technology transfer and competition. These results support that trade is a strong contributor to economic growth. The digital economy index produces negative and significant coefficients, suggesting there may be costs and inefficiencies in traditional sectors associated with digital economy growth in the sample countries, and that they can impede economic growth. Digital economic expansion could entail structural transformations or inequalities and workforce adjustment of countries might be problematical resulting in negative effects on growth at least in the short run. The results suggest that countries should focus on developing digital tools and infrastructure for facilitating trade and growth. The individual indicator, digital access, also has a negative impact on economic growth, showing that the more efficient access to digital technologies can be, the more economic activities and opportunities can be increased. However, inequalities of access potentially minimize the total benefits of technology to growth. Chen & Xing (2025), Van Deursen & Van Dijk (2019) point out that while digital tools reshape the economic landscape and provide bridges for development disparities between countries and regions and encourage inclusiveness, unequal access to these technologies may still limit growth. Digital usage coefficients are also negative but significant and show that high expectations of digital platforms can result in lower productivity in physical, erode the traditional economic activities of people and increase risks such as digital addiction such that short-term performance is hampered. Conversely, digital skills do have a positive impact on growth, as a skilled workforce stimulates innovation, productivity and competitiveness. Proficient workers use modern technology to enhance efficiency, to build high-

value jobs and to drive deeper engagement in global markets, as direct contributors to GDP growth (Brynjolfsson & McAfee, 2023).

Table 3: Digital access, digital usage and digital skill nexus with trade and GDP

Variables	(Sys. GMM)	(Sys. GMM)
TRD	0.008***	0.008***
	(0.000)	(0.000)
DigDx		-0.480***
		(0.003)
DIGACC	-0.065***	
	(0.014)	
DIGUSG	-0.458***	
	(0.008)	
DIGSK	0.031***	
	(0.004)	
FD	-0.012***	-0.0131***
	(0.000)	(0.000)
CPI	-0.014***	-0.014***
	(0.0002)	(0.000)
FDI	0.011***	0.011***
	(0.001)	(0.000)
EXR	0.0001***	0.0001***
	(0.0001)	(0.0001)
POP	-0.683***	-0.672***
	(0.030)	(0.007)
GOVEXP	-0.191***	-0.184***
	(0.019)	(0.003)
LBF	0.0001***	0.0001***
	(0.0001)	(0.0001)
FCF	0.0871***	0.085***
	(0.002)	(0.000)
L.GDP	0.249***	0.250***
	(0.0007)	(0.000)
Constant	2.301***	2.504***
	(0.0721)	(0.0353)
Observations	911	911
R-squared		
Number of id	105	105
AR1	3.55(0.010)	-3.21(0.001)
AR2	0.49(0.621)	-0.68(0.499)
Sargan test	1295.03(0.000)	1140.18(0.000)

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Among them, financial development demonstrates a negative significant effect on growth with Belt and Road Initiative countries. Excessive development in the financial area can lead to instability, inefficiencies and pressures of inflation. Another act the knocked up the effects, the consumer price index, also having a negative

impact on growth, with high inflation leading to uncertainty, which reduce investment, and consumer, as well as erosive, the purchasing powers of household, reducing overall growth.

Table 4. Interaction effect of digital economy indices and international trade

Variables	Sys. GMM	Sys. GMM
TRD	0.028***	0.015***
	(0.001)	(0.000)
Digdx		-0.000***
		(0.000)
DIGACC	-0.296***	
	(0.039)	
DIGUSG	-0.393***	
	(0.012)	
DIGSK	0.157***	
	(0.009)	
FD	-0.009***	-0.019***
	(0.000)	(0.0002)
CPI	-0.013***	-0.014***
	(0.0003)	(0.000)
FDI	0.011***	0.011***
	(0.000)	(0.000)
EXR	0.0001***	0.000***
	(0.0001)	(0.0001)
POP	-0.487***	-0.924***
	(0.0277)	(0.005)
GOVEXP	-0.194***	-0.161***
	(0.0143)	(0.002)
LBF	0.0001***	0.0001***
	(0.0001)	(0.0001)
FCF	0.094***	0.090***
	(0.00)	(0.001)
DigDx*TRD		-0.008***
		(0.0001)
DIGACC*TRD	0.000	
	(0.0005)	
DIGUS*TRD	-0.0005**	
	(0.0002)	
DIGSK*TRD	-0.001***	
	(0.0001)	
L.GDP	0.247***	0.252***
	(0.000)	(0.000)
Constant	0.0001***	2.364***
	(0.0001)	(0.034)
Observations	911	911
R-squared		
Number of ID	105	105
AR1	-3.21(0.001)	-3.23(0.001)
AR2	-0.69(0.491)	-0.68(0.498)
Sargan test	1138.1(0.000)	1132.0(0.000)

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The positive and statistically significant impact of FDI on growth is in line with existing literature in that it is these elements of foreign investment - capital, technology, managerial expertise - boost domestic productivity and generate jobs to boost the economy in the long term. Other control variables have a positive impact on FDI Exchange rate Labor Force Fixed formation Population Government expenditure Financial Development has a negative impact on growth.

The finding in Table 4 is very similar to the one in Table 3, except that the interaction terms between digital economy index and international trade are negative and significant. These results show that this positive effect of trade on growth is reduced when the index of the digital economy is higher. A rise in digital economy may have decreased the impact of the trade to the growth through possible reason of digital challenge or inefficiency of the trade cannot overcome. Likewise, the interaction between digital access and trade does not give any considerable results, thus indicating that trade and growth are not also greatly impacted by digital accessibility levels. However, digital use and trade have large negative coefficients. As the use of digital rises, the positive correlation between trade and growth declines, perhaps because the markets are saturated or the resources are inefficiently allocated. Digital skills and trade interactions also demonstrate negative significance so that as digital skills increase, the positive relationship between trade and growth decreases because the digital economy sucks up economic activity, lessening the dependence on traditional trade mechanisms.

Conclusion

Considering 149 developing countries that are a part of the Belt and Road Initiative, this study does look at the associations between digital economy, international trade, and economic growth. Using data coming from 2000-2024 and dynamic panel models, the results show that international trade is a positive and significant contributor to economic growth. In contrast, there is a negative effect for the overall digital economy, which implies that the current digital infrastructure is perhaps a barrier. The nexus between trade and the digital economy puts into perspective the need for policies that bring both trade and digital initiatives together. International trade is also significantly and positively correlated to growth in GDP in all models, strengthening the argument that trade contributes to economic development. However, the digital economy index (DIGDX) shows a surprising negative correlation to GDP growth. This means there is a lack of expected economic benefits from growing digital resources and infrastructure. These results suggest that existing digital frameworks are underused or inadequately integrated into the economy of these countries and are limiting the full potential of trade. Additionally, there are nuanced dynamics between the digital index and trade. For example, digital skills have a positive impact on economic growth in combination with international trade. This highlights the importance of human capital in using digital tools to stimulate development. Without adequate digital skills, the gains from trade may not be fully achieved, representing a high demand for initiatives that enhance digital literacy and capabilities. Based on these findings, we recommend a number of actionable policy steps to look more integrated digital-trade approach: * Governments should invest heavily on digital infrastructure, particularly in rural and underserved regions to provide equal access to digital resources necessary for participation in the global economy. * Expand digital literacy programs across all ages in partnership with institutions of educational technology. * Form public-private partnerships to ensure that training is aligned with labor-market needs to ensure that workers acquire the skills needed to succeed in the digital economy. * Develop and implement regulatory frameworks, which encourage e-Commerce and digital trade while easing cross-border regulations and ensuring data security to establish trust between businesses and consumers. * Incorporate trade policies with digital economies impetus, helping small and medium-sized enterprises to leverage the use of digital trade platforms to enter international markets and enhance competitiveness. * Incentivize research and development in digital technologies that help boost trade efficiency and promote innovation to help countries adapt to the changing global business environment. While

this study provides some nice insights, it does have some limitations that should be noted as well. Relying on aggregate data may conceal differences among individual countries, particularly in regard to local digitalization efforts and how well they work. Even in the long run it is impossible to fully capture the effects of fast technological change, or the effect of policy changes. Future research should use more nuanced analyses, potentially with either specific countries or regions in the Belt and Road Initiative in order to uncover local dynamics that influence the impact of the digital economy on trade and growth. Longitudinal studies should try to investigate the causality between digital economy factors and economic growth, which could also involve qualitative methods to build up quantitative findings. Investigating new technologies such as artificial intelligence and blockchain - and the interaction of the two with trade policy - can help deliver more insights into how to optimize the digital economy's contribution to development. Expanding the sample to include non-Belt and Road countries would allow the comparative values to be analyzed and pinpoint the role of different contexts in shaping the relation among digitalization, trade, and growth. In summary, this study underscores that it is important to align digital strategies and policies with trade policies if the goal is to foster economic growth. By addressing the identified challenges, policymakers can better capitalize on the potential of the digital economy and pave the way towards sustainable development. The insights gained from this research, however, can provide a wealth of information not only for academic discussions, but also offer a practical roadmap guide for policymakers as they navigate the complex digital landscape of an increasingly interconnected world.

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