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Digitalisation Impact on E-Commerce in Kazakhstan: Macroeconomic Effects and Forecast

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ABSTRACT

Today, digital transformation has a significant impact on the structure of trade, consumer behaviour and macroeconomic indicators, especially in developing countries. This study aims to assess the impact of digitalisation on the development of electronic commerce in Kazakhstan and its relationship with macroeconomic indicators, as well as to predict the dynamics of e-commerce using regression and time analysis. The official statistical data of the Bureau of National Statistics of the Republic of Kazakhstan, the National Bank, as well as international organisations (the World Bank, ITU) were used as source data. The research methodology includes descriptive statistics, correlation and multiple regression analysis in SPSS, as well as forecasting the volume of electronic commerce using the ARIMA. The results showed a high correlation between the volume of e-commerce and the level of Internet penetration ($r = 0.83$), the number of users ($r = 0.85$), as well as the volume of cross-border trade ($r = 0.95$). Multiple regression showed that e-commerce in the service sector ($\beta = 0.707$, $p < 0.001$) and the share of e-commerce in the retail structure ($\beta = 0.347$, $p = 0.003$) had the most significant impact. The results of the study emphasise the need to review the marketing strategies of enterprises, develop digital infrastructure and improve government policy in the field of cross-border electronic commerce. In future work, it is advisable to use microdata to include behavioural factors, as well as expand time series and apply nonlinear models, including structural shifts, to analyse the impact of digitalisation on trade more accurately.

KEYWORDS: Economy, Digital Economy, Marketing, Marketing Strategy, E-commerce, Cross-Border Trade, Macroeconomic Effect

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Влияние цифровизации на электронную коммерцию в Казахстане: макроэкономические эффекты и прогноз

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АННОТАЦИЯ

Сегодня цифровая трансформация оказывает огромное влияние на структуру торговли, потребительское поведение и макроэкономические показатели, особенно в развивающихся странах. Настоящее исследование направлено на оценку уровня влияния цифровизации на развитие электронной торговли в Казахстане и ее взаимосвязь с макроэкономическими показателями, а также спрогнозировать динамику e-commerce с использованием регрессионного и временного анализа. В качестве исходных данных использовались официальные статистические сведения Бюро национальной статистики РК, Национального банка, а также международных организаций (Всемирный банк, МСЭ). Методология исследования включает описательную статистику, корреляционный и множественный регрессионный анализ в SPSS, а также прогнозирование объема электронной торговли с применением модели ARIMA. Полученные результаты показали наличие высокой корреляции между объемами e-commerce и уровнем интернет-проникновения (r = 0.83), числом пользователей (r = 0.85), а также объемами трансграничной торговли (r = 0.95). Множественная регрессия показала, что наибольшее влияние оказывают показатели e-commerce в сфере услуг (β = 0.707, p <0.001) и доля электронной торговли в розничной структуре (β = 0.347, p = 0.003). Результаты исследования подчеркивают необходимость пересмотра маркетинговых стратегий предприятий, развития цифровой инфраструктуры и совершенствования государственной политики в сфере трансграничной электронной торговли. В будущих работах целесообразно использовать микроданные для включения поведенческих факторов, а также расширить временные ряды и применить нелинейные модели, включая структурные сдвиги, для более точного анализа влияния цифровизации на торговлю.

КЛЮЧЕВЫЕ СЛОВА: экономика, цифровая экономика, маркетинг, маркетинговая стратегия, электронная коммерция, трансграничная торговля, макроэкономический эффект

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INTRODUCTION

The digital transformation of global trade has a significant impact on market structure, business models and consumer behaviour. E-commerce, digital marketing and mobile platforms are becoming integral elements of corporate competitiveness and sustainable development of national economies. According to UNCTAD (2021), in the context of post-pandemic recovery, e-commerce has become one of the fastest-growing segments of the global economy, providing not only access to goods and services but also the development of cross-border interactions.

Kazakhstan demonstrates stable positive dynamics in the field of e-commerce. The volume of e-commerce in the country has grown from 28 billion tenge in 2013 to more than 2.4 trillion tenge in 2023 (Bureau of National Statistics, 2024). Active development of online shopping, payment and logistics infrastructure, as well as government initiatives within the framework of the Digital Kazakhstan program, creates conditions for further growth. At the same time, cross-border consumer activity is noticeably increasing, which reflects Kazakhstan's inclusion in global digital flows.

However, despite the positive trends, a number of problems remain in the country. These include the limited participation of small and medium-sized enterprises in digital turnover, insufficient integration of information systems between domestic and international platforms, fragmentation of marketing strategies and weak analytical support for e-commerce solutions. While countries with high digital maturity have already moved to the stage of predictive analytics and omnichannel marketing, Kazakhstan is only continuing to adapt to the basic requirements of the digital economy. According to Netpeak, the Kazakhstani digital advertising market is actively growing, with targeted advertising on social networks and search marketing remaining the key channels. However, the share in the development of software technologies and automated strategies remains lower than in Eastern European countries. This indicates the continuing potential for growth and the need for technological development on the part of businesses. In the international literature, we observe the importance of digital transformation as a driver of change in marketing models, consumer engagement, and business performance (Alarcón-del-Amo et al., 2021; Cheng & Zhao, 2023; Tran et al., 2024). However, in the context of Kazakhstan, there is still a lack of quantitative research, particularly in terms of statistical analysis of long-term trends and forecast modelling. Most of the existing works are either descriptive or based on case studies, which creates a scientific void that needs to be filled.

Given the growing role of digital technologies in the transformation of trade processes, as well as the limited quantitative research based on official statistics and predictive models in the Kazakh context, there is a need for a comprehensive analysis of trade digitalisation based on empirical data. Despite the availability of descriptive and review papers, the Kazakh research field still lacks an analysis of e-commerce based on a comparison of macroeconomic and digital indicators using statistical and time models. The novelty of this study lies in the empirical substantiation of the relationship between digital factors and e-commerce volumes, and the construction of a short-term forecast based on ARIMA modelling. In this regard, the following research objective is to assess the impact of digitalisation on the development of electronic commerce in Kazakhstan and its relationship with macroeconomic indicators, as well as to predict the dynamics of e-commerce using regression and time analysis.

LITERATURE REVIEW

Despite the wide range of studies devoted to digital trade and digital marketing, there remain significant gaps in the scientific literature in the context of developing countries, especially Central Asia and Kazakhstan. Most of the existing works focus on countries with high digital maturity (USA, China, EU), while studies in the post-Soviet space are fragmented and descriptive. In particular, the impact of digitalisation on trade structure and cross-border consumer activity in the context of developing infrastructure, typical for Kazakhstan, remains insufficiently studied. In addition, only a limited number of empirical works use quantitative analysis methods (SPSS, regression, forecasting) to identify sustainable trends and build applied models, which creates a justified need for an in-depth analysis of e-commerce in Kazakhstan, comparable with international practices.

The digitalisation of trade in developing countries is actively studied from the standpoint of the impact on business sustainability, changes in marketing models and consumer engagement. Tran et al. (2024) present a systematic analysis of 32 empirical studies on digital marketing in community-based enterprises (CBEs). The authors found that the technology acceptance model and consumer behaviour theory were most often used as theoretical frameworks, and social media and websites were the primary digital tools. According to their findings,

digital marketing has a positive effect on customer satisfaction, entrepreneurial skills development, and business results.

Similar results are presented by Alarcón-del-Amo et al. (2021). Using the example of Latin America, it is proven that the use of digital marketing strategies contributes to the market efficiency of small and medium-sized enterprises. Using regression analysis in SPSS, the authors found that social media marketing, content and analytics have a positive impact on consumer engagement and increase sales. An interesting parallel can be drawn with the study by Mothobi and Grzybowski (2020), which analyses the impact of mobile financial technologies on the development of trade in countries with low infrastructure. The authors show that the development and implementation of digital solutions reduce barriers to market entry for small businesses and contribute to increased participation in e-commerce.

This picture is complemented by the work of Cheng and Zhao (2023), based on the analysis of Chinese companies listed on the A-share exchange in 2012–2022. The authors prove that digital transformation stimulates the transition to innovative marketing models, which is especially characteristic of large private and labour-intensive enterprises. The mechanisms of transformation include investments in technological innovations and human capital development, and the practical significance lies in the adaptation of marketing strategies to the conditions of the digital economy.

International organisations also contribute to understanding digital change. According to UNCTAD (2021), the COVID-19 pandemic has accelerated the shift to e-commerce in developing countries. OECD (2020) studies highlight the need for reliable statistics on digital processes. ITC (2019) and EDB (2021) studies focus on SMEs and cross-border trade as key drivers of digital economy growth. According to ITF (2019), in developing countries, cross-border trade growth is limited by poor logistics infrastructure, outdated customs procedures, and the lack of unified digital solutions. These problems are also typical for Kazakhstan, where logistics often becomes a bottleneck in the development of e-commerce, especially in the cross-border segment.

Studies of digitalisation of trade are increasingly focused not only on economic effects, but also on changing consumer behaviour in the online environment. Particular attention is paid to research on the use of TAM models (Technology Acceptance Model) and UTAUT (Unified Theory of Acceptance and USE of Technology) to analyse the motivation, trust and loyalty of online buyers (Davis, 1989; Venkatesh et al., 2003). The study of Davis (1989) laid the basis for the formation of behavioural technology adoption models, including TAM2, UTAUT and UTAUT2, which continue to be used to evaluate digital involvement in e-commerce (Venkatesh et al., 2003; Valdivino et al., 2025). Model UTAUT remains one of the fundamental approaches to the analysis of digital behaviour, its effectiveness is confirmed in modern studies, such as in the Latin American context, which explains the influence of infrastructure and behavioural factors on the adoption of e-commerce during the pandemic (Venkatesh et al., 2003).

The technology adoption model developed by Davis (1989) (TAM, Technology Acceptance Model) is one of the key theoretical foundations of the analysis of digital consumer behaviour. According to the Technology Acceptance Model, the user's readiness to accept the technology is determined by two main factors: perceived usefulness and perceived ease of use. Later, this model was expanded as part of a unified theory of adoption and use of technology (UTAUT) proposed by Venkatesh et al. (2003), which includes additional variables such as social influence, efforts, conditions of relief and behavioural intention.

Along with this, research in the field of platform analytics and Digital Marketing is relevant, including strategic use of advertising on social networks and search promotion (Chaffey & Ellis-Chadwick, 2019; Tiago & Veríssimo, 2014). Järvinen and Karjaluoto (2015) analyzed the use of Web analytics in assessing the effectiveness of digital marketing in the B2B sector. The authors conclude that even with technological solutions, the organisational ability to interpret the data and use it in making management decisions plays a key role. Despite the value of the article for understanding the role of analytics, it has limited applicability in the context of countries with developing digital infrastructures, such as Kazakhstan, where access to aggregated platform analytics is limited, and the level of digital maturity of the business is still heterogeneous. In addition, the study focuses only on large organisations, which limits its relevance for the analysis of e-commerce and Digital Marketing among the SME segment.

In the context of Kazakhstan, the work of Khishauyeva (2024) deserves attention, which presents key indicators of electronic trade in Kazakhstan for 2018–2022. A SWOT analysis was carried out, and a primary regression assessment was conducted. Despite the methodological restrictions, for example, the use of only Excel, the absence of behavioural factors and control variables, the article emphasises the growth of electronic trade and offers directions for the development of the sector. Further conclu-

sions require a deeper quantitative and behavioural analysis using complex research models and international comparison (Khishauyeva, 2024). Also, in the context of Kazakhstan, Malenko, Semenikhin, and Semenikhina conducted a significant study that, using PEST and SWOT analysis, assessed the prospects and challenges of trade digitalisation in Kazakhstan, including infrastructural and institutional barriers (Malenko et al., 2023). However, the absence of quantitative models and consumer behaviour data in the study emphasises the need for our empirical analysis using regression and behavioural variables.

The work of Zhanbozova et al. (2024) is a meaningful analysis of the state of the electronic commerce market in Kazakhstan, based on official statistics and the regulatory framework. The authors distinguish key calls, including weak logistics infrastructure and insufficient digital literacy of the population. However, despite its informative value, the article remains predominantly descriptive and lacks empirical modelling or behavioural analysis. This limits the possibilities for identifying causal relationships. Nevertheless, it is helpful work as a background for further empirical studies, such as those presented in this article.

According to the reports of industry analysts, including RMAA Group, the digital advertising segment in Kazakhstan demonstrates a stable positive developmental dynamics. Thus, the expenses for digital advertising in the first quarter of 2024 increased by 35% compared to the same period last year, and its share in the total advertising market reached 46% (RMAA Group, 2024). This growth reflects the growing significance of the digital communication channels and strengthens the case for the inclusion of behavioural and marketing variables in the analysis model. Despite the lack of a full-time series by years, these data confirm the relevance and importance of assessing the influence of digital marketing tools on economic indicators within the framework of e-commerce.

Modern studies in the field of digital marketing distinguish a number of the following key tools that contribute to the growth of electronic trade, this is contextual advertising (Google ADS), targeted advertising on social networks (Instagram, TikTok), SEO (search engine optimisation), email marketing and retargeting. So in the works of Chaffey & Ellis-Chadwick (2019) and Ryan (2016), it is emphasised that successful e-commerce strategies are based on a combination of these tools, taking into account user behavioural analysis. Particularly important are personalisation technologies based on the analysis of big data (Big Data) and the recommendation algorithms that increase the conversion and level of the buyer's involvement. Thus, modern studies emphasise that big data processing technologies and personalised algorithms have become integral elements of digital marketing strategies, enabling businesses to adapt to changes in consumer behaviour and enhance conversion rates (Sheetal et al., 2023).

In the Kazakhstani academic field, research on e-commerce and digital marketing is limited. So, in the context of digitalisation of marketing and electronic trade, it should be noted that the provisions outlined in the monograph "Digital Technologies and Innovative Methods of Marketing" detail modern Internet process tools, including targeted advertising, SEO and virtual exhibitions (Davletova et al., 2023). Despite the predominantly theoretical approach and the lack of quantitative analysis, the work emphasises the transformation of communication strategies in the context of the digital economy of Kazakhstan.

The textbook "Marketing Technologies" examines modern digital promotion tools, including content marketing, email strategies and social networks (Kargabayeva, 2023). Despite the educational-methodical orientation, the material illustrates the adaptation of digital practices in Kazakhstani realities and can serve as the basis for the analysis of the marketing environment in the context of digitalisation of trade.

Despite the widespread use of these approaches in international practice, there is a lack of studies in the Kazakhstan context that systematise the use of digital marketing instruments by domestic companies. The lack of transparent analytics and the fragmentation of available data from the platforms create methodological restrictions, which require additional field research with the participation of representatives of e-commerce and digital marketing agencies.

A summary of key studies and their applicability to the study of electronic commerce in Kazakhstan is presented in Table 1.

The presented studies form a sound theoretical basis for analysing trade digitalisation in Kazakhstan, allowing national trends to be compared with global and regional practices. Therefore, based on the above, this study proposes the following hypotheses:

H1: There is a positive dependence between the level of Internet penetration among consumers and the growth of GDP per capita in Kazakhstan in 2013–2024.

Table 1. Synthesis of key sources on e-commerce and digital marketing

No.	Source	Object of analysis	Key findings
1	UNCTAD (2021)	E-commerce in developing countries	COVID-19 has become a catalyst for the growth of online trade, especially in the CIS countries
2	OECD (2020)	Digital transformation	The need for systems for assessing and monitoring the digital economy
3	ITC (2019)	SMEs in digital trade	Recommendations for the integration of SMEs into cross-border e-commerce
4	EDB (2023)	E-commerce in the EAEU countries	Barriers: logistics, incompatibility of systems, low integration
5	Cheng & Zhao (2023	Marketing Models and Transformation	Digital transformation enhances innovation in marketing and organizational design
6	Tran et al. (2024)	Digital tools in small businesses	Increased engagement through social media, personalization, and increased competencies
7	Alarcón-del-Amo et al. (2021)	Social networks and export	Digital Marketing Increases Export Activity of Companies
8	Mothobi & Grzybowski (2020)	Mobile technologies in trade	Mobile finance lowers entry barriers for SMEs
9	ITF (2019) – Transport Outlook	Logistics and cross-border infrastructure	Trade barriers are linked to outdated infrastructure and different customs regimes
10	Davis (1989)	TAM model	Technology adoption depends on perceived usefulness and ease of use
11	Venkatesh et al. (2003)	UTAUT model	Technology adoption is influenced by social influence, effort expectancy, and facilitating conditions
12	Valdivino et al. (2025)	UTAUT in Latin America	Behavioural and infrastructural factors shape e-commerce adoption during the pandemic
13	Chaffey & Ellis-Chadwick (2019)	Digital Marketing Tools	Combining SEO, email marketing, and personalisation improves e-commerce performance
14	Tiago & Veríssimo (2014)	Digital marketing strategy	Strategic use of digital tools improves competitiveness
15	Järvinen & Karjaluoto (2015)	Web analytics in B2B	Organisational ability to use data is key to digital marketing effectiveness
16	Khishauyeva Zh.T. (2024)	E-commerce in Kazakhstan	SWOT analysis, regression in Excel, highlights growth but lacks behavioral data
17	Malenko K.V et al., (2023)	Digital trade in Kazakhstan	PEST/SWOT identify barriers; lacks modelling and behavioural data
18	Zhanbozova A.B. et al., (2024)	Kazakhstan e-commerce market	Descriptive review; lacks quantitative and behavioral modelling
19	RMAA Group (2024)	Digital advertising in Kazakhstan	35% growth in Q1 2024, 46% market share; growing importance of digital channels
20	Ryan (2016)	Digital marketing fundamentals	Highlights core elements of digital strategy, including SEO, email, content marketing, and conversion funnels and etc.
21	Sheetal et al., 2023	Big data and personalisation in marketing	Big data technologies and recommendation algorithms increase personalisation, enhance conversion, and improve customer engagement in digital trade
22	Davletova M. et a (2023)	Digital marketing in Kazakhstan	Covers targeting, SEO, and virtual exhibitions; lacks quantitative analysis
23	Kargabayeva S. (2023)	Marketing tools in Kazakhstan	Content, email, and social media illustrate the adaptation of digital practices

Note: compiled by authors

H2: An increase in the number of Internet users and the level of digital penetration has a statistically significant impact on economic development, which is measured through GDP per capita in the conditions of digitalisation of trade in Kazakhstan.

MATERIALS AND METHODS

The empirical basis of this study is built on official statistical data published by the Bureau of National Statistics of the Agency for Strategic Planning and Reform of the Republic of Kazakhstan (2024), as well as data from the National Bank of the Republic of Kazakhstan (2024) on payment and cross-border Internet transaction systems. The analysis period covers 2013–2023. In addition, data on the number of Internet users, the level of Internet penetration in consumer behaviour and GDP per capita were collected from open international sources (World Bank, ITU). The data are presented in an aggregated annual format, which ensures comparability and simplifies the construction of time series models.

For the analysis, the following variables were selected: the volume of electronic trade in retail trade and the service sector (million tenge); the share of electronic trade in the structure of retail (%); the number and volumes of cross-border Internet transactions; Internet penetration (%), number of Internet users (million people); GDP per capita (USD).

Data processing and statistical analysis were performed using the IBM SPSS 30.0 and R software. At the first stage, descriptive statistics were used, including the calculation of the average value, standard deviation and ranges, which allowed to determine the dynamics of indicators and deviations by year. To determine the relationships between variables, a Pearson correlation analysis was conducted, with the coefficients interpreted at a significance level of $P < 0.01$, that made it possible to assess the strength of the associations between trade volumes, the share of e-commerce, and cross-border activity. At the second stage, a series of linear regression models was built, in which the calendar year was an independent variable, and key indicators of electronic trade were dependent.

The quality of the models was evaluated by the determination coefficient (R^2), standard error, F-statistics and p-values. To verify the adequacy of the obtained model, residual plots (ZRESID) and predicted values (ZPRED) were used. Additionally, a formal assessment of the regression assumptions was conducted, so the Breusch–Pagan test revealed no signs of heteroskedasticity ($BP = 3.30$, $p = 0.069$). The Jarque–Bera test confirmed the normality of the residuals ($JB = 0.74$, $p = 0.6899$), but the Durbin–Watson statistic ($DW = 0.52$, $p < 0.001$) indicated the presence of positive autocorrelation in the residuals, which limits the applicability of a simple linear approach. To eliminate these restrictions and increase the accuracy of the short-term forecast, the ARIMA (1.2.0) model for the variable "Electronic Trade in Retailing" was built. The model was automatically selected based on the minimum value of the Akaike Information Criterion (AIC), and it passed the residual diagnostics for stationarity and the absence of autocorrelation. Forecast values for 2025 and 2026, together with the 80% and 95% confidence intervals, are illustrated graphically.

This approach makes it possible to account for exponential dynamics and seasonality characteristic of digital markets. All data underwent preliminary processing, so missing values were removed using listwise deletion, the measurement scale (interval) was checked, and abnormal values were identified and verified by primary sources.

RESULTS

First, a descriptive analysis of the dynamics of electronic and cross-border trade in Kazakhstan for 2013–2023 was conducted. During the analysed period, the volume of electronic trade in the retail sector showed a sharp jump from 28.0 billion tenge in 2013 to 2.44 trillion tenge in 2023, which corresponds to an increase of more than 86 times. The average value for this indicator was 547.132 million tenge with a standard deviation of 840.284 million tenge, which indicates high volatility and the exponential nature of the growth of electronic commerce. Similar trends were observed in the services sector and cross-border transactions, with the volume of cross-border e-commerce increasing from 77 billion tenge to 1.77 trillion tenge, with an average annual growth rate exceeding 30% (Bureau of National Statistics, 2024; National Bank, 2024). The dynamics of these indicators is clearly shown in Figure 1.

The e-commerce market in Kazakhstan demonstrates notable dynamics and structural shifts, in the retail sector, the average electronic trading volume amounted to 764.6 billion tenge with a standard deviation of 1099.6 billion, which indicates high instability and exponential dynamics. A similar situathion is observed in the field of electronic services, with a standard deviation of 784.7 billion tenge, the mean value was 531.9 billion tenge. The share of electronic commerce in retail trade ranged from 0.5% to 14.1%, demonstrating accelerated growth, the mean value was 531.9 billion tenge. The average volume of cross-border transactions was 49.8 million units, was also differed in high variability. The descriptive statistics of key variables are presented in Table 2.

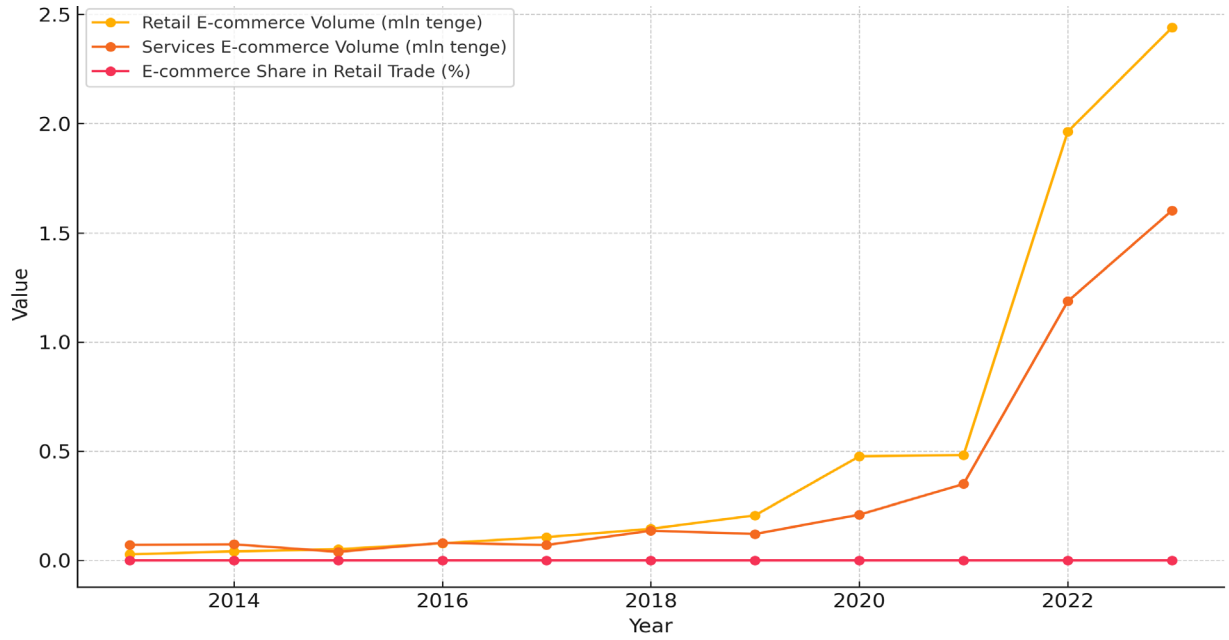

Figure 1. Development of e-commerce in Kazakhstan for 2013-2023

Table 2. Descriptive statistics of the dynamics of electronic and cross-border trade in Kazakhstan for 2013–2024

No.	Variable	N	Min	Max	Mean	Std. Deviation
1	Retail trade (million tenge)	12	28046	3156372	764569	1099651
2	Services (million tenge)	12	39156	2443353	531941	784704
3	Share of e-commerce (%)	12	0.50	14.1	4.53	5.3
4	Cross-border trade, the amount of million.	9	5.00	155	49.8	50.8

Note: calculated by the authors based on data from Bureau of National Statistics (2024)

Matrix of Pearson correlations for the main variables is presented in Table 3. The volume of electronic trading in the retail sector showed a high positive correlation with the volume of e-commerce in the service sector ($r = 0.991$, $p < 0.01$), the level of Internet penetration ($r = 0.834$, $p < 0.01$), as well as cross-border trade ($r = 0.946$, $p < 0.01$). These results confirm the close relationship between the development of digital infrastructure, consumer income and the growth of online trade.

Table 3. Matrix of Pearson correlations for key variables

No.	Variable	Pearson's r	Sig. (2-tailed)	N
1	E-commerce, services	0.991**	0.000	12
2	Internet penetration	0.834**	0.001	12
3	GDP per capita	0.607*	0.037	12
4	Share of e-commerce	0.983**	0.000	12
5	Cross-border trade	0.946**	0.000	9

Note:* $p < 0.05$, **$p < 0.01$; calculated by the authors based on data from Bureau of National Statistics (2024)

Source: calculated by the authors in SPSS based on data from the National Statistics Bureau of the Republic of Kazakhstan.

As shown in Table 4, the mean internet penetration rate was 85.06% (SD = 4.70) and the average number of internet users was 16.61 million. These values indicate the high digital accessibility, supporting the growth of e-commerce.

Table 4. Descriptive statistics of digital and economic measures

No.	Variable	Mean	Std. Deviation	N
1	Internet penetration, %	85.06	4.70	12
2	Internet users, million people.	16.61	0.94	12
3	GDP per capita, million tenge	10723	2128	12

Note: calculated by the authors based on data from Bureau of National Statistics (2024)

Table 5 shows statistically significant and strong positive correlations between the volume of e-commerce in the retail sector and Internet indicators: internet penetration ($r = 0.834$, $p < 0.001$), and with the number of Internet users, ($r = 0.849$, $p < 0.001$). In addition, the correlation between retail and service sector e-commerce is very high ($r = 0.991$, $p < 0.001$), indicating the parallel development. GDP per capita is also positively related to the volume of e-commerce ($r = 0.607$), but this correlation is moderate, although statistically significant ($p = 0.018$).

Table 5. Pearson correlation between retail e-commerce and related variables

No.	Variable 1	Variable 1	Pearson's r	p-value	Significance
1	Retail e-commerce	Internet penetration	0.834	0.000	**
2	Retail e-commerce	Internet users	0.849	0.000	**
3	Retail e-commerce	Services e-commerce	0.991	0.000	**
4	Retail e-commerce	Share of e-commerce	0.983	0.000	**
5	Retail e-commerce	GDP per capita	0.607	0.018	*

Note: ** $p < 0.01$, * $p < 0.05$; calculated by the authors based on data from Bureau of National Statistics (2024)

To assess the impact of economic and digital variables on retail e-commerce, a multiple linear regression model was constructed. The model has an excellent fit ($R = 1.000$; $R^2 = 0.999$; adjusted $R^2 = 0.999$), suggesting that 99.9% of the variability in e-commerce volume is explained by the included predictors. The Durbin–Watson statistic (2.532) may suggest negative autocorrelation in the residuals and requires further verification. To assess the overall significance of the linear regression model, an analysis of variance (ANOVA) was conducted. The obtained F-criterion value was 1792.30 ($p < 0.001$), which indicates a high statistical significance of the model. Thus, the included predictors collectively explain a significant share of the variance of the dependent variable, the volume of e-commerce in retail trade.

So, in the regression model, presented in Table 6, the two factors that contributed most to explaining the volume of retail e-commerce were the volume of e-commerce in the services sector ($\beta = 0.707$; $p < 0.001$) and the share of e-commerce in the retail structure ($\beta = 0.347$; $p = 0.003$). The remaining predictors, such as internet penetration, number of internet users, and GDP per capita were not statistically significant, possibly due to multicollinearity.

Table 6. Linear regression results for the retail e-commerce model

No.	Predictor	B	Std. Error	Beta	t	Sig.
1	Constant	212903.66	602513.66	-	0.353	0.736
2	Internet penetration (%)	176030.65	123294.70	0.753	1.428	0.203
3	Internet users (millions)	-916773.39	633129.62	-0.783	-1.448	0.198
4	E-commerce volume in services (mln. tg.)	0.991	0.131	0.707	7.570	0.000**
5	Share of e-commerce in retail (%)	72029.55	15388.79	0.347	4.681	0.003**
6	GDP per capita (mln. tg.)	-4.32	10.07	-0.008	-0.429	0.683

Note: $p < 0.05$**, significant at 5% level; calculated by the authors based on data from Bureau of National Statistics (2024)

Table 7 shows strong correlations between between internet penetration rates and the number of internet users (r = -0.999), and between the volume of e-commerce in services and the share of e-commerce in retail (r = -0.907) that indicate potential multicollinearity, which requires checking the robustness of the model using diagnostic tests.

Table 7. Correlation matrix between independent variables

No.	Variable	GDP per capita, mln. tg.	Internet penetration, %	Volume of e-commerce, mln. tg.	The Share of e-commerce in retail, %	Internet users, millions
1	GDP per capita, mln. tg.	1.000	-0.160	-0.406	0.095	0.194
2	Internet penetration, %	-0.160	1.000	0.890	-0.843	-0.999
3	Volume of e-commerce, mln. tg.	-0.406	0.890	1.000	-0.907	-0.898
4	The share of e-commerce in retail, %	0.095	-0.843	-0.907	1.000	0.830
5	Internet users, millions	0.194	-0.999	-0.898	0.830	1.000

Note: calculated by the authors based on data from Bureau of National Statistics (2024)

Residual diagnostics is presented in Table 8. The distribution of residuals confirms that the correspondence of the model to the premises of linear regression. The mean value of the residues is close to zero, the standard deviation is 28444. The range of standardized residues falls between –1.309 to 1.094, which confirms the normality and stability of error distribution. Cook's distances are below 1, suggesting that no individual observation exerts an undue influence on the model, which confirms the adequacy of the constructed regression model and the validity of its use in forecasting.

Table 8. Residual statistics of a linear regression model

No.	Indicator	Minimum	Maximum	Mean	Standard deviation	N
1	Predicted value	29 928.71	3158 783.75	764568.75	1 099 283.40	12
2	Residual	-50 419.26	42143.14	0.00	28 444.29	12
3	Standardized predicted	-0.668	2.178	0.000	1.000	12
4	Standardized residual	-1.309	1.094	0.000	0.739	12
5	Cook's distance	0.001	0.719	0.135	0.204	12

Note: dependent variable: e-commerce volume (retail trade), million tenge; calculated by the authors based on data from Bureau of National Statistics (2024)

Figures 2 and 3 confirm normality and homoskedasticity. So, Figure 2 demonstrates the normal P–P diagram of standardized residuals, which is used to assess the normality of the distribution of the regression model errors. The points along the diagonal line indicate that the model residuals are distributed close to the normal distribution. In this model, deviations from the line are minimal, which confirms compliance with the normal distribution and the admissibility of using the least squares method.

Figure 3 presents a scatterplot of standardized residuals against the predicted values of the regression model, which allows for a visual inspection of potential heteroskedasticity and the detection of possible anomalies. The dispersion of points around the X-axis does not exhibit a distinct pattern, such as a fan shape, which suggests the absence of systematic variance in the residuals, and it can be concluded that the assumption of homoskedasticity - that is, the constancy of error variance - is satisfied.

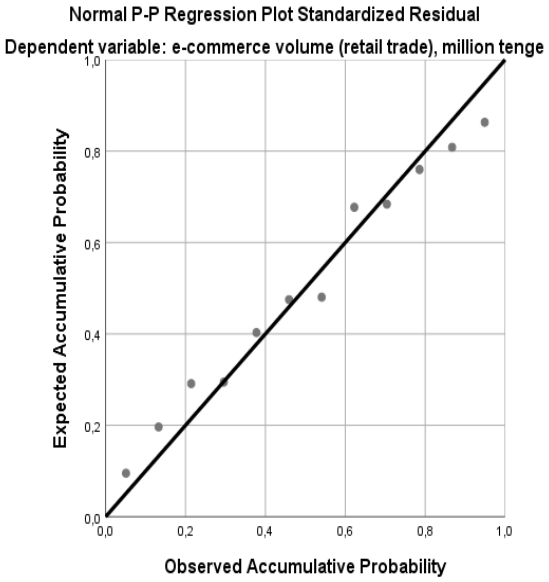

Figure 2. P–P plot of normal distribution of standardized residuals for the retail e-commerce model

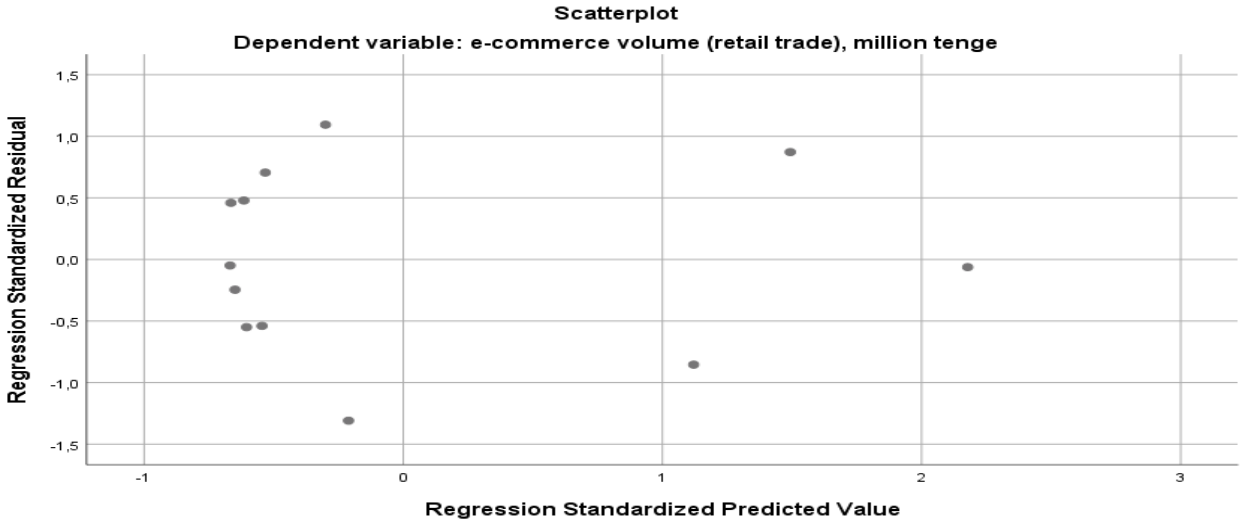

Figure 3. Scatterplot of standardized residuals and predicted values in the e-commerce model

As part of the regression analysis, linear models of the dependence of electronic trade volumes on time (year) were built. Regression model is presented in Table 9. The regression coefficient of the "Year" variable turned out to be positive and significant (b = 253 758.28, p <0.01), which confirms the stable trend of growth in e-commerce volumes over time. The model constant is -511446511.81 and reflects the base level of trade volume at a zero value of the independent variable, which is interpreted solely as a technical parameter of the model. The value of the standardized coefficient Beta (0.832) also confirms a strong relationship between time and the growth of e-commerce. The determination coefficient (R^2) was 0.692, which means that the model explains 69.2% of the dispersion of the dependent variable (adjusted $R^2 = 0.661$). F-criterion value was 22.496 ($p < 0.001$), which indicates a high statistical significance of the model. The Durbin–Watson statistic was 0.522. Thus, the model demonstrates high prognostic force, similarly to the conclusions presented by Cheng & Zhao (2023), where the effect of the temporary factor and technological changes on the development of digital trade is emphasized.

Table 9. Regression coefficients (Retail trade ~ Years)

No.	Variable	B	Std. Error	Beta	t	Sig.
1	(Constant)	–511,446,511.81	107,993,994.80	-	–4.736	0.001
2	Years	253,758.28	53,502.03	0.832	4.743	0.001

Note: calculated by the authors based on data from Bureau of National Statistics (2024)

Based on the constructed linear regression model, a forecast of the volume of retail e-commerce for 2025 and 2026 was made. Table 10 shows the forecasts for 2025 and 2026 that indicate sustained growth to 2.41 trillion and 2.67 trillion tenge, respectively. Confidence intervals (95%) indicate a high degree of reliability, from 2.04 to 2.93 trillion tenge in 2025 and from 2.34 to 3.17 trillion tenge in 2026.

Table 10. Forecast values for 2025-2026 (based on linear regression)

No.	Year	Predicted Retail sales volume forecast (million tenge)	95% Confidence Interval (Lower - Upper)
1	2025	2,413,997.55	2,041,396.14 – 2,933,359.33
2	2026	2,667,755.82	2,343,652.15 – 3,165,990.13

Note: calculated by the authors based on data from Bureau of National Statistics (2024)

Table 11 presents the ARIMA(1,2,0) model results. According it, there are predicted even higher growth: 3.73 trillion in 2025 and 4.39 trillion in 2026, consistent with global digitalization trends.

Table 11. Forecast of e-commerce volume (retail) for 2025–2026 using ARIMA(1,2,0)

No.	Year	Point Forecast (million tg)	80% CI (Lower–Upper)	95% CI (Lower–Upper)
1	2025	3,728,712	3,131,967 – 4,325,457	2,816,069 – 4,641,355
2	2026	4,387,624	3,361,102 – 5,414,147	2,817,694 – 5,957,555

Note: calculated by the authors based on data from Bureau of National Statistics (2024)

The model showed an adequate approximation of the data with an exponential growth trend, the obtained values demonstrate a steady increase in the volume of e-commerce in 2025-2026, while the forecast for 2026 exceeds 4.39 trillion tenge. Confidence intervals allow us to estimate the range of uncertainty, as well as increase the reliability of the results.

Residual diagnostics confirm ARIMA(1,2,0) model validity. So, the analysis of residuals (ZRESID) and standardized predicted values (ZPRED) did not reveal any significant deviations, which confirms the correctness of the linear regression model. All constructed regressions demonstrated statistical significance at a significance level of 0.01, the diagnostic results indicated the absence of autocorrelation and heteroscedasticity.

The findings confirm the steady growth of e-commerce in Kazakhstan, its strong links with cross-border trade, as well as the increasing role of digital channels in the consumer behavior model. The reliability of the forecast allows to talk about the reproducibility of trends and compliance with global trends identified in the studies of Alarcón-Del-Amo et al. (2021) and UNCTAD (2021). The increasing share of digital trade requires enterprises to adapt marketing strategies and actively use digital communication channels. Forecast estimates indicate the need for further development of digital infrastructure, government support and stimulation of export e-commerce.

DISCUSSION

The obtained results confirm that the e-commerce market in Kazakhstan is undergoing a phase of rapid growth and transformation. The steady increase in both absolute volumes and the share of e-commerce in retail trade reflects a shift of consumer behavior to the digital channels. The forecast values indicate continued positive dynamics until 2026, assuming a stable macroeconomic background and the development of digitalization of the economy.

A strong correlation between e-commerce and cross-border trade performance points to increasing international consumer integration. With consumers' growing confidence in foreign platforms and the simplification of cross-border payment systems, the boundaries between domestic and foreign markets are becoming increasingly blurred.

The linear regression model confirmed the existense of a stable trend. However, diagnostics revealed a positive autocorrelation of the residuals (Durbin–Watson = 0.52; $p < 0.001$), which limits the applicability of a simple linear specification. And to improve the accuracy, the ARIMA approach was used, which is able to take into account the internal dynamics of the time series. The obtained forecasts for 2025–2026 with confidence intervals (80% and 95%) provide realistic development scenarios. Model adequacy was confirmed by the normal distribution of residuals (Jarque–Bera, $p = 0.6899$) and the absence of heteroscedasticity (Breusch–Pagan, $p = 0.069$).

From a practical perspective, the findings underline the need for companies to reassess their marketing strategies. In the context of increasing digital interaction with consumers, traditional promotion channels are being replaced by mobile applications, platform ecosystems and personalized digital marketing. A particularly important task is to develop multichannel strategies for companies that can combine offline and online spaces. For small and medium-sized enterprises, this also means the need to invest in digital platforms and train staff in new competencies.

Thus, leading e-commerce platforms in Kazakhstan actively leverage digital marketing tools to expand reach and consumer engagement. Kaspi.kz, the country's largest integrated digital ecosystem, combines marketplace, payments and fintech services, and implements large-scale campaigns, including the "Kaspi Zhuma". Other key players, such as AliExpress, Wildberries, Lamoda, use SEO, e-mail marketing, platform promotions and influencer collaboration. These strategies drive digital consumption growth and align with the findings. Further inclusion of website content analysis, marketing surveys and monitoring of search trends will deepen the understanding of behavioral factors stimulating e-commerce.

From a policy standpoint, sustainable growth of e-commerce requires the development of digital logistics, simplification of customs procedures, introduction of digital identifiers for commodity flows and revision of tax mechanisms in the cross-border digital trade.

The study has several limitations. The use of aggregated macroeconomic data excludes behavioral detailing, the linear model specification does not reflect possible structural shifts, and the limited observation period (12 years) reduces statistical power. Nonetheless, the application of the ARIMA model enhanced forecast precision and strengthened the reliability of the conclusions.

Overall, the findings confirm the presence of persistent trends in digital trade, support the applicability of short-term forecasting through ARIMA modeling, and outline promising directions for future research, particularly at the micro level, focusing on consumer behavior, digital marketing strategy, and cross-sectoral dynamics.

CONCLUSION

This study presents an empirical assessment of the impact of digitalization on the development of e-commerce in Kazakhstan for the period 2013–2024. The main attention was given to the level of Internet penetration, the number of Internet users and their relationship with the macroeconomic indicator - GDP per capita. But the regression analysis results did not confirm the statistically significant impact of these digital indicators on economic growth. Both hypotheses, H1 - about the presence of a positive relationship between Internet penetration and GDP per capita growth; H2 - about the statistically significant impact of the number of Internet users and the level of digital penetration on economic development, are not supported. It was revealed that these indicators highly correlated with the volume of e-commerce in retail and services.

For refine the forecast of e-commerce volumes, the ARIMA (1,2,0) model implemented in R was used, demonstrating a stable exponential growth trend until 2026. In addition, during the study, high-quality aspects of digitalization were identified, including the role of marketing tools, such as online advertising and platform promotion. The findings underscore the need for their further inclusion in quantitative models of analysis.

The study has both academic and practical relevance. It provides guidelines for advancing digital transformation and expanding of Internet trade in Kazakhstan. At the same time, the work has several restrictions, such as the brevity of the temporary series and limited detailing of behavioural variables. Although indicators such as the level of Internet penetration into consumer behaviour and the number of Internet users indirectly reflect digital behaviour, they do not allow for a deep analysis of the motivation, barriers, the degree of trust and digital literacy of consumers. In future studies, it is recommended to include more accurate behavioural characteristics based on microdata, as well as use more flexible analysis methods, such as logarithmic models, nonlinear trends and models with a variable structure. Despite these restrictions, the identified relationships form a strong empirical base for further applied and strategic research in the field of Kazakhstan's digital economy.

AUTHOR CONTRIBUTIONS

Conceptualization and theory: SK; research design: SK, SB, KK and KA; data collection: SK and SB; analysis and interpretation: KK and KA; writing draft preparation: SK, SB, KK and KA; supervision: SK and SB; correction of article: SK; proofread and final approval of article: SK, SB, KK and KA. All authors have read and agreed to the published version of the manuscript.

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