

THE IMPACT OF DIGITALIZATION AND INNOVATION ON POSTAL AND COURIER SERVICES IN THE CONTEXT OF SUSTAINABLE ECONOMIC DEVELOPMENT: EVIDENCE FROM KAZAKHSTAN

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ABSTRACT

The processes of digitalisation and innovation are also reshaping the postal and courier services sector. Physical mail generally requires more time to access than electronic information. Even so, this remains an important service sector that should not be overlooked. The pandemic further increased demand for postal and courier services. This study examines the factors affecting the sector in the country, the ways in which it can adapt to ongoing change, and how, within the context of technological development, it can secure its role in sustainable national development. For the purposes of detailed analysis, two nonlinear autoregressive distributed lag models were developed, and the required significance tests were performed. The results of the first NARDL model show that fixed broadband subscriptions, employment in services, and ICT service exports have a positive long run effect on the volume of postal and courier services, while service imports exert a positive short run effect. The findings of the second NARDL model indicate that GDP per capita has a positive impact on the volume of postal and courier services in both the short run and the long run, while the level of innovation activity has a favourable long run effect. Several policy recommendations are presented in the conclusion.

Keywords: Public-private wage differentials, Wage decomposition, Quantile decomposition, Labour market segmentation, Türkiye

1. INTRODUCTION

Nearly all sectors, from services to manufacturing, are being reshaped by technological change (Kaliyeva et al., 2025; Bolatbek et al., 2025). In the postal, courier, and express delivery sector, advances in transport and logistics technologies not only support the growth of electronic commerce, but also create opportunities for new forms of economic activity. Postal services now cover a wide range of functions, including banking, freight forwarding, the sale of consumer goods, and the receipt and delivery of letters, packets, and parcels (Kovaleva et al., 2022; Marsita et al., 2025).

These services represent an important part of a country's economic infrastructure (Crew and Kleindorfer, 2002; Purpura, 2013). As electronic commerce expands and demand for rapid delivery increases, courier services have become a vital part of modern daily life. In conditions of

urbanisation and the globalisation of transport and logistics, courier services, which range from traditional mail delivery to the transport of small consignments, provide an essential connection between firms and consumers (Saha and Sarma, 2024; Mogire et al., 2025). At the same time, last mile delivery is becoming increasingly difficult because of rising costs, environmental pressures, and higher customer expectations associated with the rapid growth of electronic commerce. Postal operators are therefore being pushed towards digital transformation as digital services expand and information and communication technologies continue to develop (Atieh et al., 2025; Zeng et al., 2025). Electronic commerce, data collection, digital identification, and related technological advances have encouraged postal operators to introduce new services, improve efficiency, and adjust their business models to the demands of the digital economy (Marsita et al., 2025). Researchers have examined the development of postal and courier services from different perspectives. Some have focused on the role of information technology in this sector (Jaag and Loew, 2025; Siahaan et al., 2023; Baláž et al., 2024), others have explored issues related to climate change and environmental protection (Memon et al., 2013; Lazarević et al., 2020; Niemeijer and Buijs, 2023), while some have concentrated on energy efficiency (Rehmatulla and Smith, 2015; Milewski and Milewska, 2021; Wehner et al., 2022).

Against this background, the purpose of this study is to evaluate the impact of digitalisation on the volume of postal and courier services and to propose recommendations for the development of this sector in Kazakhstan in line with sustainable development principles.

To achieve this aim, the study addresses the following research questions:

RQ₁: To what extent do digitalisation and innovation influence postal and courier services?

RQ₂: To what extent can postal and courier services contribute to sustainable economic development in Kazakhstan under conditions of digitalisation and innovation?

2. LITERATURE REVIEW

Digitalisation, understood as the use of digital opportunities, is one of the key technological trends reshaping organisations and societies (Reis et al., 2020). Digital technologies now influence almost every sphere of life (Oliynyk, 2024; Wang, 2025; Wang et al., 2021). Because technological innovation and adoption are complex processes, it is essential to understand both the factors that promote and those that hinder them (Mutingi and Matope, 2013). In the postal and courier sector, rapid technological development has driven major change, generating innovations aimed at improving customer satisfaction, operational efficiency, and environmental sustainability (Crew and Brennan, 2015). At the same time, the spread of digital platforms and applications has made door to door delivery possible for almost all goods, while also intensifying competition among service providers (Quarles and Simon, 2025).

Greater competition has contributed to lower prices and rising demand for delivery services, creating new employment opportunities as consumers increasingly order goods through digital applications (Parwez, 2022; Travers et al., 2025). However, the reliability and profitability of such work remain uncertain (Pieczka and Miszczyński, 2025). Digital labour platforms, which connect providers directly with consumers, may help reduce poverty, expand employment, and empower individuals (Datta et al., 2023). In parallel with the growth of digitalised delivery services, demand for low-cost mopeds and electric bicycles has also increased. As a result, postal and courier services play a dual role in sustainable development. They support goals such as no poverty, zero hunger, decent work and economic growth, and affordable and clean energy, while also creating environmental pressures, especially in transport and final delivery, which remain the main sources of CO₂ emissions in the supply chain (UN, 2015; UN DESA, 2024). Quick delivery based on low-cost vehicles may therefore also have negative

environmental consequences. For this reason, it is important to assess how far the sector must adapt to align with sustainable development goals (Mastilo et al., 2026).

The Covid 19 outbreak accelerated both platform employment and delivery services, while also speeding up digitalisation more broadly (Sakas et al., 2022; Botelho, 2023; Hunady et al., 2025). Kazakhstan was no exception to this trend (Omarova and Sharipova, 2022; Mussina, 2024). A growing body of research confirms that innovation and digitalisation are essential to sustainable development in the postal and courier sector. Through green logistics and technological upgrading, the sector can reduce environmental harm and improve its contribution to sustainable development (Shadibekova and Ismoilov, 2021; Seysenbekov et al., 2025). Digital platforms may lower costs and reduce environmental pressure, while digitalised supply chains and process innovation are crucial for achieving both economic and environmental objectives in the long run (Dabic-Miletic, 2026; Peng et al., 2026). Since postal and courier services are an integral part of the wider supply chain, their development should be closely monitored through the lens of digitalisation and innovation (Saqib and Qin, 2024).

In Kazakhstan, delivery services have expanded significantly in recent years, with the greatest regional demand concentrated in Almaty. Platform based firms are active in several service market segments, particularly courier and transport services, represented most prominently by InDriver and Yandex Taxi (Insebayeva and Beysembayev, 2023). According to National Bureau statistics, only 26.6 per cent of all postal and courier services, amounting to 79.5 billion tenge, were provided to the public, while legal entities accounted for 58.4 billion tenge, or nearly three quarters of the total. The share of legal entities reached 74.3 per cent in Astana and 83.4 per cent in Almaty, reflecting the stronger entrepreneurial and economic activity of these large cities (Inbusiness.kz, 2024). Sociological evidence further shows that more than 90 per cent of couriers in Almaty are young men aged 18 to 35, most of whom have higher education. Over 60 per cent come from nearby regions, around one third treat delivery work as part time employment, and about 40 per cent combine it with other jobs or studies. On average, they complete up to 20 deliveries per day (Zakon.kz, 2024). Official statistics also indicate that 24 per cent of Kazakhstan's workforce was self-employed in 2022 (BNS, 2022).

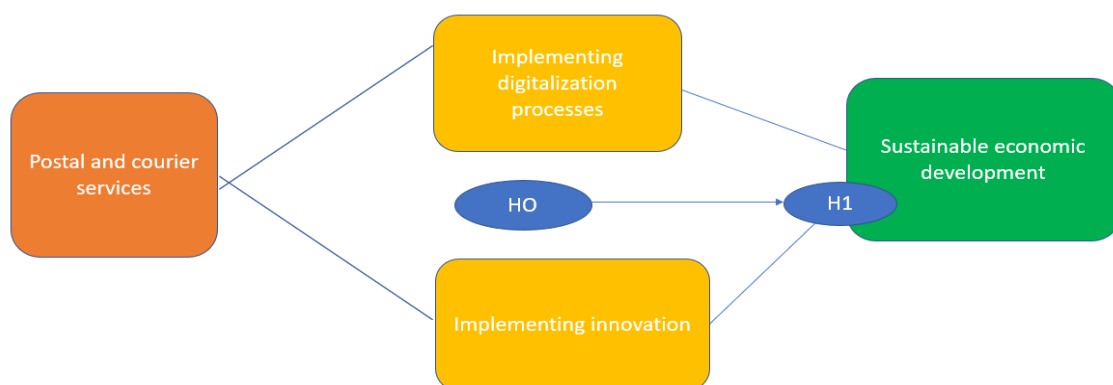
Based on this review, the study tests the following hypotheses:

H_0 : As the level of digitalisation and innovation increases, the volume of postal and courier services will continue to grow.

H_1 : The volume of postal and courier services will have a positive effect on sustainable economic development.

Design concept can be visualized as follows (Figure 1):

Figure 1. Concept of hypothesis



Source: compiled by authors

3. METHODOLOGY AND MATERIALS

3. 1. DATA

This study examines the impact of service imports, fixed broadband subscriptions, employment in services, GDP per capita, inflation, the level of innovation activity, and ICT service exports on the volume of postal and courier services in the Republic of Kazakhstan. The analysis draws on data from the World Development Indicators and the National Statistical Agency of the Republic of Kazakhstan for the period 2003 to 2023 (Table 1).

Table 1. Model Variables and sources

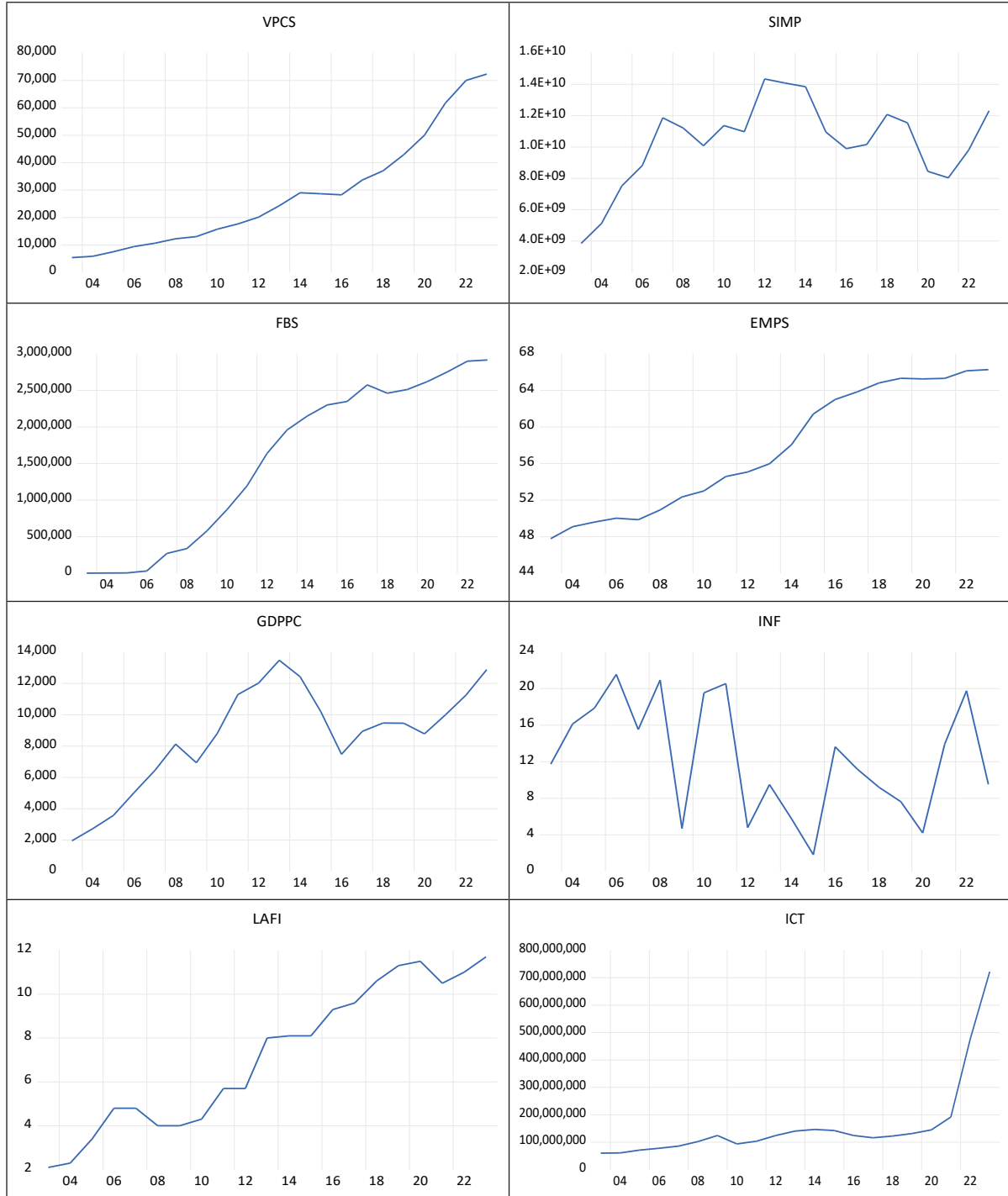
Variables	Definitions	Sources
VPCS	Volume of postal and courier services, mln tg	Compiled by authors based on National Statistic Agency of RK (2025)
Simp	Service imports (BoP, current US\$)	World Development Indicators (WDI) (2025)
FBS	Fixed broadband subscriptions (number of subscriptions)	World Development Indicators (WDI) (2025)
EmpS	Employment in services (% of total employment)	Computed by authors based on WDI and National Statistic Agency of RK (2025)
GDPpc	GDP per capita (current US\$)	World Development Indicators (WDI) (2025)
Inf	Inflation, GDP deflator (annual %)	World Development Indicators (WDI) (2025)
LAFI	Level of activity in the field of innovation, in %	World Development Indicators (WDI) (2025)
ICT	ICT service exports (BoP, current US\$)	World Development Indicators (WDI) (2025)

Source: compiled by authors

Figure 2 illustrates the changes in each indicator over the period 2003 to 2023 and highlights the main trends and fluctuations in Kazakhstan's economic, digitalisation, and innovation related indicators. The volume of postal and courier services increased steadily throughout the period under review, with particularly strong growth after the Covid 19 pandemic. Fixed broadband subscriptions, employment in services, and ICT service exports also display a generally stable upward trend, whereas the level of activity in the field of innovation is more uneven and shows noticeable fluctuations.

Service imports, GDP per capita, the level of innovation activity, ICT service exports, and inflation also recorded marked changes during and after the pandemic period. GDP per capita in Kazakhstan shows an overall upward trend, although with visible variation over time. Between 2003 and 2008, it rose sharply, after which fluctuations became more pronounced, likely reflecting broader economic cycles, including the effects of the global financial crisis. Even so, the general trend remains positive, indicating long term economic growth. Inflation and service imports likewise exhibit considerable volatility over the period.

Figure 2. Evolution of all variables for Kazakhstan (2003–2023)



Source: compiled by authors

Figure 2 shows clear, consistent and stable time patterns, indicating that the changes in the variables are suitable for further study.

3. 2. METHODS

Based on the literature review, we propose the following theoretical model (Equation 1) that examines the influence of important factors on the Volume of postal and courier services (VPCS) in the Republic of Kazakhstan:

$$VPCS = f(Simp, FBS, EmpS, GDPpc, Inf, LAFI, ICT) \quad (1)$$

All variable definitions and measurements are presented in Table 1.

Based on the results of the Augmented Dickey Fuller test, the logarithmic forms of VPCS, FBS, ICT, and the remaining variables are found to be stationary either at level $I(0)$ or at first difference $I(1)$, as shown in Table 3, under the specification without trend and intercept. Given these properties, the autoregressive distributed lag model is appropriate for capturing both the short run dynamics and long run relationships among the variables, even when expressed in logarithmic form.

The general ARDL model of order $(p, q_1, q_2, \dots, q_k)$, as proposed by Pesaran et al. (2001), is specified as follows:

$$\begin{aligned} \Delta y_t = & \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta y_{t-i} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta x_{1t-i} + \sum_{i=0}^{q_1} \alpha_{3i} \Delta x_{2t-i} + \dots \\ & + \sum_{i=0}^{q_k} \alpha_{k+1i} \Delta x_{kt-i} + \beta_0 y_{t-1} + \beta_1 x_{1t-1} + \beta_2 x_{2t-1} + \dots + \beta_k x_{kt-1} + \varepsilon_t \end{aligned} \quad (2)$$

According to the correlation matrix presented in Table 4, two nonlinear models were estimated to avoid a strong relationship among the explanatory variables and thus minimise the risk of multicollinearity. As part of the analysis, the stationarity properties of the variables were examined in advance. The results showed that the logarithmic forms of all selected variables are integrated of order $I(0)$ and $I(1)$. Accordingly, the use of the nonlinear autoregressive distributed lag model is methodologically appropriate. Expressing the variables in logarithmic form also allows the estimated coefficients to be interpreted as elasticities. On this basis, two logarithmic NARDL models are specified below, following Equations 1 and 2 and using the variables relevant to this study.

Model– NARDL1:

$$\begin{aligned} \Delta LOG(VPCS_t) = & \beta_0 + \sum_{k=1}^m \beta_1 \Delta LOG(VPCS_{t-k}) + \sum_{k=0}^n \beta_2 \Delta LOG(SIMP_{t-k}) + \sum_{k=0}^p \beta_3 \Delta LOG(FBS_{t-k}) + \\ & + \sum_{k=0}^q \beta_4 \Delta LOG(EMPS_{t-k}) + \sum_{k=0}^r \beta_5 \Delta LOG(INF_{t-k}) + \sum_{k=0}^s \beta_6 \Delta LOG(ICT_{t-k}) + \\ & + \gamma_0 LOG(VPCS_{t-i}) + \gamma_1 LOG(SIMP_{t-i}) + \gamma_2 LOG(FBS_{t-i}) + \gamma_3 LOG(EMPS_{t-i}) + \\ & + \gamma_4 LOG(INF_{t-i}) + \gamma_5 LOG(ICT_{t-i}) + \varepsilon_t \end{aligned} \quad (3)$$

where, operator Δ represents the differencing operation.

Model– NARDL2:

$$\begin{aligned} \Delta LOG(VPCS_t) = & \beta_0 + \sum_{k=1}^m \beta_1 \Delta LOG(VPCS_{t-k}) + \sum_{k=0}^n \beta_2 \Delta LOG(GDPPC_{t-k}) \\ & + \sum_{k=0}^p \beta_3 \Delta LOG(INF_{t-k}) + \sum_{k=0}^q \beta_4 \Delta LOG(LAFI_{t-k}) + \gamma_0 LOG(VPCS_{t-i}) + \\ & + \gamma_1 LOG(GDPPC_{t-i}) + \gamma_2 LOG(INF_{t-i}) + \gamma_3 LOG(LAFI_{t-i}) + \varepsilon_t \end{aligned} \quad (4)$$

where, operator Δ represents the differencing operation.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. DESCRIPTIVE STATISTICS

Descriptive statistics allow us to examine many characteristics of a data set in more detail. The properties of mean, median, skewness and kurtosis, Jarque-Bera, and probability are used in the study to analyze the variables.

Table 2. Values of descriptive statistics of the displayed series

Values	VPCS	Simp	FBS	EmpS	GDPpc	Inf	LAFI	ICT
Mean	28361.82	1.03E+10	1543801.	57.511	8630.878	12.359	7.181	1.60E+08
Median	24287.00	1.10E+10	1958820.	55.981	8943.084	11.739	8.000	1.24E+08
Maximum	72315.80	1.43E+10	2916490.	66.277	13478.46	21.552	11.700	7.22E+08
Minimum	5369.800	3.85E+09	998.0000	47.785	1958.021	1.824	2.100	60020092
Std. Dev.	20685.31	2.69E+09	1117387.	6.794	3273.838	6.235	3.273	1.54E+08
Skewness	0.877661	-0.694311	-0.271888	0.027	-0.536568	-0.015	-0.033	2.841253
Kurtosis	2.684455	3.231204	1.417702	1.374	2.458486	1.738	1.540	10.14300
Jarque-Bera	2.783136	1.734011	2.449438	2.316	1.264249	1.393	1.869	72.89922
Probability	0.248685	0.420208	0.293840	0.314	0.531462	0.498	0.393	0.000000
Sum	595598.3	2.16E+11	32419815	1207.7	181248.4	259.54	150.80	3.37E+09
Sum Sq. Dev.	8.56E+09	1.45E+20	2.50E+13	923.26	2.14E+08	777.51	214.23	4.77E+17

Source: compiled by authors

Table 2 presents the descriptive statistics for each variable. The mean values of VPCS, Simp, FBS, EmpS, GDPpc, Inf, LAFI, and ICT are 28,361.82 million tenge, 1.03E+10 US dollars, 1,543,801 subscriptions, 57.511 per cent of total employment, 8,630.878 US dollars, 12.359 per cent annually, 7.181 per cent, and 1.60E+08 US dollars, respectively.

The corresponding standard deviations are 20,685.31 million tenge, 2.69E+09 US dollars, 1,117,387 subscriptions, 6.794 per cent of total employment, 3,273.838 US dollars, 6.235 per cent annually, 3.273 per cent, and 1.54E+08 US dollars, respectively. These results indicate that LAFI displays relatively low variability, whereas Simp is characterised by very high variability. The variables Simp, FBS, GDPpc, Inf, and LAFI also exhibit negative skewness.

4. 2. CORRELATION MATRIX

As part of the model evaluation, a correlation matrix was used to examine the pairwise linear relationships among the variables. As reported in Table 4, VPCS has a negative correlation with inflation, with a pairwise correlation coefficient of -0.229. The table also shows that Simp, FBS, EmpS, GDPpc, LAFI, and ICT are positively associated with VPCS.

Table 3. Correlation matrix

	VPCS	SIMP	FBS	EMPS	GDPPC	INF	LAFI	ICT
VPCS	1,000	0,207	0,879	0,904	0,608	-0,229	0,900	0,785
SIMP	0,207	1,000	0,415	0,289	0,822	-0,293	0,368	0,220
FBS	0,879	0,415	1,000	0,771	0,746	-0,460	0,957	0,546
EMPS	0,904	0,289	0,771	1,000	0,617	-0,389	0,976	0,552
GDPPC	0,608	0,822	0,746	0,617	1,000	-0,332	0,658	0,497
INF	-0,229	-0,293	-0,460	-0,389	-0,332	1,000	-0,375	-0,061
LAFI	0,900	0,368	0,957	0,976	0,658	-0,375	1,000	0,558
ICT	0,785	0,220	0,546	0,552	0,497	-0,061	0,558	1,000

Source: compiled by authors

According to the results in this table, two models were estimated to avoid multicollinearity.

4. 3. UNIT ROOT TEST

Before estimating Models 1 and 2, this study applied the Augmented Dickey Fuller unit root test developed by **Dickey and Fuller (1979)** to determine whether the variables are stationary in levels or in first differences. This step is necessary before examining long run relationships among the series. The results indicate that the logarithmic forms of VPCS, FBS, ICT, and the other variables are integrated of order I (0) or I (1) at significance levels ranging from 1 to 10 per cent under the specification without trend and intercept. The use of the ADF test without constants and trends allows for a more precise assessment of stationarity and, consequently, a more accurate determination of the order of integration.

Table 4. ADF unit root tests

Variables	Intercept			Trend and intercept			None		
	Level	First diff.	Order of Integration	Level	First diff.	Order of Integration	Level	First diff.	Order of Integration
VPCS	3.150 (1.000)	-2.255 (0.195)	>I(1)	-1.165 (0.889)	-3.190 (0.117)	>I(1)	6.715 (1.000)	-1.315 (0.168)	>I(1)
LVPCS	-1.251 (0.631)	-3.53** (0.019)	I(1)	-3.537* (0.064)	-3.717** (0.046)	I(0)	2.061 (0.987)	-3.308** (0.002)	I(1)
Simp	-2.752* (0.083)	-3.23** (0.034)	I(0)	-2.752 (0.231)	-3.872** (0.038)	I(1)	0.404 (0.791)	-2.119** (0.037)	I(1)
FBS	-0.656 (0.836)	-2.497 (0.132)	>I(1)	-1.892 (0.617)	-2.531 (0.311)	>I(1)	-0.223 (0.592)	-1.530 (0.115)	>I(1)
LFBS	-15.0*** (0.000)	-3.631** (0.018)	I(0)	-10.8*** (0.000)	-2.490 (0.327)	I(0)	1.247 (0.938)	-4.3*** (0.0003)	I(1)
EmpS	-0.647 (0.837)	-2.446 (0.144)	I(0)	-2.446 (0.144)	-2.385 (0.375)	>I(1)	1.502 (0.962)	-1.750 (0.076)	I(1)
GDPpc	-1.753 (0.391)	-2.966* (0.057)	I(1)	-2.210 (0.458)	-2.888 (0.187)	>I(1)	0.989 (0.908)	-2.734* (0.009)	I(1)
Inf	-3.552 (0.017)	-5.21*** (0.001)	I(0)	-4.03** (0.025)	-3.404* (0.086)	I(0)	-0.674 (0.411)	-5.38*** (0.000)	I(1)
LAFI	-0.785 (0.802)	-4.45*** (0.003)	I(1)	-2.230 (0.449)	-4.37** (0.014)	I(1)	2.061 (0.987)	-3.308** (0.002)	I(1)
ICT	4.451 (1.000)	-0.478 (0.875)	>I(1)	2.993 (1.000)	-1.142 (0.894)	>I(1)	1.256 (0.941)	-0.150 (0.619)	>I(1)
LICT	1.654 (0.999)	-2.403 (0.153)	>I(1)	-1.649 (0.734)	-2.663 (0.260)	>I(1)	1.416 (0.955)	-1.935* (0.053)	I(1)

Notes: 1) *, **, *** denote statistically significant at the 10%, 5% and 1% levels, respectively
p-value is inside brackets
2) compiled by the authors

Source: compiled by authors

This study employs two nonlinear models to examine the long run relationship between the selected explanatory variables and the volume of postal and courier services in the Republic of Kazakhstan using the ARDL bounds testing approach. Before conducting the cointegration test, it is necessary to determine the appropriate lag length. Table 5 reports the results of the lag selection procedure for the nonlinear models. The optimal lag length was identified based on the LR, FPE, AIC, SC, and HQ criteria. As shown in the table, the selected lag length for both Models 1 and 2 is 1, as this option is supported by the greatest number of criteria and was therefore adopted throughout the analysis.

4. 4. LAG SELECTION CRITERIA

In this study, two nonlinear models are used to examine the long-run relationship between the selected explanatory variables and the volume of postal and courier services in the Republic of Kazakhstan using the ARDL bounds testing procedure. It is important to determine the lag length criterion before conducting the cointegration test. Table 5 presents the results for the selected lag length of the nonlinear model. The lag length criterion is determined based on LR, FPE, AIC, SC, and HQ. As can be seen from the table, the selected lag length for Models 1-2 is 1, as they have more stars and were used throughout the study.

Table 5. Selection order criteria

Model 1- NARDL(1, 0, 0, 1, 0, 0)						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	13.49090	NA	0.023137	-0.943433	-0.696108	-0.909330
1	27.27411	18.37761*	0.005655*	-2.363790*	-2.066999*	-2.322866*
2	27.28083	0.008214	0.006422	-2.253425	-1.907170	-2.205681
3	29.09171	2.012095	0.006007	-2.343524	-1.947803	-2.288959
Model 2 - NARDL(1, 1, 0, 0)						
0	2.388728	NA	0.062862	0.067919	0.216314	0.088381
1	25.88576	36.55094*	0.005184*	-2.431751*	-2.233891*	-2.404469*
2	26.19901	0.452475	0.005637	-2.355446	-2.108120	-2.321343
3	26.82758	0.838085	0.005943	-2.314175	-2.017384	-2.273252
* Indicates lag order selected by criterion. LR: Likelihood ratio criterion (Hayakawa, 1977). FPE: Final Prediction Error. AIC: Akaike information criterion (Akaike, 1970). SC: Schwarz information criterion (Schwarz, 1978). HQ: Hannan-Quinn information criterion (Hannan and Quinn, 1979)						

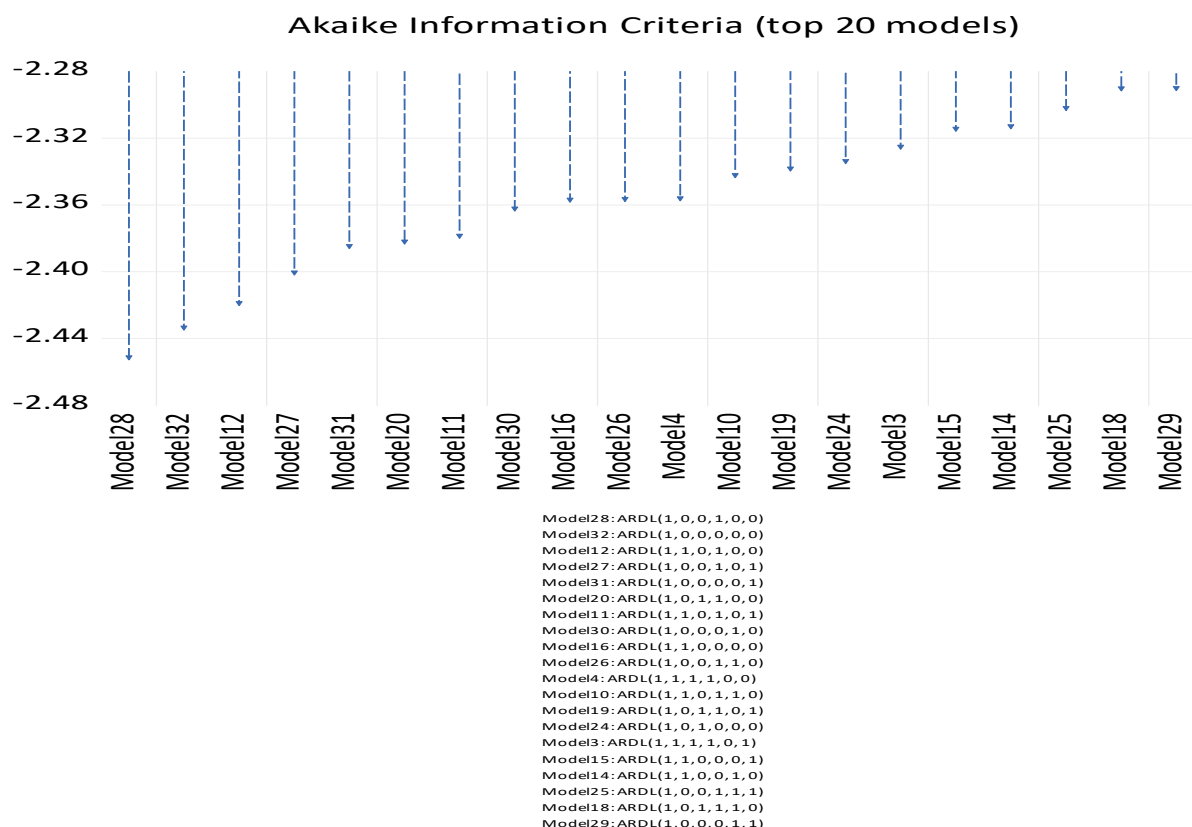
Source: compiled by authors

Based on the FPE, AIC, SC, and HQ criteria reported in Table 5, the optimal lag order for the nonlinear autoregressive distributed lag model is 1. This is because the values for lag 1 are lower than those calculated for the remaining lag lengths under all four criteria.

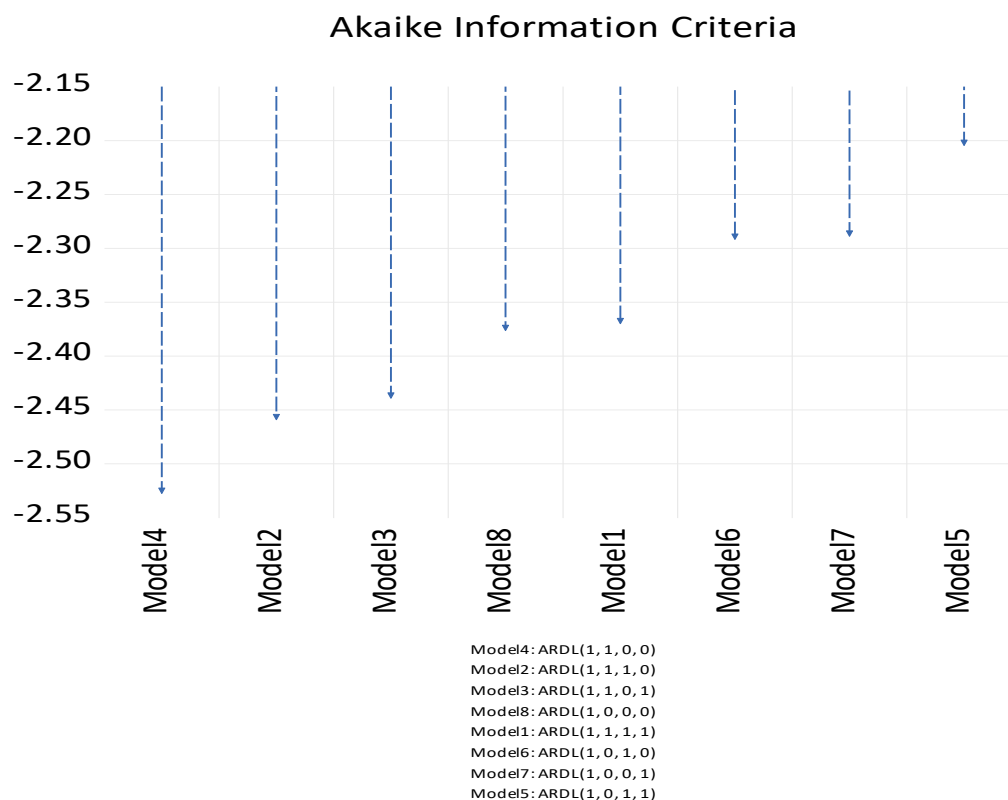
According to Figure 3, the selected specifications are Model 1, NARDL (1, 0, 0, 1, 0, 0), and Model 2, NARDL (1, 1, 0, 0).

Figure 3. Estimation of the best NARDL models 1-2

Model 1- NARDL(1, 0, 0, 1, 0, 0)



Model 2- NARDL (1, 1, 0, 0)



Source: computed by authors in Eviews

4. 5. CO-INTEGRATION TEST

In this study, the nonlinear logarithmic models NARDL (1, 0, 0, 1, 0, 0) in Equation 3 and NARDL(1, 1, 0, 0) in Equation 4 were estimated in order to analyse both the long run and short run relationships among the variables using first differences. The results of the cointegration F test, which examines the null hypothesis of no level relationship for the NARDL models, are presented in Table 6. The calculated F statistics, 11.60939 and 12.44670, respectively, exceed the critical bounds at all significance levels. These results lead to the rejection of the null hypothesis and confirm that the selected variables are cointegrated. Accordingly, in the case of Kazakhstan, a stable long run relationship exists among them.

Table 6. Results of cointegration test

Model	F Statistics	Signif.	Critical Bounds		Decision
			I(0)	I(1)	
Model 1- NARDL (1, 0, 0, 1, 0, 0)	1.60939***	10%	1.81	2.93	Cointegration
		5%	2.14	3.34	
		2.5%	2.44	3.71	
		1%	2.82	4.21	
Model 2- NARDL (1, 1, 0, 0)	12.44670***	10%	2.01	3.1	Cointegration
		5%	2.45	3.63	
		2.5%	2.87	4.16	
		1%	3.42	4.84	
Critical bounds are reported at 1% (***) and 10% (**) level of significance					

Source: compiled by authors

We can proceed to the next step, which requires estimating the long-run and short-run coefficients, since the selected variables are cointegrated over the long run. Given the power-law NARDL model, we can estimate how changes in the explanatory variables affect the dependent variable in both the long and short run. The coefficients of the power-law model indicate elasticity.

4. 6. RESULTS OF LONG- AND SHORT RUN RELATIONSHIP

Table 7 reports the estimated long run and short run coefficients. According to the NARDL (1, 0, 0, 1, 0, 0) model, all explanatory variables except inflation are significant in explaining the long run growth of postal and courier services in Kazakhstan. The estimated elasticities for fixed broadband subscriptions, employment in services, and ICT service exports are 0.153079, 2.964377, and 0.520247, respectively, indicating that each of these variables has a positive and statistically significant effect on the volume of postal and courier services, holding other factors constant. By contrast, service imports are negatively associated with VPCS in the long run, with a coefficient of -0.614063.

In the short run, however, the results differ. Employment in services and ICT service exports are negatively associated with VPCS, with elasticities of -2.469894 and -0.157434, respectively, while the coefficient on log service imports is positive at 0.185824. This suggests that the effects of imports and ICT service exports are not immediate, but rather unfold over a longer period. In Kazakhstan, these economic influences appear to accumulate gradually and are shaped by wider conditions such as oil price volatility, exchange rate movements, and global economic shocks.

Digitalisation may therefore place short run pressure on traditional postal and courier activities, even though its long run effect is positive. One possible explanation is the short run

substitution of traditional mail by email and messaging services, which reduces business correspondence and lowers demand for conventional postal services. As noted by Vivarelli and Arenas Díaz (2025), technology can replace established processes and services in the short term. At the same time, ICT supports new business models, electronic commerce, and innovation in delivery systems, which over time increases demand for courier services. Its effect can therefore be expected to strengthen in the long run.

The results of the NARDL (1, 1, 0, 0) model in Table 7 show that all explanatory variables except inflation are also significant and positively associated with the long run growth of VPCS. GDP per capita and the level of activity in the field of innovation are positively related to the volume of postal and courier services, with coefficients of 0.987887 and 1.341684, respectively, all else being equal. In the short run, the coefficient on the first difference of log GDP per capita is also positive, at 0.308139, which is consistent with the long run finding.

In both models, the lagged logarithm of VPCS is not significantly associated with the short run change in VPCS.

Table 7. Results of NARDL and ARDL Estimation (2002-2022)

Model 1- results of NARDL (1, 0, 0, 1, 0, 0) estimation $\Delta\text{LOG}(\text{VPCS})$			Model 2- results of NARDL (1, 1, 0, 0) estimation $\Delta\text{LOG}(\text{VPCS})$		
<i>Variable</i>	<i>Coefficient</i>	<i>t-Statistic (Prob.)</i>	<i>Variable</i>	<i>Coefficient</i>	<i>t-Statistic (Prob.)</i>
<i>Short Run</i>					
LOG (VPCS (-1)) *	0.302613	1.466(0.166)	LOG (VPCS (-1)) *	-0.057534	-1.215(0.243)
LOG(SIMP)**	0.185824*	1.794(0.096)	LOG (GDPPC (-1))	0.056837	1.351(0.197)
LOG(FBS)**	-0.046324	-1.537(0.148)	LOG(INF)**	0.006928	0.234(0.818)
LOG(EMPS (-1))	-0.897060	-1.379(0.193)	LOG(LAFI)**	0.077192	1.276(0.221)
LOG(INF)**	0.030921	1.146(0.272)	$\Delta\text{LOG}(\text{GDPPC})$	0.308139**	2.482(0.025)
LOG(ICT)**	-0.157434*	-1.836(0.089)			
$\Delta\text{LOG}(\text{EMPS})$	-2.469894*	-2.151(0.051)			
ECT(-1)	-0.302613***	-9.820(0.000)	ECT(-1)	-0.057534***	-7.729(0.000)
<i>Long Run</i>					
LOG(SIMP)	-0.614063**	-4.909(0.0003)	LOG(GDPPC)	0.987887	4.465(0.000)***
LOG(FBS)	0.153079***	5.096(0.0002)	LOG(INF)	0.120410	0.240(0.813)
LOG(EMPS)	2.964377***	4.748(0.0004)	LOG(LAFI)	1.341684	1.856(0.083)*
LOG(INF)	-0.102182	-1.076(0.302)			
LOG(ICT)	0.520247***	3.398(0.0048)	LOG(ICT)		
1) coefficients are statistically significant at ***1%, **5%, *10% level of significance					

Source: compiled by authors

The error correction coefficients for Models 1 and 2 are -0.302613 and -0.057534, respectively. Both are negative and statistically significant at the 1 per cent level. This confirms the existence of a long run relationship among the variables, as the error correction term lies between -1 and 0, indicating convergence towards equilibrium. More specifically, the results suggest that approximately 30.3 per cent of short run disequilibrium is corrected each year in Model 1, compared with 5.8 per cent in Model 2. This implies a faster speed of adjustment to long run equilibrium in Model 1 following shocks to the explanatory variables in the previous period.

4. 7. DIAGNOSTIC TESTS

To confirm the robustness of the linear ARDL model, diagnostic tests were conducted (Table 8). These tests include serial correlation, heteroscedasticity, and normality. All diagnostic

tests-serial correlation with the Lagrange multiplier (Arora, 2012), the Jarque-Bera normality test (Jarque & Bera, 1987), and the heteroscedasticity test-were successful, indicating the robustness of the ARDL model. For this model, the null hypotheses of no serial correlation, no homoscedasticity, and no normality are rejected.

Table 8. Short-run diagnostics

Model 1 – NARDL(1, 0, 0, 1, 0, 0)			
Test	F-statistics	P-value	Conclusion
Serial correlation LM	0.741716	0.4060	No Serial Correlation
Heteroskedasticity	0.474101	0.8356	No Heteroskedasticity
Jarque-Bera	1.362111	0.5050	Normality Exists
Model 2- NARDL(1, 1, 0, 0)			
Test	F-statistics	P-value	Conclusion
Serial correlation LM	0.031513	0.8616	No Serial Correlation
Heteroskedasticity	0.031513	0.8616	No Heteroskedasticity
Jarque-Bera	0.476732	0.7879	Normality Exists

Source: compiled by authors

4. 8. MULTICOLLINEARITY TEST

This study also uses the VIF tool to test for multicollinearity. The results of the VIF test are presented in Table 9, which show that no multicollinearity was detected.

Table 9. VIF multicollinearity test results

Model 1- NARDL(1, 0, 0, 1, 0, 0)		Model 2- NARDL(1, 1, 0, 0)	
Variable	Centered VIF	Variable	Centered VIF
LOG(SIMP)	4.794873	LOG(GDPPC)	2.749246
LOG(FBS)	9.65082	LOG(INF)	1.117506
LOG(EMPS)	6.027330	LOG(LAFI)	2.770235
LOG(INF)	1.191126		
LOG(ICT)	2.320198		

Source: compiled by authors

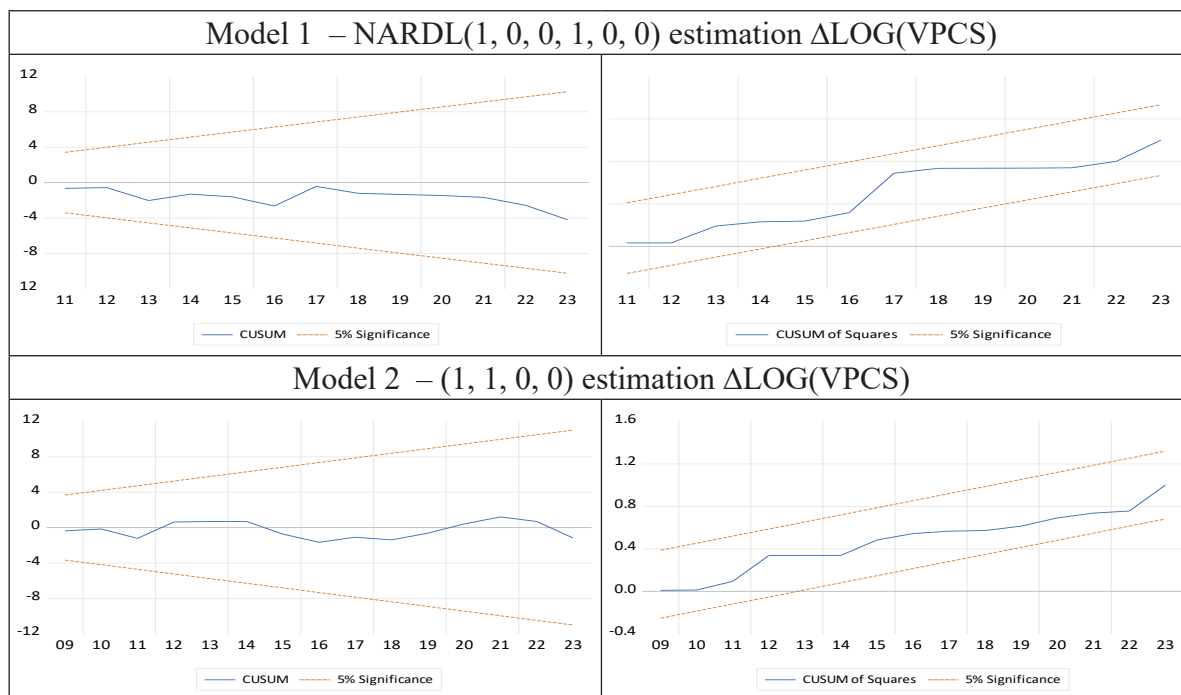
The results of the multicollinearity test are presented in Table 9. The variance inflation factor is used to assess the extent to which the variance of an estimated regression coefficient is inflated because of correlation among the independent variables. In this case, the centred VIF values are the relevant statistics to consider. As a rule, a VIF value above 10 suggests the presence of serious multicollinearity, whereas values below 10 indicate that collinearity is not a significant concern (Chavent et al., 2006).

The results show that all VIF values are below 10, in line with this empirical guideline. It can therefore be concluded that the model does not suffer from serious multicollinearity, and all variables may be retained for further analysis.

4. 9. STABILITY TESTS

To assess the dynamic stability of our model, we used the CUSUM and CUSUMSQ tests. The graphical representations of these tests, presented in Figure 4, demonstrate the overall stability of the ARDL model.

Figure 4. CUSUM and CUSUMSQ



Source: compiled by authors

Since CUSUM and CUSUMSQ in the graphs of Figure 4 remain within the 5% critical boundary, the model parameters are considered stable.

5. RESULTS AND DISCUSSION

These findings suggest that both the short run positive effect and the long run negative effect of service imports on the volume of postal and courier services reflect a complex but potentially beneficial contribution to national service delivery and entrepreneurial development. At the same time, the positive long run impact of fixed broadband subscriptions highlights the importance of digitalisation for the development of this sector, a result that is consistent with previous studies such as [Liu et al. \(2022\)](#) and [Ibrahim et al. \(2025\)](#).

Similarly, the level of activity in the field of innovation shows a positive long run effect on the volume of postal and courier services, supporting earlier findings by [Young \(2022\)](#) and [Bhat and Gupta \(2025\)](#) on the role of innovation in this sector. In addition, GDP per capita exerts a positive influence in both the short run and the long run, reflecting the fundamental relationship between economic development and the expansion of service industries. Overall, the positive effect of economic growth on the postal and courier sector indicates broader development of the national service market, as shown in Table 10.

Table 10. Percentage change in indicators over twenty years

Variables	2003	2023	Change
Volume of postal and courier services, mln tg	5369.80	72315.80	1246.71
Service imports (BoP, current US\$)	3845387585.59	12314652950.55	220.24
Fixed broadband subscriptions (number of subscriptions)	998.00	2916490.00	292133.47
Employment in services (% of total employment)	47.78	66.28	38.70
GDP per capita (current US\$)	1958.02	12879.43	557.78
Inflation, GDP deflator (annual %)	11.74	9.52	-18.88
Level of activity in the field of innovation, in %	2.10	11.70	457.14
ICT service exports (BoP, current US\$)	60020092.00	721961621.00	1102.87

Source: compiled by authors

The findings of the study show that innovation and digitalisation are important factors in advancing sustainable development goals in the postal and courier sector and in supporting its overall development. In this context, delivery vehicles play a central role, and sustainability in this field largely depends on minimising environmental harm. The recycling of paper, packaging, and other delivery related materials is also relevant to the environmental dimension of sustainable development. From this perspective, digitalisation and innovation may help reduce the volume of physical materials processed within postal and courier services, which can generate environmental benefits. Previous research likewise suggests that innovation and digitalisation have a positive effect on postal and courier services (Mikavica et al., 2022), including lower fuel costs and reduced carbon emissions (Lazarević et al., 2020). At the same time, the wider use of digital technologies may increase electricity consumption (Morley et al., 2018), which may in turn place upward pressure on energy prices.

Digital applications have also made courier work more accessible to the public. This has contributed to the growth of self-employment in both large cities and smaller urban areas. The opportunity to generate income through app-based work is therefore likely to expand employment in the service sector, particularly in the form of self-employment.

6. CONCLUSION

Innovation and digital technologies are increasingly shaping all areas of economic and social life, and the postal and courier services sector is no exception. The purpose of this study is to assess the impact of innovation and digitalisation on postal and courier services in the context of sustainable economic growth and to propose recommendations for both the short run and the long run. To achieve this aim, the authors developed two nonlinear autoregressive distributed lag models using the following indicators: volume of postal and courier services, service imports, fixed broadband subscriptions, employment in services, GDP per capita, inflation, level of activity in the field of innovation, and ICT service exports over a twenty-year period. The results of the first NARDL model show that service imports have a positive short run effect on the volume of postal and courier services, while fixed broadband subscriptions, employment in services, and ICT service exports exert a positive long run effect.

The findings of the second NARDL model indicate that GDP per capita has a positive influence on the volume of postal and courier services in both the short run and the long run, whereas the level of activity in the field of innovation has a positive effect in the long run.

In both models, inflation does not have a significant effect on the dependent variable, while service imports are negatively associated with it in the long run.

Overall, the results support hypotheses H_0 and H_1 .

7. POLICY RECOMMENDATIONS

In the Introduction, the authors posed two research questions. By addressing these questions, the study seeks to offer several practical recommendations for achieving sustainable economic development in the postal and courier services sector.

The answer to the first research question is clear: both digitalisation and innovation have a positive long run effect on this sector. The transition from paper-based communication to digital formats, together with the ability to transmit and store information electronically, reduces the use of paper and the need for physical transport. In this sense, both digitalisation and innovation contribute to sustainable economic development and create favourable conditions for the long-term development of postal and courier services.

At the same time, courier services have expanded rapidly in both small and large cities of Kazakhstan, largely because of the growing popularity of mobile ordering applications among the population. This has increased employment in the sector and supported the growth of the gig economy, creating attractive opportunities for people seeking more independent forms of work. Mopeds have also become popular among couriers as a fast and relatively inexpensive means of transport. As a result, although technological development has helped reduce paper circulation and some carbon emissions in traditional postal services, the rising demand for courier delivery continues to generate environmental pressure, especially through greater consumption of fuel. This creates new challenges for sustainable urban development.

The growing use of courier services in large cities is also linked to traffic congestion. As travel within cities becomes slower and more costly in time terms, courier services often become a more efficient alternative. In our view, the environmental sustainability of this sector could be improved by introducing stricter requirements for postal and courier packaging, for example using recycled paper and plastic only. Further gains could also be achieved through warehouse automation and the wider use of digital QR code-based systematisation. In addition, greater attention should be given to customer-oriented innovation to strengthen economic growth and competitiveness in this industry.

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