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Exploring the Impact of Information and Communication Technology in Regions of Kazakhstan[1]

The research aims to assess the impact of information and communication technology (ICT) on economic growth in different regions of Kazakhstan. A few basic complex methods, such as systematisation of statistical data and regression analysis, conducted using the STATA software package, were used to analyse the relationship of indicators in different periods. Based on data for the period 2007–2018 obtained from the World Bank, the International Telecommunication Union and statistical yearbook of Kazakhstan, we assess how ICT, expressed by such indicators as Internet access in organisations, the number of computers and fixed telephones, influences economic growth. Our analysis revealed differences in the speed of implementation and development of ICT depending on the region, meaning that the least developed territories still lag in the number of Internet users. We have concluded that since 2014, the country's currency has weakened due to the decrease in the cost of oil and consequent economic decline; mobile devices are increasingly used, reducing the demand for fixed telephones; computers in organisations are affecting economic growth in more developed regions since 2014, although the negative effect of Internet access is growing, as the model shows. The obtained results can used for strategy development to compare economic growth in regions with low, medium, and high development rates.

Keywords: region, regional development, gross regional product, information and communication technology, information technology, digital technology, digital readiness, digital economy, regression model, Kazakhstan

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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Анализ влияния информационно-коммуникационных технологий в регионах Казахстана

Цель данного исследования — оценить влияние информационно-коммуникационных технологий (ИКТ) на экономический рост в различных регионах Казахстана. Для анализа взаимосвязи показателей были применены такие комплексные методы, как систематизация статистических данных и регрессионный анализ, проведенный при помощи программного обеспечения STATA. В качестве источника послужили данные Всемирного банка, Международного союза электросвязи и статистического ежегодника Казахстана. На основе информации за 2007–2018 гг. была проведена оценка влияния ИКТ (использованы показатели доступа к интернету в организациях, количества компьютеров и стационарных телефонов) на экономический рост. Выявленные различия в скорости внедрения и развития ИКТ в регионах свидетельствуют о том, что наименее развитые территории по-прежнему отстают по количеству интернет-пользователей. Сделаны следующие выводы: снижение стоимости нефти и последующий экономический спад в 2014 г. привели к ослаблению национальной валюты; распространение мобильных устройств привело к снижению спроса на стационарные телефоны; начиная с 2014 г. количество компьютеров в организациях влияет на экономический рост в более развитых регионах, в то время как отрицательный эффект доступа к интернету растет. Полученные результаты могут быть использованы для разработки стратегий развития, для сравнения экономического роста в регионах с низкими, средними и высокими темпами развития.

Ключевые слова: регион, региональное развитие, валовой региональный продукт, информационно-коммуникационные технологии, информационные технологии, цифровые технологии, цифровая готовность, цифровая экономика, регрессионная модель, Казахстан

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1. Introduction

The spread of COVID-19 infection led to the declaration of a pandemic. This has affected the socio-economic development of many states. Digitalisation issues have come to the fore. For Kazakhstan, COVID-19 has become the biggest challenge in the past two decades. The government has imposed quarantine to combat the pandemic, starting in Almaty and Nur-Sultan cities and extending it to all regions. As a result, many regions, cities, towns, and rural settlements in Kazakhstan were isolated. At the same time, the population had to switch to a remote format of work using information and communication technology (ICT). Therefore, it is especially important for Kazakhstan, like many other emerging countries, to take advantage of ICT and assess its level of development to ensure rapid economic growth. The spread of ICT has significantly improved the efficiency of resource allocation, reduced production costs, and increased demand and investment in all sectors of the economy. Regarding the growing importance of ICT and its ability to transform the world, many researchers have focused on examining the impact of ICT on economic growth at the sectoral, national, and cross-country levels. Several theoretical and empirical studies were conducted to answer the following question: how does ICT affect economic growth?

Most articles dealing with this topic note that information and communication technologies are a major factor in the economic and social development of countries, as they have some impact on economic growth, productivity, and employment. This is evidenced by numerous scientific studies and publications, as well as many reports made by well-known international research organisations (International Monetary Fund (IMF), United Nations (UN), Organisation for Economic Co-operation and Development (OECD), World Bank, etc.) for different countries. Moreover, these global organisations claim that the ICT segment is one of the main drivers of sustainable development.

Productivity growth affects the standard of living of the population. In turn, investment in ICT is seen as a key driver for productivity growth. This relationship has been studied in developed countries at the firm, industry, and country levels, with most studies showing that the ICT productivity effect is positive and economically significant. Recent scientific literature has considered different concepts and models of the ICT contribution [1, 2, 3]. There is weak and ambiguous data on the contribution of ICT investment to economic growth of regions with less developed economy. Despite rather mixed empirical data, the World Bank is optimistic that ICT has great prospects for reducing poverty, increasing productivity, and accelerating economic growth. Weakness and ambiguity of empirical data on the ICT impact in developing countries may be largely explained by the lack of high-quality data sets at the micro and macro levels of ICT for these countries.

A priori, there may be good reasons why the impact of ICT on economic growth in low-developed regions differs from more developed regions. On the one hand, regions with low development rates may lack absorption capacity, adequate levels of human capital or other complementarities, such as research and development (R&D) expenditures, and therefore receive less investment to ICT than developed regions. On the other hand, ICT can help making an economic leap in developing regions through traditional methods of increasing productivity, as mentioned by Steinmueller [4]. Additional productivity gains can be caused by ICT-related side effects or network effects, as ICT can reduce transaction costs and speed up the process of knowledge creation. These network effects may be more pronounced when many firms in a region or industry use similar ICT levels or types.

In this study, we proceeded from the assumption that after the COVID-19 pandemic, there will be an urgent need to take safety measures to transform society through mass transition to digital technologies in Kazakhstan, as well as in the whole world. At the same time, despite the rapid adoption of digital technologies, Kazakhstan still has significant digital gaps, as there are differences in the speed of implementation and development of digital technologies depending on the region, so the least developed territories still lag behind in the number of Internet users. It is obvious that the global transition to digital technologies will transform many economic sectors in Kazakhstan and completely change the technological structure. Therefor3, we decided that the initial diagnostic algorithm should be based on methodological approaches used to analyse the data of the ICT contribution for regions by using several significant indicators.

The research findings may be useful for other countries in developing policies to overcome the post- pandemic crisis because ICT can help increase flexibility and resilience to pandemics and other threats. ICT not only plays a crucial role in shaping a sustainable development strategy in the context of lockdown and forced isolation during a pandemic but can also have a longer-term impact after the end of COVID-19. In addition, the obtained results can be used in various state documents, strategic plans of local self-government bodies and territorial development programmes.

This article contributes to the scientific research in several ways. Section 2 reviews the current empirical literature on the ICT impact on economic growth, focusing on differences in methodologies, data sources, and sample periods. Section 3 describes the unique features of the data set used for the empirical research. The analysis sample includes 16 regions of Kazakhstan with low, medium, and high gross regional product (GRP) per capita in the period from 2007 to 2018. Based on these data, the section presents results, including a comparison of estimated regression coefficients of ICT indicators for the combined sample and three subgroups of regions. The findings for the entire sample of regions confirm the positive ICT contribution to economic development. Estimates using subsamples for three groups of countries show only minor differences between regions with low, medium, and high development rates. Thus, the results show that regions with low and medium economic development do not receive more from investment in ICT than developed regions, which calls into question the economic leap from the use of ICT discussed above.

2. Theoretical Background and Literature Review

Over the past decades, the widespread use of ICT has led to a dramatic transformation of the world into the information society. Due to ICT infrastructure, such as fixed telephones, mobile phones, the Internet and broadband, people, firms and governments now have much better access to information, knowledge, and skills in terms of scale and speed. In the past three decades, numerous scientists have studied the ICT impact on the economic and social development of countries at both the country and regional levels, applying different methodologies, data sources, and periods. Most empirical studies conclude that increasing use of ICT can lead to growth in gross domestic product (GDP), productivity, and employment.

There is an increasing consensus among growth theorists and development specialists that technological innovation and diffusion can play a crucial role in driving economic growth and productivity. Early proponents of this view were Kraemer & Dedrick [5], Scott & Storper [6] and Krugman [7]. They focused on the role of technological innovation in explaining economic and productivity growth. Scott and Storper argued that economic growth and technological change are inextricably linked [6]. First, an increase in capital and labour can itself lead to economic growth, but without innovation, the return from increases in capital and labour will decrease, and productivity gains will be limited or non-existent. Second, because technological innovations are codified in instructions, such as software code or semiconductor designs, the proliferation of these instructions can lead to increased returns on scale, as the average cost of such instructions decreases with each new user. Thus, the widespread adoption of technology creates an opportunity for increasing returns on investment.

In 1998, using data from 27 Central and Eastern European countries for the period 1990–1995, Madden and Savage analysed the empirical relationship between ICT investment and economic growth [8]. The results of the study showed a positive relationship between investment in telecommunications infrastructure and economic growth. Röller & Waverman [3] examined the relationship between telecommunications infrastructure and economic growth in 21 OECD countries between 1970 and 1990, revealing its positive and significant impact. The results show 2.8 % growth in GDP with 10 % growth in telecommunications infrastructure. In another study on OECD countries, Datta and Agarwal, using the dynamic panel data method for 22 countries, investigated the long-term relationship between telecommunications infrastructure and economic growth [9]. They found a significant and positive correlation between these two factors.

At the same time, the level of ICT development in a region determines its capability to ensure the competitiveness of the regional socio-economic system (considering all its elements: infrastructure, various socio-economic institutions, economic entities, etc.). The study of the ICT impact on regional development requires an analysis of subject-object relations at all levels of information and communication interaction. Scott & Storper [6], Krugman [7], Rocha [10] and Puga [11] suggested assessing the development of the innovation infrastructure of regional clusters, considering the state of the existing infrastructure, but without highlighting its digital component.

Among Russian scientists, we can distinguish the works of Sukhanova [12], Terebova [13], Zharov [14], Dvoeglazova [15] that consider the level of innovative development of territories through the prism of regional differentiation, but do not pay due attention to the state of digital infrastructure. Charykova & Markova [16] consider theoretical and methodological provisions and development of a qualitatively new model for improving regional clusters using digital technologies, whose relevance is determined by new conditions of the economic transformation. However, the paper does not investigate the issues related to the system analysis of all clusters and their impact on the organisation of the socio-economic space of the region. The same can be said about other similar studies, which are interesting because they attempt to combine statistical data in the calculation of integral indicators [17, 18, 19].

The features of the ICT sector in the Russian economy are outlined in the work of Abdrakhmanova & Kovaleva [20]. In the scenario for the development of the ICT sector in Russia, some features (growth of telecommunications against the background of lagging in software development and services) are characteristic of catching-up development. All these trends are common to many Commonwealth of Independent States (CIS) countries, including Kazakhstan. This is reinforced by the impact of the current industrial structure, economic situation, and specificity of the Russian industrial development.

There are scientific research results in the field of management of ICT development processes and its impact on the digital economy. For example, in some works, more than two dozen indicators for assessing ICT and the level of digitalisation are given, and their borders are also indistinct [21, 22, 23]. In addition, the concept of “digital economy” was introduced by Negroponte in 1995 as a metaphor for a new information culture, an organic part of which was the content in digital form (music, movies, pictures, games, etc.), which was initially defined as computing [24]. Over time, it has become more applicable to the economy, which confirms the thesis of the dominant role of culture in creating new meanings and values.

The level of digital readiness plays a huge role in the ICT development. Digital readiness has many meanings in the literature. Its leading definition is the willingness of individuals, organisations, and sectors of the economy to adopt and apply innovative digital technologies to increase the benefits of these innovations. Quaicoe and Pata defined digital readiness as the readiness of teachers' abilities, knowledge, and conviction to accept digital learning in the primary and secondary education systems in Ghana [25]. More research into the essence of technological readiness in four dimensions will lead to more awareness of the technology adoption process [26]. Other scientists have examined this concept in their own studies of the digital readiness of correspondents in Malaysia [27, 28, 29].

Differences in terminology make it difficult to develop models of digital readiness, which indicates that there is no single definition of digital readiness. Inconsistent implementation of concepts and models of digital readiness has led to the fact that research results are not comparable and do not have any chances to be applied to form a shared knowledge of digital readiness. As a result, many works focus on the need to strive for uniformity by defining the main components of all models [30, 31, 32].

Similarly, for 105 countries that are divided into different groups (region and per capita income), Shiu & Lam [33] studied causal relationship between telecommunications development and economic growth. The authors believe that there is a bi-directional relationship between the development of telecommunications and economic growth in European countries, as well as in high-income countries [33]. For countries in other regions and the lower-income group, this relationship is usually unidirectional (from real GDP to telecommunications development). Therefore, the authors point out that the development of telecommunications is not an important factor determining economic growth for less developed countries. Cieślik and Kaniewska analysed the relationship between telecommunications infrastructure and regional income levels using panel data for 49 regions of Poland in 1989–1998 [34]. The authors found a positive and statistically significant causal relationship between telecommunications infrastructure and revenue at the regional level, but the causal relationship exists between telecommunications to revenue.

Despite the great scientific interest, the development of a methodology for assessing the ICT level considering the digital component is not analysed. As a rule, the reviewed works study certain ICT aspects, with the prevalence of the technological aspect. There are practically no works devoted to a comprehensive economic study of this phenomenon. However, we will try to make our own scientific contribution to the growing stream of such research, which constructively analyses or criticises the current understanding of the ICT impact and how to manage and use it in the process of integration between participants in the innovation process. In Kazakhstan, the digital economy is currently in the process of formation, and therefore the research and analysis of the level of regional ICT development is of relevance. This paper examines the impact of ICT access, such as the number of computers, fixed telephones, and the Internet in the regions, on economic development. For this purpose, the regional development of Kazakhstan was perceived as an indicator of growth. In general, two types of hypotheses need to be noted in a research:

Hypothesis 1: access to ICT in Kazakhstan regions has a positive impact on their economic growth.

Hypothesis 2: the use of ICT significantly increases GRP per capita in Kazakhstan regions with low development rates compared to the most developed ones.

3. Research Methods

Most economic studies are related to correlation and experimental research. In other words, the types of scientific research used (correlation or experimental) are based on a thorough analytical review of existing methods of world and domestic economic science. This research is based on a few complex methods, such as systematisation of statistical data, regression analysis, construction of cartography, etc.

While an analytical review of various scientific studies on this issue shows many different indicators, the reasons for choosing specific multi-factor indicators are not particularly obvious [35, 36, 37]. It may seem that in many cases these indicators have been chosen intuitively: some authors use only 10 evaluation indicators, while others use up to 200. In addition, a methodology contains a complex system of characteristics [38]. Nevertheless, descriptive indicators related to digital measurements in different studies are rather diverse. There are no accepted methodological approaches, which could allow us to assess the proposed indicators and their importance for digital qualities. For this reason, in our search queries we used such terms as "digital readiness", "level of ICT development" or "ICT costs". EndNote software was used to assist in data collection. Because of the search, we have previously identified methods from the following rating databases:

— 18 documents from the Scopus database;

— 32 documents from the Emerald Insight database;

— 95 documents from the Science Direct database.

Thus, it was found that various index systems differ from each other in the calculation methodology, structure, and the ratio of quantitative and qualitative indicators used. Simultaneously, on the one hand, the integrity of the resulting data is ensured; on the other hand, there is a problem with the complexity of assessing and reducing the indicators to a single index. The disadvantage of some evaluation indexes is that they are designed to have as little negative effect as possible. From our perspective, it is necessary to develop a comprehensive methodology for evaluating performance indicators that allows researchers to distinguish between positive and negative factors. In other words, it is important to show the current situation in the country.

In this paper, we used secondary data collected from multiple sources at various time points during 2007–2018. It included the examination of content in the Russian, English, and Kazakh languages from official websites of the Committee on Statistics of Ministry of National Economy of the Republic of Kazakhstan, the International Telecommunication Union, and the World Bank. In particular, the value of access to ICT by region of the country was adopted for the period 2007–2018, since the data on the number of fixed lines in regions before 2007 could not be found. This data is confirmed by the World Bank database; although they have all the necessary values before 2007, they do not consider them at the regional level. Gross regional product (GRP) converted to USD for 2019 has been adjusted for inflation since 2007. The data from Turkistan region (formerly known as South Kazakhstan region) and Shymkent city in 2018 were combined since many indicators before this period were presented without division.

In this study, based on statistical data, we assume that it is necessary to build data points for a certain period, i.e., plot them on a graph at all levels of activity, which theoretically draws the most appropriate regression line. Regression model is an analytical method that considers the relationship between all data points in the simulation. Thus, POLS (pooled ordinary least squares) indicates the combined method of the least squares (for panel studies), FE (fixed effects) is the method with fixed effects, RE (random effects) means the method with random effects, and IV (instrumental variables) implies the method with instrumental variables. All these methods were used to create a regression model with high reliability. The region's innovation activity for the number of computers in organisations was adopted as an instrumental variable because the number of computers is the most highly correlated with GRP.

The panel data regression model was estimated using the formula below (1):

$$\ln GRP_{r,t} = \alpha + \beta_{Comp} \ln Comp_{r,t} + \beta_{Int} \ln Int_{r,t} + \\ + \beta_{FixTel} \ln FixTel_{r,t} + \beta_X X_{r,t} + \lambda_t + \varepsilon_{r,t}, \quad (1)$$

where: $\ln GRP_{r,t}$ — Gross regional product per capita; $Comp_{r,t}$ — the number of computers in organisations; $Int_{r,t}$ — Internet access in organisations; $FixTel_{r,t}$ — the number of fixed telephones; X — additional control variables; λ_t — time dummy variables; α — the intercept; ε_t — the standard error of the regression.

Pooled OLS estimator for the regression model is (2):

$$\ln GRP_{r,t} = \alpha + \beta \times x'_{r,t} + \lambda_t + (\alpha_r - \alpha + \varepsilon_{r,t}), \quad (2)$$

where αr indicates region-specific effects and $x'_{r,t}$ is all independent variables mentioned above. For the fixed effect model, we used the estimator (for the STATA software package) given in the formula below (3):

$$\ln GRP_{r,t} - \overline{\ln GRP_r} + \overline{\ln GRP} = \\ = \alpha + \beta(x_{r,t} - \bar{x}_r + \bar{x}) + \lambda_t + (\varepsilon_{r,t} - \bar{\varepsilon}_r + \bar{\varepsilon}). \quad (3)$$

Breusch-Pagan/Cook-Weisberg test for heteroscedasticity showed that estimated $\chi^2 = 47.41$ on p-value = 0.000, and there is strong evidence to state that null hypothesis is failed to reject, and the variance is constant. Consequently, for a model with homoscedastic error, the term two-steps least squares (2SLS) estimator was used for IV model (4):

$$\ln GRP_{r,t} = \alpha + \beta \times x'_{r,t} + \hat{y}_2 \times x'_{r,t} + \lambda_t + \varepsilon_{r,t}, \quad (4)$$

where $\hat{y}_2$ is the first-step equation with only exogenous regressors. Multicollinearity was checked by using the variance inflation factor (VIF). The highest VIF = 7.16 was estimated for log of computers in organisations, while meaning VIF for variables is 4.15 and cannot merit further investigation.

Therefore, the proposed measurement methodology is focused on solving problems of quantitative analysis based on the use of secondary data. The results obtained will provide reliable and timely information about current ICT processes in Kazakhstan regions.

4. Analysis and Results

Since the main aim of this research is to compare the ICT contribution to economic growth in the regions with low, medium, and high GRP, it is

Table 1

Groups of Kazakhstan regions by GRP per capita in 2007, USD

High-developed			Medium-developed			Low-developed		
1.	Atyrau region	15355.25	1.	Aktobe region	5887.48	1.	Akmola region	3316.86
2.	Mangystau region	11331.81	2.	Kyzylorda region	4821.96	2.	Almaty region	2044.90
3.	Almaty city	12325.45	3.	Karaganda region	5202.68	3.	Zhambyl region	1595.87
4.	Nur-Sultan city	11483.31	4.	Kostanay region	3823.95	4.	East Kazakhstan region	3446.28
			5.	Pavlodar region	4839.10	5.	Turkistan region	1601.07
			6.	West Kazakhstan region	6125.49	6.	North Kazakhstan region	2989.62

High > 11000 USD GRP per capita, Low < 3500 USD GRP per capita for 2007.

Table 2

Summary statistics: regional groups for 2007–2018

	High-developed		Medium-developed		Low-developed		Total	
	N	Mean	*N*	Mean	*N*	Mean	*N*	Mean
GRP per capita in USD	48	17131,92	72	7230,46	72	3797,31	192	8418,39
ln (GRP)	48	9,70	72	8,85	72	8,16	192	8,80
ln (Computers in organisations)	48	10,90	72	10,18	72	10,12	192	10,34
ln (Internet in organisations)	48	8,15	72	7,62	72	7,60	192	7,75
ln (Fixed telephone in organisations)	48	5,39	72	5,31	72	5,44	192	5,37
Innovation activity of region %	48	5,81	72	7,13	72	7,69	192	7,01

necessary to divide the entire sample into three subgroups. The definition of the country groups is based on GDP/GRP per capita or indicators that are more general. The threshold variable selected in this empirical Appendix is GRP per capita in the initial year of the 2007 data set expressed in USD adjusted for inflation until January 2019 (Table 1).

According to the data, in 2007 there were six regions with low GRP, six regions with medium GRP, and four regions with high GRP. According to this definition, countries with less than 3500 USD in GDP per capita are classified as low-developed regions, and all regions with more than 11000 USD in GRP per capita are considered high-developed regions. There is a large gap in GRP per capita between West Kazakhstan region, as a medium-developed region with the highest GRP per capita, and Mangystau region, as a high-developed region with the lowest GDP per capita. However, quite close values are discovered between regions with medium and low development rates, the difference between them is only 11 %.

Table 2 provides descriptive statistics of three subgroups of regions of Kazakhstan for the period 2007–2018.

The average gross regional product (GRP) per capita in regions with low development rates is 3,797 USD. The minimum value is just under 700 USD (Turkistan region in 2015) and the maximum is 6989 USD (East Kazakhstan region in 2018). For medium-developed regions, this average is 7,230 USD, ranging from 3,823 USD to 11,999 USD. We can see the highest average GRP per capita with 17,131 USD for regions with high development. Initial data for calculation is given in Tables from 3 to 11.

The average logarithms of ICT indicators in all subgroups of regions are identical, although the number of computers, Internet access points and fixed telephones in middle-developed regions show the lowest value of 8.00, 4.88 and 4.34, respectively; the maximum value for the number of computers (11.23) in the group of low-developed regions is the lowest among all subgroups. High-developed regions were expected to show extremely high values of all three ICT development indicators. Obviously, this is an interesting result. The change in the average gross regional product per capita over time is shown in Fig. 1, demonstrating almost identical trends for all groups of regions, as well as sharp declines in 2008 and 2020 in Kazakhstan.

Table 7 shows the results of evaluating the regression model for the entire sample for the period of 2007–2018.

Table 3

Summary statistics: regions with low GRP in 2007–2018

	N	Mean	St. dev.	Min	Max
GRP per capita in USD	72	3797.31	1410.817	688.24	6989.48
ln(*GRP*)	72	8.16	.42	6.53	8.85
ln(*comp*)	72	10.12	.71	8.36	11.23
ln(*internet*)	72	7.60	.709	5.204	8.58
ln(*fix.tel.*)	72	5.44	.33	4.61	6.02
ln(*export*)	72	5.63	1.54	1.481	7.98
Innovation activity of the region %	72	7.69	4.06	.7	15.5
GRP in 2019 mln. USD	72	4898.02	2342.23	1625.94	10292.02
Population	72	1398810	735334.5	554519	2993258

Source: Committee on Statistics of MNE RK

Table 4

Summary statistics: regions with medium GRP in 2007–2018

	N	Mean	St. dev.	Min	Max
GRP per capita in USD	72	7230.469	1899.917	3823.95	11999.38
ln(*GRP*)	72	8.85	.26	8.24	9.39
ln(*comp*)	72	10.18	.71	8.005	11.29
ln(*internet*)	72	7.62	.77	4.88	8.94
ln(*fix.tel.*)	72	5.31	.44	4.34	6.06
ln(*export*)	72	7.95	.72	6.43	9.165
Innovation activity of the region %	72	7.13	3.308	1.5	14.7
GRP in 2019 mln. USD	72	6148.649	2214.895	3048.609	12708.79
Population	72	858638	242638.6	598342	1385037

Source: Committee on Statistics of MNE RK

Table 5

Summary statistics: regions with high GRP in 2007–2018

	N	Mean	St. dev.	Min	Max
GRP per capita in USD	48	17131.92	5666.78	10941.59	33115.17
ln(*GRP*)	48	9.70	.30	9.30	10.407
ln(*comp*)	48	10.90	.95	8.73	12.44
ln(*internet*)	48	8.15	1.15	5.08	10.09
ln(*fix.tel.*)	48	5.39	.69	4.36	6.59
ln(*export*)	48	8.81	.71	7.82	10.26
Innovation activity of the region, %	48	5.81	3.59	1.1	14.7
GRP in 2019, mln. USD	48	14717.14	7839.84	4616.61	33660.67
Population	48	874254.5	429403.5	407403	1854556

Source: Committee on Statistics of MNE RK

Table 6

Summary statistics: 2007–2018-combined sample

	N	Mean	St. dev.	Min	Max
GRP per capita in USD	192	8418.397	6135.656	688.24	33115.17
ln(*GRP*)	192	8.806	.68	6.53	10.40
ln(*comp*)	192	10.34	.84	8.005	12.44
ln(*internet*)	192	7.75	.89	4.88	10.09
ln(*fix.tel.*)	192	5.37	.48	4.34	6.59
ln(*export*)	192	7.29	1.72	1.48	10.26
Innovation activity of the region, %	192	7.01	3.73506	.7	15.5
GRP in 2019, mln. US$	192	7821.78	5934.11	1625.94	33660.67
Population	192	1065107	579187.9	407403	2993258

Table 7

Dependent variable: ln(GRP) for 2007–2018, combined sample

	POLS	*RE*	*FE*	*IV*
ln(*comp*)	0.77*** (.11)	0.18*** (.045)	0.17*** (.043)	−2.47** (1.247)
ln(*internet*)	−0.179* (.108)	0.066 (.040)	0.071* (.038)	2.436** (.303)
ln(*fix.tel.*)	−0.634*** (.106)	−0.027 (.090)	0.028 (.092)	−0.149 (1.014)
Constant	5.583*** (.590)	6.533*** (.508)	6.331*** (.506)	16.275*** (4.238)
Year Dummies	Yes	Yes	Yes	Yes
Adjusted R^2	0.352	0.211	0.377	
Observations	192	192	192	192

t statistics, $^*p < .10$, $^{**}p < .05$, $^{***}p < .01$.

According to the data, the impact of the number of computers in organisations in Kazakhstan regions on GRP per capita is shown with coefficients between -2.47 and 0.77, the values for random effects (column 2) and the fixed effects model (column 3) are almost identical. These coefficients are less than in the case of the combined method of least squares, which is 0.77. The fourth column shows a regression with instrumental variables (IV), where the region's innovation activity is expressed as a percentage of the number of computers in organisations. As a result, we obtained a coefficient -2.47, which shows a negative relationship with regional development. The same relationship are observed between GRP per capita and Internet access in organisations, where in case of POLS the value is -0.179, while the coefficients in RE and FE models (0.066 and 0.071, respectively) indicate a positive effect, similar to the indicators of the number of computers in organisations. Moreover, the method with instrumental variables, in contrast to the previous one, shows the strongest positive influence on development (2.436). The number of fixed telephones is decreasing due to the development of mobile devices, which is clearly demonstrated by the coefficients of all regressions except FE (0.028); the indicators obtained in other models are negative: -0.634 in POLS, -0.027 in RE and -0.149 in IV. An indicator of the reliability of the built models ranges from 0.211 to 0.377, which demonstrates the need to include the basic components of the GRP in the model.

Table 8 shows the results of the regression with an additional variable.

Compared to equation 1, an additional variable is exports to regions as a percentage of total trade turnover, which is an indicator of the openness of Kazakhstan's regions to trade. This indi-

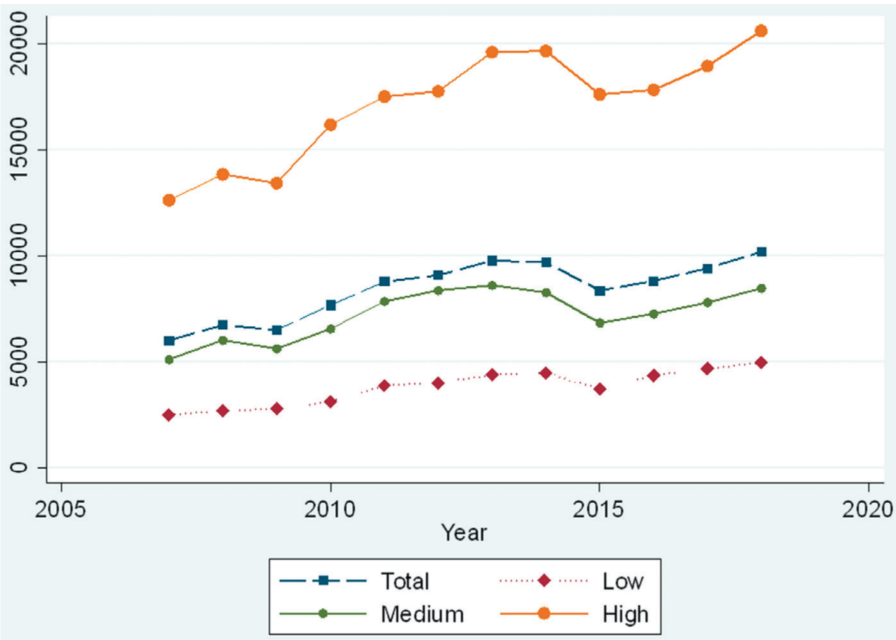

Fig. *Identical trends for all groups of Kazakhstan regions by GRP per capita, USD*

Table 8

Dependent variable: Ln(GRP) for 2007–2018, augmented regression

	POLS	*RE*	*FE*	*IV*
ln(*comp*)	0.443*** (.070)	0.231*** (.046)	0.191*** (.0424)	–0.253 (.272)
ln(*internet*)	–0.018 (.0650)	0.048 (.041)	0.063* (.0373)	0.529** (.091)
ln(*fix.tel.*)	–0.412*** (.064)	–0.092 (.084)	0.027 (.089)	–0.285*** (.218)
ln(*export*)	0.268*** (.014)	0.117*** (.018)	0.065*** (.018)	0.304*** (.022)
Constant	4.625*** (.355)	5.672*** (.495)	5.716*** (.518)	6.640*** (.865)
Year Dummies	Yes	Yes	Yes	Yes
Adjusted R^2	0.7706	0.6906	0.417	0.649
Observations	192	192	192	192

t statistics, $^*p < .10$, $^{**}p < .05$, $^{***}p < .01$.

Table 9

Dependent variable: In(GRP) for 2007–2018, Split sample

	Low-developed			Medium-developed			High-developed		
	(1) *POLS*	(2) *RE*	(3) *FE*	(4) *POLS*	(5) *RE*	(6) *FE*	(7) *POLS*	(8) *RE*	(9) *FE*
ln(*comp*)	0.0024 (.166)	0.2074** (.1055)	0.2129* (.107)	0.1547* (.084)	0.0680 (.053)	0.0651 (.0505829)	0.3839*** (.1258059)	0.3839*** (.1258059)	0.1769** (.0663405)
ln(*internet*)	0.3123* (.163)	0.1080 (.102)	0.1026 (.104)	0.0682 (.075)	0.118** (.048)	0.112** (.0461)	–0.173* (.091)	–0.173* (.091)	0.0062 (.04)
ln(*fix.tel.*)	–0.1189 (.153)	–0.1205 (.152)	–0.1175 (.159)	–0.17** (.0801)	0.124 (.120)	0.351** (.148)	–0.212* (.110)	–0.212* (.110)	0.21 (.15)
Constant	6.41*** (.837)	5.897*** (.950)	5.865*** (.980)	7.696*** (.453)	6.594*** (.629)	5.4625*** (.763)	8.07*** (.61)	8.07*** (.61)	6.57*** (.71)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.2109	0.2260	0.382	0.199	0.1206	0.451	0.1266	0.1823	0. 467
Observations	72	72	72	72	72	72	48	48	48

t statistics, $^*p < .10$, $^{**}p < .05$, $^{***}p < .01$.

cator demonstrates differences in production of technology between countries. At the same time, the increasing share of exports in total GRP over time is an indirect indicator for many different regional characteristics (regulation, infrastructure, knowledge flow, etc.).

While clearly a positive and significant coefficient of the export trade openness is correlated with higher growth rates of GRP of the regions, the effect of computers in organisations in this extended model statement is now greater than in Table 7 for all specifications except POLS. The greatest differences are observed in RE and IV models with ICT coefficients of 0.231 and –0.253. The impact of fixed phones on growth checked using the fixed effect method remained virtually unchanged. The same applies to the method of instrumental variables, which has not shown any changes relative to others. The coefficients in the specification of the combined method of least squares and IV model with the augmented variable of the regression equation are also clearly greater than in the simple econometric model in Table 3. Certainly, the adjusted value has increased as expected: it is in the range from 0.417 to 0.7706.

The main goal of this study is to compare the contribution of ICT to economic growth in regions with low, medium, and high development rates. Therefore, at the next stage, regression models are evaluated for each subgroup of regions separately. Table 9 shows the results of regressions for divided samples of three subgroups of regions for the period of 2007–2018.

The coefficients for ICT show small differences between subgroups. Internet access in organisations estimated using the random effects and fixed effects approaches shows almost similar coefficients (in the range from 0.012 to 0.118) for both low-developed regions and middle-developed regions. The contribution of ICT is slightly greater in developed regions, which have a computer impact factor with a maximum score of 0.3839. This can be

Table 10

Dependent variable: In(GRP) for 2007–2018, split sample — augmented regression

	Low-developed			Medium-developed			High-developed		
	(1) *POLS*	(2) *RE*	(3) *FE*	(4) *POLS*	(5) *RE*	(6) *FE*	(7) *POLS*	(8) *RE*	(9) *FE*
ln(*comp*)	−0.026 (.144)	−0.023 (.144)	0.228** (.1080)	0.231*** (.0622)	0.116*** (.0369)	0.1136*** (.0375)	0.294*** (.0696)	0.294*** (.0696)	0.202*** (.0666)
ln(*internet*)	0.3671** (.141)	0.3644** (.141)	0.097 (.104)	0.0157 (.0553)	0.113*** (.0331)	0.114*** (.0337)	−0.0606 (.0512)	−0.0606 (.0512)	−0.0057 (.0665)
ln(*fix.tel.*)	−0.269* (.135)	−0.268** (.135)	−0.073 (.163)	−0.244*** (.0587)	−0.159 (.107)	−0.1311 (.126)	−0.1008 (.061)	−0.1008 (.061)	0.157 (.156)
ln(*export*)	0.125*** (.025)	0.125*** (.025)	0.032 (.028)	0.225*** (.028)	0.197*** (.024)	0.194*** (.025)	0.362*** (.035)	0.362*** (.035)	0.0975 (.058)
Constant	6.392*** (.724)	6.3834*** (.725)	5.330*** (1.088)	5.882*** (.401)	6.078*** (.498)	5.977*** (.562)	4.325*** (.498)	4.325*** (.498)	5.835*** (.829)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.4092	0.4424	0. 384	0.5786	0.5662	0. 707	0.7367	0.7591	0.489
Observations	72	72	72	72	72	72	48	48	48

t statistics, $^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

explained by the fact that in large megacities like Almaty or Nur-Sultan, with relatively small territories and dense population (leading to increased ICT use), there are great opportunities for growth in all areas. ICT-related side effects or network effects can cause additional productivity gains, as ICT can reduce transaction costs and speed up the process of knowledge creation. However, the criterion of equality of fixed effect coefficients of ICT for all three subgroups of regions cannot be rejected. In other words, although ICT coefficients are higher in developed regions than in low- and medium-developed regions, there is no statistically significant difference between subgroups. Thus, even with this slightly higher point estimate, there is no clear evidence to support the hypothesis of an economic leap of regions with low development rates through ICT, as described in the Steinmueller's research [4].

Table 10 demonstrates the results for subgroups of regions for the same reliability check as for the complete sample specification in Table 7, as shown earlier.

The standard formula of the regression model for the three subgroups is supplemented by the value of exports in GRP in the region's turnover. Exports in regions with low and medium economic development, as in the combined sample, are positively correlated with GRP growth, whereas for the developed regions only the POLS and RE specifications show significant effects (0.362). The fixed-effect specifications (Columns 3, 6, and 9) show slightly higher coefficients than before that range from 0.032 in high-developed regions to 0.194 in medium-developed regions.

The results for 2007–2013 and 2014–2018 sub-periods show a lower percentage of computers in organisations in the earlier period. The split into these periods was due to two reasons: a) since 2014, the country's currency has weakened due to the decline in the cost of oil and the consequent economic decline; b) the widespread of mobile devices, reducing the demand for fixed telephones. As expected, with the fixed effects method, negative feedback can be observed starting in 2014. This statement is confirmed for all methods. Computers in organisations are increasingly affecting economic growth in more developed regions after 2014, although the negative effect of Internet access is increasing, as the model shows. However, such a significant difference in the ICT impact in developed regions cannot serve as a statistically significant proof of the economic leap hypothesis. Nevertheless, over the final period

Table 11

Groups of Kazakhstan regions by GRP per capita in 2018, USD

High-developed			Medium-developed			Low-developed		
1.	Atyrau region	33115.17	1.	Aktobe region	8360.65	1.	Akmola region	6178.13
2.	Mangystau region	15052.19	2.	Kyzylorda region	5567.07	2.	Almaty region	3679.10
3.	Almaty city	17561.23	3.	Karaganda region	9218.93	3.	Zhambyl region	3654.81
4.	Nur-Sultan city	16693.13	4.	Kostanay region	6364.68	4.	East Kazakhstan region	6989.48
			5.	Pavlodar region	9781.03	5.	Turkistan region	3438.40
			6.	West Kazakhstan region	11483.91	6.	North Kazakhstan region	5867.16

(2018), significant economic growth is observed in Kazakhstan regions as shown in Table 11.

5. Conclusions

Generally, the COVID-19 pandemic has become a major challenge for various countries, including Kazakhstan. Many governments have imposed quarantine to combat the pandemic, starting in major cities and extending it to all regions. As a result, many regions, cities, towns, and rural settlements were isolated. Simultaneously, people had to switch to a remote work using digital tools and services. In turn, this situation required determining the level of digitalisation of the country. Despite the rapid adoption of digital technologies, Kazakhstan still has significant digital gaps: implementation and development of digital technologies differs depending on the region, so the least developed territories still lag behind in the number of Internet users. This study tries to solve the problem of determining the level of development of Kazakhstan territories in terms of digitalisation. Based on the research, the following conclusions were made.

First, the issues related to the study of digital processes and the impact of ICTs are quite extensive and dynamically developing, as they cover many areas. Differences in terminology make it difficult to develop a methodology for assessing digital readiness, indicating the lack of a single definition of digital readiness. As a result, many papers emphasise the need to strive for uniformity by defining the main components of all models. Some works do not focus on the digital component and the ICT impact on the region.

Second, this paper examines the impact of ICT access, examining how the number of computers, fixed telephones, and the Internet in regions influence economic development. For this purpose, the regional development of Kazakhstan was perceived as an indicator of growth. As a result, we proposed two hypotheses. Next, the article emphasised the necessity to consider an alternative hypothesis as the direction of its investigation, rather than pointing on its relative null hypothesis. Therefore, we decided to use POLS as a combined method of least squares (for panel studies). Regressions for three regional subsamples show small differences in the impact of ICT access in organisations on economic growth between low-, medium-, and high-developed regions. The criterion of equality of these estimated coefficients cannot be rejected, even though the coefficients are slightly higher for regions with medium and high development rates.

Third, the study examines the importance of ICT for economic growth based on 16 regions of Kazakhstan for the period 2007–2018. The main question is whether the benefits of ICT investment differ between regions with low, medium, and high development rates. This question can be answered by conducting several independent regressions for subsamples of regions with low, medium, and high development and then checking the equality of the estimated coefficients between subgroups of Kazakhstan regions. Based on this analysis, the macro-econometric validity of the economic leap through ICT development, as defined by Steinmueller [4], remains highly questionable. Nevertheless, ICT continue to make a significant contribution to economic growth not only in high-developed regions, but also in regions with low and medium development rates.

Fourth, when studying the ICT impact in regions with different levels of development, it is necessary to consider not only economic, but also political and social aspects, such as facilitating access to information. Additional analyses based on a larger sample size for the time interval, as well as the number of samples considered in each subgroup, should use better econometric methods that help confirm current results. This is particularly important in relation to potential indigeneity problems in meso-level regression model estimates. Besides, additional research at the firm level could help to understand the ICT impact on productivity and economic growth in low-, medium-, and high- developed regions. The main conclusions of the study are as follows: a) access to ICT has had a positive impact on the regional development of Kazakhstan in the period 2007–2018; b) in the least developed Kazakhstan regions, the ratio between Internet access and GRP per capita is the highest; in the most developed regions, access to computers has a significant impact; c) according to the split sample analysis, fixed telephone communication played a positive role in the regional economic growth before 2014, and then a negative one after 2014; d) regional groups do not show significant differences. Accordingly, the first hypothesis is accepted, the second is rejected.

Fifth, the obtained results provided a scientific basis for selecting effective measures for the development of various territories. Based on new knowledge on the development of various types of regions, it is possible to assess their current state by the level of primary (availability, quality, and accessibility of infrastructure) and secondary digitalisation (intensity and skills of infrastructure use, availability of digital competencies). In the world practice, scientific research is widely funded to assess the regional development to ensure the effective ICT use. Measures could be taken to provide a basis for making decision and developing strategies for sustainable development of territories, considering the level of ICT development of each region. The results can provide a solution for the implementation of the strategic plans of state local self-government bodies and territorial development programmes; they also can be integrated in the strategy development based on the comparison of economic growth in low-, medium-, and high-developed regions. In addition, the expected results of scientific research will contribute to the development of fundamental and applied science in the long term, not only in Kazakhstan, but also abroad.

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