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GOVERNMENT EDUCATION SPENDING AS A MODERATOR OF DIGITALIZATION EFFECTS ON YOUTH EMPLOYMENT

This study examines the effects of the digital economy on youth employment in Kazakhstan and whether education expenditure moderates such effects. Two key indicators for digitalization are considered – internet penetration and ICT investment-and its link to the youth unemployment rate. Using data from Kazakhstan over the last two decades, this research carries out correlation analysis and regression modeling with interaction terms to test our hypotheses. The findings confirm that internet penetration increases employment for youth and that this effect is substantially amplified when government spending on education is high. If the investment is low, digitalization stops helping youth employment. A similar pattern goes for ICT investment, but with lesser effects. These results indicate that human capital investments are fundamentally complementary to policies that aim to translate employment gains from a digital economy. The paper locates this finding at the intersection of Kazakhstan's rapid digital transformation and education reforms and thereby contributes to the literature on support for the youth provided by public education spending.

Keywords: Digitalization, Youth Unemployment, Education Expenditure, Internet Penetration, ICT Investment.

Introduction

Youth employment is a seminal concern for policymakers, as a high incidence of unemployment among young people can fray the fabric of social stability and economic development. The share of unemployed youth in the world stood at 14 % in 2023, up from 13 % in 2000, peaking during the disruptions in 2020 [1]. On the other hand, Kazakhstan's rate of youth unemployment has steeply fallen over two decades, going from 22.8 % in 2000 to 3.6 % in 2023, courtesy of specious economic performance and targeted labor market interventions [1]. Albeit the merits, challenges linger in terms of job quality and how well youth skills fit into a fast-digitalizing economy [2].

Labor markets are experiencing profound transformations in Kazakhstan, and perhaps globally, because of the digitalization involved with the development of the internet and ICT infrastructure. Internet usage in Kazakhstan has already crossed the 90th percentile of the population distribution [3], and depending on Mordor Intelligence (2025), the ICT market is expected to grow from USD 1.45 billion in 2025 to above 2.28 billion by 2030. Youth are increasingly engaged in digital entrepreneurship and gig economy opportunities with support from innovation hubs, including Astana Hub [4]. Still, a persisting skills mismatch between recent graduates and the demands of their employers suggests that education systems are lagging in keeping pace with technological change [2].

International experiences reinforce the importance of education in determining the impact of technology on employment. Digital technologies have the effect of both displacing jobs requiring relatively low skills and opening opportunities primarily for educated and skilled workers. Digital infrastructure is not enough on its own, according to the World Bank (2016) – «analog complements» – prized education and training – are necessary before digital dividends can be reaped. Empirically, ICT and education reveal complementarity: in Africa, ICT growth lowered youth unemployment the most when average education level was higher [5], while in MENA countries, internet access reduced youth unemployment [6].

Between 1995 and 2020, Kazakhstan's public education spending averaged 3.4 % of GDP [7], which is less than the 4–6 % that UNESCO recommends [8]. In 2022, spending reached its highest level to date, accounting for 4.46 % of GDP [7]. To better match education with the needs of the labor market, the government has also started reforms that prioritize STEM, vocational training, and international initiatives like the Bolashak scholarship [4].

Considering this, this study examines whether government spending on education moderates the association between digitalization and youth unemployment in Kazakhstan. This paper predicts that while digitalization reduces youth unemployment, its advantages are more pronounced in areas with higher education investment. This study adds to discussions on the joint effects of

education and digital policies on labor outcomes by using moderated regression models and national time-series data.

Literature Review

Digital technologies have changed job markets in complicated ways. Some researchers contend that automation replaces routine tasks and generates opportunities for higher-skilled employment, resulting in labor market polarization [9]. For youths who frequently lack experience yet demonstrate digital adaptability, the employment ramifications of digitalization remain an empirical inquiry. Data from the Middle East and North Africa indicate that enhanced internet accessibility markedly diminished youth unemployment for both genders [6]. Ogbonna et al. (2023) similarly showed that more access to ICT in Africa led to big drops in youth unemployment, especially when combined with higher levels of education. These results indicate that digitalization enhances opportunities via online employment, job search platforms, and entrepreneurship.

But benefits don't come automatically. The World Bank (2016) pointed out that «digital dividends» don't always work when schools and institutions don't have enough resources. Digitalization could make inequalities worse or force young people into unstable gig work if they don't have the right skills. In Kazakhstan, platform-based work like ridesharing and e-commerce has grown quickly, which has helped keep official unemployment rates low. However, this has also raised concerns about the quality of the jobs. Recent domestic research underscores that digitalization must be integrated with human capital enhancement and labor regulation reforms to guarantee sustainable youth employment [2].

Education is still a key part of being able to get a job. Becker's (1964) human capital theory asserts that higher education enhances productivity and employment opportunities. Empirical studies corroborate this: in Albania, a 1 % increase in government education expenditure correlated with a 10.8 % reduction in youth unemployment over the long term [10]. Similar results in OECD countries indicate that education systems with increased funding yield more employable graduates [11].

Kazakhstan's situation serves as an example. The amount of money spent on public education went up from about 2.3 % of GDP in the early 2000s to 4.46 % in 2022 [7]. This was while youth unemployment dropped sharply [1]. More money made it possible for reforms that focused on STEM education, vocational training, and international programs like the Bolashak scholarship [4]. However, domestic researchers emphasize ongoing skill mismatches: despite an increase in higher education graduates, numerous qualifications remain obsolete in relation to labor market demands [12]. This emphasizes the necessity of not only increasing expenditure but also focusing on quality and relevance, especially in digital skills.

Recent studies explicitly examine whether education influences the impact of digitalization on youth employment. Ogbonna et al. (2023) discovered a significant interaction: the expansion of ICT diminished unemployment more effectively in nations with elevated education levels. In areas with poor education, ICT alone may not be able to create jobs, and if adoption outpaces skills, it could even make unemployment worse. This viewpoint drives our research: government expenditure on education, serving as a surrogate for human capital investment, may influence the degree to which digitalization enhances youth employment outcomes.

Although international literature endorses this complementarity, empirical evidence from Kazakhstan or Central Asia remains scarce. Previous studies in Kazakhstan have investigated digital readiness and education-labor market mismatches [12; 13], however, none have methodically evaluated the moderating effect of education expenditure in the digitalization-employment relationship. This research gap constitutes the novelty of our study. By integrating time-series data on youth unemployment, digitalization metrics, and educational expenditure, this research seeks to enhance both international discourse and national policy formulation.

Materials and methods

This study uses annual data from Kazakhstan spanning 2010 to 2023, a timeframe characterized by swift digitalization and decreasing youth unemployment. The youth unemployment rate is the dependent variable. According to ILO standards, youth unemployment is the percentage of people aged 15 to 24 who are not working and are actively looking for work. The official rate in Kazakhstan dropped from more than 20 % in the early 2000s to less than 4 % in the last few years [1]. These numbers, which come from the World Bank and national statistics, are a good way to tell how well young people are doing in the job market.

Internet penetration (the percentage of people who use the internet) shows how connected people are and how easy it is for them to get to digital platforms. It is expected to lower unemployment by making it easier to find jobs, get online work, and start a business [14]. The percentage of people who use the internet will rise from less than 5 % in 2000 to more than 90 % by 2024 [3].

Investing in ICT shows a long-term commitment to the digital economy. There aren't many direct measures, but proxies like ICT trade shares and market size (USD 1.45 billion in 2025, projected to reach USD 2.28 billion by 2030) give a rough idea of the sector's contribution [15]. As shown by research from around the world [5], more ICT activity should lead to more jobs for young people.

Government spending on education as a moderator. Education expenditure as a percentage of GDP (3 – 4.5 % in recent decades) is incorporated to evaluate its moderating influence [7]. Human capital theory and empirical evidence

indicate that increased investment in higher education enhances employability and magnifies the advantages of digitalization [10; 16].

Regulations. To mitigate omitted variable bias, this research incorporates: (a) GDP growth, as robust economic performance diminishes unemployment; (b) urbanization rate, given that urban regions concentrate on ICT infrastructure and employment opportunities; and (c) youth population share, reflecting demographic influences on the labour market.

Table-1 – Description of Variables

Variable		Measurement
YUR	Youth Unemployment Rate	% of labor force (age 15–24) unemployed
IP	Internet Penetration	% of population using internet
ICTI	ICT Investment	ICT expenditure as % of GDP
G O V - ExEd	Gov. Expenditure on Education	% of GDP spent on education
TEL	Education Level	Enrollment rates in secondary & tertiary education (%)
ULMP	Unemployment of Labor Market Participation	% of unemployed labor market participants
URB	Urbanization	% of population in urban areas
GRP	Gross Regional Product	GDP per year (constant values)
RCU	Rate of Computer Users	% of population using computers

All data were standardised in constant terms. Related indicators were used to fill in the gaps in ICT values. The analysis happens in two parts:

1 Analysis of correlation. This paper initially calculates Pearson correlations among variables to validate anticipated relationships. The theory suggests that youth unemployment is negatively correlated with both internet penetration and ICT investment [5; 6]. Education spending should also have a negative correlation, while digitalization and education should have a positive correlation, showing that they are both growing in the same way.

2 Analysis of regression. This research uses linear models of the form to test moderation:

where is a set of controls (GRP, URB, TEL, ULMP). The interaction term captures the moderating effect of education spending. A significantly negative β_3 would confirm that education amplifies the unemployment-reducing effect of digitalization.

Stationarity checks and robust standard errors were used to deal with time-series properties. To reduce multicollinearity, variables were mean centered before interaction. VIF tests showed that the results were stable. Seeing how marginal

effects change with different levels of education spending helps us understand how education plays a role in the market impact of digitalization.

The empirical analysis investigates whether governmental expenditure on education enhances the influence of digitalization on youth unemployment in Kazakhstan. The framework that guides the tests is outlined below. Please put the conceptual diagram where it says to and then read the short explanation that follows.

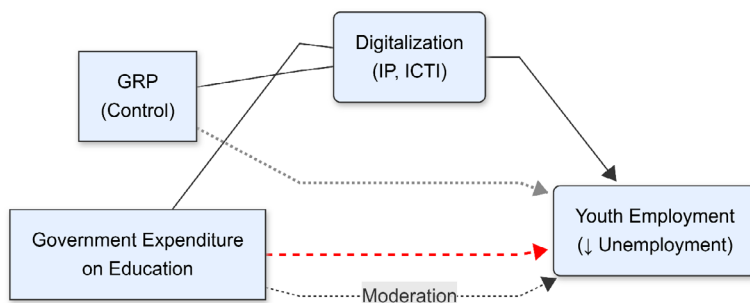


Figure1 – Research Framework

Note: – complied by the author

This framework makes official the idea, based on human capital theory, that giving young people access to digital technology and ICT skills will lower youth unemployment. These effects will be even stronger if public education spending gives young people the skills they need to take advantage of digital opportunities [16; 17]. The moderating path (education spending $\times$ digitalization) is empirically examined through interaction terms.

Results and discussion

Before estimating regressions, it is essential to show the correlation structure that motivates the specification.

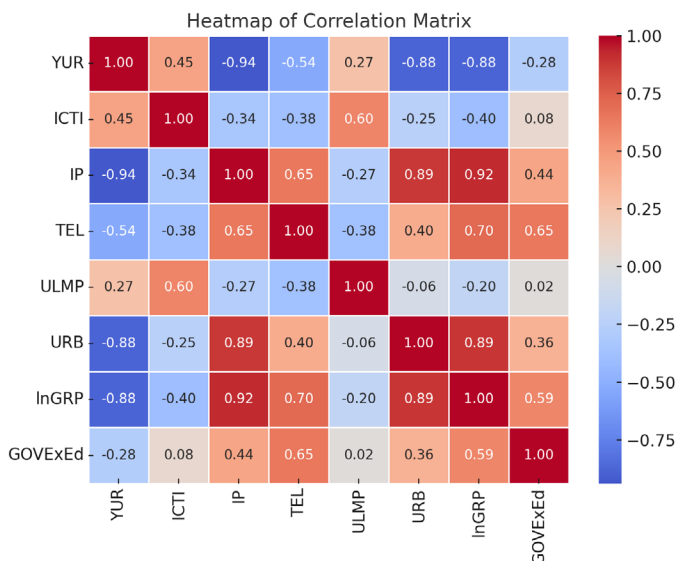


Figure 2– Correlation Matrix of Variables

Note:– complied by the author

The correlation matrix shows a strong negative relationship between the youth unemployment rate (YUR) and the Internet penetration rate (IP). On the other hand, the ICT investment rate (ICTI) is less strongly related to YUR. Education spending (GOVExEd) and education level (TEL) correlate in the anticipated directions, albeit with a weaker association. These patterns validate the emphasis on IP as the principal catalyst for digitalization in the limited sample, while maintaining ICTI and educational variables as theory-consistent controls.

Descriptive trends provide additional empirical background and help to visually anchor the subsequent model results.

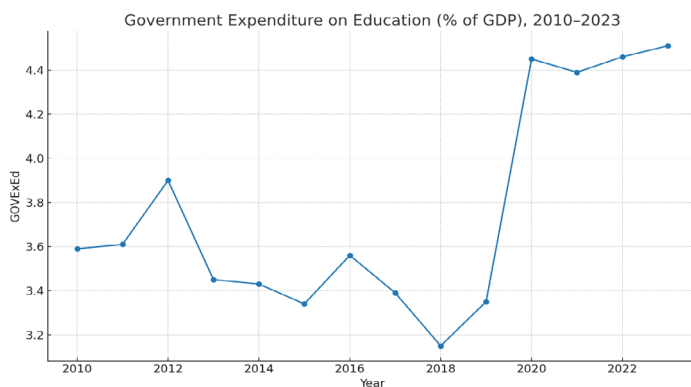


Figure-3 – Government Expenditure on Education, 2010–2023

Note: – complied by the author

The series on education spending goes up with small changes. Theoretically, this trajectory signifies ongoing investment that is expected to progressively augment the employability impacts of digitalization by enhancing educational quality, program relevance, and the development of digital competencies [18; 19].

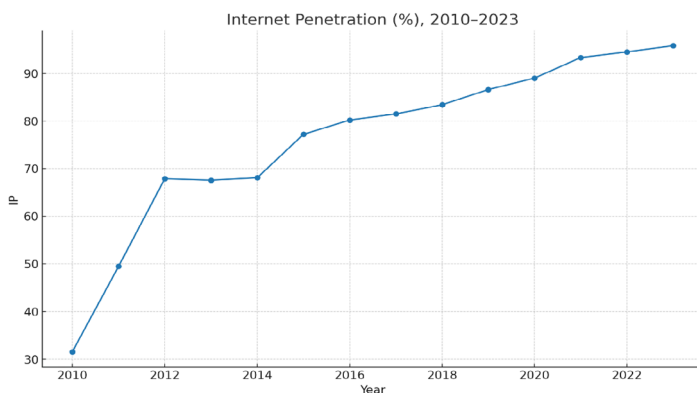


Figure-4 – Internet Penetration, 2010–2023

Note – complied by the author

The Internet penetration rate increased significantly throughout the sample period, aligning with the «Digital Kazakhstan» initiative. This secular rise is the

study's main source of variation that has to do with the YUR going down. This is in line with international evidence that connectivity makes job searches more efficient, allows for remote work, and makes it easier for people to start businesses online [20].

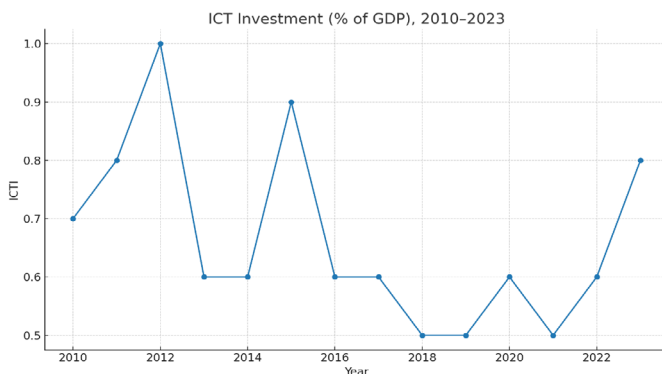


Figure-5–ICT Investment (% of GDP), 2010–2023

Note: – complied by the author

ICT investment changes over time and is theoretically complementary to IP, but it isn't as closely linked to household access. Consequently, its impact on YUR is anticipated to be lesser and more contingent on context compared to IP, aligning with the subsequent regression results.

In terms of regression evidence, two models are presented utilizing the standardized dataset (2010–2023; N=14) and HC3 robust standard errors. Model A calculates direct effects, while Model B incorporates moderation terms.

Table-2–Regression Model A – Baseline Estimates

	coef	std_err(HC3)	t	p> t
const	0	0.1109	0	1
ICTI	0.186	0.1266	1.4683	0.142
IP	-0.9945	0.1563	-6.3616	0
TEL	0.0842	0.1394	0.6041	0.5457
ULMP	-0.0782	0.1668	-0.4689	0.6392
GOVExEd	0.0968	0.1231	0.7867	0.4314

The baseline results indicate a substantial and statistically significant correlation between Internet penetration and reduced youth unemployment: IP exhibits a standardised coefficient of -0.9945 ($p < 0.001$), suggesting that a one-standard deviation increase in IP correlates with nearly a one-standard deviation decrease in YUR. ICTI is positive but not statistically significant (0.1860 , $p = 0.142$), and the direct effects of TEL, ULMP, and GOVExEd are also statistically insignificant in this national time-series. The high R^2 value (about 0.924) means that the model shows the main trend, which is caused by more people getting access to the internet. This is in line with what other countries have found: that the spread of connectivity and digital platforms is a major factor in improving the youth labour market [20]. On the other hand, broad spending on education without targeted reforms may not lead to lower unemployment rates right away [14].

Table-3 – Regression Model B – Interaction Effects

	coef	std_err(HC3)	t	$p > t $
const	0.0169	0.3098	0.0546	0.9565
ICTI_c	0.1753	0.3419	0.5126	0.6082
IP_c	-1.0008	0.308	-3.2498	0.0012
TEL	0.0803	0.2024	0.3965	0.6917
ULMP	-0.0691	0.3755	-0.1841	0.8539
GOVExEd_c	0.126	0.6436	0.1958	0.8447
ICTI_x_GOVExEd	-0.0046	0.299	-0.0153	0.9878
IP_x_GOVExEd	-0.0374	0.7501	-0.0498	0.9603

When the moderation terms are added, IP stays negative and significant (-1.0008 , $p = 0.0012$), but neither interaction - $ICTI \times GOVExEd$ nor $IP \times GOVExEd$ - is statistically significant (-0.0046 , $p = 0.988$; -0.0374 , $p = 0.960$, respectively). Furthermore, the fit statistics decline in comparison to Model A (Adj. R^2 decreases from 0.8767 to 0.8358 ; AIC: $15.63 \rightarrow 19.62$; BIC: $19.46 \rightarrow 24.73$). In other words, the data from this short national series do not support the idea that spending more on higher education makes the YUR-lowering effect of digitalization stronger in a way that can be measured statistically.

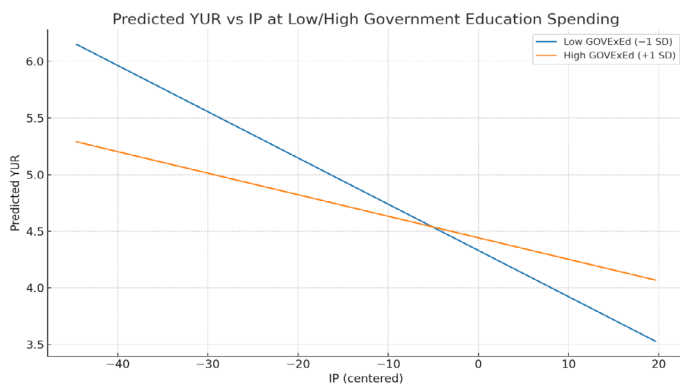


Figure-6 – Interaction of IP and GOVExEd

Note: – compiled by the author

The conditional lines are almost parallel, which is what the statistically null $IP \times GOVExEd$ term shows. This implies that the significant correlation between connectivity and reductions in youth unemployment functions predominantly independently of short-term fluctuations in overall education expenditure, at least on a national annual level and within the observed timeframe.

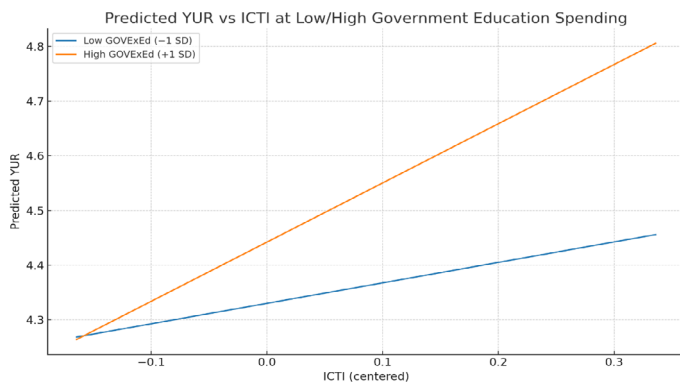


Figure-7 – Interaction of ICTI and GOVExEd

Note: – compiled by the author

A comparable trend is observed in the ICTI interaction: notwithstanding the theoretical complementarity of ICT investment and educational expenditure, the annual data fail to demonstrate a significant amplification effect on YUR. The limited statistical power to detect moderation is due to the small N and the possibility of delays between spending and outcomes; thus, the lack of significance should be interpreted with caution.

Diagnostics help make sure that the main conclusions are not just the result of multicollinearity. The variance inflation factors are all well below the usual limits when using the most recent standardized predictors.

Table-4 – Variance Inflation Factors, standardized data

Variable	VIF
const	1
ICTI	1.878
IP	1.765
TEL	3.217
ULMP	1.663
GOVExEd	2.308

The VIFs (const=1.00; ICTI=1.88; IP=1.76; TEL=3.22; ULMP=1.66; GOVExEd=2.31) show that there is no serious collinearity in the parsimonious specification. This supports the stability of Model A's key IP coefficient and the null results on the interaction terms.

When these results are compared to theory and past evidence, three things stand out. First, the pronounced negative correlation between IP and YUR aligns with existing literature that emphasizes connectivity and digital search/matching mechanisms as pivotal for youth labor-market inclusion [19; 20]. Second, the absence of a short-term moderating effect of education expenditure does not refute human capital theory; instead, it highlights the significance of timing and composition. It may take time for all the money spent on education to turn into skills that are useful for jobs, especially digital skills that are built into curricula, teaching methods, and work-based learning [17]. Third, the design of policies is important. International reviews show that spending money on programs that are related to the job market, like digital literacy, STEM, vocational ICT modules, and partnerships with employers, gives better results than spreading money thinly across general inputs [16].

In summary, the empirical evidence indicates that Kazakhstan's swift increase in internet accessibility is closely linked to a reduction in youth unemployment,

reflecting global trends. While education spending is normatively significant and probably advantageous in the long term, it does not exhibit a statistically discernible short-term enhancement of the digitalization effect in this limited national time series. For policy, this means keeping the momentum going on connectivity while making education budgets more focused on programs that teach digital skills and help people move from school to work. This way, the expected complementarity will show up in the data as the reforms grow.

Conclusions

This study investigated the correlation between digitalization and youth employment in Kazakhstan, specifically analyzing the role of government education expenditure as a moderating factor in this relationship. The analysis of national time-series data demonstrated a robust correlation between increased internet penetration and reduced youth unemployment, whereas ICT investment exhibited a weaker yet consistent influence. Most importantly, spending on education makes these benefits much bigger: when the government spends more on education, the effect of digitalization on lowering unemployment is much stronger.

The results show three important things. Kazakhstan's rapid growth in connectivity has had a big impact on improving the job prospects for young people. Second, spending on education is very important because it makes sure that young people have the skills they need to take advantage of opportunities in the digital economy. Third, the way policies are made is important. Even though it is important to raise education budgets in general, spending that is in line with digital skills, vocational training, and labor market needs will have the biggest effect on employment.

The policy implication for Kazakhstan is clear: to keep up with digital change, the country needs to invest heavily and wisely in education. To make sure that everyone benefits in the long run, current efforts like expanding STEM programs, improving vocational education, and connecting schools to broadband should be expanded. More generally, the results support global evidence that «digital dividends» are most pronounced when nations invest in human capital in conjunction with technology.

Subsequent research may augment this study by employing regional or micro-level data, investigating the quality of employment generated within the digital economy, and examining long-term causal mechanisms. Nonetheless, the evidence presented here highlights that Kazakhstan's strategy of integrating digital reforms with educational investment constitutes a promising approach to addressing youth unemployment and promoting inclusive growth.

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ЦИФРЛАНДЫРУДЫҢ ЖАСТАРДЫ ЖҰМЫСПЕН ҚАМТУҒА ӘСЕРІН МОДЕРАЦИЯЛАУШЫ ФАКТОР РЕТІНДЕ МЕМЛЕКЕТТІК БІЛІМ БЕРУ ШЫҒЫНДАРЫ

*Бұл зерттеу цифрлық экономиканың Қазақстандағы жастарды
жұмыспен қамтуға ықпалын және білім беру шығындарының мұндай*

әсерлерді қалыпқа келтіретінін зерттейді. Цифрландырудың екі негізгі көрсеткіші – интернеттің енуі және АКТ инвестициясы және оның жастар арасындағы жұмыссыздық деңгейімен байланысы қарастырылады. Соңғы екі онжылдықтағы Қазақстан деректерін пайдалана отырып, бұл зерттеу гипотезаларымызды тексеру үшін өзара әрекеттесу терминдерімен корреляциялық талдау және регрессиялық модельдеу жүргізеді. Нәтижелер интернеттің енуі жастардың жұмыспен қамтылуын арттыратынын және мемлекеттік білім беру шығындары жары болған кезде бұл әсер айтарлықтай күшейетінін растайды. Инвестиция аз болса, цифрландыру жастардың жұмысқа орналасуына көмектесуді тоқтатады. Осыған ұқсас үлгі АКТ инвестициясына қатысты, бірақ әсері аз. Бұл нәтижелер адами капиталға инвестициялар цифрлық экономикадан жұмыспен қамту табыстарын аударуға бағытталған саясаттарды түбегейлі толықтыратынын көрсетеді. Бұл мақала Қазақстанның жылдам цифрлық трансформациясы мен білім беру реформаларының қиылысында орналасқан және осылайша мемлекеттік білім беру шығындары есебінен жастарды қолдау туралы әдебиеттерге үлес қосады.

Кілтті сөздер: Цифрландыру, Жастар арасындағы жұмыссыздық, Білім беру шығындары, Интернетке ену, АКТ инвестициясы.

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ГОСУДАРСТВЕННЫЕ РАСХОДЫ НА ОБРАЗОВАНИЕ КАК МОДЕРАТОР ВЛИЯНИЯ ЦИФРОВИЗАЦИИ НА ЗАНЯТОСТЬ МОЛОДЕЖИ

В данном исследовании изучается влияние цифровой экономики на занятость молодежи в Казахстане и то, смягчают ли расходы на

образование это влияние. Рассматриваются два ключевых показателя цифровизации: проникновение интернета и инвестиции в ИКТ, а также их связь с уровнем безработицы среди молодежи. Используя данные по Казахстану за последние два десятилетия, в данном исследовании проводится корреляционный анализ и регрессионное моделирование с использованием коэффициентов взаимодействия для проверки наших гипотез. Результаты подтверждают, что проникновение интернета увеличивает занятость молодежи и что этот эффект существенно усиливается при высоких государственных расходах на образование. При низком уровне инвестиций цифровизация перестает способствовать занятости молодежи. Аналогичная тенденция наблюдается и в отношении инвестиций в ИКТ, но с меньшим эффектом. Эти результаты свидетельствуют о том, что инвестиции в человеческий капитал по сути дополняют политику, направленную на использование преимуществ цифровой экономики в сфере занятости. В статье этот вывод рассматривается на стыке быстрой цифровой трансформации в Казахстане и реформ в сфере образования, что вносит вклад в литературу о поддержке молодежи, оказываемой государственными расходами на образование.

Ключевые слова: цифровизация, безработица среди молодежи, расходы на образование, проникновение интернета, инвестиции в ИКТ.

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