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Article

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The Effect of Electricity Generation, Thermal Energy Production, Fixed Capital Investment, and Consumer Price Index on Economic Growth in Kazakhstan

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ABSTRACT

Many local and global factors affect the growth of national economies. Among these factors, energy production is one of the main sources of economic growth. This study examines the impact of energy production, especially electricity generation and thermal energy production, on economic growth in Kazakhstan. To provide a better explanation for the effect of energy production on economic growth, we also included fixed capital investment and consumer price index variables in our research model. Thus, economic growth data, fixed capital investments, consumer price index, electricity generation, and thermal energy production are determined as research variables. Research data were obtained from the databases of the World Bank and the National Bureau of Statistics of the Republic of the Agency of Strategic Planning and Reforms of Kazakhstan. The data range is from 2002 to 2020. The findings showed that fixed capital investment has the most dominant effect on economic growth. This is a natural result from a macroeconomic point of view. Another critical finding is that both electricity generation and fixed capital investments have a positive effect on economic growth. When the variable of the amount of electricity generated is included in the model, the explanatory power of the model increases from 85% to 90.7%. However, the effect of thermal energy production was found to be statistically insignificant. This insignificance is a research problem that needs to be analyzed in detail, taking into account the general energy production structure of Kazakhstan.

Keywords: Kazakhstan, Electricity Generation, Thermal Energy, Fixed Capital Investment, Consumer Price Index, Multivariate Regression
Jel Classifications: C13, C20, C22

1. INTRODUCTION

This study examines the impact of energy production, especially electricity generation and thermal energy production, on economic growth. To provide a better explanation for the effect of energy production on economic growth, we also included fixed capital investment and consumer price index variables in our research model.

Kazakhstan gained its independence after the collapse of the Soviet Union and soon started a major transformation in its economic mentality. In this way, it expanded its economy and experienced a rapid and great transformation by integrating with the world economy. National economies such as Kazakhstan, which experienced a series of changes to adapt to the free market economy after the Soviets, were called transition economies (Kökocak, 2011). Since transition economies are a subject of interest, many academic studies have been conducted on different dimensions of economic growth (GDP) in Kazakhstan (Alagöz et al., 2011; Khan, et al., 2012; Mudarissov and Lee, 2014; Xiong et al., 2015; Özdil and Turdalieva, 2015; Kelesbayev et al., 2022a; Raihan and Tuspekova, 2022; Mukhamediyev and Spankulova, 2020, Bolganbayev et al., 2022).

Mukhtarov et al. (2020) emphasized that Kazakhstan managed to become the second country after Russia among the post-Soviet countries in terms of economic size. Economic growth based on natural resources alone is not enough for a country's wealth. Because when a country bases its economy only on oil and similar natural resource exports, it can be adversely affected by fluctuations in world oil prices. Studies on the effect of fluctuations in global oil prices on Kazakhstan's GDP also support this effect (Bolganbayev et al., 2021; Kelesbayev et al., 2022b; Aldıbekova, 2018).

The data range is 2002-2020. The relevant data were obtained from the World Bank database and the database of the Bureau of National Statistics of the Agency of Strategic Planning and Reforms of the Republic of Kazakhstan.

2. LITERATURE REVIEW

Due to its importance, numerous academic studies have been conducted on the different dimensions of Kazakhstan's economic growth. These studies examined different variables that affect and interact with Kazakhstan's economic growth. Some of the important ones are summarized below.

Suleimenova (2016) tried to reveal the relationship between economic growth, energy consumption, and financial development in Kazakhstan in her master's thesis titled "Empirical Analysis on the Relationship between Energy, Finance, and Growth in Kazakhstan (1994-2013)." She analyzed empirical data and differentiated economic growth models using models such as the vector autoregression model for cointegration, Johansen cointegration, and impulse response tests for Kazakhstan, using data from 1994 to 2013. She concluded that there is a strong and long-term relationship between economic growth, energy consumption, and trade openness factors in Kazakhstan.

Aldıbekova (2018), in her doctoral thesis titled "The Effects of Oil Prices on the Economy of Kazakhstan," examined the structure of the oil market and the role of oil in economic development, the general view of the economy of Kazakhstan, the importance of oil in the economy of Kazakhstan and the effects of developments in oil prices on the economy of Kazakhstan. She concluded that the declines in oil prices negatively affected the economic growth of Kazakhstan.

Yağmur (2019), in her doctoral thesis titled "The Curse of Natural Resources and Kazakhstan's Economic Policies," states that Kazakhstan can be defined as an economy based on natural resources and industries such as metalworking and petrochemicals that partially use these resources. She argued that most of the problems associated with the curse of natural resources thesis are valid for Kazakhstan. Thus she argues that problems such as low economic growth, an undiversified economy, over-dependence on natural resource exports, energy and capital-intensive production structure, low institutional and managerial quality, and insufficient investment in human capital are valid for Kazakhstan.

Syzdykova (2020), in her article titled "Kazakhstan's Renewable Energy Potential," draws attention to various factors that prevent renewable energy technologies from becoming more widespread in Kazakhstan. These include low electricity tariffs, transmission losses, outdated and inefficient technologies, weak regulatory and legal frameworks, and a high-risk business environment. She also presents her recommendations to overcome these obstacles.

Ongdash et al. (2020), in their article named "Economic Growth Modeling for the Republic of Kazakhstan Based on the Higher Energy Efficiency Level," aimed to develop a model that will provide energy efficiency, which is an important factor in establishing a sustainable economy in Kazakhstan. They suggest that the Republic of Kazakhstan should reject existing global projects and instead focus on solving local problems to reduce energy costs. They stated that further research on this subject could determine the direction that the investment policy in the energy sector should take in connection with Kazakhstan's development strategy.

Ahmad et al. (2017), in their article titled "Multi-criteria evaluation of renewable and nuclear resources for electricity generation in Kazakhstan", subjected renewable and nuclear resources, which can be alternatives to fossil-based resources, for electricity generation in Kazakhstan, to a multi-criteria evaluation. They showed that Kazakhstan has the potential to develop a non-fossil fuel-based electricity system.

Xiong et al. (2015), in their article titled "The relationship between energy consumption and economic growth and the development strategy of a low-carbon economy in Kazakhstan", examined the relationship between energy consumption and economic growth in Kazakhstan and the development strategy of a low-carbon economy. They suggested strategies for Kazakhstan, such as improving the energy consumption structure, developing renewable energy, using cleaner new production technologies, adjusting the industrial structure accordingly, and expanding forest areas.

Kurmanov et al. (2020), in their article titled "Energy Intensity of Kazakhstan's GDP: Factors for its Decrease in a Resource-export Developing Economy," revealed that Kazakhstan continues to use several times more energy per production unit than the more developed countries and regions of the world. They examined the impact of various factors on GDP energy intensity, such as indicators that characterize the country's economic growth, energy industry, and living standards. They argued that using energy primarily in the production of products with high added value is more rational for Kazakhstan in terms of both economic development and energy saving.

Bolganbayev et al. (2021), in their article titled "The Effect of Oil Prices on the Economic Growth of Oil Exporting Countries Bordering the Caspian Sea: Panel Data Analysis", examined the effects of oil price fluctuations on the economic growth of Russia, Iran, Kazakhstan, and Azerbaijan. They used the panel data analysis method and quarterly data for the period 2007–2020.

Karatayev and Clarke (2016), in their article "A review of current energy systems and the green energy potential in Kazakhstan", first provide an overview of Kazakhstan's current energy system. Then, they identified the main obstacles preventing the diffusion of renewable energy technologies in Kazakhstan and suggested some measures. They emphasized that Kazakhstan has resources such as wind energy, solar energy, biomass, and hydro energy that can be alternatives to fossil fuels.

3. METHOD AND ANALYSIS

This research aims to analyze the effect of energy production, especially electricity generation and thermal energy production on economic growth in Kazakhstan. To better explain this effect, fixed capital investment and consumer price index are also included in the research. Thus, the research variables were determined as follows:

X1 Fixed capital investments in directions of use
X2 Consumer price index (2000=100)
X3 Electric power, mln. kWh
X4 Thermal energy, thsd. Gcal
Y Economic growth (GDP)

We obtained data on fixed capital investments and economic growth from the World Bank database (https://data.worldbank.org/indicator/NE.GDI.FTOT.CD?locations=KZ, https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=KZ), and consumer price index (2000=100), electricity generation and thermal power generation data from the database of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (https://stat.gov.kz/). The data range is from 2002 to 2020.

Explanatory statistics are presented given in Table 1 and the changes over time are presented visually in Graph 1. Explanatory statistics show that all variables fit normal distribution according to the Jarque-Bera test. As can be seen from the graph in Graph 1, all of the variables follow an exponential increase trend over time. In line with these observations and the literature, the logarithms of the variables were used in the analysis.

The first dimension of econometric time series to be analyzed is their stationarity. Because if a series is not stationary, the results do not reflect the truth and therefore they are misleading. Stationarity of a series is also an important criterion for models in which relationships between two or more variables are analyzed. The relevant variables must be at the same level and stationary. Therefore, various unit root tests have been developed to examine stationarity in time series. Augmented Dickey-Fuller (ADF) test was used in this study. The test statistic is obtained using the following equation:

$$\Delta Y_t = \beta_0 + \beta_1 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

In the ADF test, if the null hypothesis is rejected for the k=0, 1, 3, values, the series is considered stationary for the relevant level (Sevüktekin and Nargeleçekenler, 2007). The ADF test findings of the research variables are given in Table 2. The findings showed that LOGX1 and LOGY variables were stationary at the level, while LOGX2, LOGX3, and LOGX4 variables were stationary at the first difference. Since the difference levels of all variables were the same, the first differences of the variables were used.

Regression analysis aims to model the relationship between a dependent variable and independent variables and to produce estimations with this model. ANOVA (F) test is used to determine the significance of the model. The rate at which the independent variable explains the change in the dependent variable is expressed by the adjusted determination (adjusted R-squared) coefficient. Statistically, the significance of the variable coefficients (Beta coefficient) is determined by the student test.

This study examines the effect of energy production on economic growth with three stepwise regression models.

$$\text{Model 1: } \Delta Y_t = \alpha + \beta_1 \Delta X_{1t} + \beta_2 \Delta X_{2t} \quad (2)$$

$$\text{Model 2: } \Delta Y_t = \alpha + \beta_1 \Delta X_{1t} + \beta_2 \Delta X_{2t} + \beta_3 \Delta X_{3t} \quad (3)$$

$$\text{Model 3: } \Delta Y_t = \alpha + \beta_1 \Delta X_{1t} + \beta_2 \Delta X_{2t} + \beta_3 \Delta X_{3t} + \beta_4 \Delta X_{4t} \quad (4)$$

The effect of the consumer price index and fixed capital investments on economic growth is included in all three models. Thus, with the contribution of fixed capital investments and the consumer price index, the effect of energy production on economic growth has been demonstrated more realistically.

In multivariate regression models, when there is a high level of correlation between independent variables, this is called the multicollinearity problem. Multicollinearity is important and needs to be fixed as it leads to inconsistent estimates. This problem can be detected by the condition index calculated using the eigenvalues of the correlation matrix. With the largest eigenvalue of the correlation matrix being λ_{max},

Table 1: Explanatory statistics

	X1	X2	X3	X4	Y
Mean	3.27E+10	254.5921	85438.21	89593.62	1.38E+11
Median	3.60E+10	240.5	86585.5	90829.3	1.48E+11
Maximum	5.18E+10	451.5	108628.4	103350.3	2.37E+11
Minimum	5.92E+09	113.4	58330.5	77759.6	2.46E+10
Standard deviation	1.38E+10	107.6273	15371.34	6962.27	6.55E+10
Skewness	–0.740077	0.358008	–0.084444	–0.116922	–0.384523
Kurtosis	2.449292	1.901472	1.934984	2.286431	1.980998
Jarque-bera	1.974525	1.361225	0.920536	0.446392	1.290255
Probability	0.372595	0.506307	0.631114	0.799958	0.524596

Graph 1: Line graph of the research variables

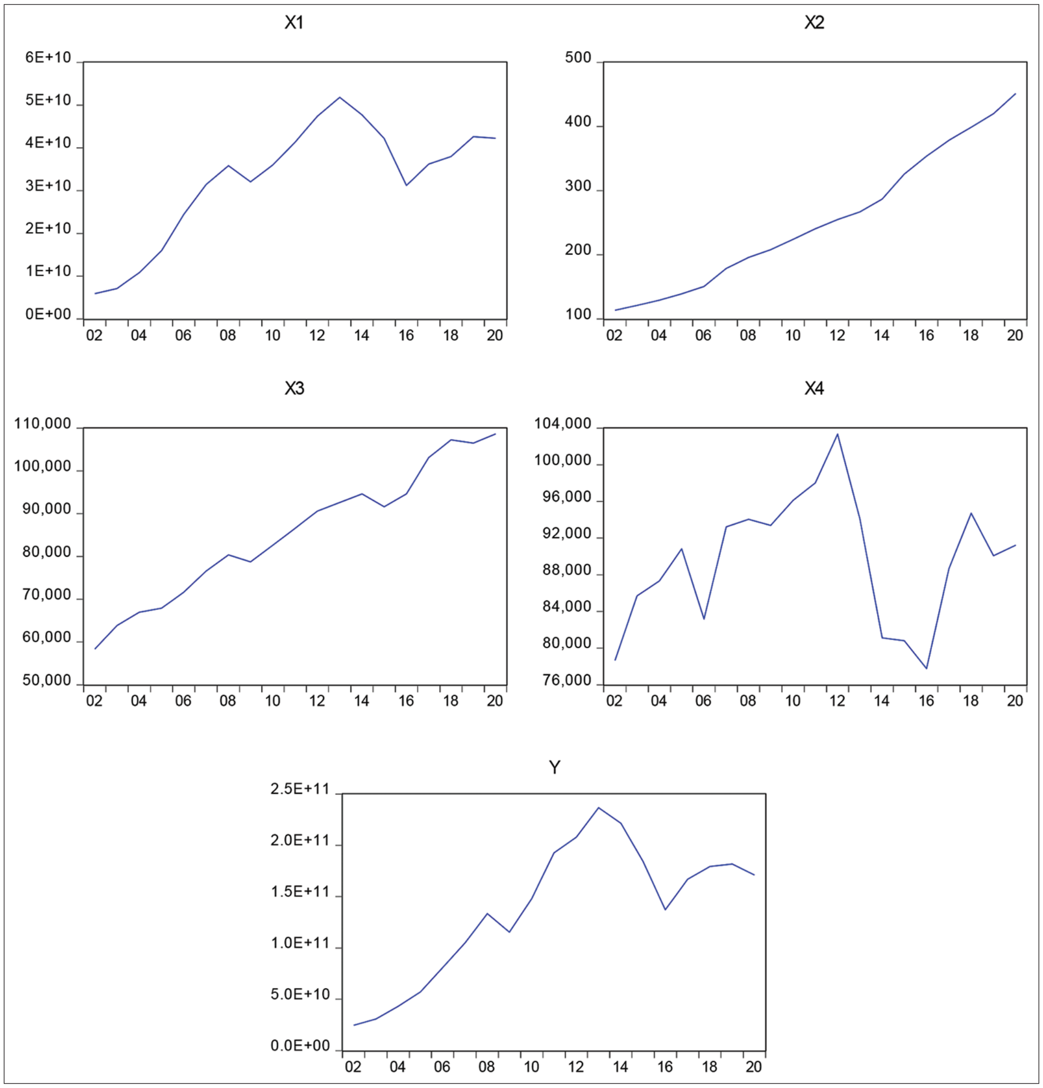

Table 2: ADF unit root test findings of research variables

	Level		First diference		Conclusion
	t-statistics	P-value	t-statistics	P-value	
LOGX1	–4.001375	0.0075	–1.934833	0.3099	I (0)
LOGX2	–0.934171	0.7527	–3.102844	0.0455	I (1)
LOGX3	–1.659840	0.4312	–4.632301	0.0026	I (1)
LOGX4	–2.526818	0.1260	–4.013459	0.0078	I (1)
LOGY	–3.583295	0.0174	–2.407013	0.1544	I (0)
Test critical values					
1% level	–3.857386		–3.886751		
5% level	–3.040391		–3.052169		
10% level	–2.660551		–2.666593		

$$\kappa = \sqrt{\frac{\lambda_{\max}}{\lambda_i}}$$

the above condition index value is calculated for each eigenvalue of λ_i. A condition index exceeding 15 informs about the existence of negative effects related to multicollinearity, while a value above 30 indicates that remedial measures should be taken (Alpar, 2013). Multicollinearity findings of the research variables are given in Table 3. The findings show that there is no multicollinearity between the variables in the model.

Table 3: Multicollinearity results of research variables

Dimension	Eigenvalue	Condition ındex
1	3.135	1.000
2	0.997	1.774
3	0.577	2.331
4	0.236	3.642
5	0.054	7.606

The findings regarding the effect of energy production on economic growth according to multivariate regression are presented in Table 3.

Table 4: Results of regression analysis on the effect of SMEs on economic growth

Variables	Model 1		Model 2		Model 3	
	Beta	t	Beta	t	Beta	t
X1	0.922	9.212 (*P*<0.05)	0.801	8.779 (*P*<0.05)	0.802	8.482 (*P*<0.05)
X2	0.011	0.112	0.000	–0.001	0.006	0.068
X3			0.268	2.931 (*P*<0.05)	0.280	2.621 (*P*<0.05)
X4					–0.025	0.244
F	42.485 (*P*<0.05)		45.518 (*P*<0.05)		31.861 (*P*<0.05)	
R^2	0.850		0.907		0.907	
ΔR^2	0.850 (*P*<0.05)		0.057 (*P*<0.05)		0.000 (*P*>0.05)	

The regression analysis findings in Table 4 show that the effect of fixed capital investment on economic growth is statistically significant in all three models. In Model 1, only fixed capital investment and consumer price index are used. Considering that the effect of only the consumer price index in this model is statistically insignificant, it can be said that according to Model 1, fixed capital investments explain 85% of the variability in economic growth. The effect of the consumer price index on economic growth was found to be statistically insignificant in all three models. The effect of energy production on economic growth is examined with two variables. The electricity generation variable is included in Model 2. Both in Model 2 and Model 3, the effect of the electrical energy production variable was found to be statistically significant. The increase in the coefficient of determination by including the electricity generation variable in Model 2 was found to be statistically significant. However, the effect of thermal energy production was not statistically significant. Accordingly, the inclusion of this variable in the model did not provide a statistically significant increase in the coefficient of determination.

4. CONCLUSION AND RECOMMENDATIONS

One of the main sources of economic growth is energy production. This study examined the impact of energy production, especially electricity generation and thermal energy production, on economic growth. To provide a better explanation for the effect of energy production on economic growth, we also included fixed capital investment and consumer price index variables in the research model.

The findings showed that fixed capital investment has the most dominant effect on economic growth. This is a natural result from a macroeconomic point of view. Another critical finding is that both electricity generation and fixed capital investments have a positive effect on economic growth. When the variable of the amount of electricity generated is included in the model, the explanatory power of the model increases from 85% to 90.7%. However, the effect of thermal energy production was found to be statistically insignificant. This insignificance is a research problem that needs to be analyzed in detail, taking into account the general energy production structure of Kazakhstan.

This study considers energy production throughout the country. Regions can be included in statistical models and the effects of regions can be evaluated using panel analysis methods. Thus, it can be revealed whether the effect of energy production varies from region to region.

Adding different variables to the research could also broaden our understanding of the impact of energy production on economic growth. In this context, some of the macro variables (such as population, schooling level, level of health services, and household expenditure structure) can be used as control variables, and the effect of energy production can be evaluated from a different perspective.

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