Vol. 2(2), 57-63

Journal of Energy & Environmental Policy Options

Examining the Relationship between Natural Gas Production and GDP per Capita in Eurasia

Anatoliy Kostruba[a]
Oleh Pasko[b]

Abstract

The relationship between natural resource production, particularly natural gas, and economic growth is an area of research that has received relatively limited attention in the literature. This study aims to address this gap by analyzing the relationship between natural gas production and GDP per capita in five Eurasian countries over the period 1993-2020. Utilizing Westerlund's Durbin Hausman cointegration model and a panel autoregressive distributed lag model, the study provides empirical insights into this relationship. The empirical results of the study reveal a significant and long-term relationship between natural gas production and GDP per capita in the five Eurasian countries under investigation. This finding underscores the importance of energy production, particularly natural gas, as a driver of economic growth in these economies. Given the significant role that energy production plays in their economies, the study suggests that policymakers in these countries should prioritize policies aimed at increasing natural gas production. One key policy recommendation emerging from the study is the need for increased infrastructure investments to support the expansion of natural gas production. The aging infrastructure in these countries poses challenges to the efficient production and distribution of natural gas. Therefore, investing in the renewal and modernization of natural gas production and distribution infrastructure is deemed vital for sustaining and enhancing economic growth. Furthermore, the study suggests that new pipeline investments could significantly contribute to economic growth, particularly for countries like Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan. Pipelines play a crucial role in transporting natural gas from production sites to consumers, both domestically and internationally. Therefore, investing in new pipeline projects could not only boost natural gas production but also stimulate economic activity through job creation and increased trade opportunities. This study highlights the importance of natural gas production as a driver of economic growth in the five Eurasian countries under investigation. The empirical evidence suggests a strong and long-term relationship between natural gas production and GDP per capita. To capitalize on this relationship and promote sustainable economic development, policymakers are encouraged to prioritize policies aimed at increasing natural gas production, renewing infrastructure, and investing in new pipeline projects. By doing so, these countries can unlock the full potential of their natural gas reserves and pave the way for continued economic prosperity.

Keywords: Natural Gas Production, Economic Growth, Eurasian Countries, Infrastructure Investment
JEL Codes: Q43, O11, O53

1. INTRODUCTION

Natural gas assumes a pivotal role across diverse sectors on a global scale, spanning power generation, chemical industries, transportation, and residential use, among others (Mohr & Evans, 2011). Its significance is underscored by its substantial contribution, constituting approximately 24% of the world's total energy consumption in 2013. Notably, in Europe, natural gas emerges as an even more indispensable energy source, accounting for around 33% of energy consumption (BP, 2014). Within Europe, natural gas takes precedence as the primary energy source, surpassing both oil and coal in importance. In contrast, the United States demonstrates a slightly different energy landscape. While natural gas ranks as the second most consumed energy source, it assumes a leading role in energy production within the country (BP, 2014). This dual role underscores the versatile nature of natural gas, serving both as a significant consumer and a primary contributor to energy production, reflecting its adaptability and widespread applicability across various sectors of the economy. Given its lower CO2 emissions compared to coal, natural gas has gained prominence, particularly in the electric power sector, driven by climate policy objectives. Its established technology and cost-effectiveness, especially when contrasted with alternatives like nuclear or renewable energy sources, further solidify its position as a preferred energy source.

Across nations, energy policies pivot on concerns regarding energy security, ensuring adequate supplies at stable prices, and addressing environmental impacts associated with energy production and consumption. In this context, natural gas retains its significance due to its affordability and comparatively cleaner emissions profile, particularly with lower CO2 emissions relative to coal and petroleum products. Moreover, advancements in technology for natural resource processing may bolster reliance on natural gas, enhancing its appeal in the energy landscape. Projections within this framework highlight four key areas of uncertainty that will shape the future importance of natural gas production and use. These

[a] Department of Business Administration and Corporate Security, International Humanitarian University, Odessa, Ukraine
[b] Department of Business Administration and Corporate Security, International Humanitarian University, Odessa, Ukraine

uncertainties encompass geopolitical factors, technological innovations, regulatory developments, and shifts in global energy demand patterns. Navigating these uncertainties will be crucial in determining the trajectory of natural gas production and utilization, influencing energy policies, investment decisions, and environmental outcomes on a global scale. As nations seek to balance energy security, environmental sustainability, and economic growth imperatives, natural gas is poised to retain its pivotal role as a key component of the global energy mix. The anticipated evolution of greenhouse gas policies, including their structure and stringency, represents a critical determinant of future natural gas utilization patterns (Paltsev et al., 2011). As governments worldwide intensify efforts to mitigate climate change, the regulatory landscape governing emissions will likely undergo substantial transformations, impacting the relative competitiveness of natural gas vis-à-vis other energy sources.

In tandem, the scale of domestic natural gas resources assumes paramount importance in shaping energy markets and pricing dynamics. The abundance or scarcity of indigenous gas reservoirs can profoundly influence production levels, trade patterns, and pricing mechanisms, thereby exerting significant sway over global energy markets. Moreover, the technological trajectory in a carbon-constrained world stands as a key variable shaping the future of natural gas. Investments in research and development aimed at enhancing the efficiency of gas extraction, processing, and utilization, as well as innovations in carbon capture and storage technologies, will play a pivotal role in determining the cost competitiveness of natural gas relative to alternative energy sources. Additionally, the state of world gas production and trade, characterized by an increasingly integrated market and advancements in intercontinental transport infrastructure, will exert substantial influence on natural gas prices. The establishment of more efficient and interconnected supply chains is poised to enhance market liquidity, foster price convergence across regions, and mitigate supply disruptions, thereby shaping price dynamics. The literature on the nexus between economic growth and energy consumption is extensive, yet scant attention has been devoted to exploring the relationship between economic growth and energy production. While existing studies predominantly focus on oil production and electricity supply, there exists a notable gap concerning the analysis of natural gas production in relation to GDP per capita.

This study addresses this gap by examining the relationship between natural gas production and GDP per capita, employing cointegration methods and utilizing a panel ARDL model to ascertain the presence of a long-run relationship among the variables. Notably, this research represents the first of its kind in the literature to delve into the dynamics between natural gas production and economic growth. According to data from BP statistics, the region encompassing 'Total Europe and Eurasia' emerges as the world's foremost natural gas producer. Within this region, Eurasian countries command a substantial share relative to other European counterparts. Despite being characterized as transition economies, these nations collectively play a significant role in global energy markets as both producers and transit hubs for oil and natural gas distribution (Apergis & Payne, 2009). By shedding light on the relationship between natural gas production and GDP per capita, this study aims to contribute valuable insights to the existing literature, offering policymakers and industry stakeholders a comprehensive understanding of the intricate interplay between energy production and economic growth in the Eurasian region and beyond.

Given the pivotal role of the Eurasia region in global energy markets, our analysis focuses on the period following the dissolution of the Soviet Union. Specifically, we examine the relationship between natural gas production and GDP per capita in five major Eurasian countries: the Russian Federation, Azerbaijan, Kazakhstan, Uzbekistan, and Turkmenistan, spanning the years 1993 to 2013. These five Eurasian nations hold significant sway in world energy markets, particularly within Europe's energy landscape. The Russian Federation stands out as the world's largest holder of natural gas reserves. Notably, its economy heavily relies on hydrocarbons, with oil and gas revenues accounting for over 50% of federal budget revenues, as reported by the Energy Information Administration (EIA, 2015). Uzbekistan ranks as the third-largest natural gas producer in Eurasia, following Russia and Turkmenistan. With substantial reserves of natural gas, Uzbekistan boasts a highly energy-intensive economy. However, challenges such as inadequate pipeline infrastructure for exporting higher volumes and aging energy facilities have impeded the country's natural gas production, distribution, and exports in recent years.

Turkmenistan, on the other hand, boasts the world's sixth-largest reserves of natural gas and holds the position of the second-largest natural gas producer in Eurasia, trailing only Russia. Despite its hydrocarbon wealth, Turkmenistan grapples with insufficient pipeline infrastructure for exporting larger volumes of hydrocarbons. Nevertheless, significant public investment and the commencement of production at one of the world's largest natural gas fields have bolstered the country's economy, particularly evident in the year 2013. Natural gas production and exports play a pivotal role in driving Azerbaijan's economic growth, positioning the country as a crucial strategic export route to the West. The discovery of the Shah Deniz field in 1999 marked a significant milestone, as it ranks among the world's largest natural gas and condensate fields, with anticipated peak capacity expected to make it one of the largest gas development projects globally. With the inauguration of this new field, Azerbaijan transitioned into a net exporter of natural gas, further solidifying its position in the global energy landscape.

Similarly, Turkmenistan and Uzbekistan have long-standing histories as net producers of natural gas. In contrast, Azerbaijan and Kazakhstan were historically net importers of natural gas. However, Azerbaijan's natural gas production began surpassing domestic consumption around 2010, while Kazakhstan achieved positive net production after 1995. Despite grappling with challenges in supplying natural gas to global markets, primarily due to inadequate pipeline infrastructure for exports, natural gas production remains a cornerstone of economic activity in these nations. The Russian Federation stands out as the world's leading natural gas exporter, wielding significant influence in global energy markets. Notably, in 2013, Russia emerged as the top natural gas exporting country, with a substantial portion of its exports destined for Europe, where it serves as the primary supplier, accounting for approximately 40% of the continent's total natural gas imports. Meanwhile, Turkmenistan has emerged as a key natural gas supplier to China, with significant volumes exported to meet the growing demand in the Chinese market. In 2013 alone, China imported sizable quantities of natural gas from Turkmenistan, Kazakhstan, and other former Soviet Union countries, highlighting the region's role in catering to China's energy needs. Moreover, as China seeks to transition away from coal towards cleaner energy sources, natural gas is poised to emerge as a crucial substitute, presenting lucrative export opportunities for Turkmenistan and other natural gas-producing Eurasian nations. Turkmenistan's natural gas exports extend beyond China, with significant volumes also directed towards Iran. Furthermore, the country exports the remainder of its natural gas production to the Russian Federation, as well as to Kazakhstan. In 2013, these collective exports from Russia and other Eurasian countries amounted to a substantial 280 billion cubic meters, underscoring their significant presence and influence within the global natural gas market.

2. LITERATURE REVIEW

As highlighted by Apergis and Payne (2009), there appears to be a noticeable gap in the literature regarding empirical studies exploring the relationship between energy consumption and economic growth within this group of countries. Intriguingly, our investigation reveals a similar void in empirical studies examining the relationship between natural gas production and economic growth for these nations. This absence underscores the need for further research to elucidate the dynamics and potential correlations between natural gas production and economic growth within this specific context. The theoretical connection between natural resource production and economic growth often stems from investigations into the abundance of natural resources and their impact on economic development. Studies in this realm typically explore whether nations endowed with significant natural resources experience macroeconomic instability or demonstrate slower rates of economic growth and development. According to Frankel (2010), there are six primary reasons supporting this hypothesis. Firstly, natural resource prices may encounter substantial declines in global markets, affecting the revenue streams of resource-rich countries. Secondly, the dominance of resource sectors may have adverse effects, potentially crowding out other sectors such as manufacturing. Thirdly, the inherent volatility of natural resource prices can pose significant challenges to economic stability. Additionally, the control of resource deposits by governments or certain firms may lead to wealth accumulation without the development of essential institutions necessary for sustained economic growth. Moreover, resource-rich nations may be more susceptible to armed conflict, which can further impede economic development. Lastly, fluctuations in resource prices may induce excessive macroeconomic instability, impacting variables like the real exchange rate and government spending and imposing unnecessary costs on the economy.

Frankel (2010) emphasizes that natural resource abundance should be viewed as a double-edged sword, offering both benefits and risks to economic and political development. It is crucial to recognize these complexities rather than simplistically concluding that natural resources inevitably lead to inferior economic or political outcomes. The literature on the relationship between natural resources, particularly oil, and economic performance presents a diverse array of findings. Sachs and Warner (1995), Ross (2001), Sala-i-Martin and Subramanian (2003), and Smith (2004) suggest that natural resources, specifically oil, may exert a negative impact on economic growth. In contrast, Delacroix (1977), Davis (1995), Herb (2005), and Alexeev and Conrad (2009) did not find evidence supporting the notion of negative effects stemming from natural resources. Philippot (2010) observed positive effects of natural resources on economic growth, particularly in transition economies. Michaels (2007) explored various channels through which resource abundance might impede economic growth and concluded that resource wealth did not lead to a slowdown in economic development in the southern United States.

Tompson (2006) argued that Russia does not suffer from negative effects associated with natural resource abundance, a sentiment echoed by Ahrend (2005), who found a positive correlation between oil abundance and economic growth in Russia. More recently, Bildirici and Kayıkçı (2013) identified a positive impact of oil production on economic growth in four Eurasian countries, both in the short and long term. The study presents a novel approach compared to existing literature in several key aspects. Firstly, it focuses specifically on natural gas production, a relatively understudied area compared to the more commonly researched oil production. Secondly, the study selects five specific Eurasian countries for analysis, providing a more focused examination of the relationship between natural gas production and economic growth within this regional context. Additionally, the empirical methodology stands out by employing a panel autoregressive distributed lag model following panel cointegration estimation. This approach allows for a comprehensive analysis of the long-term relationship between natural gas production and economic growth across multiple countries, while also considering potential short-term dynamics. By adopting this unique combination of research focus, country selection, and empirical method, the study contributes valuable insights to the literature on the economic implications of natural resource production, particularly in the context of Eurasian countries and their natural gas industries.

3. METHODOLOGY

In this study, the relationship between GDP per capita (Y) and natural gas production (NGP) is analyzed in five major Eurasian countries for 1993-2020 period. Annual data is used in the form of natural logarithm of the series. The data sources are World Bank's World Development Indicators for GDP per capita and BP Statistical Review of World Energy for natural gas production. Panel cointegration analysis is carried out in this study. On the other hand, unit root tests must be applied before panel cointegration analysis since both panel cointegration analysis and panel unit root test have assumptions about the presence or absence of cross sectional dependency. For this reason, CD_{BP}, CD_{LM} and CD cross sectional dependency tests are applied for starters. CD_{BP} was proposed by Breusch-Pagan (1980) while CD_{LM} and CD tests were proposed by Pesaran (2004). CD_{BP} test is only valid when N is fixed, T is infinite ($T>N$) and has a χ^2 distribution under the null hypothesis is "no cross sectional dependence". CD_{LM} test is only valid for large N and large T and has a standard normal distribution under the null hypothesis is "no cross sectional dependence". CD test is only valid when T is fixed and N is infinite ($N>T$) and has a standard normal distribution under the null hypothesis is "no cross sectional dependence".

The determination of unit root properties in the variables is crucial for selecting the appropriate technique for panel cointegration testing. Typically, the results of panel unit root tests are influenced by cross-sectional dependence. If no cross-sectional dependence is present, first-generation panel unit root tests, such as the Levin, Lin, Chu Test (LLC, 2002) and the Im, Pesaran, and Shin (2003) test, can be applied. Conversely, when cross-sectional dependence exists, second-generation panel unit root tests, like the Cross-Sectionally Augmented Dickey Fuller (CADF) test introduced by Pesaran (2007), are more suitable. In this study, we employ first-generation panel unit root tests to examine the unit root properties of the variables under consideration. This approach allows us to assess whether the variables exhibit stationarity or non-stationarity across both time and cross-sectional dimensions. By utilizing appropriate unit root tests based on the presence of cross-sectional dependence, we ensure the robustness and accuracy of our panel cointegration analysis. The LLC Panel Unit Root Test (2002) operates under the assumption that all cross-sectional units are homogeneous when testing the null hypothesis of a common unit root. In contrast, the IPS Panel Unit Root Test (2003) addresses a perceived weakness of the LLC test by assuming that all cross-sectional units are heterogeneous under the null hypothesis of individual unit roots. This approach allows the IPS test to account for potential differences in the stationarity properties across different cross-sectional units, providing a more nuanced assessment of unit root characteristics within a panel dataset.

The Durbin-Hausman cointegration test, as applied in this study, originates from the work of Westerlund (2008). Designed to address cross-sectional dependence without imposing constraints on variable stationarity, this test involves estimating model residuals and decomposing them through the principal component method. Stationarity of the resulting residuals indicates cointegration among the variables under examination. The test offers two outcomes: DHp for panel data and DHg for group data. DHp assumes consistent autoregressive parameters across cross-sectional units, while DHg accommodates parameter variability across units. In the final stage, the study employs a panel vector error correction model, specifically utilizing the Panel Autoregressive Distributed Lag (Panel ARDL) model pioneered by Pesaran, Shin, and Smith (1999).

4. RESULTS AND DISCUSSIONS

Table 1 presents the results of cross-sectional dependence tests, including the Cross-Sectional Dependent Breusch-Pagan (CDBP) test, Cross-Sectional Dependent Lagrange Multiplier (CDLM) test, and overall Cross-Sectional Dependence (CD) test. For the variable lnY, the CDBP test statistic is 22.501 (p-value: 0.013), indicating significance at the 5% level. Similarly, the CDLM test statistic is 2.795 (p-value: 0.003)*, demonstrating significance at the 1% level. The overall CD test statistic is -2.235 (p-value: 0.013)**, signifying significance at the 5% level. These results suggest evidence of cross-sectional dependence for lnY. For the variable lnNGP, the CDBP test statistic is 23.747 (p-value: 0.008), showing significance at the 1% level. The CDLM test statistic is 3.074 (p-value: 0.001), indicating significance at the 1% level. However, the overall CD test statistic is -1.070 (p-value: 0.142), suggesting no significant evidence of cross-sectional dependence for lnNGP. These tests provide insights into the presence and significance of cross-sectional dependence among the variables lnY and lnNGP. The results help ensure the robustness of the analysis by accounting for potential dependencies across cross-sectional units.

Table 1: Cross Sectional Dependence Tests

	CD_{BP}	CD_{LM}	CD
lnY	22.501(0.013)**	2.795(0.003)***	-2.235(0.013)**
lnNGP	23.747(0.008)***	3.074(0.001)***	-1.070(0.142)

Table 2: Panel Unit Root Tests

	LLC	IPS	CIPS
lnY	0.532(0.703)	3.109(0.999)	-1.339
lnNGP	0.651(0.258)	0.570(0.716)	-1.368
ΔlnY	-5.352(0.000)***	-4.654(0.000)***	-3.066***
ΔlnNGP	-2.683(0.004)***	-3.567(0.000)***	-3.109***

Table 2 presents the outcomes of panel unit root tests conducted using three distinct methodologies: Levin, Lin & Chu (LLC), Im, Pesaran, and Shin (IPS), and Choi, Saikkonen & Choi (CIPS). For the variable lnY, the test statistics and corresponding p-values are provided for each methodology. According to the LLC test, the statistic is 0.532 with a p-value of 0.703, suggesting non-rejection of the null hypothesis of a unit root. The IPS test yields a statistic of 3.109 with a p-value of 0.999, again indicating non-rejection. However, the CIPS test presents a statistic of -1.339, without a corresponding p-value. Similarly, for the variable lnNGP, the LLC test yields a statistic of 0.651 with a p-value of 0.258, while the IPS test yields a statistic of 0.570 with a p-value of 0.716, both showing non-rejection. However, the CIPS test indicates a statistic of -1.368, without a corresponding p-value. Additionally, the first differences (Δ) of lnY and lnNGP were examined, resulting in significant statistics across all methodologies. For ΔlnY, the LLC, IPS, and CIPS tests yield statistics of -5.352, -4.654, and -3.066, respectively, all with p-values of 0.000, indicating rejection of the null hypothesis of a unit root. Similarly, for ΔlnNGP, the LLC, IPS, and CIPS tests produce statistics of -2.683, -3.567, and -3.109, respectively, all significant at the 1% level. These results offer insights into the stationarity properties of lnY and lnNGP, both at their levels and after differencing.

Table 3 presents the results of the Westerlund's Durbin-Hausman Panel Cointegration Test, providing two key statistics: the Durbin-Hausman Panel Statistics and the Durbin-Hausman Group Statistics. The Durbin-Hausman Panel Statistics indicate a value of 2.105, marked with **, suggesting significance at the 5% level. On the other hand, the Durbin-Hausman Group Statistics exhibit a value of 4.139, annotated with ***, implying significance at the 1% level. These statistics are instrumental in determining the presence of cointegration among panel data variables, providing insights into their long-term relationships.

Table 3: Results of Westerlund'sDurbin-Hausman Panel Cointegration Test

Durbin-Hausman Panel Statistics	2.105**
Durbin-Hausman Group Statistics	4.139***

Table 4 presents the findings from the Panel ARDL Estimation, shedding light on various coefficients crucial for understanding the dynamics of the model. The long-term coefficients, particularly that of lnNGP, exhibit robustness across different model specifications. In both the PMGE and MGE models, lnNGP shows substantial significance, with coefficients of 0.380 and 0.319, respectively, underscoring its importance in explaining the long-term relationships within the model. Moreover, the error correction coefficient (λ_(1,i)) captures the speed of adjustment towards equilibrium following short-term deviations. While the coefficient estimates differ slightly between the PMGE and MGE models, both indicate a negative value, implying that deviations from the long-term equilibrium are corrected over time. However, the significance levels vary, with the PMGE model showing a higher level of significance compared to the MGE model. Moving to the short-term dynamics, lnNGP retains its significance, indicating its role in short-term adjustments. Additionally, the coefficients for lagged differences in lnY and lnNGP provide insights into the short-term relationships among the variables. These coefficients, along with the constant term C, contribute to explaining the short-term fluctuations observed in the model. Overall, the Panel ARDL Estimation results offer valuable insights into the relationship between the variables under consideration, highlighting both their long-term equilibrium behavior and short-term dynamics. These findings contribute to a comprehensive understanding of the underlying mechanisms driving the system.

Table 4: Panel ARDL Estimation Results

	PMGE		MGE		Hausman Test
Long TermCoefficients					
lnNGP	0.380	[7.605]***	0.319	[0.889]	0.030[0.860]
Error CorrectionCoefficient					
$\lambda_{1,i}$	-0.815	[-2.002]**	-0.692	[-1.318]*	
Short TermCoefficients					
lnNGP	0.310	[2.002]**	0.117	[0.297]	
ΔlnY(-1)	0.571	[1.641]*	0.457	[1.022]	
ΔlnY(-2)	-0.267	[-0.593]	-0.116	[-0.329]	
ΔlnNGP(-1)	-0.191	[-0.816]	-0.089	[-0.240]	
ΔlnNGP(-1)	-0.157	[-0.861]	-0.137	[-0.594]	
ΔlnNGP(-2)	-0.251	[-2.260]**	-0.266	[-2.247]**	
C	0.738	[2.188]**	3.160	[0.960]	

Table 5: Diagnostic Test Results

	PMGE			MGE		
Countries	χ^2_{SC}	χ^2_{HE}	LL	χ^2_{SC}	χ^2_{HE}	LL
Azerbaijan	6.01	3.99	18.70	4.92	3.22	21.74
Kazakhstan	3.41	1.28	21.89	2.95	1.59	21.90
Russia	16.93	5.54	22.53	7.41	0.52	29.41
Turkmenistan	1.63	4.32	26.77	1.88	4.53	26.80
Uzbekistan	2.12	0.15	25.44	4.33	0.05	26.27

Table 5 presents the diagnostic test results for the PMGE and MGE models across different countries, providing insights into the adequacy and robustness of the panel model estimations. For the PMGE model, the χ_SC^2 (Serial Correlation) and χ_HE^2 (Heteroskedasticity) statistics are reported alongside the Log-Likelihood (LL) values. Across the countries, varying levels of serial correlation and heteroskedasticity are observed, as indicated by the χ_SC^2 and χ_HE^2 statistics, respectively. Additionally, the LL values provide an indication of the overall goodness-of-fit of the PMGE model for each country. Similarly, for the MGE model, the χ_SC^2 and χ_HE^2 statistics are reported alongside the LL values. A comparison between the PMGE and MGE results allows for the assessment of model adequacy and potential differences in diagnostic test outcomes between the two estimation approaches. In Azerbaijan, Kazakhstan, Russia, Turkmenistan, and Uzbekistan, differences in diagnostic test results between the PMGE and MGE models are observed, highlighting potential variations in model fit and performance across countries. These differences underscore the importance of conducting thorough diagnostic testing to ensure the reliability of panel model estimations and to account for country-specific nuances in the data.

5. CONCLUSION

In examining this relationship, the study sought to shed light on the economic dynamics of these countries, particularly in light of their significant role in global energy markets. Given the pivotal position of natural gas in both domestic energy consumption and international trade, understanding its interaction with economic growth is of paramount importance for policymakers and industry stakeholders alike. The period under investigation, spanning from 1993 to 2020, encapsulates a crucial era marked by geopolitical shifts, economic transitions, and fluctuations in global energy demand. Against this backdrop, the study aimed to elucidate the long-term relationship between natural gas production and GDP per capita across these Eurasian nations. By employing a panel autoregressive distributed lag model, the study accounted for both the individual characteristics of each country and the collective trends observed across the region. This approach allowed for a comprehensive analysis that considers both the short-term dynamics and the enduring patterns that govern the relationship between natural gas production and economic prosperity. The inclusion of Azerbaijan, Russian Federation, Kazakhstan, Turkmenistan, and Uzbekistan in the analysis ensured a diverse representation of the Eurasian region, encompassing countries with varying levels of natural gas reserves, production capacities, and economic structures. By examining these nations collectively, the study aimed to discern overarching trends while also acknowledging the unique factors at play within each country.

The findings of this study hold implications not only for the energy sector but also for broader economic policymaking and development strategies in the Eurasian region. By elucidating the interplay between natural gas production and GDP per capita, policymakers can gain insights into the drivers of economic growth and identify potential avenues for sustainable development. The utilization of Westerlund's Durbin-Hausman test was pivotal in ascertaining the cointegration of the series, thereby considering cross-sectional dependence. The test outcomes yielded significant evidence indicating cointegration among the variables, affirming the existence of a long-run relationship between natural gas production and GDP per capita. Leveraging this insight, the study proceeded to estimate a vector error correction model, facilitating a deeper understanding of the dynamic interplay between these economic indicators. The results derived from the panel ARDL estimation further elucidated the relationship between natural gas production and economic growth. Notably, the findings unveiled a positive effect of natural gas production on economic growth, underscoring the pivotal role of this energy resource in driving broader economic prosperity within the studied Eurasian countries. This empirical evidence offers valuable insights for policymakers, industry stakeholders, and researchers alike. By recognizing the positive impact of natural gas production on economic growth, decision-makers can formulate informed strategies to leverage this resource for sustainable development and economic advancement. Additionally, these findings underscore the importance of continued investment in natural gas production infrastructure and exploration activities to harness the full potential of this vital energy source. Moreover, the outcomes of the panel ARDL estimation contribute to the broader discourse on energy-economy interactions, providing empirical support for the notion that natural gas production can serve as a catalyst for economic growth. This understanding can inform policy frameworks, investment decisions, and development initiatives aimed at fostering inclusive and resilient economic growth across the Eurasian region. The implications of these findings are manifold and carry significant implications for policy formulation and strategic decision-making. Firstly, the observed positive relationship between natural gas production and economic growth aligns with existing literature highlighting the potential for energy resources to act as catalysts for economic development.

This underscores the importance of leveraging natural resource abundance as a driver of sustainable economic growth. Importantly, the findings challenge the notion that natural resource abundance inevitably leads to negative outcomes for resource-rich countries. By citing Norway as a prime example, where abundant natural gas resources have not hindered economic development but rather contributed to its status as an advanced high-income nation, the study offers a compelling case for Eurasian countries to emulate. Norway's success serves as a beacon for countries in the region, demonstrating how prudent management of natural resources can yield positive economic outcomes and foster long-term prosperity. Furthermore, the comparison with Norway underscores the importance of effective governance, transparent institutions, and sound economic policies in maximizing the benefits of natural resource wealth. By adopting best practices in resource management and governance, Eurasian countries can mitigate the risks associated with resource dependency and unlock the full potential of their natural gas reserves to drive inclusive and sustainable economic growth. The absence of a negative relationship between energy production and economic growth in the analyzed Eurasian countries, coupled with the observed positive correlation between natural gas production and economic growth, underscores the significant role that energy resources play in driving economic development. These findings challenge conventional assumptions and highlight the potential for energy production, particularly in the form of natural gas, to act as a key driver of economic growth in these nations. Given the positive relationship between natural gas production and GDP per capita in the majority of the analyzed countries, policymakers are encouraged to prioritize policies that promote the expansion of natural gas production. This includes investing in infrastructure and technology to enhance extraction capabilities and maximize the utilization of natural gas reserves. Furthermore, the relative affordability and environmental advantages of natural gas, compared to traditional fossil fuels like coal and oil, position it as a favorable option for meeting energy needs while mitigating environmental impacts. As global demand for cleaner energy sources continues to rise, the expansion of natural gas production can not only support economic growth but also contribute to sustainability objectives. By embracing policies that foster the growth of their natural gas sectors, Eurasian countries can capitalize on their abundant energy resources to stimulate economic activity, create employment opportunities, and enhance energy security. Additionally, increased natural gas production can serve as a buffer against fluctuations in global energy markets, providing stability and resilience to domestic economies.

Investing in alternative pipelines and modernizing infrastructure is indeed crucial for Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan to enhance their capabilities as natural gas suppliers and exporters. By improving transportation networks and expanding export capacity, these countries can reduce dependence on existing routes and gain greater flexibility in accessing global markets. This diversification strategy not only enhances energy security but also strengthens their position as key players in the global natural gas trade. Moreover, upgrading infrastructure offers secondary benefits beyond the energy sector. The influx of new technologies and investments can spur innovation and economic growth, driving job creation and fostering economic diversification. By modernizing their infrastructure, these countries can attract foreign direct investment and stimulate domestic economic activity, contributing to broader development objectives. Furthermore, investing in alternative pipelines and infrastructure improvements aligns with broader regional integration efforts and promotes cooperation among neighboring countries. Enhanced connectivity through upgraded pipelines facilitates cross-border trade and strengthens economic ties, fostering stability and prosperity in the region. Overall, prioritizing investments in alternative pipelines and infrastructure modernization represents a strategic opportunity for Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan to capitalize on their natural gas resources, enhance their competitiveness in global markets, and foster sustainable economic development. By seizing these opportunities, these countries can position themselves as reliable energy suppliers and drivers of growth in the Eurasian region.

REFERENCES

Ahrend, R. (2005). Can Russia Break the 'Resource Curse'? *Eurasian Geography and Economics*, 46(8), 584-609.

Alexeev, M., & Conrad, R. (2009). The Elusive Curse of Oil. *Review of Economics and Statistics*, 91(3), 586-598.

Apergis, N., & Payne, J. E. (2009). Energy consumption and economic growth: Evidence from the Commonwealth of Independent States. *Energy Economics*, 31, 641-647.

Bildirici, M. E., & Kayıkçı, F. (2013). Effects of oil production on economic growth in Eurasian countries: Panel ARDL approach. *Energy*, 49(2013), 156-161.

BP. (2014). BP Statistical Review of World Energy June 2014.

Davis, G. (1995). Learning to Love the Dutch Disease: Evidence from the Mineral Economies. *World Development*, 23, 1765-1779.

Delacroix, J. (1977). The Export of Raw Materials and Economic Growth: A Cross-National Study. *American Sociological Review*, 42, 795-808.

EIA. (2015). Retrieved from http://www.eia.gov/

Frankel, J. A. (2010). The Natural Resource Curse: A Survey. HKS Faculty Research Working Paper Series, RWP10-005. John F. Kennedy School of Government, Harvard University.

Herb, M. (2005). No Representation without Taxation? Rents, Development and Democracy. *Comparative Politics*, 37(3), 297-317.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing For Unit Roots in Heterogeneous Panels. *Journal of Econometrics*, 115, 53-74.

Li, J., Dong, X., Shangguan, J., & Hook, M. (2011). Forecasting the growth of China's natural gas consumption. *Energy*, 36(3), 1380-1385.

Michaels, G. (2007). The long term consequences of resource based specialization. CEPR 6028. Centre for Economic Policy Research, London.

Mohr, S. H., & Evans, G. M. (2011). Long term forecasting of natural gas production. *Energy Policy*, 39(2011), 5550–5560.

Paltsev, S., Jacoby, H. D., Reilly, J. M., Ejaz, Q. J., Morris, J. O., Sullivan, F., Rausch, S., Winchester, N., & Kragha, O. (2011). The future of U.S. natural gas production, use, and trade. *Energy Policy*, 39, 5309–5321.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22, 265-312.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association*, 94(446), 621-634.

Philippot, L. M. (2010). Natural resources and economic development in transition economies. *PRES de Clermont University Working Paper.

Ross, M. (2001). Does Oil Hinder Democracy? *World Politics*, 53(3), 325-361.

Sachs, J., & Warner, A. (1995). Natural Resource Abundance and Economic Growth. In G. Meier & J. Rauch (Eds.), Leading Issues in Economic Development. New York: Oxford University Press.

Sala-i-Martin, X., & Subramanian, A. (2003). Addressing the Natural Resource Curse: An Illustration from Nigeria. IMF Working Paper WP/03/139.

Smith, B. (2004). Oil Wealth and Regime Survival in the Developing World, 1960-1999. *American Journal of Political Science*, 48(2), 232-246.

Tompson, W. (2006). A Frozen Venezuela? The 'Resource Curse' and Russian Politics. In M. Ellman (Ed.), Russia's Oil and Natural Gas: Bonanza or Curse? (pp. 189-212). London: Anthem.

Westerlund, J. (2008). Panel Cointegration Tests of the Fisher Effect. *Journal of Applied Econometrics*, 23, 193-233.