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Research on the impact of energy consumption on economic growth from the perspective of new quality productivity

Chenchen Hu[1,*]

[1]*Department of Economics, Capital University of Economics and Business, Beijing, China*
[*]*Corresponding author: 18813098837@163.com*

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Abstract: New-quality productivity is the transformation of traditional productivity to adapt to the new stage of development. Based on the relevant data of 27 provinces and cities in China from 2010 to 2022, this paper establishes a benchmark regression model to empirically analyse the correlation between energy consumption and economic growth in China. From the perspective of new quality productivity, the decline of GDP has an obvious promotion effect on economic growth. On this basis, from the perspective of new quality productivity, policy suggestions are provided to promote the structural transformation of China's energy consumption and achieve high-quality development.

1. Introduction

In September 2023, General Secretary first put forward the concept of developing new-quality productive forces, and the subsequent report of the two sessions listed ‘accelerating the development of new-quality productive forces’ as the first of the ten important tasks in 2024, which has created a new engine and a new impetus for China's high-quality development in the new stage, and provided an important guideline for China's new journey of reform and opening up. The new stage of China's high-quality development has created a new engine and new momentum, providing important guidance for the new journey of China's reform and opening-up. Raising the level of new productivity is a major issue that the country must address in the new era, and is also an important way to achieve catching up. With the rapid development of China's economy, as well as the trend of digital economy, artificial intelligence, and big data, it provides sufficient resources and development environment for the development of new quality productivity, and promotes the construction of new social production relations and institutional systems. Based on the framework of traditional economic development requirements, this paper focuses on the actual impact of new quality productivity on economic development and explores the relationship between new quality productivity development and economic growth. The study shows that there are great regional differences in the degree of China's economic development due to factors such as geography and history, which are also important factors contributing to the development of new quality productivity. Among them, the development momentum of economically developed countries has

slowed down, and it is difficult for new productive forces to give full play to their roles in the large market that has already been formed; the economically backward regions have stronger development momentum, and the development of new quality productive forces has provided them with ample opportunities for development. Therefore, how to fully mobilise the new productive forces in the advanced regions and make them develop in a sustainable manner has become an important issue to be discussed in this paper[1].

2. Definition and meaning of new quality productivity

2.1 Definition of new quality productivity

New-quality productivity refers to a new form of productivity formed in the production process, the core features of which are innovative, high value-added and sustainable. Compared with traditional productive forces, new productive forces pay more attention to technological innovation and the optimisation of resource allocation, and the formation and development of new productive forces can help to improve productivity and economic efficiency and promote economic growth[2].

2.2 The meaning of new quality productivity

The connotation of new quality productivity includes the following aspects.

(1) Innovation: New quality productivity is centred on innovation, which improves production efficiency and economic benefits through continuous technological progress and management innovation. Innovation is the key factor to promote the development of new quality productivity, which can improve production efficiency, reduce production costs, increase the added value of the product new quality productivity innovation not only includes technological innovation, but also includes management innovation, institutional innovation and other aspects[3].

(2) High value-added: new quality productivity can create higher value-added, bringing more wealth and employment opportunities for society. High value-added is a distinctive feature of the new quality of productivity, which means that the new quality of productivity can create more value and wealth in the production process of the new quality of productivity, high value-added is reflected in the improvement of product quality, production efficiency and the expansion of market share and so on.

(3) Sustainability: new quality productivity focuses on the rational use of resources and environmental protection, with long-term development potential. Sustainability is an important feature of the new quality of productivity, which requires the full use of resources and protection of the environment in the development process of the new quality of productivity, the sustainability of the new quality of productivity is reflected in the recycling of resources, energy saving and emission reduction, green development and other aspects.

The essence of the new quality productivity is a knowledge economy, which relies on the production, dissemination and application of knowledge and information in order to improve productivity and economic efficiency. The knowledge economy is relative to the traditional industrial economy, which places greater emphasis on the important role of knowledge and information in the production process. In the era of the knowledge economy, the new quality of productive forces will become the main driving force for economic growth[4].

3. The effectiveness test of energy consumption on economic growth under the perspective of new quality productivity

3.1 Model construction

Traditional economic models cannot fit the relationship between variables well, so this paper constructs an OLS benchmark regression model to study the contribution of new quality productivity to economic growth.

$$gdp_{nt} = c + \alpha_0 gdpn_{t-1} + \alpha_1 E_{nt} + \sum_{m=2}^{M} \alpha_m Control_{nt} + \mu_n + \omega_t + \varepsilon_{nt} \quad (1)$$

Where gdp represents the level of economic growth, c is the intercept term, E represents energy consumption, which is replaced by energy consumption GDP, and Control is a series of exogenous control variables, which mainly include: fixed asset investment (Inv), consumption (Con), export (Exp), fiscal expenditure (Gov), human capital investment (Edu), and the growth rate of labour (Lab); μn is a region fixed effect to control for unobservable variable factors, ωt is a year fixed effect to control for unobservable variable factors, and εnt is a random disturbance term. n and t are region and time, respectively [5].

3.2 Description of variables and descriptive statistics

Based on the content of the study and the availability of data, this paper selects the total GDP data of 27 provinces, cities and autonomous regions (except Hainan, Qinghai, Ningxia, Hong Kong, Macao and Taiwan) from 2010 to 2022 as the explanatory variables, and the data come from the official website of the National Bureau of Statistics (NBS) and China Statistical Yearbook (CSY).

This paper refers to the research method of Lu Jiang et al. on the new quality productivity, and adopts the 'new improved entropy pitchfork-TOPSLS method' to measure the quantitative index of the new quality productivity, with the GDP of energy consumption replacing the energy consumption as the explanatory variable, and the fixed asset investment, consumption, export, financial expenditure, human capital investment and labour growth rate as the control variables. At the same time, fixed asset investment, consumption, export, fiscal expenditure, human capital investment and labour growth rate were selected as control variables, as shown in Table 1.

Table 1: List of model variables

Variable type	variable name	Role of variables	variant
explanatory variable	Economic Growth	Reflects the level of economic growth	*gdpnt*
explanatory variable	Energy consumption GDP	Reflects the level of energy consumption	*Ent*
control variable	Fixed Asset Investment	Reflects the level of fixed asset investment	*Invnt*
	Total retail sales of consumer goods	Reflects consumer demand	*Connt*
	Total imports and exports	Reflects external demand	*Expnt*
	Local public expenditure	Reflects local government fiscal spending	*Govnt*
	Number of students in higher education	Reflects the level of education	*Edunt*
	Urban employment	Reflects employment level	*Ladnt*

When choosing the explanatory variables, GDP is chosen as the indicator from the perspective of new quality productivity and the geographical characteristics of China's energy consumption structure. On the one hand, this choice is based on the fact that the origins of energy and energy raw materials in China are mostly concentrated in the inland areas, while the demand for energy consumption is mostly concentrated in the eastern areas. With the development of the new quality

of productive forces, each region needs to make full use of its own advantages according to its own actual situation, and actively integrate the local industry into the development of the new quality of productive forces. Energy consumption in GDP can fully reflect the actual situation of the local economic development, and reduce the influence of other factors [6]. On the other hand, since there are certain regional differences in the degree of economic development in China, which is spatially very similar to the spatial distribution of the difference in energy consumption, the choice of energy consumption GDP can be combined with the level of local economic development, and its role in economic growth can be objectively assessed.

Table 2 shows the statistical results of the main variables (on the original sample area, in order to reduce the error, the following tests have been excluded Hainan Province, Qinghai Province and Ningxia Hui Autonomous Region), the results show that the minimum value of the explanatory variable GDP (Gross Domestic Product) is 4,120.75, the maximum value of 129,118.60, and the median is 222.70. The data indicate that there are large regional differences among the regions tested, which again supports the unevenness of China's level of economic development illustrated above. The rest of the explanatory variables in the test also show similar trends. Accordingly, this paper uses both OLS and fixed effects models for regression [7].

Table 2: Descriptive Statistics of Major Variables

Variable	Sample size	Mean	median	statistics	Minimum value	Maximum value
gdp	351	29 375.68	22 226.7	22 240.31	4 120.75	129 118.6
E	351	0.07	0.06	0.04	0.01	0.21
Con	351	15 116.06	11 043.31	13 124.42	2 435.4	91 928.57
Exp	351	-1 009.08	-537.35	3 603.48	-14 477.1	10 329.49
Inv	351	15 644.37	12 798.94	9 941.77	2 177.9	56 522.78
Edu	351	98.07	86.12	52.81	25.12	282.33
Lab	351	610.83	505.7	376.56	194.3	2 110.9
Gov	351	5 618.97	4 908.55	2 957.01	1 376.84	18 533.08

3.3 Empirical analyses

Table 3 shows the results of the panel estimation of the relationship between energy consumption and economic growth from the perspective of new quality productivity. In (1), this paper controls the three variables of investment, export and consumption, and also controls the time effect and regional effect, and uses the OLS mixed regression method to estimate the coefficient of E is found to be -10302.91 at 1% confidence level, indicating that the energy consumption of GDP is significantly negatively correlated with the economic growth under the perspective of the new quality productivity. (2) On the basis of (1), local public financial expenditure, the number of students in colleges and universities, and the number of urban employment are added as control variables, and it is found that the coefficient of E is -10308.21 at 5% confidence level, which further indicates that the GDP of energy consumption is significantly negatively correlated with economic growth under the perspective of new quality productivity. After adding control variables, the model's goodness-of-fit slightly decreased from 0.9792 to 0.9662, indicating that the control variables of the model are appropriate; at the same time, the size of the coefficients of the explanatory variables changed little, and the direction of the change remained unchanged, so it can be considered that the model estimation results are robust[8].

Considering that there may be omitted variables that do not change over time, (3) and (4) show the estimation results of the fixed effects model. In (3), the paper controls for investment, export and consumption variables, as well as time and region effects, and then uses the fixed-effects model for estimation. At 1% confidence level, the coefficient of E is -7438.24, which indicates that energy

consumption GDP has a negative correlation with economic growth under the perspective of new quality productivity. (4) On the basis of (3), local public financial expenditure, the number of university students and urban employment are added as control variables, and it is found that the coefficient of E is -7439.18 at 1% confidence level, which further indicates that energy consumption GDP has a negative correlation with economic growth under the perspective of new quality productivity. In addition, after adding control variables, the adjusted goodness of fit of the model slightly increases from 0.9493 to 0.9881, which indicates that the control variables of the model are appropriate; at the same time, the coefficients of the explanatory variables change in a small amount and the direction of change remains unchanged, so it can be considered that the model estimation results are robust.

Table 3: Test of the effectiveness of energy consumption on economic growth under the perspective of new quality productivity

variant	mixed regression		fixed effect	
	(1)	(2)	(3)	(4)
L1.gdp	0.38***	0.36***	0.49**	0.46***
	(0.000)	(0.000)	(0.016)	(0.000)
E	-10302.91***	-10308.21**	-7438.24**	-7439.18*
	(0.001)	(0.013)	(0.009)	(0.076)
Inv	1.16***	1.21***	1.88***	1.82***
	(0.000)	(0.000)	(0.000)	(0.000)
Exp	1.20***	1.07***	1.48***	1.43***
	(0.000)	(0.000)	(0.000	(0.000)
Con	0.09***	0.08***	0.11***	0.22***
	(0.000)	(0.000)	(0.000)	(0.003)
Gov		0.11*		0.17**
		(0.064)		(0.013)
Edu		-9.91***		2.52
		(0.000)		(0.75)
Lab		1.96***		5.41***
		0.000		0.000
Constatnt	1557.79***	550.75**	-3462.56**	-3153.37***
	(0.000)	(0.028)	(0.045)	(0.002)
Observations	351	351	351	351
ρ			39.060***	15.220***
time effect	containment	containment	containment	containment
regional effect	containment	containment	containment	containment
Adjusting the goodness-of-fit	0.9792	0.9662	0.9493	0.9881

Note: *, ** and *** denote significance levels of 10 per cent, 5 per cent and 1 per cent, respectively, with p-statistics in parentheses.

According to the results of the test, it can be seen that the GDP of energy consumption has a significant impact on economic growth in the perspective of new quality productivity. The reduction of energy consumption GDP will effectively promote economic growth. Since China's reform and opening up, the socialist market economy has entered a period of rapid development, and to date, China's average annual economic growth rate has reached about 10%, in the background of rapid economic development, is a huge consumption of energy. The report of the 20th CPC National Congress proposes that ‘high-quality development is the primary task of building a modern socialist country in all aspects’, and makes a strategic plan for ‘accelerating the construction of a new development pattern, and striving to promote high-quality development’. High-quality development

of the economy requires the entire industry to reduce costs and increase efficiency, and to improve the efficiency of the use of various factors of production and energy. The reduction of energy consumption GDP can, on the one hand, effectively reduce the production cost of the whole industry, significantly improve the profitability of enterprises, and at the same time promote the transformation and upgrading of machinery and tools in the industry, driving the development of the whole industrial chain[9]. On the other hand, the reduction of energy consumption GDP echoes the requirements for new industries, new technology and new energy under the new quality productivity. Economic and social development is accompanied by the emergence of serious problems such as environmental pollution, resource shortage and energy crisis, which requires the whole society to adopt new technologies to promote the technological upgrading of all factors and the innovative development of the whole industry. In this process, new quality productivity is also gradually formed, and feeds back to economic growth.

4. Conclusions and Recommendations

4.1 Conclusion

Empirical tests show that energy consumption GDP has a significant negative correlation with economic growth under the new quality productivity perspective. Reducing energy consumption GDP can effectively promote economic growth. However, the development level of NPP in China shows distinctive geographical differences, which are not coincidental but closely related to the economic and social development of each region. Theoretically, regions with higher economic levels tend to lead the country in terms of new quality productivity, mainly due to their significant advantages in scientific and technological innovation, industrial restructuring, and talent concentration, etc. In contrast, the level of new quality productivity in less-developed regions is often lower than that in other regions. In contrast, less economically developed regions have relatively low levels of NPP. These regions often face problems such as insufficient scientific and technological innovation, lagging industrial restructuring, and brain drain, which constrain the development of new quality productivity.

4.2 Suggestions

(1) Improve the development level of new quality productivity and strengthen the innovation drive

Increase investment in scientific and technological innovation and enhance R&D capabilities. Governments at all levels should increase financial support for the development of new quality productivity, encourage enterprises to increase R&D investment, promote breakthroughs in key core technologies, and form a number of innovative achievements with independent intellectual property rights.

(2) Give full play to regional advantages and lead high-quality development

Inland regions should deeply analyse the core elements of scientific and technological innovation, industrial restructuring and talent gathering, and increase policy support and capital investment. In view of the problem that the business income of high-tech industries is not significant, special policies should be formulated to encourage the establishment and development of high-tech enterprises, and to attract more high-quality capital, high-end technology and innovative talents through tax exemptions and financial support, so as to push forward the overall improvement of the level of new high-quality productivity in inland areas. Coastal regions, with their unique geographical advantages and strong economic foundation, should give full play to their advantages to further enhance the quality of the development of new quality productivity. By strengthening

co-operation and exchanges with international advanced science and technology, and introducing advanced foreign technology and management experience, the new quality productivity of the coastal region will be pushed to achieve a breakthrough at a higher level.

References

[1] Wang Fei, Han Xiaoyuan, Chen Ruihua. New quality productivity empowers modern industrial system: internal logic and realisation path [J]. Contemporary Economic Management, 2024, 46(6): 12-19.

[2] Wang Guocheng, Cheng Zhenfeng. New quality productivity and basic economic mode conversion [J]. Contemporary Economic Science, 2024, 46(3): 71-79.

[3] Jin Bei. On the national strategy and policy orientation of 'new quality productivity' [J]. Journal of Beijing Institute of Technology (Social Science Edition), 2024, 24(2): 1-8.

[4] SONG Jia, ZHANG Jinchang, PAN Yi. The impact of ESG development on firms' new quality productivity: empirical evidence from Chinese A-share listed firms [J]. Contemporary Economic Management, 2024, 46(6): 1-11.

[5] Zhang Silu, Guo Chaoyi, Zhou Ziqiao, Pan Yujie, Ma Xiaotian, Dai Hancheng. Emission reduction contribution and economic cost of China's main coal-producing provinces and regions under carbon neutral target [J]. Coal Economics Research, 2024, 44(1): 6-13.

[6] Jia Zongqian, He Tian, Hu Sihu, Mao Xinyan. Analysis of correlation between coal production and consumption and economic growth in Gansu Province [J]. China market, 2024(14): 20-23+122.

[7] Zhou ZQ. Research on the impact of green technology innovation on the decarbonisation of energy consumption in the context of 'double carbon' - an empirical analysis based on five northwestern provinces [J]. Commercial Exhibition Economy, 2024(6): 155-158.

[8] Qi Haozhi. Research on economic development stage, financial structure and economic growth [D]. Wuhan: Zhongnan University of Economics and Law, 2018.

[9] Dirma V .The Impact of Renewable Energy Development on Economic Growth [J]. Energies, 2024.