Study on Causal Relationship between Expressway Construction and Regional Economic Development in Shandong Province

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Abstract

By collecting historical data of highway mileage and gross national product in Shandong Province in the past ten years, it analyzes the pulling effect of highway construction on the regional economy and explores the causal relationship between the two. Carry out Granger causality test and impulse response analysis on historical data, and use the VAR model to obtain the interaction between highway construction and the regional economy of Shandong Province. The results found that the second phases of the expressway after its completion and opening to traffic have the greatest effect on the economy, and the impact of the expressway on the economy of Shandong Province at this stage is less than the promotion effect of the good economic development trend on the construction of the expressway, which means only Promoting economic development by increasing highway construction can no longer meet the current needs of the development of Shandong Province, and will provide a solid theoretical support for the future highway construction and regional economic development in Shandong Province.

Keywords

Transportation Planning and Management; Shandong Province; Expressway; Regional Economy; VAR Model.

1. Introduction

Highway controls the main context of highway transportation, and its construction investment can not only have a direct impact on the regional economy, but also promote the regional concentration of economic activities along the route and local areas [1-3]. Highway as one of the most important transportation infrastructure, its convenient and fast characteristics of "door to door" play a great role in speeding up the modernization of regional economy in Shandong Province. In recent years, most scholars have verified through various methods and models that expressways can reduce transportation costs, save time costs, and promote the development of integrated transportation system, so as to strengthen the spatial interaction between regions. promote large-scale economic growth in the region [4-9].

At the end of 2019, the density of expressways in Shandong Province is 4.19 km / 100 square kilometers, ranking eighth in the country, and the expressway construction in Shandong Province has transitioned from the period of rapid development to the period of sustainable development at the present stage. Whether the construction scale of expressways in Shandong Province can keep up with the pace of regional economic development in Shandong Province at the present stage is a question to be explored. The study of the causal relationship between highway construction and regional economic development at the present stage is of great significance for the near-medium-and long-term planning of highway network in Shandong Province.

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2. Oresearch Object and Model Method

2.1. Research Object

Shandong Province is the strategic node of China's opening up from south to north and gradient development from east to west, taking into account the advantages of land and sea development. The GDP of Shandong Province has grown at an average annual rate of 10.7% since 2000 and reached 7.10675 trillion yuan in 2019. The mileage of expressways ranks ninth in the country with 6447 kilometers. In macroeconomic research, gross national product (GDP) is generally used to quantify economic growth, and highway mileage is used to represent highway construction, so this study selects Shandong Province's gross national product (GDP) and highway mileage (HGL) to explore the relationship between highway construction and economic development in Shandong Province.

2.2. Model Method

Vector autoregressive (VAR) model can simultaneously satisfy the analysis of endogenous problems, stationarity problems, and linkage effects among indicators. It is a commonly used econometric model for scholars to deal with economic problems in recent years [10-12]. In addition, the VAR model has no premise constraints, so it is necessary to determine the number of lag periods and use the lag values of endogenous variables in the system to construct the model. Based on the above analysis, the research model of the relationship between expressway and economic growth in Shandong Province chooses VAR model. In order to eliminate the large volatility of the original data, make the data show random normal distribution as much as possible, and reduce the absolute value of the data to facilitate the model analysis without changing the original correlation of the data, we deal with the logarithm of the two indicators respectively, and the processed variables are expressed as LNGDP and LNHGL [13-17] respectively, and the formula 1 is obtained through this index.

$$LNGDP_t = \alpha_1 + \sum_{n=1}^{N} \beta_{1n} LNGDP_{t-n} + \sum_{n=1}^{N} \gamma_{1n} LNHGL_{t-n} + \delta_{1t}$$

$$LNHGL_t = \alpha_2 + \sum_{n=1}^{N} \beta_{2n} LNGDP_{t-n} + \sum_{n=1}^{N} \gamma_{2n} LNHGL_{t-n} + \delta_{2t}$$

(1)

Among them, α、β、γ are the parameters to be estimated in the vector autoregressive model; δ_{1t}、δ_{2t} is the error term, t represents the year, and n represents the order of lag.

3. Empirical Analysis

3.1. Sequence Stationarity Test

Before testing the correlation between highway construction and economic growth in Shandong Province, the stationarity of index data (GDP and HGL) is tested. Stationarity, that is, the stability of the mean, variance and covariance of time series, is generally realized by ADF

unit root test. The unit root test results of LNGDP and LNHGL by Eviews10.0 are shown in Table 1[18].

Table 1. Results of stationarity test of variables

Variable	ADF Test	Inspection type(c,t,k)	1% critical value	5% critical value	P-Value	Results
LNGDP	-4.699	(c,t,4)	-4.2971	-3.213	0.006	Steady
LNHGL	-5.755	(c,t,3)	-5.1245	-3.933	0.005	Steady

Note: a. In the test form (c,t,k), c,t,k represents the constant term, time trend term and lag order in the model, respectively; b. The choice of lag period is based on AIC information criterion.

The results of ADF unit root test show that both LNGDP and LNHGL are stationary series, and the test results are less than the critical values at 1% and 5% significance levels, which satisfies the condition of sequence stationarity, and a vector autoregressive model can be created.

3.2. Robustness Test

The VAR model mainly reflects the linkage relationship between variables by selecting the optimal lag order. Therefore, according to the test results of LR, PEP, AIC, SC and HQ (Table 2), it can be seen that lagging behind one order is the best choice. Secondly, after selecting the optimal lag order, the robustness of the VAR model is tested. After the visualization of the test results, it is found that all the points fall in the unit circle, and the reciprocal of the root is less than 1, indicating that the constructed VAR model system is stable and can be further analyzed.

Table 2. Lag test results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	19.009	0.000	0.000	-2.835	-2.754	-2.865
1	54.342	52.999*	-2.982*	-8.057	-7.814*	-8.146
2	57.445	3.619	0.000	-7.907	-7.503	-8.057
3	63.566	5.101	0.000	-8.260940*	-7.695	-8.470392*

3.3. Granger Causality Test

On the basis of the above analysis, it is necessary to test the lag impact of highway construction and economic variables in Shandong Province. By introducing the lag terms of the two variables into the equation of the other variable, if the test results have Granger causality, it means that there is a causal relationship between the two. It has been determined that the optimal lag order is the first order, and the final Granger causality test results are shown in Table 3 [19-20].

Table 3. Granger causality test results

Original hypothesis	Number of samples	Lag order	F statistics	P-value
LNHGL is not the Granger reason of LNGDP.	14	1	0.054	0.821
LNGDP is not the Granger reason of LNLC.			3.494	0.088

The results of Table 1-Table 3 show that the lag order is 1, and at 10% confidence level, highway construction is not the Granger cause of economic development is accepted, while economic development is not the Granger reason of highway development is rejected. this shows that economic development has an obvious impact on highway construction. In other words, there

is a unilateral causal relationship between highway construction and economic growth, that is, economic growth can be considered as the Granger cause of highway construction, and the reverse is not true.

3.4. Impulse Response Analysis

In the VAR model, impulse response analysis can predict the impact of a variable transmitted to another variable through the dynamic structure of the model. The impulse response analysis of LNGDP and LNHGL is carried out respectively, and the results are shown in figure 1 and figure 2.

As can be seen from figure 1, the impulse response of the standard information pulse of the LNGDP random error term to itself is positive, with an initial response of 2.15%, and then decreases slowly, but has been at a high level. The response of the information pulse to LNHGL is also positive, and the value is maintained in the fourth period after reaching the maximum value of 3.46% in Phase 2, and then begins to decline slowly, and finally tends to a stable value. This means that the driving effect of highway construction on economic growth in Shandong Province is very rapid, and the driving effect of Phase 2-4 is the greatest after the highway is completed and opened to traffic.

Then the impulse response of LNHGL is analyzed, as shown in figure 2. The standard information pulse response of LNLC random error term is positive to itself and to LNGDP pulse. Specifically, the impulse response of the standard information pulse of the LNLC random error term to the LNGDP reached the maximum value of 12.6% in the first period, and then continued to decline, and basically maintained at the 5% level after the 8th period, while the response of the information pulse to itself reached the maximum in the third period and declined slowly after intersecting with the response value curve to LNGDP, and the curve has been above the response curve to LNGDP ever since. This means that national economic growth has a significant positive relationship with highway construction.
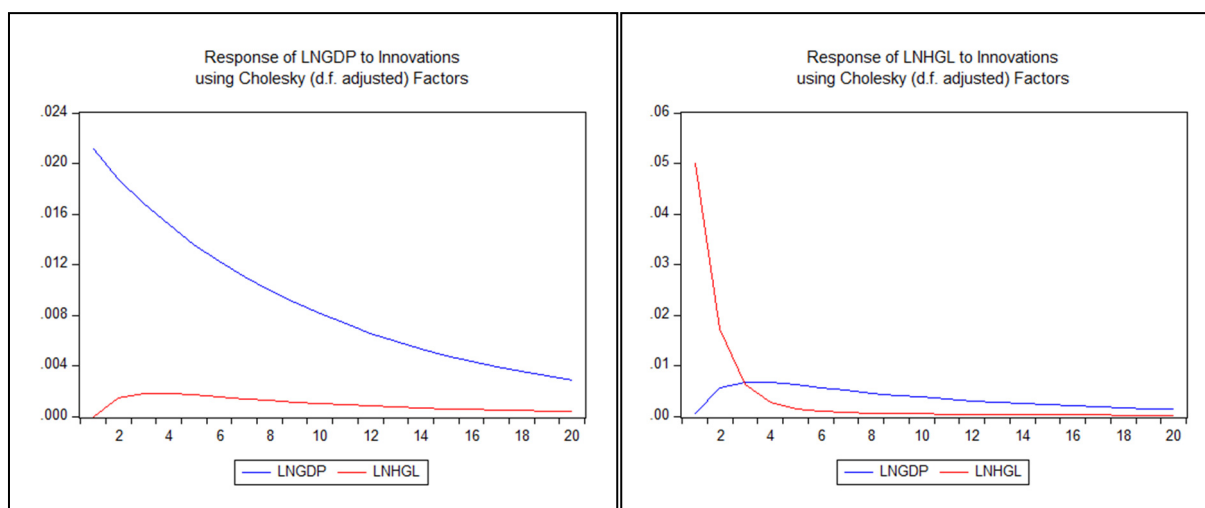

Figure 1. LNGDP impulse response analysis   **Figure 2.** LNHGL impulse response analysis

According to the range of ordinate values of figures 1 and figure 2, we can see that the response of LNGDP to information pulse is smaller than that of LNHGL, that is, the pulse influence of highway construction is more significant. In other words, highway construction is more sensitive to external information shocks than the economic growth of Shandong Province. According to the red curve of figure 1 and the blue curve of figure 2, we can see that the influence of LNHGL on LNGDP standard information pulse, especially at the initial stage, is less than that of LNGDP on LNLC, that is, the impact of economic development of Shandong Province

on highway construction is greater than that of highway construction on economic development. In other words, the growth of national economy is the main reason for the continuous increase of highway construction in Shandong Province.

3.5. Variance Decomposition

Variance decomposition is used to observe the influence of each variable on the change of a variable. At the end of the impulse response analysis, it is necessary to decompose the variance of each variable, so as to see how different variables affect a variable with the increase of lag. The variance decomposition of LNGDP and LNHGL is carried out respectively, and the specific results are shown in Table 4. It is not difficult to find that LNGDP is more affected by its own impact, while the impact of LNHGL on LNGDP begins to increase slowly from the second year and finally tends to a stable value of about 1. It can be considered that highway construction has a lagging long-term growth effect on economic growth. Relatively speaking, LNHGL is more affected by LNGDP shock, and the final stable value is about 10.

Table 4. Variance decomposition tables of LNGDP and LNHGL

Lag period	LNGDP decomposition result			LNHGL decomposition result		
	S.E.	LNGDP	LNHGL	S.E.	LNGDP	LNHGL
1	0.021105	100	0	0.049991	0.009065	99.99094
5	0.038799	99.23841	0.761593	0.054834	5.312046	94.68795
10	0.045082	99.03831	0.961691	0.055852	8.66288	91.33712
15	0.047107	98.98952	1.010484	0.056209	9.798582	90.20142
20	0.047803	98.97415	1.025854	0.056335	10.19391	89.80609

4. Conclusion

According to the causality analysis of the vector autoregressive model between highway construction and regional economic development in Shandong Province, the results show that the economy is more vulnerable to its own impact at the initial stage, on the contrary, although the impact of highway construction on the economic development of Shandong Province is not significant in the initial stage, it will reach the maximum in the second stage and maintain the influence to the fourth stage, and then gradually weaken. At the present stage, expressway construction is more easily affected by the national economy, especially in the initial stage of expressway construction, the impact of economy on it is extremely obvious and huge. the momentum of economic growth directly determines the capital scale of expressway construction in Shandong Province. the possible reason for this result is that expressway construction in Shandong Province is no longer in the stage of rapid development. The sustainable development of regional economy has laid the economic foundation for highway construction, so that the demand of highway transportation can be met, to further improve the utilization rate of expressway and promote the development of expressway. Therefore, the development prospect of expressway can be predicted through the current situation and trend of economic growth in Shandong Province.

At present, under the background of Shandong Province actively promoting the transformation of new and old kinetic energy, Jinan, Qingdao and Yantai should give full play to the key role of "three nuclear leadership" and build a new pattern of kinetic energy transformation of regional integration and interaction. Therefore, at the present stage, the direction of highway construction in Shandong Province needs to conform to the new pattern, pay attention to the construction of highway network system, reasonably construct the regional structure of

highway network in Shandong Province, and further enhance the demand of highway transportation. stimulate the economic vitality of various districts and cities in Shandong Province to promote regional economic development. Only by forming a more efficient and fast highway network, can we enhance the sensitivity of expressways to external information shocks, and thus continue to promote the regional economy during the period of rapid development of expressway construction. it makes Shandong Province continue to maintain a good situation under the new situation of economic development, and lays a solid economic foundation for building a high-quality regional economic layout of "one core, two cores and three circles" in Shandong Province.

Acknowledgments

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