Empirical Analysis on the Relationship between Highway Construction and Economic Development based on VAR Model

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Abstract. According to the data of the highway infrastructure construction and economic development from 1988 to 2017, a double-quantities VAR model was established to studied the long-term and short-term relationship between the two quantities of China's highway infrastructure construction and economic development. The research results show that the expressway construction index and economic development index are greatly disturbed by their own degree and influenced by each other's variables for a long time. The influence of highway construction on economic development is greater than that of economic development on highway infrastructure construction.

Keywords: Highway; GDP; VAR.

1. Introduction

The relationship between highway construction and economic development has been the focus of scholars at home and abroad research, In 1990, Aschauer first used the time series model to verify that the operating capacity of roads could improve the economic growth rate of the region where the roads were located [1].Pradhan demonstrated through empirical research that road expansion can stimulate demand for intermediate inputs from other sectors, resulting in a multiplier effect for economic growth[2].In China, Fleisher et al. have proved through their research that highway construction can improve the capital of the economically backward regions of China, narrow the income gap and reduce poverty [3].Wang wulin et al. used spatial analysis and GIS network analysis to establish the cobb-douglas production function model to prove the impact of highway accessibility on the GDP of different cities in wuling mountain area [4]. Zhang guanghai et al. used the spatial econometric model to verify that the strengthening of transportation infrastructure construction such as expressway, civil aviation and inland river navigation can have a positive effect on the development of China's regional tourism economy [5]. Xu mengbo et al. took the expressway in northeast China as the research object and used the generalized moment estimation method to reveal that the expressway investment and financing were negatively correlated with the economic growth in northeast China in the short term but positively correlated in the long term [6]. Li yao et al. took the data from 2002 to 2015 as samples and used the multi-layer perception neural network model and data mining method to study and predict the contribution of highway investment and education level of highway practitioners to the primary, secondary and tertiary industries. The results showed that the contribution of highway investment and education level of highway practitioners to the added value of the tertiary industry was the largest [7]. Highway construction can promote economic development, but how much does economic development contribute to highway construction? Especially in the early stage of reform and opening up, China was forced to use expressway toll to repay loans, government loans to repair roads and other measures to build expressways in the absence of funds? Based on the above two problems, this paper studies and analyzes the long-term and short-term correlation between expressway construction and economic development by constructing a double-volume VAR model.

2. Methods

2.1 Data Selection and Processing

Based on the convenience and reliability of data acquisition and referring to the newly issued China statistical yearbook in 2018, this paper selects the expressway mileage from 1988 to 2017 as the index to measure the expressway construction. Through the statistical yearbook of China, the GDP index based on GDP in 1978 (set as 100)and nominal GDP can be found. The real GDP was obtained by deflating the GDP, and the real GDP from 1988 to 2017 (100 million Yuan) was selected as the index to measure economic development, with a time span of 30 years.

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2.2 The Research Methods

VAR model, also known as vector autoregression model, is an unstructured multi-equation simultaneous model that uses endogenous variables to make regression to the lag period of all endogenous variables to study the relationship between endogenous variables. The biggest characteristic of the vector autoregressive model is that it does not rely on economic theory as the basis. The expression is as follows:

$$LNDGDP_t=A_1LNDGDP_{t-1}+...+A_pLNDGDP_{t-p}+B_0LNHIGHWAY_t+...+B_rLNHIGHWAY_{t-r}+\varepsilon_t \quad t=1,2,...,n \qquad (1)$$

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3. Methods

3.1 Time Series Stationarity Test

Table 1. ADF test results

变量	ADF 检验值	1%临界值	5%临界值	10%临界值	P 值	结论
LNHIGHWAY	-4.687848	-4.498307	-3.658446	-3.268973	0.0069	平稳
LNRGDP	-3.903643	-4.339330	-3.587527	-3.229230	0.0260	平稳

As can be seen from table 1, the ADF t test statistical value of the sequence LNHIGHWAY were -4.498307, -3.658446, -3.268973 at the critical value of 1%,5%,10%.These indicate that the time series LNHIGHWAY rejects the null hypothesis at the significance level of 5% and 1%. LNHIGHWAY has no unit root.It is same to LNRGDP at the significance level of 5%. LNHIGHWAY and LNRGDP are both stationary sequences at the significance level of 5%.

3.2 Optimal Lag Order and Stability Test of VAR Model

Table 2. delay judgment results of VAR model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-44.15683	NA	0.119415	3.550525	3.647302	3.578394
1	97.07053	249.8638	3.12e-06	-7.005426	-6.715096	-6.921821
2	112.8157	25.43455*	1.27e-06*	-7.908902*	-7.425019*	-7.769561*
3	115.6199	4.098369	1.42e-06	-7.816914	-7.139477	-7.621836
4	118.4647	3.720195	1.60e-06	-7.728056	-6.857066	-7.477243

Note: * represents the optimal lag period given under different criteria

The ADF test verifies that the time series LNHIGHWAY and LNRGDP are stationary sequences, and the VAR model can be constructed. Eviews8.0 was used to construct VAR models According

to AIC, SC and HQ, the optimal lag order of the model was determined to be 2. The VAR(2) model satisfies the stability condition.

3.3 VAR Model Construction

References are cited in the text just by square brackets [1]. (If square brackets are not available, slashes may be used instead, e.g. /2/.) Two or more references at a time may be put in one set of brackets [3, 4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the contribution under a heading References, see our example below.

Eviews8.0 software is used, LNHIGHWAY and LNRGDP are taken as endogenous variables with a lag of 2 periods, and an unconstrained vector autoregression model is established with constant term c to verify the short-term and long-term impact of expressway construction on China's economic development. VAR(2) model is expressed as:

$$LNRGDP=0.367+1.387LNRGDP(-1)-0.415LNRGDP(-2)-0.070LNHIGHWAY\ (-1)+0.072LNHIGHWAY(-2)$$

$$LNHIGHWAY=0.380+1.287LNRGDP(-1)-1.319LNRGDP(-2)+1.214LNHIGHWAY\ (-1)-0.239LNHIGHWAY(-2)$$

3.4 Impulse Response Analysis

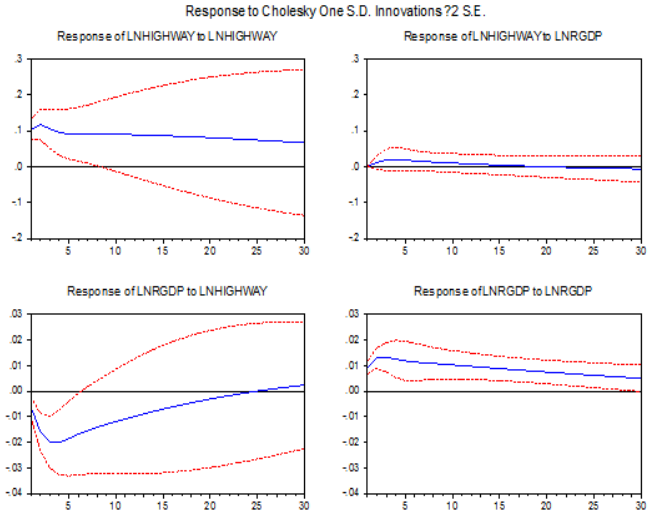

Figure 1. impulse response result diagram

LNHIGHWAY construction and economic development (LNRGDP) will make a strong positive response immediately after being hit by their own impacts. In a short period of time, the rapid rise will reach the peak and then decline steadily, but both maintain a positive response, with the value greater than 0. LNHIGHWAY made a long-term positive response to the impact of LNRGDP, and produced a weak negative response in the latter 5 periods. However, it can be said that in the first 25 periods, LNRGDP had a positive driving effect on lnrhighway. Although LNRGDP made a negative response to the impact of LNHIGHWAY at the beginning, the negative effect continued to weaken and eventually turned into a positive effect.

3.5 Variance Decomposition Analysis

Table 3. variance decomposition results

期间	LNRGDP 的方差分解			LNHIGHWAY 的方差分解		
	S. E.	LNRGDP	LNHIGHWAY	S. E.	LNHIGHWAY	LNRGDP
1	0. 011160	100. 0000	0. 000000	0. 103536	100. 0000	0. 000000
2	0. 023213	93. 24218	6. 757816	0. 157312	99. 41761	0. 582392
3	0. 033361	88. 72815	11. 27185	0. 190707	98. 61927	1. 380730
4	0. 040894	86. 64714	13. 35286	0. 214301	98. 02966	1. 970345
5	0. 046432	85. 90223	14. 09777	0. 233667	97. 71511	2. 284889
6	0. 050680	85. 79927	14. 20073	0. 251133	97. 59522	2. 404783
7	0. 054097	85. 98468	14. 01532	0. 267468	97. 58506	2. 414936
8	0. 056936	86. 29576	13. 70424	0. 282854	97. 63134	2. 368663
9	0. 059333	86. 66035	13. 33965	0. 297346	97. 70607	2. 293931
10	0. 061371	87. 04471	12. 95529	0. 310997	97. 79505	2. 204950
11	0. 063110	87. 43038	12. 56962	0. 323876	97. 89048	2. 109516
12	0. 064598	87. 80523	12. 19477	0. 336051	97. 98758	2. 012416
13	0. 065873	88. 16033	11. 83967	0. 347581	98. 08320	1. 916798
14	0. 066968	88. 48874	11. 51126	0. 358514	98. 17525	1. 824751
15	0. 067910	88. 78502	11. 21498	0. 368892	98. 26237	1. 737629
16	0. 068722	89. 04482	10. 95518	0. 378748	98. 34374	1. 656264
17	0. 069423	89. 26469	10. 73531	0. 388112	98. 41887	1. 581127
18	0. 070030	89. 44188	10. 55812	0. 397011	98. 48757	1. 512434
19	0. 070558	89. 57429	10. 42571	0. 405468	98. 54977	1. 450228
20	0. 071019	89. 66042	10. 33958	0. 413505	98. 60557	1. 394430
21	0. 071425	89. 69929	10. 30071	0. 421141	98. 65512	1. 344878
22	0. 071784	89. 69046	10. 30954	0. 428395	98. 69865	1. 301354
23	0. 072105	89. 63397	10. 36603	0. 435284	98. 73640	1. 263604
24	0. 072395	89. 53033	10. 46967	0. 441824	98. 76865	1. 231349
25	0. 072661	89. 38052	10. 61948	0. 448029	98. 79570	1. 204299
26	0. 072908	89. 18592	10. 81408	0. 453914	98. 81784	1. 182157
27	0. 073141	88. 94829	11. 05171	0. 459492	98. 83537	1. 164626
28	0. 073363	88. 66977	11. 33023	0. 464776	98. 84859	1. 151412
29	0. 073579	88. 35278	11. 64722	0. 469779	98. 85777	1. 142229
30	0. 073791	88. 00001	11. 99999	0. 474511	98. 86321	1. 136795

As shown in table 3, in the first-phase forecast, the forecast variance of LNRGDP is all caused by the disturbance of LNRGDP itself, and the forecast variance of LNRGDP in the 2-30 phase is caused by the disturbance of LNRGDP and LNHIGHWAY. In LNRGDP predict changes in the 30 years, 6.7% - 14.5% can be attributed to the change of LNHIGHWAY, the changes of 85.79% to 100% were attributed to LNRGDP itself, while 100% affected by LNRGDP itself in the first period. Later, as period goes on, The part causes by changes in LNRGDP itself go through a process of decline, but the percentage is still relatively large, remaining above 85%. On the whole, LNHIGHWAY has a lasting and important influence on the changes of LNRGDP, while the influence of its own changes is greater than that of LNHIGHWAY. As shown in table 3, in the first-phase forecast, the forecast variance of LNRGDP is all caused by the disturbance of LNRGDP itself, and the forecast variance of LNRGDP in the 2-30 phase is caused by the disturbance of LNRGDP and LNHIGHWAY. In LNRGDP predict changes in the 30 years, 6.7% - 14.5% can be attributed to the change of LNHIGHWAY, the changes of 85.79% to 100% were attributed to LNRGDP itself, while 100% affected by LNRGDP itself in the first period. Later, as period goes on, The part causes by changes in LNRGDP itself go through a process of decline, but the percentage is still relatively large, remaining above 85%. On the whole, LNHIGHWAY has a lasting and important influence on the changes of LNRGDP, while the influence of its own changes is greater than that of LNHIGHWAY.

4. Summary

(1) The ADF test shows that LNHIGHWAY and LNRGDP are both stationary time series at the significance level of 5%. Two variables can be used to build a bivariate VAR model.

(2) VAR(2) has a high goodness of fit. According to the influence coefficient, it can be found that LNHIGHWAY construction and economic development (LNRGDP) can influence each other, and the influence of LNHIGHWAY construction on economic development (LNRGDP) is greater than that of economic development (LNRGDP).

(3) The two variables of expressway construction and economic development have a strong positive response to their own impacts, while the two variables will also be affected by the impact of the other side. LNHIGHWAY has a long-term positive response to the impact of LNRGDP, indicating that LNRGDP has a positive driving effect on lnr highway. On the other hand, the impact of LNRGDP on LNHIGHWAY has changed from a negative response to a positive effect. It shows that although the initial construction of expressway will have a certain negative impact on economic development, it can promote economic development in the long run.

(4) The two variables of LNHIGHWAY and LNRGDP are mainly influenced by themselves, but they are also subject to the long-term influence of the other variables. Moreover, the influence of LNHIGHWAY on LNRGDP is greater than that of LNRGDP on LNHIGHWAY.

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