Study on the Relationship Between Financial Revenue and Expenditure, Scientific and Technological Progress and Residents' Income Level: PVAR Model Analysis based on Panel Data in Central China

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Abstract: Based on the PVAR model, this paper studies the dynamic relationship between financial expenditure, scientific and technological progress and residents' income level by using China's provincial panel data in the past 20 years. The results of co-integration test show that there is a long-term stable relationship between the three. The results of PVAR model show that scientific and technological progress and resident income level are Granger causes for each other. Government revenue and expenditure is a one-way Granger cause of people's income level. The increase of fiscal expenditure and the progress of science and technology have a continuous and significant positive effect on the income level of residents. The improvement of residents' income level will also lead to the growth of fiscal revenue, thus promoting the growth of fiscal expenditure and the progress of scientific and technological development. Therefore, we should optimize the structure of government expenditure and promote the development of science and technology.

1. Introduction

Since the reform and opening up, with the rapid development of China's economy, the living standards of residents have greatly improved. China nineteenth National Congress of the Communist Party has taken increasing people's income level as an important goal to realize the era of common prosperity for all the people. In order to realize the people's longing for a better life, various regions have proactively introduced relevant fiscal policies. Fiscal policy is very important for the economic development of a country. Since 1998, China has implemented an active fiscal policy. Active fiscal policy refers to an important means of regulating macroeconomics by increasing government input and reducing tax rates[3]. The increase in the income level of residents is the basis for promoting residents' consumption and an important driving force for economic development.

Innovation is the first driving force for development. The report of the 19th National Congress also pointed out the need to strengthen the national innovation system and strengthen strategic scientific and technological strength. Scientific and technological innovation provides new momentum for China's economic development, and scientific and technological progress is an important factor affecting the income level of residents.

At present, scholars have conducted a lot of research on the impact of fiscal revenue and expenditure and scientific and technological progress on residents' consumption.For example, Zhao Henan and Wu Yujing used static panel data models to analyze the impact of scientific and technological progress on the growth of residents 'consumption. Studies have shown that scientific and technological progress has a significant positive impact on the growth of residents' consumption [1]. Sun Zengwei, Wang Dingyun, Zheng Siqi analyzed the increase in local fiscal expenditure through OLS estimation and fixed effect estimation, which will effectively increase the level of human capital and thus increase the income level of residents [2]. Wang Zongshun used the VAR model to analyze the impact of local finance on the income level of residents since the reform and opening up, and concluded that there is a long-term positive equilibrium relationship between local fiscal expenditure and the income level of residents [4]. Li Guanglong and Fan Xianxian used

fixed-effect models and threshold models to believe that fiscal expenditure, technological innovation, and the interaction between the two have a significant role in promoting economic growth [6]. While there is less research on fiscal income and technological progress on the level of residents' income, and the living standards of residents play a vital role in consumption Role. Therefore, this paper uses the PVAR model to study the interactive relationship between fiscal revenue and expenditure, scientific and technological progress, and residents' income level.

2. Methodology and data

2.1. Variable selection and data description

This paper selects the inter-provincial panel data of the central region over the period 1998-2016 as a sample for research, including 8 provinces in Heilongjiang, Shanxi, Neimenggu, Henan, Hubei, Hunan, Anhui, and Jiangxi (because the data in Jilin Province are missing, they are excluded). The specific descriptions of the variables involved in the article are as follows:

The level of resident income (dpi) is measured by the per capita disposable income of residents, of which the per capita disposable income of residents is weighted by the per capita disposable income of urban residents and rural per capita net income. Fiscal expenditure (lexp), which selects local fiscal expenditure to measure fiscal expenditure. Fiscal income (tax), because the impact of fiscal income on residents mainly comes from taxation, so this paper uses taxation to measure fiscal expenditure. Scientific and technological progress (rd), using internal expenditures of research and experimental development (R&D) funds to represent the degree of technological advancement in the environment. The table 1 presents some descriptive statistics for the period 1998-2016.

Variable	Obs	Mean	Std.Dev.	Min	Max
lndpi	152	8.751	0.518	7.764	9.698
lntax	152	5.924	0.716	4.352	7.290
lnlexp	152	6.892	0.902	5.102	8.529
lnrd	152	3.868	1.179	0.211	5.927

Table 1 Summary statistics

2.2. Research method

This paper uses the Panel Vector Auto-regression (PVAR) method to analyze the relationship between fiscal revenues and expenditures, technological progress, and household income levels. The PVAR model relaxes the requirement that the traditional VAR model requires large sample observations, and treats all variables as endogenous variables, which can better analyze the interactive relationship between dynamic panel data. It has been widely used in empirical analysis. This article builds the following PVAR model:

$$Y_{it} = A_0 + \sum_{j=1}^{n} A_j Y_{i,t-j} + \eta_i + \varepsilon_t + \mu_{it}$$

Among them, i represents the province, t represents the year, Y_{it} is a vector containing four variables $\{\ln dpi, \ln tax, \ln l\exp, \ln rd\}$, η_i and ε_t are the individual effect vector and the time effect vector, respectively. Y_{it-j} is the j-order lag term of Y_{it}, and u_{it} is assumed to be a random perturbation term that follows a normal distribution.

3. Analysis

3.1. Panel unit root test and co-integration test

Before performing panel vector auto-regression, the stability of each variable needs to be tested. This paper uses LLC test, IPS test and other methods to test the stability of each variable. The test results are shown in Table 2. It can be seen from Table 2 that the first-order differences of the four variables lndpi, lntax, lnlexp, and lnrd are all stable at a significant level of 1%, so they are all first-order single integer variables.

Variables	LLC	IPS	ADF-Fisher	PP-Fisher
lndpi	-2.723***	2.122	9.472	2.036
lntax	0.0131	3.465	2.414	2.290
lnlexp	-3.528***	0.860	9.197	23.218
lnrd	-4.461***	-0.605	16.528	37.184***
Δ lndpi	-16.087***	-17.638***	209.902***	170.898***
Δ lntax	-7.750***	-6.728***	70.322***	66.681***
Δ lnlexp	-8.547***	-6.758***	70.788***	70.399***
Δ lnrd	-5.563***	-4.562***	52.768***	71.592***

Note: ***, **, * indicate that the P value is significant at the levels of 1%, 5%, and 10%, respectively.

Table 2 Panel data unit root test results

Although the panel unit root test shows that each variable is I (1), it is necessary to further investigate the co-integration test to see if there is a long-term stable equilibrium relationship. This paper uses Pederoni and Fisher (combined Johansen) to compare and verify.

Method	Statistic	Prob.	Method	Statistic	Prob.
Panel.v	-1.208	0.8864	Group.rho	-0.357	0.3604
Panel.rho	-2.582***	0.0049	Group.PP	-7.013***	0.0000
Panel.PP	-6.921***	0.0000	Group.ADF	-6.911***	0.0000
Panel.ADF	-7.802***	0.0000			

Note: ***, **, * indicate that the P value is significant at the levels of 1%, 5%, and 10%, respectively.

Table 3 Pedroni test results

Hypothesized No.of CE(s)	Fisher* (from trace text)	Prob.	Fisher*(from max-eigen text)	Prob.
None	297.20	0.0000	253.00	0.0000
At most 1	107.30	0.0000	82.73	0.0000
At most 2	43.52	0.0002	34.07	0.0053
At most 3	36.18	0.0027	36.18	0.0027

Table 4 Fisher (combined Johansen) test results

From the test results in Table 3 and Table 4, it can be seen that except for the Panel.v and Group.rho results in the Pedroni test, the rest have a co-integration relationship at a significant level of 1%, so it can be considered that the four variables There is a long-term stable relationship.

3.2. Determination of the lag order

The delay order was determined according to AIC, BIC and HQIC minimization criteria. According to the calculation results of stata 15.0, the optimal lag order was determined to be 2, so the PVAR(2) model was established.

Lag	AIC	BIC	HQIC
1	-6.950	-5.922	-6.533
2	-9.241*	-7.815*	-8.661*
3	-8.237	-6.379	-7.482
4	-7.371	-5.041	-6.426
5	-8.427	-5.579	-7.273

Table 5 Selection of lag order

3.3. Granger causality test

Co-integration analysis reveals a long-term equilibrium relationship between government fiscal revenue and expenditure, technological progress, and household income levels. To determine whether there is a causal relationship of economic significance between them, further Granger causality tests are needed.

According to Table 6, at a significant level of 10%, government fiscal revenue and technological progress are all Granger reasons for residents' income levels. Moreover, it can be seen from the test results that the income level of residents is also the Granger reason for technological progress, but the income level of residents is not the Granger cause of fiscal revenue and expenditure. It can also be seen that fiscal expenditure and technological progress are the Granger reasons for each other, and fiscal revenue is the one-way Granger reason for technological progress. The results show that government revenue and expenditure, scientific and technological progress are the driving forces for the improvement of residents' income level, fiscal revenue and expenditure,resident income are also the driving forces for technological progress. All in all, there is a significant causal relationship between government fiscal revenue and expenditure, technological progress, and residents' income levels.

Null Hypothesis	F-Statistic	Prob	Conclusion
lntax does not Granger Cause lndpi	7.672	0.001	False
lndpi does not Granger Cause lntax	0.861	0.425	True
lnlexp does not Granger Cause lndpi	4.489	0.013	False
lndpi does not Granger Cause lnlexp	1.410	0.248	True
lnrd does not Granger Cause lndpi	2.690	0.072	False
lndpi does not Granger Cause lnrd	4.869	0.009	False
lnlexp does not Granger Cause lntax	3.156	0.046	False
lntax does not Granger Cause lnlexp	6.923	0.001	False
lnrd does not Granger Cause lntax	0.132	0.876	True
lntax does not Granger Cause lnrd	4.679	0.011	False
lnrd does not Granger Cause lnlexp	3.134	0.047	False
lnlexp does not Granger Cause lnrd	4.834	0.001	False

Table 6 Granger test results

3.4. Impulse response and variance decomposition

Before performing impulse response and variance decomposition, it is necessary to check whether the PVAR model has good stability. In this paper, the stability of the model is tested by using AR charts. The results in Fig.1 show that the PVAR (2) model has 8 unit roots, and the inverses of the AR roots are all located inside the unit circle, so it can be judged that the model is stable.

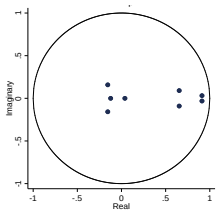

Fig. 1 Test of PVAR system stability

3.4.1. Impulse response analysis

The impulse response function describes the response of an endogenous variable to the impact of an error. Specifically, it describes the impact on the current and future values of endogenous variables after a standard error impact is applied to a random error term. In this paper, the impulse response analysis is performed on the basis of constructing the PVAR (2) model, and the Monte Carlo simulation is performed 500 times to obtain the orthogonal impulse response function diagram. The impulse response function graph shown in Figure 2 has a confidence interval of 95%, the horizontal axis s represents the number of lags, and the vertical axis represents the degree of impact of endogenous variables on the impact of the corresponding variables.

It can be seen from Fig. 2 that the 16 impulse response graphs as a whole have a relatively large impact during the first 6 lags, and tend to be stable by the 10 lags. In terms of lndpi, the first line is the response of lndpi to 4 variables. The response of lndpi to lntax, lnlexp, and lnrd shocks is positive, and the response of lndpi to the lntax shock reaches the maximum in the second period,

and then gradually decreases; the response of lndpi to the lnlexp and lnrd shocks reaches the maximum in the fourth period. The results show that the increase in fiscal expenditure and scientific and technological progress will increase the income level of residents, and it is durable. In terms of lntax, observe the third line of the impulse response graph. A positive standard deviation of lndpi, lnexp, and lnrd impacts, and lntax all responds positively, that is, the increase in fiscal income by residents' income levels, fiscal expenditures, and scientific and technological progress is obvious. Positive promotion effect. As far as lnrd is concerned, it can be seen from the fourth line of the impulse response graph that the income level of residents, fiscal revenue and themselves have a positive impact on technological progress.

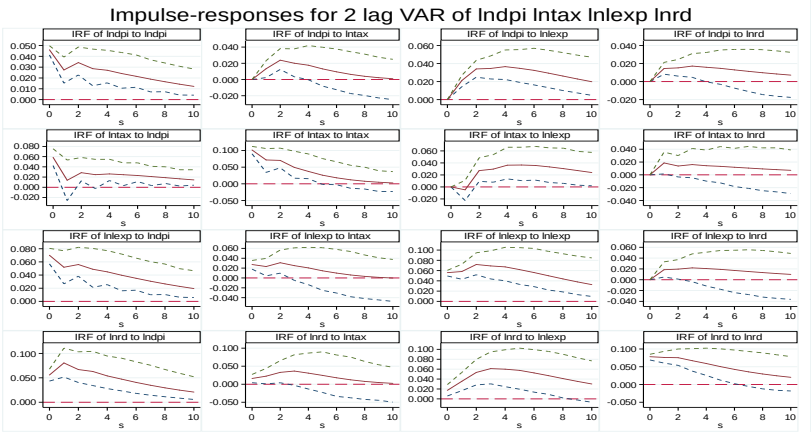

Fig. 2 Impulse response graph

To sum up, the fiscal revenue and expenditure and technological progress have significantly promoted the increase in residents 'income. At the same time, the increase in the level of residents' income will also bring about an increase in fiscal income, which will promote the growth of fiscal expenditure and the development of science and technology.

3.4.2. Variance decomposition

	Lag	lndpi	lntax	lnlexp	lnrd
lndpi	1	1.000	0.000	0.000	0.000
	2	0.775	0.048	0.121	0.057
	3	0.591	0.109	0.235	0.065
	4	0.509	0.120	0.293	0.077
	5	0.459	0.120	0.340	0.081
lntax	1	0.250	0.750	0.000	0.000
	2	0.186	0.795	0.001	0.018
	3	0.170	0.780	0.029	0.021
	4	0.167	0.753	0.054	0.026
	5	0.169	0.714	0.088	0.029
lnlexp	1	0.559	0.085	0.357	0.000
	2	0.483	0.081	0.414	0.022
	3	0.423	0.056	0.460	0.029
	4	0.390	0.085	0.489	0.036
	5	0.369	0.080	0.511	0.040
lnrd	1	0.318	0.026	0.031	0.626
	2	0.402	0.032	0.065	0.501
	3	0.371	0.048	0.116	0.465
	4	0.350	0.062	0.158	0.430
	5	0.336	0.066	0.188	0.410

Table 7 Variance decomposition results

On the basis of the impulse response function, we should further investigate the contribution between the variables through variance decomposition. It can be seen from the results in Table 7

that fluctuations in lnlexp, lntax, and lnrd have a long-term increasing trend in the contribution rate of lndpi, and that lndpi has a greater impact on lndpi. Specifically, in the fifth period, 46% of the fluctuations in residents' income levels were caused by themselves, 34% were caused by fiscal expenditures, 12% were caused by fiscal revenues, and 8% were caused by technological progress. This means that the past residents' income level and fiscal expenditure can explain the current residents' income level to a large extent, and the driving effect of taxation and technological progress on the residents' income level is relatively small. It can also be seen that the contribution rate of residents' income to fiscal revenue and technological progress is relatively high, while maintaining stability.

4. Conclusion and suggestion

This paper uses the PVAR model and combines the relevant data of eight provinces in central China to analyze the dynamic impact of fiscal revenue, technological progress, and residents' income levels, draws the following conclusions. And based on this, several policy suggestions are put forward.

4.1. Conclusion

First, the long-term stable and balanced relationship between fiscal revenue and expenditure, scientific and technological progress, and residents' income levels is examined based on co-integration test.

Second, the Granger causality test shows that technological progress and the level of income of residents are Granger reasons for each other. Government fiscal revenue and expenditure is the one-way Granger reason for residents' income levels. In other words, the increase in fiscal revenue and expenditure and technological progress can promote the increase of residents' income levels.

Third, according to the results of the impulse response graph and variance decomposition, government expenditure has a significant and lasting effect on the level of residents 'income. At the same time, an increase in the level of residents' income will promote the increase of government fiscal revenue, which in turn will increase government fiscal expenditure and promote Scientific and technological progress. Therefore, there is a ternary interaction between fiscal revenue and expenditure, technological progress, and residents' income level.

4.2. Policy suggestion

First, as fiscal expenditure plays a key role in raising the level of residents' income, the government should continue to expand government investment, increase investment in people's livelihood, and increase spending on medical services, social security and other public services. At the same time, strengthen supervision of fiscal expenditures to ensure that the funds of fiscal expenditures benefit the people.Second, the government continues to increase its support for scientific research funding, optimize the direction of capital investment, and accelerate the progress of enterprise technological innovation.

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