

Team Number:

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Problem Chosen:

B

2019 APMCM summary sheet

Regional economic vitality is an important part of regional competitiveness. This paper establishes the index system of influencing factors of regional economic vitality through factor analysis, and uses Granger causality test and impulse response analysis to analyze the factors that affect regional economic vitality in the short and long term, and finally uses the first level index to measure the economic vitality of the studied region.

For question 1, through the index system, we can measure the impact of enterprise vitality and population on regional economic vitality. The results of factor analysis show that two factors have significant influence on regional economic vitality, and the model obeys the regression equation.

For question 2, through Granger causality test and impulse response analysis, we find that the two indicators of residents' quality of life and enterprise vitality can promote economic vitality in the long-term and short-term.

For question 3, Based on a comprehensive analysis of various factors affecting regional economic vitality, a three-level indicator system is established, which is based on three first-level indicators, namely, economic growth, living standards of residents and enterprises, so as to measure regional economic vitality. After determining the weight of each index through factor analysis, the result of ranking the provinces in the central region by index value is: Henan, Anhui, Hubei, Hunan, Jiangxi, Shanxi (from high to low).

For question 4, after studying question 1, 2 and 3, we suggest that we should improve the living standard of the residents and the business operation of the enterprises to enhance the vitality of the regional economy.

Finally, we generate some strengths and shortages of our analysis, and give some suggestions based on our results.

Keywords: Economic vitality, Factor analysis, Granger causality test, Impulse response

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1. Introduction

Region economic vitality plays an important and supporting role for a city's development. With the current, rapid development of economy, what cities demand most is vitality, to keep the region's sustainable development. Region economic vitality isn't just a reflection of the development of region economic. Nowadays, along with the rapid improvement of technology and residents' living standards, the economic vitality of a region is also related to education, scientific research, residents' living conditions, and corporate development in this region. A region with high vitality often have better development prospects, and also, places with low economic vitality, need policy support and capital transfer, to stimulate the region's vitality. So, the measurement of region economic vitality is an important guarantee for sustainable development of urban economy and coordinated development of social groups.

In recent years, new policies on talent introduction and support for privately-held-companies have come out, to stimulate region vitality. This is a very effective approach. According the surveyed data, it can be seen that recently, almost all regions' economic vitality index and the number of enterprises in this region show an upward trend. This not only benefits from economic development, but also the government's introduction of talents and the optimization of business environment.

However, although region economic vitality is generally improving, there are still problems in many aspects. For instance, there is a problem of brain drain in many areas. For some developing areas, it is difficult to compete with first-tier cities for talent resources because it cannot retain high-level talent, and this always results in a vicious circle – when few talents are left in some region, this region will suffer a lower speed of development, and this leads to the region's less appealing for talents. Secondly, there are also problems of corporate monopoly in some areas. The existence of some large enterprises has led to the closure of some medium-sized, small companies, which is not conducive to the business environment in the area. Also, in some areas, growth has stagnated. The growth rate is very slow, which shows that these regions are in great need of newly-developed technologies and industries, like artificial intelligence, investment companies.

2. Analysis

Regional comprehensive competitiveness is an important indicator of regional development capacity and regional economic vitality is a significant part of regional comprehensive competitiveness. In order to provide some constructive suggestions for development of the district, it is worthy for us to explore the factors that influence the regional economic vitality. We did some research on the regional economic vitality and tried to apply statistical and econometric methods to our analysis with our own data.

Question 1: From the aspects of population and enterprise vitality, we need to build two models. Here we build two models instead of one multiple regression model to avoid the multiple trigonometric problem and the small sample problem. And we suppose that the provided index 'Quantity of Enterprises which registered and established from 2009 to 2018 and survive up in 2019' can perfectly represent a regions' economic vitality. In this way we

can separately analyze the population's and enterprise vitality's influence on region economic vitality.

Question 2: We choose central region as an example. In this question, we need to select some suitable variables from existed index systems and literatures, and perform PCA or factor analysis on the variables. And we then use the selected variables to do Granger test of causality with the trend in incremental changes to enterprises in central region, to see the short term and long term effects of selected factors on the region vitality.

Question 3: According to the surveyed data and literature, we selected several index to represent three aspects of economic vitality. We perform factor analysis on these indexes, to compute a suitable index system. Once we get the index system, we can compute the total region economic vitality, and sort the index.

Question 4: Based on the analysis of question1, 2, and 3, we can get the conclusion and give some constructive suggestions on city improvement, to help maintain the region's sustainable development.

3. Assumptions

There are many factors that affect region economic vitality. Our model is setting up and implemented in a relatively ideal environment. Thus, we make some assumptions as follows:

- We assume that the region (province, city) can fully measure the level of economic vitality of the region.
- We assume that the regional (province, city) enterprise vitality level can be better measured by four indicators: Corporate profits, research funding, New product development costs (hereinafter referred to as Total value of goods).
- We assume that factors other than the regional economic vitality index system have the same degree of influence on the regional economic vitality, so it will not affect the calculation of the regional (province, city) economic vitality level based on the proposed indicator system.
- We assume that all selected factors can perfectly represent the changes in economic policies and can response to these changes very quickly. This assumption is very important in question 2.

5. Problem analysis and Model building

5.1 Data Resource

We surveyed our data on National Bureau of Statistics¹. National Bureau of Statistics provides official data for provinces and national accounting index. For the data surveyed, we make sure that they come from the same diameter. And for data which are too large, we change their units to better perform out models. Also, we removed data that does not exist in all months, and can promise the facticity of the data. We use EXCEL and MATLAB to complete these preprocessing.

In the upcoming analysis, we combine Eviews and SPSS to perform the statistical tests and basic data process. The results are promised to be accurate and believable.

5.2 Summarize

In order to establish the index system of regional economic vitality, we collected data from 17 dimensions for 19 years since 1999. The statistics are described in the figure below.

Descriptive statistic						
	Minimum	Maximum	Average		Standard criterion	Variance
	Magnitude	Magnitude	Magnitude	Standard criterion	Magnitude	Magnitude
GDP per capita (x1)	29344	285316	128173.84	19916.319	86813.223	7536535632
Number of enterprise	31167	88678	58088.16	5019.419	21879.138	478696686
Population	35056	36900	35767.89	121.575	529.932	280828.322
Revenue	972.9	16339.87	6479.97632	1269.751025	5534.716403	30633085.66
Fiscal expenditure	1715.67	36957.87	14165.0853	2777.288674	12105.92067	146553315.2
GDP of primary industry	3926.46	16780.94	9569.17842	1095.558088	4775.426994	22804702.97
GDP of secondary industry	6897.11	79937.91	37277.4826	5985.787556	26091.44305	680763400.5
GDP of tertiary industry	6897.11	79937.91	37277.4826	5985.787556	26091.44305	680763400.5
Household consumption level	13599	111465	47799.58	7179.319	31293.924	979309707.8
Number of urban employed people	528.93	2621.49	1164.90474	155.7247233	678.7883319	460753.599
Number of regular higher education institutions	256	686	518.79	34.533	150.525	22657.842
Patents	10511	242245	79348.05	18902.758	82395.211	6788970765
Technical market turnover	78.25	1753.05	453.794211	118.3585548	515.9129794	266166.202
Total corporate profits	31167	88678	58088.16	5019.419	21879.138	478696686
Total assets	9995.5461	83625.53	39934.2724	6199.065707	27021.10096	730139897.2
Investment in fixed assets	496.537	16613.946	5879.17763	1287.68945	5612.908182	31504738.26
Total export-import volume	116.3169	2755.4806	1144.24542	218.7308534	953.4256858	909020.538
Effective N						

Figure 1 Descriptive statistic

And here are some explanations of the second-level index:

Secondary Index Explanations		
Symbol	Name	Implication
y	Number of enterprise	Dependent variable, reflecting regional economic vitality
x1	Regional characteristics	Reflect the basic status of the region
x2	Financial situation	Regional fiscal revenue and expenditure
x3	Regional economic level	The development level of industries at all levels
x4	Household consumption	The consumption level of residents
x5	Resident work	The employment situation of residents
x6	Education level	Reflect residents' Education
x7	Business innovation	Reflect the innovation ability of enterprises
x8	Business status	The basic characteristics of the enterprise
x9	Corporate capital attraction	The ability of enterprises to attract capital

Figure 2 Explanations of second-level index

Before building the mathematical model, we hope to have a general understanding of the relationship between the features. First of all, we take the number of regional enterprises as the representative of regional economic vitality and observe its change over time. Overall, it shows an upward trend, with small fluctuations around 2008.

¹ National Bureau of Statistics: <http://www.stats.gov.cn/tjsj/>

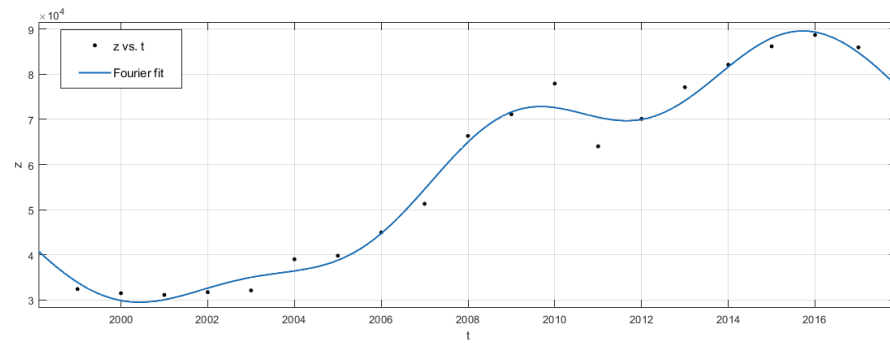


Figure 3 Relations between features

Secondly, in the process of establishing the index system, we agreed that the education level of personnel should be included in the system. Therefore, we have established a hierarchical color map of "regional economic vitality-regional characteristics education level" to observe the position of education level in the system. It can be seen from the figure that when the regional characteristics change, the level of regional economic vitality can keep stable, and the influence of the education level of regional personnel on economic vitality is more significant. Therefore, we need to pay attention to the education level of regional personnel, especially under the long-term effect, the role of high-level talents and higher education facilities will become more and more obvious.

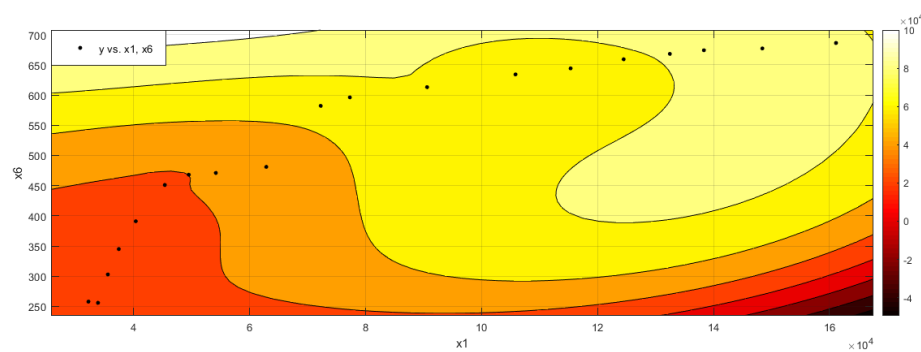
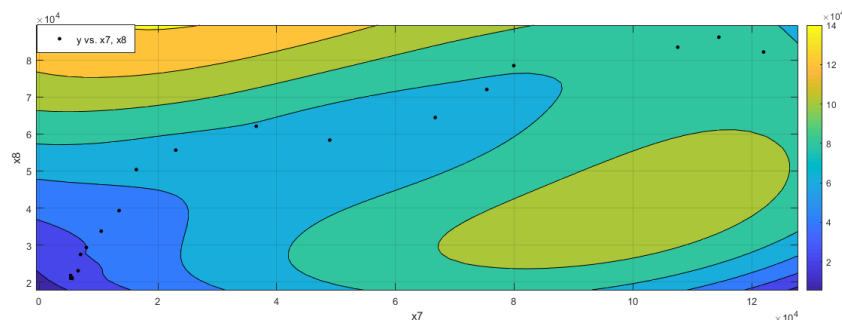


Figure 4 Heat map of the index system 1

In addition, we know that the level of enterprises in the region has a greater impact on economic vitality. In recent years, China has been advocating "smart manufacturing in China",



so we pay attention to the relationship between enterprise innovation and enterprise status. From the layered color map, we can roughly infer that in order to better stimulate regional economic vitality, the innovation level of enterprises needs to be improved. Of course, improving the state of enterprises can also enhance economic vitality, but if we want to go further, we need to stimulate the innovation ability of enterprises.

Figure 5 Heat map of index system 2

After a series of shallow analysis, we can roughly feel what factors are related to the regional economic vitality. Next, we will carry out a deeper analysis.

5.3 Question 1

According to the requirements of the topic, we estimate and calculate the economic vitality of the central region from the two aspects of population and business vitality. At present, the concept of corporate vitality is still relatively vague, and no scholar has given a standard definition and standard measurement method for the term corporate vitality. Drawing on the research methods of previous scholars, we will achieve the effect of measuring the vitality of enterprises through the measurement method of the index system. In order to make the estimated vitality of the enterprise have good representativeness, taking into account the availability of data, we have selected corporate profit indicators that can represent the profitability of the enterprise, research funding indicators and investment that can reflect the company's research and innovation capabilities The amount of new product development; in addition, we choose the total value of goods imported and exported by foreign-invested enterprises to measure the region's ability to attract capital.

Table1 Amount of relevant indicators of provinces in central China in 2018

Province	Number of companies (Million)	Population (ten thousand)	Corporate profits (Billion)	research funding (Million)	New product development costs (Million)	Total value of goods (Thousands of United States dollars)
shanxi	55.6	3718	1356	1095.2006	872.8798	1222.1248
henan	146.3	9605	3053	5310.5420	4404.9691	5331.6958
hubei	105.3	5917	2755	5193.0842	5046.9278	1362.5079
hunan	79.9	6899	1727	5278.7716	5497.9726	913.9516
jiangxi	66.1	4648	2158	2637.4959	3887.1653	1418.5785
anhui	113.8	6324	2448	5023.5660	5734.3856	1947.4993

We will adopt a factor analysis method to obtain the vitality index of enterprises by weighting the four secondary indicators of corporate profits, scientific research funding, new product development costs, and total imports and exports of goods by foreign-invested enterprises. After KMO and Bartlett tests, we get the relevant weight results as shown in Table 2.

Table 2 Corporate vitality score table

variable	score
Corporate profits	0.331
research funding	0.342
New product development costs	0.305
Total value of goods	0.223

$$V = \sum_{i=1}^n X_i W_i \quad (1)$$

According to formula (1), the calculated corporate vitality values are in table 3

Table 3 Vitality Value of Enterprises in Central Provinces

Province	Enterprise vitality value
shanxi	2083.108
henan	8854.043
hubei	7948.616
hunan	7731.41
jiangxi	4853.998
anhui	8017.542

We use the number of enterprises in each province in the central region as the explanatory variable, and the vitality and population of the enterprise as the explanatory variables. We establish a binary regression model to measure the impact of the two explanatory variables on the explanatory variable.

The binary regression equation has the form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon_i \quad (2)$$

The regression estimation results are as follows:

Table 4 Binary regression results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X2	0.004047	0.005867	0.689720	0.5399
X1	0.010430	0.007471	1.396027	0.2571
C	3.353670	26.21376	0.127935	0.9063

According to the results of binary regression, important variables are not significant, considering that this result may be due to the existence of collinearity. At the same time, the model already contains only two variables, so we choose to use a univariate linear regression model, which uses two variables and the explained variables to perform a univariate linear regression to measure their impact. The equation of the unary regression model is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \varepsilon_i \quad (3)$$

Table 5 Regression results of population

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X1	0.014757	0.003783	3.900456	0.0175
C	3.228105	24.43491	0.132110	0.9013

Table 6 Enterprise vitality regression results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X2	0.010924	0.003545	3.081249	0.0369

C	22.60439	24.79734	0.911565	0.4136
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We take a significance level of 0.05. From the P values of the two regression results, we can see that these two important explanatory variables have remained significant. It can be considered that the above two variables are not significant. The reason is that they are highly collinear. The presence. According to the parameter estimates we can draw the following conclusions:

- An increase of 10,000 permanent residents in the central region can increase the number of enterprises in the region by 0.014757.
- Each increase in the vitality value of enterprises in the area can increase the number of enterprises in the area by 0.010924.

5.4 Question 2: Long-term and short-term analysis of effects of economy vitality

We observe that there are many factors that affect the economy vitality. According to surveyed data and literature, we select 16 third-level index ,9 second-level index and 3 first-level index (see Attachment 1), and these index can fully represent economic policy uncertainty. We use factor analysis and PCA to determine the specified score of each index and form a suitable index system. Considering the complexity of the surveyed data, we test the long-term and short-term effects of economy vitality using the 3 first-level index. We perform granger test of causality to see the effects of the 3 index, and also impulse response analysis to see how long will the system become relatively smooth. Because granger test is very sensitive in time changes, we use granger test to see the long-term and short-term effects.

5.4.1 Building Index System

There is a certain complexity in describing the economic vitality level of a region, and many factors will affect the economic vitality of the region. We hope to construct an indicator system to measure the economic vitality of a region with a better index. The region we selected is the central region. Based on the research of Yi Wei(2016)^[1], Ruqun He(2019)^[2], Ruqun He (2016)^[3], Yuling Ni(2014)^[4], Yonghua Li(2007)^[5], Xiaoli Xu(2007)^[6], in the construction of the entire indicator system, we selected three indicators of economic growth, residents' living standards, and corporate vitality as the first-level indicators to form a macro framework of the entire indicator system. The economic growth indicators included regional characteristics, financial conditions, and regional economic levels. Three secondary indicators: residents 'living standards include three secondary indicators of residents' consumption, working conditions of residents, and education level of residents. Enterprise vitality includes three secondary indicators of enterprise innovation level, enterprise operation level, and enterprise's ability to attract foreign investment, where each secondary indicator is composed of several primary indicators.

In order to achieve the calculation of the specific economic vitality index, we must first determine the weight of the indicators at all levels. Here we follow the method of factor analysis to determine the weights in stages. First determine the weight of each three-level indicator based on the score matrix of the factor analysis. The weight of each three-level indicator included in the regional characteristics is shown in the table below.

Table 7 Weights of the three levels of indicators included in the regional characteristics

Tertiary indicators	score
Gross Regional Product per capita	0.5
Population	0.5

The weight of the third-level indicators included in the second-level indicators such as financial status, regional economic level, and consumption of the residents are also obtained in accordance with this step. Based on the values of the third-level indicators, we can calculate the corresponding value of each second-level indicator. Further, We can thus calculate the weight (ie score) of each secondary indicator in the process of forming the primary indicator from the secondary indicator. In table 8, we give a report on economic growth after factor analysis. The weight of each secondary indicator contained in the primary indicator. The weights of the secondary indicators included in other primary indicators are also determined accordingly, so the related score tables of secondary indicators are no longer listed one by one.

Table 8 Weights of secondary indicators included in economic growth indicators

Secondary indicators	Score
Regional characteristics	0.33
Financial situation	0.33
Regional economic level	0.34

By summing up the amount of secondary indicators and continuing to use factor analysis, we conclude that the values of primary indicators are:

Table 9 value of each level index

Year	Economic Growth	Living standard of residents	Corporate vitality
2017	82086.01	58559.72	71280.68
2016	75715.21	54227.97	69932.45
2015	70896.84	51144.23	66470.53
2014	67974.51	50963.9	55285.3
2013	63756.75	48063.07	51262.51
2012	59139.84	45640.41	45487.5
2011	53746.49	41592.59	37220.45
2010	45035.24	33827.23	34132.9
2009	37639.8	26904.94	27179.8
2008	34661.35	24619.14	23029.22
2007	29502.17	20016.41	18180.78
2006	24974.52	16243.31	15177.92
2005	22218.89	13676.52	12777.03
2004	19793.22	11210.34	11749.34
2003	17204.02	8967.303	10080.6
2002	15732.15	7730.19	9190.84
2001	14795.04	7059.813	8931.311
2000	13922.24	6432.27	8964.132
1999	13148.42	5906.893	9017.775

According to the value of the first-level indicators, we can get the weight of each first-level indicator in the process of forming the regional economic vitality. From the selection of the indicators, the construction of the indicator system, the calculation of the relevant indicator values, and the calculation of the weights of the relevant indicators, we have given corresponding conclusions through factor analysis. The specific tables are listed in the annex, and are not listed in the article.

In the construction of the indicator system, we have calculated the weights of related indicators through factor analysis. Due to the related analysis, the required data is only updated to 2017 in the statistical yearbook. Therefore, we selected the values of the six province-related indicators in the central region in 2017 and ranked them based on this.

Table 10 Province economic vitality index values and ranking

Province	Index value	Ranking
Henan	185365.67	1
Anhui	183376.775	2
Hubei	171310.67	3
Hunan	139771.255	4
Jiangxi	115227.915	5
Shanxi	84907.945	6

5.4.2 Granger Causal Relation Test Along with Impulse Response Analysis

5.4.2.1 Smoothness test

We select 9 second-level index in the previous section, before we perform granger causal relation test, we need to test the smoothness of the time series. We use the unit root test(ADF test) to perform this.

Table 11 Unit Root Test

Method	Statistic	Prob.	Cross-sections
Unit root	-2.61188	0.0045**	4

Because Prob. is less than 5%, so we reject the original hypothesis, and assume that the time series is smooth. Then, we can perform granger causal relation test on this result.

5.4.2.2 Granger cause between region economic vitality and economic growth

Table 12 Pairwise Granger Causality Test between Economic growth and Region economic vitality(Lags:2)

H_0 : Economic growth does not Granger Cause Region economic vitality	H_1 : Region economic vitality does not Granger Cause Economic growth
Prob.	Prob.
0.0187**	0.9716

This table shows that, the H_0 , Economic growth does not granger cause region economic vitality is rejected, and the H_1 , Region economic vitality dose not granger cause economic growth is accepted. This means that, in the short term, which is 2 years, the region

economic vitality won't granger affect the economic growth, however, changes in economic growth always affects region economic vitality. Let's see how this performs in the long term.

Table 13 Pairwise Granger Causality Test between Economic growth and Region economic vitality(Lags:5)

H_0 : Economic growth does not Granger Cause Region economic vitality	H_1 : Region economic vitality does not Granger Cause Economic growth
Prob.	Prob.
0.1783	0.1130

This table show that, the H_0 , Economic growth does not granger cause region economic vitality, is accepted, and the H_1 , Region economic vitality does not granger cause economic growth, is also accepted. This means that there may be some other factors, that are affecting economic growth and region economic vitality, but none of it is each other's cause. This briefly shows that, actually, in a long term like 5 years, the change in economic growth won't affect region economic vitality.

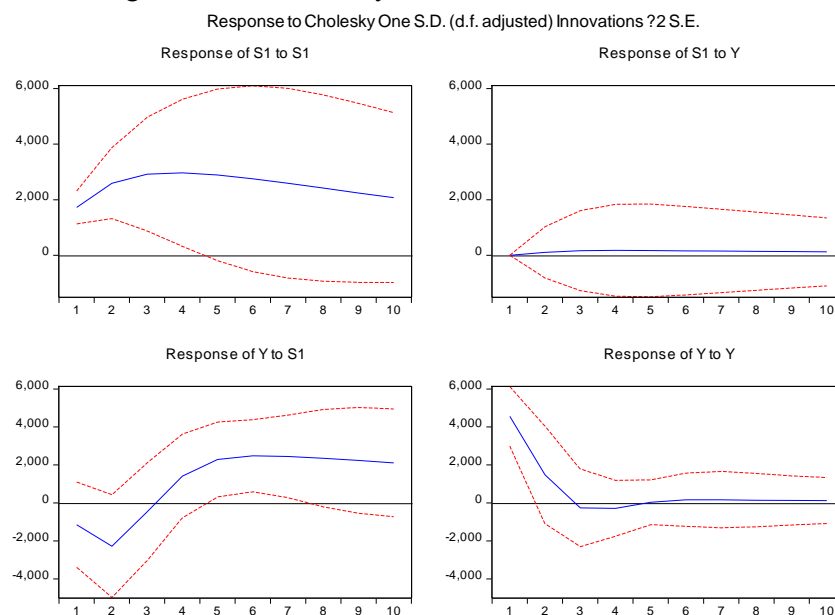


Figure 6 Impulse Response Analysis of Economic growth and Region economic vitality

In the impulse response analysis, we can see that for a short term, 2 years, the impulse will have an obvious effect, and when it comes to 5 years or more, the trend becomes more smooth.

This is an important point, because this shows that, economic growth, in GDP or something like this, will only affect region economic vitality in a short-term but not a long-term. This also means that when the government wants to stimulate the short-term economic vitality, it can consider some policies that have a positive influence on economic growth.

5.4.2.3 Granger cause between region economic vitality and living conditions

We also perform granger causality test on economic vitality and living conditions.

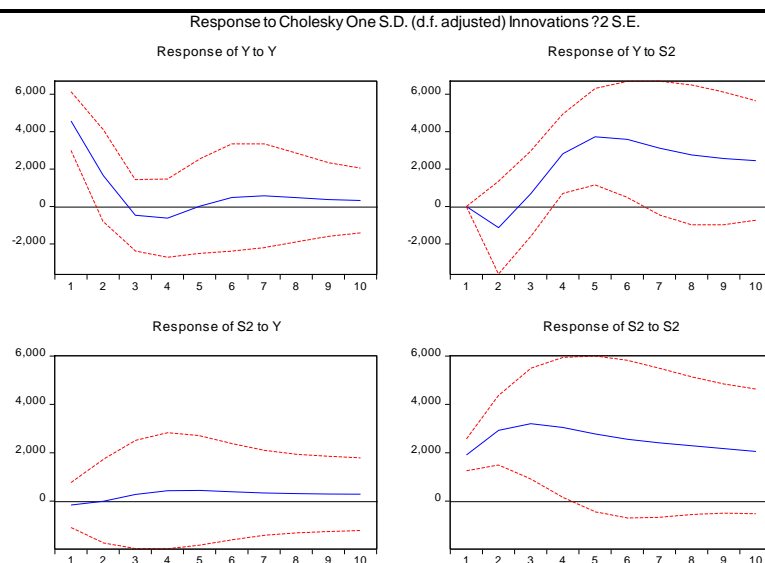
Table 14 Pairwise Granger Causality Test between Living conditions and Region economic vitality(Lags:2)

H_0 : Living conditions does not Granger Cause Region economic vitality	H_1 : Region economic vitality does not Granger Cause Living conditions
Prob.	Prob.
0.0135**	0.7437

This table reveals that, in the short term, living conditions always granger cause region economic vitality, however, region economic vitality does not granger cause living conditions. This means, living conditions can be an important factor affecting region economic vitality, in the short term. Let's see how this performs in the long term.

Table15 Pairwise Granger Causality Test between Living conditions and Region economic vitality(Lags:5)

H_0 : Living conditions does not Granger Cause Region economic vitality	H_1 : Region economic vitality does not Granger Cause Living conditions
Prob.	Prob.
0.0363**	0.4124

**Figure 7** Impulse Response Analysis of Living conditions and Region economic vitality

In impulse response analysis, the figure shows that in about 2 years, the impulse will have a significant effect and this will continue to about 7 years, and the line becomes relatively smooth.

This is an interesting result because, unlike the economic growth, for living conditions, it is still a granger cause of region economic vitality even in the long term. This shows that, changes in living conditions can have both short term and long term effects on region economic vitality. So, for the government, to stimulate region economic vitality either in short term or long term, the improvement in living conditions can always be the first choice.

5.4.2.4 Granger cause between region economic vitality and Corporate vitality

We also perform granger causality test on economic vitality and corporate vitality.

Table16 Pairwise Granger Causality Test between Corporate vitality and Region economic vitality(Lags:2)

H_0 : Corporate vitality does not Granger Cause Region economic vitality	H_1 : Region economic vitality does not Granger Cause Corporate vitality
Prob.	Prob.
0.0443**	0.1590

This result shows that for corporate vitality, H_0 is rejected, which means that corporate vitality granger cause region economic vitality. This shows that, in short term like 2 years, corporate vitality can have an effect on region economic vitality.

Table17 Pairwise Granger Causality Test between Corporate vitality and Region economic vitality(Lags:5)

H_0 : Corporate vitality does not Granger Cause Region economic vitality	H_1 : Region economic vitality does not Granger Cause Corporate vitality
Prob.	Prob.
0.0062**	0.1217

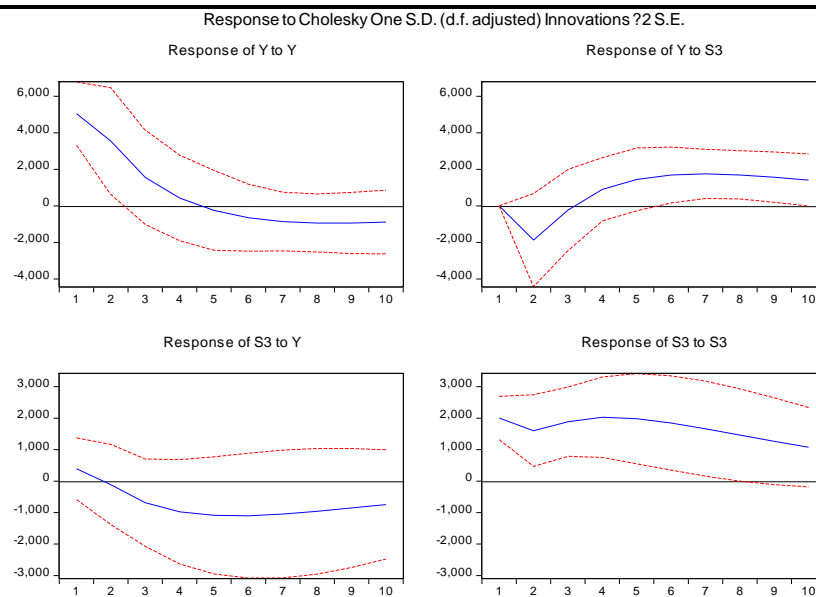


Figure8 Impulse Response Analysis of Corporate vitality and Region economic vitality

In the impulse response analysis, the figure shows that, in about 2 years, the impulse for 2 years will have a significant effect, and for about 7 years, the trend becomes relatively smooth.

This result shows that in the long term, corporate vitality can still improve region economic vitality. This is also an interesting and meaningful result because this reveals that, policies supporting enterprise or improving business conditions, can also have a both long term and short term effect on region economic vitality.

In problem 2, we consider granger causality test and impulse response analysis between the first-level index and region economic vitality. For the central region, which we selected in problem 2 as an example, we suggest that, for sustainable development, the improvement

of living conditions of residents and corporate vitality is very important because, these factors can have both long term and short term effects on region economic vitality. To improve the living conditions and corporate vitality, the government can improve the business environment for private enterprise or focus more on talent cultivating.

5.5 Question 5: Policies suggestions

The government should pay more attention to the living standards of the residents and the operation of the enterprises. Reduce the burden for the people, make the most of it for the people, reduce the burden for the people, moderately adjust the consumption tax, house purchase tax, car purchase tax and other fees, and return the invisible wealth lost by the people to the people first, so as to improve people's consumption and improve the living standard of the residents. At the same time, we will strengthen the protection of people's basic life and increase investment in medical care and social security.

At the same time, enterprises are the source of market vitality and the important embodiment of regional economic vitality. The government should create a good business and economic environment for the operation and survival of enterprises, provide preferential policies for the operation and investment of enterprises, and encourage enterprises to make continuous attempts to activate the market. Secondly, increase education investment, strive to cultivate innovative talents, inject high-quality talents into enterprises and society, and constantly promote the improvement of enterprise innovation level.

6. Strength and Weakness

6.1 Strength

Our model shows impressive and constructive results, which can provide suggestions on sustainable developments. Also, we surveyed many datasets and finally select the index system, so the availability of data and the accuracy is also promised. In all the statistical tests, we all perform the suitable tests and the test result also passed. Applying granger causality test along with impulse analysis to long term and short term analysis, can promise the correct answer of the test and also provide more specific information on our model.

6.2 Weakness

The dataset is not large enough to do some more specific analysis, actually. And because of time limitation, we can only get data from 1999 to 2017. This is not a large sample, yet. And this will have some negative effect on our model and our results. Also, our index system is not complete because of the data and time limitation. We only select several index which are available and can represent the economy policy changes and features of region economic vitality.

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Appendix

Appendix 1: Region Economic Vitality Index System

Region Economic Vitality Index System					
First-level Indicators	Weight	Second-level Indicators	Weight	Third-level Indicators	Weight
Economic growth	0.336	Regional characteristics	0.335	Gross Regional Product per capita	0.5
				Population	0.5
		Financial situation	0.334	Revenue	0.5
				Fiscal expenditure	0.5
		Regional economic level	0.334	Gross Regional Product of primary industry	0.333
				Gross Regional Product of secondary industry	0.333
				Gross Regional Product of tertiary industry	0.333
Living conditions of residents	0.334	Household consumption	0.335	Household consumption level (quality of life)	1
		Resident work	0.334	Number of urban employed people	1
		Education level	0.334	Number of regular higher education institutions	1
Corporate vitality	0.334	Business innovation	0.337	Patent	0.5
				Technology market turnover	0.5

