Research on the Relationship between the Total Factor Productivity of Each Industry and Its Influence Factors in China

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Abstract: In order to study the influence factors of the total factor productivity and the relationship between these factors and the total factor productivity, this paper analyzed such aspects as the financial deepening, education development, energy consumption, opening to the outside world. The relationship between these factors and total factor productivity of each industry was studied by using the vector error correction model (VEC) in this paper on the basis of the existing literature research. The conclusion is that the financial deepening has a long-term role in promoting technology progress of the secondary industry and the tertiary industry. The innovation of this paper is that it distinguished among three industries to study the total factor productivity.

1 INTRODUCTION

Burak R. Uras et al., (2014) studied the quantitative relevance of the cross-sectional dispersion of corporate financial structure in explaining the intra-industry allocation efficiency of productive factors. Chadwick C. Curtis et al., (2015) studied on the impact of economic reforms on China's growth in total factor productivity. Xingle Long et al., (2015) compared total productivity and eco-efficiency in China's cement manufactures from 2005 to 2010. Many scholars have studied the total factor productivity from different perspectives (Thomas Scherngell et al., 2014; Maria Gabriela Ladu and Marta Meleddu, 2014; Shuiping Zhang, 2014; Yen-Chun Chou et al., 2014; Zibin Zhang, and Jianliang Ye, 2015).

Based on the existing literature research, this paper studies the influencing factors of the total factor productivity and the relationship between these factors and the total factor productivity of the three industries in china from 1952 to 2013.

2 MODEL, INDEX AND DATA

Solow residual method which was proposed by Robert M. Solow is the method widely used of calculation of total factor productivity. It is established under the condition of constant return to scale. The calculation formula is as follows:

$$TFP_t = \frac{Y_t}{K^{\alpha} L^{\beta}} \tag{1}$$

- Y refers to the total industrial output value, represented by actual GDP, which is deflated by GDP deflator. K and L refers to the input of capital and labor. Capital K are caculated by use of the method of the perpetual inventory. The calculation formula is as follows.

$$K_t = K_{t-1}(1-\delta) + I_t \tag{2}$$

K refers to the capital stock, δ Refers to depreciation rate，I refers to investment.

- α and β refer to the output elasticity of capital and labor respectively. In this paper, the elastic coefficient applied the coefficient measured by the "Quantitative Calculation Method on the Role of Scientific and Technological Progress in Economic Growth" issued by the State Planning Commission of China in 1992. That is, the capital elasticity coefficient is 0.35, the corresponding labor elasticity coefficient is 0.65. Taking logarithm of TFP, this paper get LNPTFP as the index of the total factor productivity of the primary industry, and get LNSTFP as the index

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Table 1: Variable Stationary test.

Test sequence	Testform (C,T,K)	ADF test statistic	The critical value of each significant level			Test result
			1%	5%	10%	
LNM	(C,T,0)	-1.969621	-4.115684	-3.485218	-3.170793	Unstatationary
DLNM	(C,N,0)	-9.531509***	-3.544063	-2.910860	-2.593090	Stationary
LNEDU	(C,T,1)	-2.604001	-4.118444	-3.486509	-3.171541	Unstatationary
DLNEDU	(N,N,1)	-4.215640***	-2.604746	-1.946447	-1.613238	Stationary
LNEU	(N,N,8)	6.253966	-2.609324	-1.947119	-1.612867	Unstatationary
DLNEU	(C,N,1)	-4.505033***	-3.546099	-2.911730	-2.593551	Stationary
LNTIE	(C,T,1)	-2.465281	-4.118444	-3.486509	-3.171541	Unstatationary
DLNTIE	(C,N,0)	-5.097995***	-3.544063	-2.910860	-2.593090	Stationary
LNPTFP	(C,T,0)	-2.159173	-4.115684	-3.485218	-3.170793	Unstatationary
DLNPTFP	(C,N,0)	-6.071282***	-3.544063	-2.910860	-2.593090	Stationary
LNSTFP	(C,T,1)	-2.550908	-4.118444	-3.486509	-3.171541	Unstatationary
DLNSTFP	(C,N,1)	-9.040902***	-3.546099	-2.911730	-2.593551	Stationary
LNTTFP	(C,T,0)	-1.269348	-4.115684	-3.485218	-3.170793	Unstatationary
DLNTTFP	(C,T,0)	-6.711633***	-4.118444	-3.486509	-3.171541	Stationary

of the total factor of the secondary industry, LNTTFP as the index of the total factor productivity of the tertiary industry.

Taking logarithm of each index, the financial deepening (LNM), education development (LNEDU), energy onsumption (LNEU) and opening to the outside world (LNTIE) are the influencing factors of technological progress.

Data in this paper are derived from the CSMAR database, the website of the Nationgal Bureau of Statistics of the People's Republic of China and the *New China 60 Years Statistical Data Compilation*.

3 EMPIRICAL ANALYSIS

3.1 Stationary Test

Before the construction of VAR model, it is necessary to carry out unit root test. Unit root test is the sequence of the stationary test. In this paper, the ADF method is used to test the total factor productivity and its influencing factors. The test results are shown in Table 1. All the variables are 1 stage single integration, therefore can be tested by the cointegration test method.

3.2 Primary Industry VAR Model

Through test, the LNPTFP and other variables are not cointegrated relationship. Therefore, the VAR model is constructed to analyze the relationship among the difference of the LNPTFP and that of other variables.

According to the test of table 2, the optimal lag period of the VAR model is selected as 1 stage. Not significant variables are removed, and the test results of VAR model are shown in the formula (3). The number in the parentheses is the standard error and the T statistics in the brackets.

3.3 Secondary Industry VEC Model

The test of LNSTFP and other variables are co-integrated relationship. Therefore, the VEC model is constructed to analyze the relationship among the LNSTFP and other variables.

According to the test of table 3, the optimal lag period of the VEC model is selected as 2 stage, that is 3 stage minus 1 stage because of cointegration constraint. Cointegration test results are shown in Table 4. According to the trace statistics, there is cointegration relationship among the variables. Not significant variables are removed, and the test results of VEC model are shown in the formula (4) and formula (5).

3.4 Tertiary Industry VEC Model

The test of LNTTFP and other variables are co-integrated relationship. Therefore, the VEC model is constructed to analyze the relationship among the LNTTFP and other variables.

According to the test of table 5, the optimal lag period of the VEC model is selected as 1 stage, that is 2 stage minus 1 stage because of cointegration constraint. According to the trace statistics, there are cointegration relationship among the variables. Not significant variables are removed, and the test results of VAR model are shown in the formula (6) and formula (7).

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Table 2: Variable lag length test.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	180.3035	NA	1.63e-09	-6.044948	-5.867324	-5.975760
1	235.8736	99.64287*	5.70e-10*	-7.099088*	-6.033342*	-6.683959*
2	254.5886	30.33134	7.22e-10	-6.882367	-4.928499	-6.121296
3	273.0901	26.79518	9.50e-10	-6.658279	-3.816288	-5.551266

$$DLNPTFP_t = -0.287DLNEU_{t-1} + 0.139DLNTIE_{t-1}$$
$$(0.091) \quad (0.073) \qquad (3)$$
$$[-3.172] \quad [1.894]$$

Table 3: Variable lag length test.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-151.0157	NA	0.000136	5.288668	5.464730	5.357396
1	197.8435	626.7640	2.33e-09	-5.689609	-4.633234*	-5.277243
2	246.9987	79.98143	1.05e-09	-6.508432	-4.571744	-5.752427
3	285.5240	56.15553*	6.95e-10*	-6.966916*	-4.149917	-5.867274*

Table 4: Johansen cointegration test result of LNSTFP、LNM、LNEDU、LNEU and LNTIE.

Hypothesized No. Of CE(s)	Trace Statistic	0.05 critical value	Max-Eigen Statistic	0.05 critical value
None*	76.92855*	69.81889	31.50815	33.87687
At most 1	45.42040	47.85613	17.61823	27.58434
At most 2	27.80217	29.79707	15.61677	21.13162
At most 3	12.18540	15.49471	12.17002	14.26460
At most 4	0.015378	3.841466	0.015378	3.841466

$$DLNSTFP_t = -0.211ECM_{t-1} - 0.273DLNSTFP_{t-1} - 0.519DLNSTFP_{t-2} - 0.397DLNM_{t-1}$$
$$(0.082) \quad (0.122) \quad (0.120) \quad (0.135)$$
$$[-2.580] \quad [-2.248] \quad [-4.316] \quad [-2.946] \qquad (4)$$
$$-0.121DLNEDU_{t-2} + 0.583DLNEU_{t-1} - 0.493DLNEU_{t-2} + 0.162DLNTIE_{t-1} + 0.067$$
$$(0.062) \quad (0.167) \quad (0.154) \quad (0.101) \quad (0.022)$$
$$[-1.962] \quad [3.489] \quad [-3.203] \quad [1.603] \quad [3.083]$$

$$LNSTFP_{t-1} = 0.366LNM_{t-1} + 0.200LNEDU_{t-1} + 0.171LNEU_{t-1} - 0.280LNTIE_{t-1} + 5.192$$
$$(0.137) \quad (0.055) \quad (0.115) \quad (0.111) \qquad (5)$$
$$[-2.670] \quad [-3.614] \quad [-1.488] \quad [2.514]$$

Table 5: Variable lag length test.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-168.8526	NA	0.000249	5.893307	6.069370	5.962035
1	231.6231	719.4987	7.43e-10	-6.834683	-5.778308*	-6.422317
2	273.8622	68.72796*	4.22e-10*	-7.419057	-5.482370	-6.663053*
3	299.0095	36.65545	4.40e-10	-7.424052*	-4.607052	-6.324410

Table 6: Johansen cointegration test result of LNTTFP、LNM、LNEDU、LNEU and LNTIE.

Hypothesized No. Of CE(s)	Trace Statistic	0.05 critical value	Max-Eigen Statistic	0.05 critical value
None*	78.38199*	69.81889	29.58991	33.87687
At most 1*	48.79208*	47.85613	19.45679	27.58434
At most 2	29.33529	29.79703	14.33239	21.13162
At most 3	15.00290	15.49471	12.73030	14.26460
At most 4	2.272598	3.841466	2.272598	3.841466

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$$DLNTTFP_t = -0.209ECM_{t-1} + 0.244DLNTTFP_{t-1} + 0.130DLNEU_{t-1}$$
$$(0.043) \quad (0.112) \quad (0.090) \qquad (6)$$
$$[-4.871] \quad [2.185] \quad [1.444]$$

$$LNTTFP_{t-1} = 0.533LNM_{t-1} - 0.572LNEU_{t-1} - 0.168LNTIE_{t-1} - 1.634$$
$$(0.146) \quad (0.129) \quad (0.119) \qquad (7)$$
$$[-3.779] \quad [4.441] \quad [1.413]$$

4 CONCLUSIONS

From the perspective of industrial production efficiency, the opening to the outside world helps to promote the primary industrial technology progress. Energy consumption and the primary industrial technology progress have a negative relationship, and the production of high energy consumption is not conducive to technological progress of the primary industry. The impacts of financial deepening and educational development on technological progress of the primary industry are not significant. Energy consumption is helpful to promote the technological progress of the secondary industry. Financial deepening and improving the level of education have a long-term role in promoting the technology progress of the secondary industry. Opening up to the outside world helps to promote the technological progress of the secondary industry in the short term, but in the long run is a reverse change relationship. In the long run, the financial deepening is helpful to promote the technological progress of the tertiary industry. Energy consumption in the short term is conducive to the technological progress of the tertiary industry, from the long-term view is not conducive to technological progress. The level of education has no significant effect on the technological progress of the tertiary industry. From a long time to see the relationship between the opening up and the technological progress of the tertiary industry is the reverse.

Therefore, policy should further deepen the role of finance in the economy, and strive to play a role of financial in promoting the technology development. To promote the development of education, and strive to promote the role of education in the promotion of technological progress. In energy consumption, energy consumption although promote the technology progress of the secondary industry, it is not conducive to the primary industrial technological progress, and from the long-term view is not conducive to the technological progress of the tertiary industry. Therefore, in the energy consumption we should be rational use of resources, play the role of energy in the economy, change the way of economic growth, encourage intensive production, and promote technological progress. In opening up, we should improve the export of high value-added products, and use international trade to promote technological progress.

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