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Empirical analysis of tax incentive policy for digital transformation of manufacturing industry—Take A-share listed companies of manufacturing industry in Heilongjiang Province as an example

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Abstract: The report of the 20th National Congress of the Communist Party of China proposed that we must develop the digital economy and promote the digital and intelligent transformation of manufacturing industry. By constructing a model, this paper analyzes the tax factors affecting the digital transformation of manufacturing enterprises in Heilongjiang Province, and draws a conclusion that the tax incentive policy mainly promotes the digital transformation of manufacturing enterprises by reducing the corporate income tax burden.

1. Introduction

Heilongjiang Province is the beginning of the Republic's industry which has a complete range of industrial systems. It has become an important national heavy equipment manufacturing base, energy base and raw material base. At present, the digital and intelligent transformation and upgrading of traditional industries are imminent. [1]Heilongjiang Province has issued the "14th Five-Year Plan" digital economy development plan and supporting policies, focusing on the demonstration application of digital scenes, the cultivation and introduction of industrial Internet platforms, and the improvement of digital transformation capabilities, to improve the digital level of industrial enterprises in research and development, design, production and manufacturing and other business links, [2]and help the digital transformation of Heilongjiang's manufacturing industry.

2. Empirical analysis

2.1. Variable selection and data source

This paper uses Guotai 'an database. Taking the financial key indicators of 22 listed companies in Heilongjiang Province from 2012 to 2023 as the initial samples, the year 2018 is set as the point of exogenous impact of the policy, [3]11 manufacturing enterprises are set as the experimental group, 11 non-manufacturing enterprises are set as the control group, and 264 sample data are processed:① Delete ST and ST* listed companies;② Delete data outliers: such as key variables missing enterprises; Finally, a total of 264 panel data were obtained from the national Tai 'an database.

2.1.1. Selection of explained variables, data sources and screening

This paper sums up the number of digital technologies applied by listed companies to represent the digital transformation index of enterprises; Digital technologies include: artificial intelligence, blockchain, cloud computing, big data processing, etc. We have compiled and measured the keywords related to “digital transformation” in the annual reports of all A-share manufacturing listed companies. Afterwards, we classify and sum these keywords to form the initial measurement index of digital transformation of manufacturing enterprises.

Explained variable (Tec): degree of digital transformation; Quantitative method: digital technology.

2.1.2. Selection of explanatory variables, control variables, data sources and screening

The core explanatory variable (Post×Treat) is equal to the product of the time dummy variable (Post) and the policy dummy variable (Treat), which belongs to the manufacturing industry Treat=1, otherwise Treat=0;Post=0 before 2018, otherwise Post=1 (i.e., take the implementation year of tax reduction and fee reduction policy as an example).Explanatory variable (Post) : time dummy variable, that is, before 2018 =0, after 2018 (including 2018) =1;Explanatory variable (Treat) : policy dummy variable, that is, manufacturing enterprise =1, other enterprise =0.

Control variable(Tax) :①Asset-liability ratio (Lev) : Total liabilities/total assets *100%; ② Income tax rate = Income tax/total profit *100%; ③Financial leverage (FL) : rate of change in earnings per share/rate of change in EBIT; ④Operating leverage (BL) : rate of change in EBIT/rate of change in sales volume; ⑤ Fixed assets ratio (FAR) : fixed assets/total assets *100%; ⑥ Cost expense margin (CER) : Total cost expense/operating income *100%, etc.

2.2. Model construction and testing

2.2.1. Construction of model

This paper uses the differential differential model to study the impact of tax incentive policies on the degree of digital transformation of enterprises.The setting model is as follows:

$$Tec_{i,t} = \beta_0+\beta_1 treat_i \times post_t + \alpha X_{i,t} + \theta_i + \mu_t + \varepsilon_{i,t}$$

In the upper style, the subscript i represents the enterprise, and t represents the year; $Tec_{i,t}$ indicates the degree of enterprise digital transformation; $treat_i$ indicates whether enterprise i is a manufacturing enterprise, is 1; otherwise, it is 0;$X_{i,t}$ Is the control variable at the enterprise level;θ_i represents the fixed effect of individual enterprises; μ_t stands for year time fixed effect; $\varepsilon_{i,t}$ are error terms.

2.2.2. Descriptive statistics of data

In this paper, descriptive statistical analysis is conducted on the mean value, standard deviation, minimum value and maximum value of variables in the model, and the results are shown in Table 1:

As can be seen from Table 1, the mean value of the digital transformation degree of the explained variable is 5.913, and the median value is 2, indicating that there is a large difference in digital transformation among the selected data of listed enterprises in the same industry. The standard deviation is 12.11, which means that the sample selection is relatively stable and the difference is small.

Table 1: Descriptive statistics

variable	N	mean	p50	sd	min	max
Tec	264	5.913	2	12.11	0	90
did	264	0.25	0	0.434	0	1
Lev	264	0.501	0.481	0.238	0.003	1.28
Tax	264	0.202	0.174	0.244	-0.195	2.843
FL	264	1.769	1.095	2.325	-0.817	28.87
BL	264	1.521	1.31	0.852	0	7.698
FAR	264	0.204	0.167	0.171	0.002	0.727
CER	264	0.148	0.063	0.289	-0.944	1.268

2.2.3. Correlation analysis of data

stata 15.0 software was used to perform pwcorr correlation, as shown in Table 2:

Table 2: Correlation analysis

Tec	did	Lev	Tax	FL	BL	FAR	CER	
Tec	1							
did	0.203***	1						
Lev	-0.064	0.011	1					
Tax	-0.141**	-0.085	-0.02	1				
FL	-0.098	-0.032	0.180***	0.226***	1			
BL	0.290***	0.068	-0.113*	0.118*	0.095	1		
FAR	-0.187***	-0.082	0.054	-0.055	0.155**	0.189***	1	
CER	-0.028	-0.178***	-0.258***	-0.038	-0.183***	-0.1	-0.101	1

Note: wherein***:p<0.01;**:p<0.05;*p<0.1

It can be seen from Table 2 that the data with stars accounts for about 46.43%, indicating that the relationship between the above variables is relatively close, that is, there is a high correlation between variables, and the selection of variables is reasonable.

2.2.4. Stationary trend test

The premise of using the differential method is to pass the stationary trend test, that is, the data selected before the implementation of the policy is divided into the experimental group and the control group, and there should be no obvious difference between the two, as shown in Figure 1, there should be a parallel trend. The subgroup dummy variable treated was treated with the dummy variable of the year before the implementation of the policy and the interaction item of the dummy variable after the implementation of the policy. The horizontal axis represents the number of years before and after the implementation of the tax incentive policy, and the vertical axis represents the change difference in the degree of enterprise digital transformation. The specific results are shown in Figure 1:

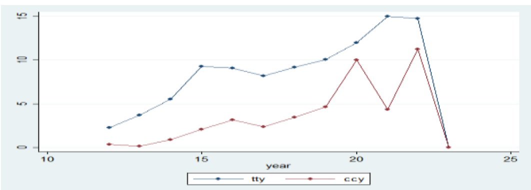

Figure 1: Parallel trend test

Before 2018, the trend of the experimental group and the control group was roughly the same, indicating that the change was not obvious and the difference was not significant; Although there is a trend of catch-up in 2020 after the implementation of the policy, there is a certain distance in 2021, indicating that the implementation of the policy has a significant impact on the degree of digital transformation of enterprises, and there is a significant difference.Therefore, the hypothesis of stationary trend is valid: Before the implementation of the policy, there is a good parallelism between the experimental group and the control group, and there is no significant difference.In addition, it can be seen that the values of the experimental group (tty) are higher than those of the control group (ccy), which indicates that the transformation and innovation degree of the manufacturing industry, as a pillar industry, has always been ahead of other industries. Although other industries have also enjoyed the preferential policies before and after the implementation of the tax incentive policy, they are not as deep as the impact on the manufacturing industry.

2.2.5. Collinearity test

Here, the collinearity between variables will be tested, and VIF collinearity test will be applied to eliminate the multicollinearity problem between variables.The results show, VIF is 1.1 (much less than 10), indicating that there is almost no serious collinearity between the variables of the selected financial key indicators of listed companies, so regression analysis can be continued.

2.3. Empirical regression results and analysis

2.3.1. Analysis of basic regression results

Using the regression results of the two-factor model (other control variables: omitted) , the interaction term did (treat×post) and other control variables for the interpreted variables (Tec) were analyzed: The estimated coefficient of the interactive term did is 3.947 * * * , indicating that the result is significantly positive at the level of 1% , that is, after the implementation of tax incentives, there is a significant positive effect on the degree of digital transformation of manufacturing enterprises.

2.3.2. Stability test

The Hausmann test can tell whether the selection of fixed effect or random effect, which is a kind of model selection test. Therefore, the original hypothesis H0 is set first: there is no significant difference in variables, and the model selects random effects. The results of specific operations (other control variables: omitted) are shown in Table 3:

Table 3: Hausmann test results derived

	(1)Mixed ols model	(2)Fixed effect Fe	(3)Random effect Re
Tax	-8.604^{***}	-5.350^{**}	-5.837^{**}
	-2.886	-2.429	-2.366
_cons	3.408	1.743	2.343
	-2.466	-2.683	-3.104
N	264	264	264
r2	0.406	0.16	-
r2_a	0.384	0.059	-
Prob > chi2 = 0.0000			

It can be seen from Figure 1 and Table 3 that a p value of 0 is less than 0.05, indicating that the original hypothesis H0 is strongly rejected. So the fixed effect is better than the random effect. By comparing (1) and (2) ,it is shown that individual effect is significant and the fixed effect is better.By comparing (1) and (3) ,it is shown that the random effect is significant and the fixed effect should be selected for regression analysis through Hausmann test.

2.3.3. Placebo test

In order to test the effect mechanism of tax incentive policies on the degree of digital transformation of manufacturing enterprises, and exclude the influence of unobservable data on the results, 123 out of 264 samples were randomly selected as the "pseudo-experimental group", and the placebo test was conducted on them, and the process was repeated 500 times. The product of the time dummy variable is used as the core explanatory variable for regression, which presents a normal distribution on the whole, and the values are all distributed near 0, indicating that the influence of the pseudo-experimental group is very weak. The sample combination after random sampling has almost no impact on the degree of digital transformation, and the construction of the model does not miss enough important influencing factors. The regression results of the benchmark regression are robust by distinguishing the experimental group and the control group by industry type.

2.3.4. Basic conclusion

The research shows that the tax incentive policy is conducive to the digital transformation of manufacturing enterprises and has a positive and significant promoting effect.

3. Countermeasures and suggestions

The research shows that tax policy support is needed to promote the digital transformation of enterprises in manufacturing. [4]Therefore, we can consider taking the lead in reducing the tax burden by lowering the first class tax rate. At the same time, the enterprise income tax system can be piloted, from the classical system to the vesting system or the double tax rate system. Form a local level, promoting the digital transformation of the manufacturing industry requires the formulation of clear main functions. At the same time, targeted tax incentives will be provided for financing, R&D, experimentation, achievement transformation, income distribution, and reproduction in the transformation and upgrading of the equipment manufacturing industry.

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