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Research Article

Evaluation and Influence of Chinese Enterprises' Financial Efficiency Based on the Malmquist Index

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This paper introduces a superefficiency financial efficiency model with undesirable output based on the features that the output of industrial enterprises contains desirable output as well as undesirable output. Furthermore, the Malmquist index model is constructed for financial efficiency dynamic study, and the spatial Durbin model is constructed for evaluation and impact of enterprises. According to the financial data of Chinese enterprises from 2007 to 2019, this paper evaluates the financial efficiency of Chinese interprovincial industrial enterprises dynamically and measures the influence levels of major impacts on the financial efficiency of Chinese interprovincial industrial enterprises quantitatively. As reported by this paper, the conclusions are as follows: (1) In reference to the financial efficiency dynamic study analysis, there is an obvious growth trend in the financial efficiency of Chinese interprovincial industrial enterprises in different years. Based on the horizontal analysis of financial efficiency, there is a relatively large gap in financial efficiency among Chinese interprovincial industrial enterprises. (2) From the separation factors of financial efficiency analysis, the main factor affecting the growth of the financial efficiency of Chinese industrial enterprises is the modification of technology, and the modification of technical efficiency has a minor impact. (3) In accordance with the impacts of enterprise efficiency analysis, several major factors influence the financial efficiency of Chinese industrial enterprises such as major business cost, operating profit, total liabilities, national capital, and the number of R&D personnel.

1. Introduction

With the world economy getting into the stage of rapid development of postindustrialization, the resource shortage and environmental pollution issues are getting worse and worse, which affect people's lives and the development of society. Therefore, the use of scientific methods to analyze and evaluate the financial efficiency of regional industrial enterprises and to dig out their influencing factors and influencing directions is of great practical significance for promoting energy conservation and emission reduction of regional industrial enterprises, improving the ecological environment, and realizing regional sustainable development. Financial efficiency refers to the ratio between input and output of financial resources and other ratio relationships derived therefrom. There are multiple methods to evaluate enterprise financial efficiency, and the primary methods are the single index method, DEA, comprehensive index method, principal component analysis, and regression analysis of linear and nonlinear parameters.

Mykola et al. [1] constructed a single index system which includes financial stability, liquidity and solvency, operating activities, profitability, and evaluates the financial efficiency of an industrial enterprise. Güner [2] conducted deep research on infrastructure, operational efficiency, and financial efficiency based on the DEA model to measure the financial efficiency of 13 Turkish seaport enterprises. Deng et al. [3] established a dynamic evaluation system based on data envelopment analysis (DEA), analytic hierarchy process (AHP), and priority ranking enrichment evaluation organization method and evaluated the financial efficiency of China's nuclear power-related enterprises. Charmondusit et al. [4] constructed three sustainable development indicators which are economic indicators, environmental

indicators, and social indicators and measured the financial efficiency of the wooden toy industry. Ricardo et al. [5] used a multi-indicator system that included representativeness, participation, and leadership to evaluate the relationship between governance and financial efficiency of Brazilian credit cooperatives. Le et al. [6] used the sample data of 31 Asian countries from 2004 to 2016 to construct a comprehensive index system of three financial dimensions using principal component analysis (PCA) based on standardized variables and conducted research on the financial efficiency of the samples. Mitchell [7] used the linear and nonlinear regression analysis method to evaluate and analyze the financial efficiency of guarantor enterprises. Shu and other scholars [8] combined multilevel dynamic fuzzy evaluation and the BP neural network to establish a financial efficiency evaluation model of private enterprises. Ross [9] used the advantages of the questionnaire and comprehensive interview method to evaluate financial efficiency based on the internal status of the company's management department. Robert [10] proposed a balanced scorecard with distinct advantages to evaluate financial efficiency when implementing the integration of financial and nonfinancial indicators.

From the analysis of the current research data, there are multiple studies on the financial efficiency of an industry or enterprise, but rare on the financial efficiency of macroregional industries. There is abundant research on the static evaluation of financial efficiency but insufficient research on the dynamic research of financial efficiency. There is plenty of analysis on the evaluation of financial efficiency but a lack of analysis on the influencing factors of financial efficiency. Therefore, this paper will construct the superefficiency financial efficiency model with undesirable output and the financial efficiency index model and combine them to evaluate the financial efficiency of Chinese interprovincial industrial enterprises dynamically. The evaluation model of influencing factors of enterprise financial efficiency is constructed as well to quantitatively measure the impacts of industrial enterprise financial efficiency. The conclusion will provide a theoretical basis for formulating policies to improve the financial efficiency of Chinese industrial enterprises.

2. Construction of an Enterprise Financial Efficiency Research Model

2.1. Construction of an Enterprise Financial Efficiency Evaluation Model. This paper introduces a superefficiency financial efficiency model with undesirable output based on the feature that the output of industrial enterprises contains desirable output as well as undesirable output. The model also comprehensively evaluates the financial efficiency of interprovincial industrial enterprises. Suppose there are "n" types of DMU and "m" types of inputs, then the i^{th} input of k^{th} DMU is recorded as $x_{ik}\,(i = 1, 2, \ldots, m)$; suppose there are q_1 types of desirable output and q_2 types of undesirable output, then the r^{th} undesirable output of k^{th} DMU is recorded as $y_{rk}(r = 1, 2, \ldots, q_1)$ and the t^{th} undesirable output of k^{th} decision sheet is recorded as $b_{tk}\,(t = 1, 2, \ldots, q_2)$; the superefficiency US-DEA model with undesirable output is as follows:

$$
\begin{aligned}
&\min \quad \rho = \frac{1 + 1/m\sum_{i=1}^{m} s_i^- / x_{ik}}{1 - 1/q_1 + q_2\left(\sum_{r=1}^{q_1} s_r^+ / y_{rk} + \sum_{t=1}^{q_2} s_t^{b-} / b_{tk}\right)},\\
&s.t. \sum_{j=1\, j\neq k}^{n} x_{ij}\lambda_j - s_i^- \le x_{ik},\\
&\sum_{j=1\, j\neq k}^{n} y_{rj}\lambda_j + s_r^+ \ge y_{rk},\\
&\sum_{j=1\, j\neq k}^{n} b_{tj}\lambda_j - s_t^{b-} \le b_{tk},\\
&1 - \frac{1}{q_1 + q_2}\left(\sum_{r=1}^{q_1}\frac{s_r^+}{y_{rk}} + \sum_{t=1}^{q_2}\frac{s_t^{b-}}{y_{tk}}\right),\\
&\lambda, s^-, s^+ \ge 0,\\
&i = 1, 2, \ldots, m;\ j = 1, 2, \ldots, q;\ j = 1, 2, \ldots, n\,(j \neq k),
\end{aligned}
\tag{1}
$$

where s_i^- is the input slack variable; s_r^+ is the desirable output slack variable; s_t^{b-} is the undesirable output slack variable; and λ is the combination proportion in effective decision-making unit.

2.2. Construction of an Enterprise Financial Efficiency Index Model. A financial efficiency index model is constructed to work on the dynamic financial efficiency of industrial enterprises. In general, indexes include fixed base index and chain base index. A fixed base index for which the base period for calculation remains unchanged. This is different from a chain base index in which the base period for calculation is based on the previous period. This paper will use the fixed base index, which refers to the fixed reference Malmquist index (MI_f) to dynamically compare the financial efficiency of industrial enterprises. The MI_f index is divided into technical efficiency change index EC_f and technical change index TC_f. The following shows the relationship between the three indexes:

$$MI_f = EC_f \times TC_f = \frac{E^f\left(x^{t+1}, y^{t+1}\right)}{E^f\left(x^t, y^t\right)}, \tag{2}$$

where $E^f(x^t, y^t), E^f(x^{t+1}, y^{t+1})$ refers to the $t, t+1$ financial efficiency of a fixed period, respectively.

The formula of technical efficiency change index, EC_f shows as follows:

$$EC_f = \frac{E^{t+1}\left(x^{t+1}, y^{t+1}\right)}{E^t\left(x^t, y^t\right)}, \tag{3}$$

where $E^t(x^t, y^t), E^{t+1}(x^{t+1}, y^{t+1})$ refer to $t, t+1$ financial efficiency of a current period, respectively.

The formula of technical change index, EC_f shows as follows:

$$TC_f = \frac{E^f\left(x^{t+1}, y^{t+1}\right)/E^{t+1}\left(x^{t+1}, y^{t+1}\right)}{E^f\left(x^t, y^t\right)/E^t\left(x^t, y^t\right)} = \frac{E^f\left(x^{t+1}, y^{t+1}\right)}{E^{t+1}\left(x^{t+1}, y^{t+1}\right)} \frac{E^t\left(x^t, y^t\right)}{E^f\left(x^t, y^t\right)}, \tag{4}$$

where $E^f(x^t, y^t), E^f(x^{t+1}, y^{t+1})$ refer to $t, t+1$ financial efficiency of a fixed base period, respectively.

2.3. Construction of the Evaluation Model of Influencing Factors of Enterprise Financial Efficiency. Since the research object of this paper is the financial efficiency of 30 interprovincial enterprises in China, the financial efficiency of these interprovincial enterprises has a spatial correlation. The construction of a regression equation has the feature of solving the spatial correlation of variables. Hence, this paper will construct a spatial Durbin model (SDM) to measure spatial association. The formula of SDM is as follows:

$$e = \lambda \mathbf{W}e + \mathbf{X}\beta + \delta \mathbf{W}\mathbf{X} + \varepsilon, \tag{5}$$

where e is the explanatory variable (interprovincial financial efficiency), $\mathbf{W}$ is the spatial weight matrix, $\mathbf{X}$ is the explanatory variable, λ, β, δ are the coefficients, and ε is the random disturbance.

3. Input and Output Indicator Selection and Data Source of Enterprise Financial Efficiency Measurement

3.1. Index Selection

3.1.1. Input Indicator. Total assets, employment, total water consumption, and total energy consumption of interprovincial industrial enterprises are selected as input indicators to calculate the financial efficiency of Chinese industrial enterprises by using the superefficiency DEA model.

3.1.2. Output Indicator. The profit of industrial enterprises, total industrial output, industrial wastewater discharge, industrial waste gas discharge, and the total amount of industrial solid waste are selected at the same time as the output indicators. The first two items are regarded as desirable outputs, and the last three items are regarded as undesirable outputs.

3.2. Data Source. This paper selects the data of China's provinces, municipalities directly under the central government and autonomous regions (Hong Kong, Macao, Taiwan, and Tibet are not included in the analysis due to the lack of data) from 2007 to 2019 as the research sample, with a total of 390 observations. All the data are from the Chinese Industrial Statistics Yearbook, Chinese Environment Yearbook, and Chinese Energy Statistics Yearbook from 2008 to 2020.

4. Analysis on the Dynamic Changes of the Financial Efficiency of Industrial Enterprises

4.1. Dynamic Analysis of the Financial Efficiency of Industrial Enterprises. According to the input and output index data of Chinese interprovincial industrial enterprises from 2007 to 2019, the financial efficiency of Chinese industrial

enterprises in 2007 as a fixed reference can be calculated by using MaxDEA7 software and formulas (1) and (4). The detailed data are shown in Table 1.

The following can be seen from the interprovincial financial efficiency data in Table 1:

(1) On the basis of the dynamic analysis, the average financial efficiency of Chinese interprovincial industrial enterprises in different years is shown. The average value in 2007 was 1.163, rising to 2.715 by 2019. There is an obvious ascended of the financial efficiency of Chinese interprovincial industrial enterprises.

(2) From the horizontal analysis, there are large differences in the average financial efficiency among Chinese interprovincial industrial enterprises. The top five interprovinces with the highest average values are Shandong, Beijing, Jiangsu, Guangdong, Tianjin, Qinghai, and Shanghai, which are 7.456, 4.663, 3.549, 3.355, 2.988, 2.965, and 2.668, respectively. These interprovinces, except Qingdao, are all economically developed areas. The last three provinces with the lowest average value are Shanxi, Guizhou, and Yunnan, which have 0.891, 1.053, and 1.101, respectively. These provinces are economically underdeveloped areas.

4.2. Analysis on the Total Change of Financial Efficiency of Industrial Enterprises. The financial efficiency of industrial enterprises in different periods is calculated above. Based on this, the absolute amount of financial efficiency change (ΔE) in different years can be calculated and decomposed into the absolute amount caused by technical efficiency modification (ΔE_{EC}) and the absolute amount caused by technical modification (ΔE_{TC}). The absolute relationship between the three can be expressed as follows:

$$\Delta E = E\left(x^{t+1}, y^{t+1}\right) - E\left(x^{t}, y^{t}\right) = \Delta E_{EC} + \Delta E_{TC}, \quad (6)$$

where $E(x^{t+1}, y^{t+1})$ is the financial efficiency calculated in period $t+1$ and $E(x^{t}, y^{t})$ is the financial efficiency calculated in period t.

According to formula (6) and the data in Table 1, the absolute change of financial efficiency (ΔE) of Chinese industrial enterprises in different years can be calculated. This refers to the difference between the financial efficiency of the previous year and the financial efficiency of the next year. If the difference is greater than 0, it indicates that the financial efficiency will increase in the next year, and if the difference is less than 0, it indicates that the financial efficiency will decrease in the next year. The detail data can be seen in Table 2. It is worth knowing from Table 2 : (1) the financial efficiency of dynamic industrial enterprises in most provinces has increased. Of 30 provinces, 27 provinces increased, accounting for 90%. (2) The financial efficiency of dynamic industrial enterprises is decreasing in only a few provinces, such as Heilongjiang, Ningxia, and Xinjiang, accounting for 10%.

4.3. Analysis on the Difference of Financial Efficiency of Industrial Enterprises Caused by the Technical Efficiency Modification. According to formula (6), the difference in financial efficiency in different years can be decomposed into absolute quantity (ΔE_{EC}) caused by technical efficiency modification and absolute quantity (ΔE_{TC}) caused by technical modification. The data of the financial efficiency differences caused by technical efficiency modification are shown in Table 3. The following conclusions are drawn from the data in Table 3 : (1) From the analysis of the cumulative differences in value caused by technical efficiency modification in different years among provinces, there are 18 interprovinces greater than 0, accounting for 60% of all interprovinces; there are 12 interprovinces less than 0, accounting for 40% of all interprovinces. It reflects that most interprovincial differences caused by technical efficiency modifications are increasing. (2) From the analysis of the average difference value caused by technical efficiency modification in different years of all provinces, it was 0.032 in 2007 and -0.036 in 2019. It is surprisingly a decrease, reflecting that the differences in overall financial efficiency caused by technical efficiency modification did not increase.

4.4. Analysis on the Differences of Financial Efficiency of Industrial Enterprises Caused by Technological Modification. Similarly, the data of financial efficiency change caused by technical modification is decomposed according to formula (6) and the detailed data can be seen in Table 4. The following conclusions are drawn:

(1) From the analysis of the cumulative differences in value caused by technical modification in different years among provinces, all of them are greater than 0, reflecting that the main reason that caused the increase of financial efficiency among provinces is technical modification. Simultaneously, there is a large index differences among provinces, with the highest being 5.285 in Shandong and the lowest being 0.380 in Hainan.

(2) From the analysis of the average difference value caused by technical efficiency in different years of all provinces, it was 0.123 in 2007 and 0.061 in 2019, with no upward tendency.

5. Determination and Evaluation of Influencing Factors of Enterprise Financial Efficiency

5.1. Determination of Influencing Factors of Enterprise Financial Efficiency. This paper selects the following influencing factors to conduct research on the influence levels of different impacts on the financial efficiency of industrial enterprises: main business cost (cost), operating profit (prof), total liabilities (liab), national capital (scap), foreign capital (fcap), the number of patents applied (pate), and the number of R&D personnel (R&D). The abovementioned data of indicators are from 2007 to 2019, and the data source is the same as in Section 3.2.

Table 1: Financial efficiency of industrial enterprises in various provinces in China.

Provinces	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average value
Beijing	2.652	3.187	3.182	4.199	4.231	4.326	4.273	5.124	5.542	5.987	5.940	5.652	6.318	4.663
Tianjin	1.891	2.224	1.839	2.564	3.165	3.231	3.047	3.346	3.495	3.255	3.642	3.537	3.604	2.988
Hebei	0.875	1.064	1.110	1.380	1.711	1.759	1.895	1.874	1.864	1.993	2.124	2.456	2.544	1.742
Shanxi	0.541	0.600	0.557	0.793	1.138	1.048	1.049	0.986	0.835	0.879	0.890	1.214	1.059	0.891
Inner Mongolia	0.816	1.028	1.289	1.896	2.579	2.288	2.191	1.876	1.844	2.026	2.578	2.811	2.656	1.991
Liaoning	0.805	1.064	1.143	1.452	1.734	1.882	2.037	2.014	1.659	1.294	1.573	1.784	1.652	1.546
Jilin	0.832	0.879	0.938	1.144	1.498	1.630	1.821	1.924	1.933	2.092	2.318	2.643	3.148	1.754
Heilongjiang	1.739	2.044	1.011	1.453	1.644	1.471	1.330	1.240	1.114	1.137	1.454	1.573	1.603	1.447
Shanghai	1.355	1.623	1.573	2.428	2.198	2.153	2.494	2.860	2.914	3.562	3.626	4.200	3.694	2.668
Jiangsu	1.192	1.514	1.664	2.599	3.230	3.496	3.940	4.487	4.803	5.242	4.970	4.499	4.504	3.549
Zhejiang	1.079	1.242	1.296	1.543	1.636	1.668	1.837	1.952	2.014	2.328	2.106	2.283	2.698	1.822
Anhui	0.706	0.793	0.812	1.033	1.316	1.289	1.436	1.541	1.631	2.144	2.217	2.038	2.113	1.467
Fujian	0.898	0.920	0.911	1.072	1.282	1.204	1.193	1.390	1.460	1.863	2.055	2.241	2.789	1.483
Jiangxi	0.936	0.931	0.976	1.160	1.296	1.348	1.503	1.699	1.671	1.915	1.766	1.902	1.954	1.466
Shandong	3.571	4.288	4.963	6.222	7.317	8.148	8.742	9.304	9.097	9.131	9.488	8.558	8.099	7.456
Henan	1.075	1.098	1.125	1.524	1.767	1.636	1.784	1.979	1.976	2.144	2.084	2.544	2.516	1.789
Hubei	0.624	0.738	0.763	1.106	1.407	1.336	1.562	1.629	1.804	1.997	2.044	2.212	2.056	1.483
Hunan	0.849	0.876	0.900	1.061	1.336	1.235	1.379	1.435	1.536	1.993	2.329	1.969	2.082	1.460
Guangdong	1.872	1.742	2.285	3.296	2.972	2.704	3.067	3.708	4.155	4.556	4.039	4.379	4.845	3.355
Guangxi	0.712	0.769	0.777	0.878	1.070	1.116	1.306	1.444	1.556	1.678	1.919	2.190	2.461	1.375
Hainan	0.897	0.899	0.875	0.901	1.012	1.121	1.134	1.214	1.235	1.345	1.469	1.504	1.625	1.172
Chongqing	0.736	0.777	0.761	0.863	1.024	0.959	1.130	1.289	1.447	1.935	2.049	1.783	1.814	1.274
Sichuan	0.662	0.707	0.804	0.982	1.244	1.389	1.404	1.519	1.603	1.804	1.815	2.028	2.153	1.393
Guizhou	0.646	0.707	0.660	0.710	0.791	0.863	1.002	1.060	1.152	1.347	1.426	1.617	1.711	1.053
Yunnan	0.663	0.733	0.741	0.875	1.044	1.019	1.141	1.205	1.224	1.340	1.329	1.501	1.499	1.101
Shaanxi	0.807	1.143	0.916	1.620	2.130	2.115	2.074	1.872	1.574	1.789	2.518	2.863	2.625	1.850
Gansu	0.710	0.685	0.657	0.822	1.242	1.275	1.450	1.380	1.306	1.313	1.548	1.636	1.665	1.207
Qinghai	1.092	1.237	2.406	1.911	2.196	3.989	2.581	5.539	2.631	3.801	4.429	3.775	2.958	2.965
Ningxia	1.893	2.183	1.647	1.251	1.248	1.077	1.249	1.279	1.326	1.512	1.519	1.604	1.539	1.487
Xinjiang	1.775	1.861	1.149	1.923	2.143	1.729	1.621	1.495	1.324	1.359	1.398	1.678	1.453	1.608
Average value	1.163	1.319	1.324	1.689	1.953	2.017	2.089	2.322	2.258	2.492	2.622	2.689	2.715	2.050

Table 2: Differences in the total changes in the financial efficiency of industrial enterprises in various provinces in China.

Provinces	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Cumulative value
Beijing	0.535	−0.005	1.017	0.031	0.095	−0.052	0.851	0.418	0.445	−0.047	−0.288	0.666	3.666
Tianjin	0.333	−0.385	0.725	0.602	0.066	−0.184	0.300	0.149	−0.241	0.387	−0.105	0.066	1.713
Hebei	0.189	0.046	0.271	0.330	0.048	0.136	−0.021	−0.010	0.130	0.130	0.333	0.087	1.669
Shanxi	0.060	−0.043	0.236	0.344	−0.090	0.001	−0.063	−0.151	0.044	0.011	0.324	−0.155	0.518
Inner Mongolia	0.211	0.262	0.607	0.682	−0.291	−0.098	−0.314	−0.033	0.182	0.552	0.233	−0.153	1.840
Liaoning	0.259	0.079	0.308	0.283	0.148	0.155	−0.023	−0.355	−0.365	0.279	0.211	−0.132	0.847
Jilin	0.048	0.059	0.206	0.355	0.132	0.191	0.103	0.009	0.160	0.226	0.325	0.502	2.316
Heilongjiang	0.305	−1.033	0.442	0.191	−0.172	−0.141	−0.090	−0.125	0.023	0.317	0.119	0.028	−0.136
Shanghai	0.268	−0.050	0.855	−0.230	−0.045	0.341	0.366	0.054	0.648	0.065	0.574	−0.507	2.339
Jiangsu	0.323	0.149	0.935	0.632	0.266	0.443	0.548	0.315	0.439	−0.272	−0.471	0.005	3.312
Zhejiang	0.163	0.054	0.246	0.093	0.032	0.169	0.115	0.061	0.314	−0.222	0.177	0.417	1.619
Anhui	0.087	0.019	0.221	0.283	−0.027	0.147	0.105	0.091	0.513	0.073	−0.179	0.074	1.407
Fujian	0.022	−0.010	0.162	0.210	−0.079	−0.011	0.197	0.070	0.402	0.192	0.185	0.551	1.891
Jiangxi	−0.005	0.045	0.184	0.137	0.051	0.156	0.195	−0.027	0.244	−0.149	0.136	0.051	1.018
Shandong	0.717	0.675	1.259	1.095	0.831	0.595	0.562	−0.207	0.034	0.357	−0.930	−0.460	4.528
Henan	0.023	0.027	0.398	0.244	−0.131	0.148	0.195	−0.003	0.169	−0.060	0.460	−0.029	1.441
Hubei	0.114	0.025	0.343	0.301	−0.071	0.226	0.067	0.175	0.193	0.047	0.168	−0.156	1.432
Hunan	0.027	0.025	0.161	0.275	−0.100	0.144	0.056	0.101	0.458	0.335	−0.359	0.110	1.233
Guangdong	−0.131	0.543	1.012	−0.324	−0.268	0.363	0.641	0.447	0.400	−0.516	0.340	0.466	2.973
Guangxi	0.056	0.008	0.101	0.192	0.047	0.190	0.138	0.111	0.122	0.241	0.271	0.272	1.749
Hainan	0.002	−0.024	0.026	0.111	0.109	0.013	0.080	0.021	0.110	0.124	0.035	0.121	0.728
Chongqing	0.041	−0.015	0.102	0.161	−0.065	0.171	0.159	0.159	0.487	0.114	−0.266	0.030	1.078
Sichuan	0.044	0.098	0.177	0.263	0.145	0.015	0.114	0.085	0.201	0.011	0.213	0.125	1.491
Guizhou	0.061	−0.048	0.050	0.082	0.072	0.138	0.058	0.093	0.194	0.079	0.191	0.095	1.065

Table 2: Continued.

Provinces	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Cumulative value
Yunnan	0.070	0.009	0.134	0.169	−0.025	0.121	0.064	0.019	0.116	−0.011	0.172	−0.002	0.836
Shaanxi	0.336	−0.227	0.704	0.510	−0.014	−0.041	−0.202	−0.298	0.215	0.729	0.345	−0.239	1.818
Gansu	−0.024	−0.029	0.165	0.420	0.033	0.175	−0.070	−0.074	0.007	0.235	0.088	0.029	0.955
Qinghai	0.145	1.169	−0.494	0.285	1.793	−1.408	2.958	−2.908	1.170	0.627	−0.654	−0.817	1.866
Ningxia	0.291	−0.536	−0.397	−0.002	−0.171	0.171	0.030	0.047	0.186	0.007	0.086	−0.066	−0.354
Xinjiang	0.087	−0.712	0.774	0.220	−0.414	−0.108	−0.126	−0.171	0.035	0.038	0.280	−0.225	−0.322
Average value	0.155	0.006	0.364	0.265	0.064	0.072	0.233	-0.065	0.235	0.130	0.067	0.025	—

Table 3: Differences in the financial efficiency of China's interprovincial industrial enterprises due to changes in technical efficiency (ΔE_{TC}).

Provinces	2007	2008	2009	2010	2011	2012	2013	2014	2015	2017	2018	Cumulative value
Beijing	−0.101	−0.044	−0.037	−0.272	0.022	0.960	−0.134	0.418	0.433	0.801	0.312	2.148
Tianjin	0.139	−0.490	0.213	0.139	−0.108	−0.072	−0.035	0.013	−0.006	−0.276	−0.004	−0.034
Hebei	0.066	−0.040	0.021	−0.004	−0.022	−0.036	−0.064	−0.017	−0.006	0.075	0.015	−0.040
Shanxi	0.028	−0.063	0.038	0.026	−0.025	−0.058	−0.044	−0.073	0.000	0.252	−0.070	−0.072
Inner Mongolia	0.130	0.461	−0.132	0.097	−0.195	−0.093	−0.155	−0.054	0.034	0.252	−0.073	0.199
Liaoning	0.091	0.007	0.083	−0.061	0.032	−0.038	−0.051	−0.177	−0.170	0.137	−0.066	−0.256
Jilin	0.003	0.064	0.064	0.029	0.040	0.004	−0.012	−0.009	0.052	0.062	0.050	0.248
Heilongjiang	0.163	−0.753	−0.088	−0.043	−0.077	−0.102	−0.154	−0.083	−0.010	−0.007	−0.066	−1.194
Shanghai	−0.021	−0.123	0.092	−0.179	−0.027	−0.029	0.007	−0.026	0.208	0.457	−0.393	−0.037
Jiangsu	0.035	−0.019	−0.002	0.032	0.097	−0.079	0.035	0.082	0.479	0.389	−0.424	0.628
Zhejiang	−0.015	−0.012	0.003	−0.028	−0.034	−0.058	−0.022	−0.032	0.238	0.160	0.077	0.284
Anhui	0.034	0.002	0.072	0.050	−0.045	0.030	0.003	0.030	0.067	0.026	−0.020	0.156
Fujian	−0.019	0.009	0.090	0.038	−0.126	−0.015	0.069	0.030	0.032	0.200	0.362	0.740
Jiangxi	−0.045	0.085	0.131	0.017	0.051	0.109	0.135	−0.151	−0.002	0.015	−0.043	0.063
Shandong	0.095	0.139	−0.610	0.104	0.455	−0.117	−0.173	−0.148	−0.317	−0.140	−0.423	−0.757
Henan	−0.029	0.221	−0.044	−0.016	−0.218	−0.051	0.025	0.010	0.009	0.103	−0.033	−0.045
Hubei	0.075	0.010	0.056	0.066	−0.049	0.045	0.031	0.028	0.017	0.088	−0.033	0.278
Hunan	0.008	0.047	0.062	0.079	−0.053	0.040	−0.008	0.055	0.042	−0.055	−0.008	0.153
Guangdong	−0.431	0.239	−0.031	−0.203	−0.080	0.046	0.161	−0.042	0.118	0.237	0.396	0.283
Guangxi	0.009	−0.002	0.055	0.034	0.018	0.026	0.042	0.083	0.077	−0.040	−0.046	0.291
Hainan	0.001	−0.013	0.002	0.100	0.011	−0.004	0.012	0.014	0.025	0.017	0.049	0.348
Chongqing	0.004	0.016	0.033	0.052	−0.048	0.078	0.007	0.050	0.069	0.077	−0.026	0.185
Sichuan	−0.004	0.065	−0.017	0.036	−0.048	−0.014	0.022	0.088	0.006	0.101	0.086	0.258
Guizhou	−0.004	0.023	−0.039	−0.027	0.130	−0.129	0.004	0.039	0.122	0.206	0.082	0.236
Yunnan	−0.008	−0.006	−0.027	−0.005	−0.017	0.006	0.010	−0.015	0.023	0.216	0.080	0.079
Shaanxi	0.292	−0.111	−0.058	0.078	−0.060	0.016	−0.209	−0.087	0.019	0.667	−0.305	0.344
Gansu	−0.056	−0.007	0.007	0.088	0.006	0.028	−0.072	−0.061	−0.028	0.016	0.005	−0.157
Qinghai	0.117	0.600	−0.380	0.008	1.659	−1.236	2.475	−3.093	0.255	−0.055	−0.436	−0.075
Ningxia	0.501	−1.534	−0.077	0.055	−0.192	0.044	−0.032	0.005	0.057	−0.009	−0.025	−1.326
Xinjiang	−0.090	−0.575	0.091	−0.146	−0.145	−0.013	−0.151	−0.095	−0.017	0.236	−0.102	−1.168
Average value	0.032	−0.060	−0.014	0.005	0.032	−0.024	0.057	−0.107	0.061	0.140	−0.036	—

5.2. Analysis of Influencing Factors of Financial Efficiency Based on the Spatial Dobbin Model. StataSE-64 software is applied for the research on the influence levels of various influencing factors on interprovincial financial efficiency. The spatial Durbin model is used for regression according to the dynamic data of the financial efficiency of interprovincial industrial enterprises in Table 1. The regression results are shown in Table 5:

(1) As shown in Table 5, the data in column coef. of the Min project reflects the impact of various influencing factors on the financial efficiency of their own provinces. The necessary factors that impact on financial efficiency are operating profit (prof), national capital (scap), and the number of *R&D* personnel (R&D), and the credibility is 99%. Operating profit (prof) and national capital (scap) have positive coefficients, and this indicates that these two factors have a positive correlation on the financial efficiency of their own province. The coefficient of other factors is negative, indicating that these factors have a negative correlation with the financial efficiency of the province.

(2) In Table 5, the data in column coef. of the Wx project reflects the impact of various influencing factors on the financial efficiency of neighboring provinces. The major factors that impact on the financial efficiency of neighboring provinces are the main business cost (cost), total liabilities (liab), national capital (scap),

Table 4: Differences in financial efficiency changes caused by technological changes in China's interprovincial industrial enterprises (ΔE_{TC}).

Provinces	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Cumulative value
Beijing	0.636	0.039	1.054	0.304	0.073	−1.013	0.985	0.000	0.011	0.163	−1.088	0.354	1.518
Tianjin	0.194	0.105	0.512	0.463	0.174	−0.112	0.334	0.136	−0.235	−0.066	0.172	0.070	1.747
Hebei	0.123	0.085	0.250	0.334	0.070	0.173	0.043	0.007	0.136	0.158	0.258	0.072	1.709
Shanxi	0.032	0.020	0.198	0.319	−0.065	0.059	−0.019	−0.079	0.044	0.094	0.072	−0.085	0.590
Inner Mongolia	0.081	−0.199	0.739	0.585	−0.096	−0.004	−0.159	0.021	0.148	0.625	−0.019	−0.081	1.641
Liaoning	0.169	0.072	0.226	0.344	0.116	0.193	0.028	−0.178	−0.195	0.322	0.074	−0.068	1.103
Jilin	0.045	−0.006	0.142	0.326	0.091	0.187	0.115	0.018	0.108	0.325	0.263	0.454	2.068
Heilongjiang	0.141	−0.280	0.530	0.234	−0.096	−0.040	0.064	−0.042	0.033	0.291	0.126	0.097	1.058
Shanghai	0.290	0.072	0.764	−0.052	−0.019	0.370	0.359	0.080	0.441	0.068	0.116	−0.113	2.376
Jiangsu	0.288	0.169	0.937	0.600	0.169	0.523	0.513	0.234	−0.040	−0.275	−0.860	0.426	2.684
Zhejiang	0.178	0.066	0.243	0.122	0.066	0.228	0.137	0.093	0.077	−0.230	0.017	0.338	1.335
Anhui	0.053	0.017	0.149	0.234	0.017	0.117	0.102	0.060	0.445	0.166	−0.205	0.096	1.251
Fujian	0.041	−0.019	0.071	0.172	0.047	0.004	0.129	0.040	0.371	0.123	−0.014	0.186	1.151
Jiangxi	0.039	−0.040	0.052	0.120	0.000	0.047	0.061	0.124	0.245	0.090	0.121	0.096	0.955
Shandong	0.622	0.536	1.869	0.991	0.376	0.711	0.735	−0.059	0.351	−0.021	−0.791	−0.035	5.285
Henan	0.052	−0.194	0.442	0.260	0.086	0.199	0.170	−0.012	0.160	−0.038	0.357	0.004	1.486
Hubei	0.039	0.014	0.288	0.235	−0.022	0.182	0.036	0.147	0.176	0.103	0.079	−0.123	1.154
Hunan	0.018	−0.023	0.099	0.195	−0.047	0.103	0.063	0.047	0.415	0.392	−0.305	0.113	1.070
Guangdong	0.301	0.303	1.043	−0.121	−0.188	0.317	0.480	0.489	0.282	−0.390	0.103	0.071	2.690
Guangxi	0.047	0.011	0.046	0.157	0.028	0.164	0.096	0.028	0.046	0.206	0.310	0.319	1.458
Hainan	0.001	−0.011	0.024	0.011	0.098	0.017	0.068	0.007	0.085	−0.010	0.018	0.072	0.380
Chongqing	0.037	−0.031	0.070	0.109	−0.017	0.093	0.152	0.108	0.419	0.241	−0.343	0.055	0.893
Sichuan	0.048	0.033	0.194	0.227	0.193	0.029	0.092	−0.004	0.195	0.074	0.112	0.040	1.233
Guizhou	0.065	−0.071	0.089	0.109	−0.058	0.267	0.054	0.054	0.073	0.250	−0.015	0.012	0.829
Yunnan	0.078	0.015	0.160	0.174	−0.007	0.116	0.054	0.035	0.093	0.167	−0.045	−0.083	0.757
Shaanxi	0.044	−0.116	0.762	0.432	0.045	−0.057	0.007	−0.210	0.196	0.626	−0.322	0.067	1.474
Gansu	0.031	−0.021	0.159	0.331	0.027	0.148	0.002	−0.013	0.035	0.318	0.072	0.023	1.112
Qinghai	0.028	0.569	−0.114	0.277	0.134	−0.172	0.483	0.186	0.915	0.616	−0.599	−0.382	1.941
Ningxia	−0.210	0.998	−0.320	−0.058	0.022	0.127	0.062	0.042	0.129	0.126	0.095	−0.041	0.972
Xinjiang	0.177	−0.137	0.683	0.365	−0.269	−0.095	0.025	−0.076	0.052	0.199	0.044	−0.122	0.846
Average value	0.123	0.066	0.379	0.260	0.032	0.096	0.176	0.043	0.174	0.157	−0.073	0.061	—

Table 5: Regression results of influencing factors on financial efficiency based on the spatial Durbin model.

	y	Coef.	Std. err.	z	$z > \|p\|$	(95% conf. interval)	
	ln cost	0.0448	0.1434	0.31	0.754	−0.2361	0.3258
	$prof$	0.0006***	0.0003	18.78	0.000	0.0005	0.0006
	ln $liab$	−0.2393	0.2388	−1.00	0.316	−0.7074	0.2287
Min	ln $scap$	0.3143***	0.0782	4.01	0.000	0.1608	0.4677
	ln $fcap$	−0.1638	0.1015	−1.61	0.107	−0.3628	0.0352
	ln $pate$	−0.1348	0.0885	−1.52	0.128	−0.3083	0.0386
	ln $R\&D$	−0.3375***	0.1092	−3.09	0.002	−0.5517	−0.1234
	ln $cost$	−2.4826***	0.4758	−5.22	0.000	−3.4151	−1.5499
	$prof$	0.0001	0.0002	0.78	0.438	−0.0002	0.0004
	ln $liab$	3.6954***	0.6307	5.86	0.000	2.4592	4.9316
Wx	ln $scap$	−0.7251***	0.2087	−3.47	0.001	−1.1341	−0.3161
	ln $fcap$	−0.0534	0.6730	−0.08	0.937	−1.3725	1.2657
	ln $pate$	0.0064	0.1529	0.04	0.967	−0.2933	0.3061
	ln $R\&D$	0.9787***	0.1991	4.91	0000	0.5884	1.3689
Spatial	rho	−0.2604	0.1761	−1.48	0.139	−0.6056	0.0848
Variance	sigma2_e	0.1128***	0.0081	13.94	0.000	0.0969	0.1286
	ln $cost$	0.0803	0.1491	0.54	0.590	−0.2119	0.3725
	$prof$	0.0006***	0.0003	18.99	0.000	0.0005	0.0006
	ln $liab$	−0.2693	0.2404	−1.12	0.263	−0.7405	0.2019
LR_Direct	ln $scap$	0.3227***	0.0764	4.22	0.000	0.1730	0.4724
	ln $fcap$	−0.1655*	0.0957	−1.73	0.084	−0.3530	0.0221
	ln $pate$	−0.1352	0.0859	−1.57	0.116	−0.3037	0.0334
	ln $R\&D$	−0.3514***	0.1122	−3.13	0.002	−0.5713	−0.1316

Table 5: Continued.

	y	Coef.	Std. err.	z	$z > \|p\|$	(95% conf. interval)	
	ln *cost*	−2.0160	0.3406	−5.92	0.000	−2.6837	−1.3483
	prof	−0.0000	0.0001	0.20	0.845	−0.0002	0.0002
	ln *liab*	3.0108	0.4361	6.90	0.000	2.1559	3.8656
LR_Indirect	ln *scap*	−0.6472	0.1773	−3.65	0.000	−0.9948	−0.2997
	ln *fcap*	−0.0087	0.5402	−0.02	0.987	−1.0676	1.0501
	ln *pate*	0.0260	0.1312	0.20	0.843	−0.2312	0.2833
	ln *R&D*	0.8655	0.1722	5.02	0.000	0.5278	1.2032
	ln *cost*	−1.9357	0.3152	−6.14	0.000	−2.5536	−1.3177
	prof	0.0006	0.0009	5.99	0.000	0.0004	0.0007
	ln *liab*	2.7415	0.3556	7.71	0.000	2.0444	3.4385
LR_Total	ln *scap*	−0.3245	0.1552	−2.09	0.037	−0.6287	−0.0203
	ln *fcap*	−0.1742	0.5552	−0.31	0.754	−1.2624	0.9140
	ln *pate*	−0.1092	0.1043	−1.05	0.295	−0.3136	0.0953
	ln *R&D*	0.5141	0.1312	3.92	0.000	0.2568	0.7714

Note. The data with *, **, and *** in the table indicate, respectively, $p < 0.10$, $p < 0.05$, and $p < 0.01$.

and the number of *R&D* personnel (R&D), and the credibility is 99%. The factors with positive coefficients are total liabilities (liab) and the number of *R&D* personnel (R&D), showing that these factors have a positive correlation with the financial efficiency of neighboring provinces. The coefficient of other factors is negative, showing that these factors have a negative correlation with the financial efficiency of neighboring provinces.

(3) The data in coef. column of the LR_Direct project in Table 5 reflects the direct impact of various influencing factors on the financial efficiency of the province. The main factors that have an impact on the financial efficiency are operating profit (prof), national capital (scap), and the number of *R&D* personnel (R&D), and the credibility is 99%. The positive coefficients are operating profit (prof) and national capital (scap), meaning that these factors have a direct impact on the financial efficiency of the province. The coefficient of other factors is negative, meaning that these factors have a negative correlation with the direct impact on the financial efficiency of the province.

(4) As shown in Table 5, the data in the coef. column of the LR-Indirect project reflects the indirect impact of various influencing factors on the financial efficiency of the province, and the indirect impact is not significant.

(5) As shown in Table 5, the data in the coef. column of the LR-Total project reflects the overall impact of various influencing factors on the financial efficiency of the province, and the overall impact is not significant.

6. Conclusion

This paper constructs a superefficiency financial efficiency model and a financial efficiency index model with undesirable output to dynamically evaluate the financial efficiency of Chinese interprovincial industrial enterprises. A spatial Durbin model is constructed as well to quantitatively measure the influencing factors of the financial efficiency of industrial enterprises. The conclusions of this paper are as follows:

(1) According to the dynamic analysis of the average values of financial efficiency of Chinese interprovincial industrial enterprises in different years, the dynamic growth trend of financial efficiency is noticeable. Based on the horizontal analysis of the average value of the financial efficiency of different Chinese interprovincial industrial enterprises, there is a large financial efficiency disparity among provincial industrial enterprises, indicating that the financial efficiency of some interprovincial enterprises can be enhanced.

(2) On the basis of the analysis of the financial efficiency of Chinese interprovincial industrial enterprises, the main factor affecting the growth of the financial efficiency of Chinese industrial enterprises is the modification of technology, and the modification of technical efficiency has a minor impact.

(3) From the influence factors analysis of the financial efficiency of Chinese interprovincial industrial enterprises, the factors that have a significant impact on the financial efficiency of industrial enterprises are as follows: main business cost, operating profit, total liabilities, national capital, and the number of *R&D* personnel, and the credibility is up to 99%. It is necessary to start from these factors if the financial efficiency of industrial enterprises would like to be improved.

Data Availability

This paper selects the data of China's provinces and municipalities directly under the central government and autonomous regions (Hong Kong, Macao, Taiwan, and Tibet are not included in the analysis due to the lack of data) from 2007 to 2019 as the research sample, with a total of 390

observations. All the data are from the Chinese Industrial Statistics Yearbook, Chinese Environment Yearbook, and Chinese Energy Statistics Yearbook from 2008 to 2020.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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