Monopoly behavior of China's manufacturing enterprises

Rent-seeking or innovation-oriented

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Abstract

Purpose – With the increase of state capital, corporate total factor productivity (TFP) has a tendency to jump up at first and then slowly decrease. Generally, no significant "productivity paradox" can be observed in China's manufacturing industry. With the increase of export density, corporate TFP also shows a trend of initial jump growth and subsequent slow decline. This paper aims to discuss these issues.
Design/methodology/approach – Using the 1996–2013 China Industrial Enterprise Database, this paper studies the monopolistic behavior of Chinese manufacturing enterprises through the measurement of TFP and corporate monopoly power.
Findings – Results show that China's manufacturing monopoly enterprises are generally innovation-oriented rather than rent-seeking. However, there are certain differences between diversified types of monopoly enterprises: the ones with state capital are more inclined to innovate than those without, whereas the ones with export delivery value are more inclined to seek rent than those without.
Originality/value – Therefore, the government should implement differentiated policies for diversified types of monopoly enterprises, and do so in a targeted manner fully reflecting the containment of rent-seeking and the encouragement of innovation.

Keywords Rent-seeking, Monopoly power, Total factor productivity, Productivity paradox

Paper type Research paper

1. Research questions

Monopoly enterprises (monopolies) are the common concern of all sectors of society as their every single move may have a huge impact on the industry, the real economy, and even the entire society. With the control of existing resources, monopolies can choose between the behaviors of rent-seeking and innovation. In choosing rent-seeking, they can win a bigger portion of a "cake" in the zero-sum game, whereas choosing innovation gets them an entire new "cake" in the field. Although both rent-seeking (cutting the "cake") and innovation (producing the "cake") can achieve the profit-seeking purposes, their impacts on social welfare are diametrically opposite. The total welfare losses caused by rent-seeking to society or groups have been denounced by academic circles (Tullock, 1967; Krueger, 1974; Posner, 1975; Cowling and Mueller, 1978; Dechenaux *et al.*, 2015)[1]. The driving role of innovation in economic growth is not only supported by neoclassical economic growth theory (Solow, 1956), but also further confirmed by the theory of endogenous economic growth in the fields of product category innovation (Judd, 1985; Grossman and Helpman, 1991) and product quality innovation (Grossman and Helpman, 1991; Aghion and Howitt, 1992). Certainly, rent-seeking and innovation may also occur in non-monopoly enterprises, but this is far less likely to happen than in monopoly enterprises[2].

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In terms of rent-seeking, entities can be determined as rent-seeking monopolies directly according to the definition of rent-seeking, that is, the non-productive profit-seeking activity for securing monopolistic profits. In terms of innovation, according to Chen and Schwartz (2013), monopolistic firms are more motivated to innovate than non-monopoly firms, and based on the expanded quality innovation model of Acemoglu and Cao (2015), the higher the degree of monopoly, the more R&D investment in monopoly firms. In terms of financial constraints, rent-seeking non-productive inputs and innovative R&D investments require large amounts of capital, and the monopoly profits accumulated by monopoly enterprises in the early stage can directly provide financial support for rent-seeking and innovation. Therefore, the basic logic of this paper is as follows: the enterprise has an *ex ante* monopoly position, such that to maintain a continuous flow of monopoly profits, it will adopt innovative or rent-seeking methods, but followed by different "additional effects" (high TFP or low TFP). Here, the "additional effect" characterized by TFP (total factor productivity) refers to the increase in output caused by factors other than traditional production factors like capital and labor, thus reflecting the production efficiency form factor input to product output.

This paper focuses on the Chinese manufacturing sector during the economic transition period. On the one hand, the institutional arrangements at this stage are characterized by transitionality, short-term, uncertainty, and non-equilibrium, which can easily induce non-productive rent-seeking (Zhou, 2004). On the other hand, with the promulgation of the Patent Law of the People's Republic of China in 1984 and the Company Law of the People's Republic of China in 1993, along with the gradual improvement of relevant laws and regulations, China is providing better legal protection for R&D and innovation in firms[3]. Then, during the economic transition period, are Chinese manufacturing monopolies generally rent-seeking monopolies or innovation-oriented monopolies? What kinds of nuances exist between different types of monopolies; are they slightly oriented toward innovation, or slightly oriented to seek rent? To answer these two questions, this paper needs to introduce the concept of "monopoly power," which refers to the ability of enterprises to control the price of products sold, and often expressed as the "ratio of price vs the marginal cost" (Markup) by the academic community[4]. For the first type of problem, this paper attempts to exploit the relationship between corporate monopoly power and corporate TFP to explore the specific monopoly types of Chinese monopolies. When the monopoly power has a positive relationship with TFP, then the monopoly enterprise can be considered an innovative monopoly. This is because innovation cannot only significantly increase the TFP of the monopoly enterprise itself, but also the TFP of the same industry and related industries through the spillover effect. When the monopoly power has a negative relationship with the TFP, the monopoly enterprise can be judged as a rent-seeking monopoly. This is because the monopolies take the means of bribing government officials, striking ties with industry associations, conspiring with related companies and recruiting public relations personnel to obtain product operational rights, possess the production factors and carve up their own niches in the sales market. This leads to the non-productive expenditure of capital factors (e.g. money, etc.) and labor factors (public relations personnel), which can be passively expressed as a lower TFP. For the second type of problem, this paper can use the same method to make judgments, but here it becomes the relationship between "corporate monopoly power and corporate type cross-term" and corporate TFP, and the specific corporate type can be divided into state-owned and non-state-owned equity enterprises, export and domestic sales firms and so on.

The existing literature features many studies on the production efficiency of Chinese monopolies, and most of them focus on the impact of one aspect or another. Jian *et al.* (2011) used the micro data of Chinese industrial enterprises to find that the transformation of China's industrial sector from state monopoly to competitive market promoted efficiency improvement. Xu and Xie (2016) found that lower-intensity market segmentation would, on the contrary, promote local enterprise's efficiency enhancement and that only after a certain threshold is

exceeded will it hinder the efficiency enhancement. Using the ISCP analysis framework, Yu and Zhang (2010) analyzed the power, telecommunications, petroleum, and railway industries and found that administrative monopoly can lead to a reduction in resource allocation efficiency in such industries. Zhou *et al.* (2012) analyzed the independent innovation performance of enterprises and found that the innovation activities of Chinese enterprises from 2005 to 2007 significantly improved output performance (elasticity: 5.5 percent). A common feature of this type of literature is the specific analysis of the impact on the productivity of monopolies based on known behaviors (e.g. specific rent-seeking means, innovative methods). However, in reality, rent-seeking is "dirty," and companies do not expose rent-seeking behavior (Tullock, 1967). Innovations that are not protected by the Patent Law are easily imitated by other firms, so firms will not disclose such innovations. In other words, comprehensively and meticulously observing the monopolies' rent-seeking and innovative behaviors is a highly challenging task. Therefore, unlike this kind of literature, the current paper principally backsteps the "comprehensive" behaviors through the behavioral results of monopolies. Here, the word "comprehensive" is used to emphasize that the innovative monopoly stated in this paper does not mean complete innovation without rent-seeking, and similarly, the rent-seeking monopoly does not mean completely rent-seeking without innovation. In the strict sense, it means a relative concept on weights. Therefore, the major issues of this paper are as follows: to make basic judgments on the monopoly types (innovative monopoly, rent-seeking monopoly) of Chinese monopolies and to analyze the difference (innovation-oriented or rent-seeking-oriented) between diversified types (state-owned equity, non-state-owned equity, exports, domestic sales, etc.) of monopolies.

2. Research design

The data used in this paper are the fusion of the Chinese Industrial Enterprises Database and the China Economic Census Database, with a total sample size of 4,446,309. In the absence of ambiguity, this paper directly refers to the fusion data as the Chinese Industrial Enterprises Database. The processing software in this paper is STATA14.2, and all key data are operated with double precision. Furthermore, this paper also carried out two basic data collation procedures, namely, enterprise ID identification and price adjustment. First, enterprise ID identification adopts the cross-identification method, that is, the enterprises with the same name (in the same province) are identified as the same enterprise, and those with the same organization code are identified as the same enterprise. This method is more accurate[5] than the sequential identification method[6] of Brandt *et al.* (2012), because the latter identifies the same company with different organizational codes as multiple enterprises. Second, as for price adjustment, this paper uses the regional price index[7] to deflate the nominal price, and the base period is set at 2010.

2.1 TFP calculation

First, the calculation of TFP needs to set the firms' production functions, which can be divided into the following functions: linear production, Leontief production, CD production, CES production, VES production and trans-log production function. This paper mainly uses the CD production function form, which is obtained after logarithmization:

$$\ln Y\_\text{add}_{it} = \alpha_L \cdot \ln L_{it} + \alpha_K \cdot \ln K_{\text{it}} + \underbrace{\ln A_{it}}_{\ln tfp}, \tag{1}$$

where *Y_add* denotes industrial added value, *L* denotes labor, *K* denotes capital, *A* denotes TFP, the subscript *i* denotes individual enterprise and *t* denotes the year. The enterprise TFP can be measured by using the OP method (Olley and Pakes, 1996) to estimate (1). Moreover, in view of the large differences in the output elasticity of factors in different industries, this paper estimates the TFP according to the major categories of 30 (manufacturing) industries.

Compared with the other studies (Qian *et al.*, 2013; Gai *et al.*, 2015), the manufacturing sector of this paper retains the "waste resources and waste materials recycling and re-processing industry." It should be noted the 1996-2013 Chinese Industrial Enterprises Database have three sets of national economic industry classification standards: GB/T4754-1994 (1996–2002), GB/T4754-2002 (2003–2012), and GB/T4754-2011 (2013). This paper will uniformly adjust GB/T4754-1994 and GB/T4754-2011 to the GB/T4754-2002 industry category.

In the TFP measurement, aside from the three basic variables of industrial added value (*Y_add*), labor (*L*), and capital (*K*), the OP method requires two extra variables of investment (*invest*) and enterprise exit (*exit*). For investment (*invest*), the calculation can be directly made via the "fixed assets in the current year – fixed assets in the previous year + depreciation in the current year." However, there are two problems in the actual calculation. First, when an enterprise's fixed assets are null in the previous year, it will not be able to calculate the investment of the enterprise in the current year; second, where the observations of an enterprise in the previous year are interrupted and do not appear in the Chinese Industrial Enterprises Database (due to the scale requirements or incorrect identification of the corporate ID), calculating the investment of the enterprise in the current year would be impossible. Therefore, this paper improves the calculation formula of investment as "fixed assets in the current year – estimated fixed assets in the previous year + depreciation in current year." Among them, the estimated value uses the "geometric" interpolation method [8]. When the fixed assets of the enterprise are null in the previous year, the estimated value is the true interpolation; when the previous observations of the enterprise do not exist, the estimated value is the virtual interpolation. This method of estimation contributes approximately 700,000 investment data[9]. For an enterprise exit, the following requirements must be met: the enterprise does not appear at the end year[10] of the observation period, and the enterprise time series is not interrupted before it is judged to be a "seceded enterprise." Once the company is recognized to withdraw from business, the enterprise exit variable is denoted as 1 for the year, in which the company last appears, and 0 for other years. All enterprise exit variables for non-seceded enterprise are marked as 0.

Finally, using the industrial added value (*Y_add*), labor (*L*) and capital (*K*), and investment (*invest*) and enterprise exit (*exit*) variables, this paper estimated the labor output elasticity and capital output elasticity[11]. Substituting it in Equation (1), we calculated the TFP of the Chinese manufacturing enterprises, and on this basis, carried out the extreme value control by the median method[12]. The specific process is described as follows. First, while calculating the median TFP of each enterprise in the time series, if the TFP of a certain enterprise is greater than 10 times or less than 0.1 times of the median, it is determined as an extreme value and shall be replaced with a null value. Second, while calculating the annual TFP median of each industry's sub-category, if a company's TFP is greater than 100 times or less than the median of the industry's sub-category in a certain year, it is also determined as an extreme value and shall be replaced with a null value. In addition, because the density function of the TFP logarithm (ln*tfp*) is more symmetrical[13] than TFP (*tfp*), ln*tfp* is used in the final quantitative regression.

Notably, the absolute value of TFP does not have much value, what is important is the relative value of TFP. This is because in the production function $Y\_add_{it} = A_{it}L_{it}^{\alpha_L}K_{it}^{\alpha_K}$, Y_add_{it} and K_{it} are represented in the form of currency and the original unit is ¥1,000. If the unit is adjusted to ¥1, the original TFP increases to $1{,}000^{1-\alpha_K}$. In other words, the choice of dimension changes the absolute value of the TFP.

2.2 Monopoly power measurement

The measurement of corporate monopoly power requires basic information, such as sales prices and marginal costs, and the latter, as hidden information, are often difficult to obtain. To this end, De Loecker and Warzynski (2012) overcame the limitations of traditional methods and proposed a more general measurement method, which was quickly promoted in a short-term

(Ren and Zhang, 2013; Gai *et al.*, 2015; Lu and Yu, 2015; Huang *et al.*, 2016). The basic research ideas are as follows: given the factor price P_i^X and output Q of an enterprise who minimizes costs by choosing factor price X_i, the Lagrange equation is thus available:

$$L = \sum_{i=1}^{n} P_i^X X_i + \lambda(Q - Q(X)), \tag{2}$$

where λ denotes the shadow price of the enterprise reflecting the marginal cost MC of the enterprise, that is, $\lambda \equiv MC$, and X is the factor vector, namely, $X \equiv (X_1, \ldots, X_n)$. The first-order condition of Equation (2) yields $P_i^X = MC \cdot (\partial Q(X)/\partial X_i)$, which can be further refined as follows:

$$\frac{P}{MC} = \frac{\partial Q(X)\, X_i}{\partial X_i\, Q(X)} \Big/ \frac{P_i^X \cdot X_i}{P \cdot Q(X)}, \tag{3}$$

where P denotes the product sales price. The left side of Equation (3) is exactly the monopoly power[14] of the enterprise. The numerator on the right side is exactly the output elasticity ε_{X_i} of the factor X_i, and the right denominator is exactly the return share $share_{Xi}$ of the factor X_i. The advantage of Equation (3) is that, first, it bypasses the enterprise sales price P and the hidden information of marginal cost, and can directly use the factor output elasticity ε_{X_i} and the factor payment share $share_{Xi}$ to measure the enterprise monopoly power. Moreover, second, it is not necessary to obtain all-factor output elasticity and factor payment share and just the single-factor data will suffice. Finally, third, almost no limitation is required on the production functions $Q(X)$. Thus, linearity, CD, CES, VES, Trans-log and other production functions can invariably be used.

2.2.1 Estimation of the elasticity of factor output. In general, the interpreted (explained) variable of the OP method (Olley and Pakes, 1996) is the logarithm of the industrial added value, and the interpreted variable of the LP method (Levinsohn and Petrin, 2003) is the logarithm of industrial added value or the industrial gross value. In the Chinese Industrial Enterprises Database, the time series data of the industrial output value (1996–2013) are longer than that of the industrial added value (1996–2007, 2010), and the industrial output value or industrial value-added data need to be reused when calculating the share of compensation later. Therefore, this paper mainly uses the LP method (Levinsohn and Petrin, 2003) to estimate the factor output elasticity, and the explained variable is the logarithm of the industrial output value. Additionally, as the De Loecker and Warzynski (2012) method does not require any setting of the production function, this paper directly uses the double logarithmic model to estimate the factor output elasticity. The measurement model[15] is given by:

$$\ln Y_{jt} = \beta_0 + \beta_L \cdot \ln L_{jt} + \beta_K \cdot \ln K_{jt} + \beta_M \cdot \ln M_{jt} + \varepsilon_{jt}, \tag{4}$$

where Y denotes the total industrial output value; L, K and M denote labor, capital and intermediate inputs, respectively, and β_L, β_K, and β_M are the corresponding output elasticities; subscript j represents the individual enterprise; and subscript t represents the year. Table I presents the statistics of the LP method variables.

Variable	Explanation	Sample size	Mean	SD	Min.	Max.
ln$Y$	Industrial gross output value logarithm	3,796,163	10.4528	1.4306	–0.1050	19.7465
ln$K$	Fixed asset logarithm	3,777,114	8.6438	1.7624	–0.1194	18.9587
ln$L$	Number of employees	3,794,326	4.8680	1.1621	0.0000	12.3159
ln$M$	Logarithm of industrial intermediate input	1,999,906	9.7549	1.4542	0.0777	19.0302

Source: Calculated by the author

Table I. LP method variable statistics

Using Table I data to estimate Equation (4), the output elasticities of capital, labor and intermediate input in 30 (manufacturing) industry categories can be obtained, as shown in Table II. It is not difficult to find that the output elasticity of labor and intermediate inputs all fit in the 1 percent significance interval, whereas those of the capital in five industries fail to fit in the 10 percent significance level, but this basically does not affect our measurement of monopoly power, because the De Loecker and Warzynski (2012) method is very flexible, and the output elasticity of only one factor will do. Therefore, the elasticity of the labor output and intermediate inputs can all be used as the selection factors for measuring the monopoly power of firms.

2.2.2 Calculation of factor payment share. The share of factor payment can be calculated by dividing the total compensation of the factor by the gross industrial output value. In the Chinese Industrial Enterprises Database, there is no total capital return data; the total labor compensation can be expressed by the total wages payable, and the time span is from 1996–2008 to 2011–2013. Meanwhile, the total intermediate industrial input can be used to denote the total compensation of intermediate inputs, and the time span is from 1996 to 2007. Therefore, the time series of total labor compensation is the longest. Thus, taking into account the significance of the output elasticity of each factor in Table II, this paper considers that labor is the best choice factor for measuring the monopoly power of enterprises.

2.2.3 Monopoly power (markup) measurement. Based on the estimated labor output elasticity and the calculated labor compensation share, according to the De Loecker and Warzynski (2012) method, this paper calculates the monopoly power of Chinese manufacturing enterprises from 1996–2008 to 2011–2013, and on this basis the extreme value control is carried out and, first, the median of the monopoly power of each enterprise in the time series is calculated. If the monopoly power of a certain enterprise is greater than 10 times or less than 0.1 times (23,375 total) of the median in a certain year, it is considered as an extreme value and shall be replaced by a null value. Next, the median of the monopoly power of each industry sub-category every year is calculated. Second, if the monopoly power of enterprise is greater than 100 times or less than 0.01 times the median of the industry's sub-category in a certain year (a total of 1,053[16]), then it is judged as an extreme value and replaced with a null value. Third, the "unreasonable"[17] monopoly power values (a total of 837 [18]) that is greater than 100 or less than 0.01 times of the median is considered as an extreme value and is replaced with a null value. After the extreme value control of the monopoly power, the average value of the monopoly power in this paper is 1.2366 (1996–2008, 2011–2013). In similar studies, Gai *et al.* (2015) measured the average value of China's manufacturing monopoly powers at 1.2421–1.5068 (1998–2007), and Huang *et al.* (2016) measured the average value of the monopoly power of Chinese industrial enterprises at 1.22–1.29 (1998–2007).

Figure 1 shows the annual monopoly powers of different types of enterprises. In the Chinese Industrial Enterprises Database[19], only some industrial enterprises were counted in 1996–1997. In 1998–2006, the statistics cover "all state-owned industrial corporations and non-state-owned ones with annual main business income of ¥5m or more," the 2007–2010 statistics cover the industrial corporations with "industrial corporations with annual revenues of ¥5m or more"[20], and in 2011–2013, it has counted "industrial corporations with annual revenues of ¥20m or more." The monopoly powers of enterprises with different scales often differ. Thus, we carried out the control of firms above the state designated scale in Figure 1 and adopted the latest standards for such scale: "Industrial corporations with annual revenues of ¥20m or more." Taking into account the greater use of the data of industrial enterprises above the state designated scale, this paper uses 2011 as the base (benchmark) year for such scale[21]. As shown in Figure 1, the monopoly power of state-owned equity enterprises is lower than that of non-state-owned equity enterprises[22], but the gap between the two has narrowed with time. This shows that the reform of the state-owned enterprises in China has achieved

Code	Industry name	Factor output elasticity			Valid sample	Total sample
		Capital	Labor	Intermediate inputs		
13	Agricultural and sideline food processing industry	0.0444***	0.0332***	0.8073***	122,352	241,185
14	Food manufacturing	0.0439***	0.0259***	0.8535***	48,887	90,910
15	Beverage manufacturing	0.0472***	0.0446***	0.7484***	34,561	63,716
16	Tobacco industry	0.0000	0.0531***	0.6473***	2,614	3,546
17	Textile industry	0.0487***	0.0395***	0.7399***	172,938	320,184
18	Textile and garment, shoes and hat manufacturing	0.1096***	0.0890***	0.5556***	94,437	176,510
19	Leather, fur, feather (velvet) and its products	0.0224***	0.0625***	0.6656***	47,235	87,770
20	Wood processing and wood, bamboo, rattan, palm, grass products industry	0.0795***	0.0481***	0.7396***	39,374	86,407
21	Furniture manufacturing	0.0416***	0.0521***	0.7763***	22,860	48,751
22	Paper and paper products industry	0.0375***	0.0378***	0.7746***	59,232	104,319
23	Printing industry and recording media reproduction	0.0865***	0.0508***	0.7663***	42,090	71,528
24	Culture, education and sporting goods manufacturing	0.0076	0.0738***	0.6557***	25,841	47,318
25	Petroleum processing, coking and nuclear fuel processing industry	0.0273	0.0185***	0.9315***	14,197	25,860
26	Chemical raw materials and chemical products manufacturing	0.0677***	0.0236***	0.7023***	147,015	282,154
27	Pharmaceutical manufacturing	0.0541***	0.0294***	0.6543***	41,568	76,595
28	Chemical fiber manufacturing	0.0379	0.0191***	0.9182***	10,358	20,902
29	Rubber products industry	0.0000	0.0372***	0.9725***	23,545	44,748
30	Plastic products industry	0.0721***	0.0486***	0.6793***	92,028	179,419
31	Non-metallic mineral products industry	0.0458***	0.0357***	0.7306***	169,123	324,636
32	Ferrous metal smelting and rolling processing industry	0.0893***	0.0238***	0.8290***	47,051	86,352
33	Non-ferrous metal smelting and rolling processing industry	0.0397***	0.0355***	0.8439***	38,301	69,723
34	Metal products industry	0.0872***	0.0382***	0.6340***	106,614	213,707
35	General equipment manufacturing	0.0598**	0.0295***	0.7114***	149,580	312,527
36	Special equipment manufacturing	0.0921***	0.0203***	0.7240***	84,025	170,641
37	Transportation equipment manufacturing	0.0533***	0.0404***	0.6932***	90,023	180,665
39	Electrical machinery and equipment manufacturing	0.0611***	0.0366***	0.6722***	117,676	240,521
40	Communication equipment, computers and other electronic equipment manufacturing	0.2045***	0.0606***	0.6232***	66,119	134,859
41	Instrumentation and culture and office machinery manufacturing	0.0717***	0.0460***	0.6363***	27,348	53,366
42	Crafts and other manufacturing	0.0292***	0.0663***	0.7199***	44,922	79,290
43	Waste resources and waste materials recycling industry	0.0507*	0.0632***	0.8212***	2,037	7,718

Notes: The *p*-value is determined by the Bootstrap Method, and the number of repetitions is not less than 100. *,**,***Significant at the 10, 5 and 1 percent levels, respectively
Source: Calculated by the author

Table II.
Industry-specific quantitative regression results by LP method

remarkable results and the monopoly power of state-owned equity enterprises has maintained steady growth. Thus the trend of the private sector withdrawing as the state sector advances has been explained to a certain extent[23]. The monopoly power of export enterprises is lower than that of domestic enterprises, and the gap between the two has expanded with time. This shows that the trade environment of Chinese export enterprises has deteriorated, especially

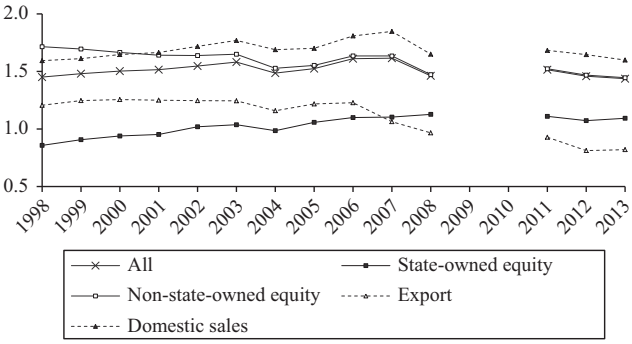

Figure 1.
Annual monopoly power of the different types of enterprises

Note: As the National Bureau of Statistics only counted a portion of the industrial enterprises in 1996 and 1997, there are no figures for 1996 and 1997
Source: Drawn by the Author

after the 2008 financial crisis. Moreover, this paper uses the ln*markup* in the final quantitative regression, because the density function of the monopolistic power value logarithm (*lnmarkup*) is more symmetrical than that of the monopolistic power (*markup*)[24].

Notably, the values of the monopoly power of enterprises are 1, greater than 1, and less than 1 under the perfect competition, imperfect competition, and excessive competition markets, respectively. The reasons for the monopoly power being less than 1 include the following: first, in the short-term, not all factors can be adjusted freely, but only the short-term optimal production arrangements can be made; second, the industry has overcapacity, and enterprises destock large amounts of inventory at low prices, especially for industries with huge fixed assets investments and long production cycles; third, the increase of factor prices, such as wages, intermediate input prices, energy prices, interest rates, etc.; fourth, or an abundance of government subsidies leading to price declines.

2.3 Other explanatory variables

In this paper, an enterprise with a monopoly power greater than 1 is defined as a monopoly enterprise, and that with a value less than or equal to 1 is defined as a non-monopoly enterprise. To study the differences in monopolistic behaviors of different types of monopolies, we also introduce two types of cross-term[25] as key variables: the cross-term of monopoly power vs state-owned equity (*state*#c.ln*markup*[26]) and the cross-term of monopoly power vs export (*export*#c.ln*markup*). For the cross-term of monopoly power vs state-owned equity (*state*#c.ln*markup*), it mainly includes the cross-term of the state-owned equity and monopoly power (1.*state*#c.ln*markup*), such that if the enterprise contains state capital, its value is equal to the logarithm of monopoly power[27] and 0 otherwise[28], and the cross-term of the non-state-owned equity vs monopoly power (0.*state*#c.ln*markup*), such that if the enterprise does not contain state capital, the value is equal to the monopoly power logarithm and 0 otherwise. For the cross-term of the monopoly power vs export (*export*#c.ln*markup*), it mainly includes the cross-term of export vs monopoly power (1.*export*#c.ln*markup*), wherein if the enterprise contains the export delivery value, its value is equal to the monopoly power logarithm, otherwise, 0, and the cross-term of domestic sales vs monopoly power (0.*export*#c.ln*markup*), wherein if the enterprise does not contain the domestic sales value, the value is equal to the monopolistic power logarithm, otherwise it is 0.

The key variables already contain the logarithm of the monopoly power (ln*markup*). Multiple collinearities may arise if the key variables are simultaneously added with

the cross-terms of the state-owned equity vs monopoly power (1.*state*#c.ln*markup*), the non-state-owned equity vs monopoly power (0.*state*#c. ln*markup*), the export vs monopoly power (1.*export*#c.ln*markup*) and the domestic sales vs monopoly power (0.*export*#c. ln*markup*). Therefore, in the actual quantitative regression, this paper excludes the benchmark non-state-owned equity vs monopoly power cross-term (0.*state*#c.ln*markup*) and the domestic sales vs monopoly power cross-term (0.*export*#c.lnmarkup). Then, when the coefficient of the state-owned equity vs the monopoly power cross-term (1.*state*#c. ln*markup*) is significantly positive, it indicates that the state-owned equity monopoly enterprise is more inclined to innovate than the non-state-owned ones[29], and vice versa. When the coefficient of the export vs the monopoly power cross-term (1.*export*#c.ln*markup*) is significantly positive, it indicates that the export monopoly enterprise is more inclined to innovate than the domestic ones[30], and vice versa.

In addition, the control variables studied in this paper mainly include the following: state-owned equity (*state*), the proportion of state-owned shares (*state_per*), export (*export*), export density (*export_den*), survival age (*age*), asset liquidity (*capital_liq*), product diversity (*diversity*) and new product (*new*). First, for the state-owned equity (*state*) variable, if the enterprise's shareholding structure contains state capital, the value is 1, and 0 otherwise. Second, for the proportion of state-owned shares (*state_per*), the calculation formula is as follows: the proportion of state-owned shares = state capital/paid-in capital = state capital/(state capital + foreign capital + collective capital + corporate capital + personal capital + Hong Kong, Macao and Taiwan Capital). The primary cause for differentiating the state capital in terms of the state-owned shares and the proportion of state-owned shares is that the impacts on corporate behavior of the proportion of state-owned shares of 0 and of the positive infinitesimal, albeit almost equal in value are tremendously different. The former is rarely intervened by the local (or central) government, whereas the latter mostly enjoys the special care of the local (or central) government, and assumes certain social responsibilities, and even has a veto power of state-owned shares. As the latter is likely to be transformed from state-owned enterprise shareholding reform, corporate behavior is closer to state-owned enterprises. Third, for export (export), if the enterprise contains the export delivery value, the value is 1; if the enterprise does not contain the export delivery value, the value is 0. Fourth in relation to export density (*export_den*), Fan and Feng (2013) used different groups of export density (= export delivery value/enterprise total output) to represent export trade variables. The current work directly uses export density continuous value to express export trade, and the calculation formula is as follows: export density = export delivery value/industrial sales value. The primary reason why we distinguish export trade as export and export density is because the export density of 0 and of positive infinitesimal, albeit almost equal in value has different impacts on corporate behavior. The former is rarely affected by China's and foreign trade policies, whereas the latter is mostly affected by the China's and foreign customs, China's export subsidies, export tariffs, foreign import tariffs, barriers to entry, exchange rates and so on. Given that the latter is likely to be rapidly reduced to an infinitesimal value due to factors like foreign importer defaults and the global financial crisis, corporate behavior is very different from that of firms with pure domestic sales. Fifth, to obtain survival age (*age*), the calculation formula is as follows: survival age = observation year – opening year[31]+1[32]. Given that the difference between the 1- and 2-year-old enterprises is usually greater than that between the 20- and 21-year-old enterprises, this paper selects the survival time logarithm (ln*age*) to be part of the regression[33] and adds the quadratic term (2) to explore the complex relationship between corporate survival time and TFP. Sixth, to obtain asset liquidity (*capital_liq*), the calculation formula is as follows: asset liquidity = liquid assets/(liquid assets + fixed assets). In general, the greater the proportion of fixed assets, the higher the sunk cost, resulting in firms being more reluctant to change existing technologies. This paper expects the estimated coefficient of asset liquidity to be positive. Seventh, for product diversity (*diversity*), the variable is a dummy variable. When the number of

the firm's product categories is greater than or equal to 2, the value is 1; when the number of the firm's products is equal to 1, the value is 0. Eighth, finally, for the new product (*new*) variable, when the firm's new product output value is greater than 0, the value is 1; when the firm's new product output value is null or 0, the value is 0.

This paper also controls the following fixed effects: first, industry fixed effects (i.*industry*). Different industries have diverse production technologies, and thus have different TFPs, specifically, in 30 (manufacturing) industry major categories[34]. Second, regional fixed effects (i.*region*)[35]. Different regions have diverse market segments, which then lead to varied TFPs. Third, year fixed effects (i.*year*). There are diverse market shocks in different years, thereby leading to fluctuations in TFP.

2.4 Model setting

The measurement model of this paper is set as follows:

$$\ln tfp_{it} = \gamma_1 \cdot \ln markup_{it} + \gamma_2 \cdot 1.state\#\text{c.}\ln markup_{it} + \gamma_3 \cdot 1.export\#\text{c.}\ln markup_{it}$$

$$+ \gamma_4 \cdot \boldsymbol{control}_{it} + \gamma_5 \cdot \boldsymbol{factor}_{it} + \gamma_0 + \varepsilon_{it}, \quad (5)$$

where ln*markup*, 1.*state*#c.ln*markup* and 1.*export*#c.ln*markup* are key explanatory variables; ***control*** is a control variable group composed of *state*, *state_per*, *export*, *export_den*, ln*age*, ln^2*age*, *capital_liq*, *diversity*, *new*, etc.; ***factor*** is a group of factor variables composed of factor variables like i.*industry*, i.*region*, i.*year*, etc.; subscript *i* represents individual enterprise; and subscript *t* represents the year. Meanwhile, Table III also gives the statistics of the variables required by Equation (5).

3. Analysis of the measurement results

In the quantitative regression, the interpreted variable is the TFP logarithm (ln*tfp*), and the explaining variable contains the monopolistic power logarithm (ln*markup*) and the cross-terms (1.*state*#c.ln*markup*, 1.*export*#c.ln*markup*). Given that TFP may adversely affect the monopoly power and produce endogenous problems, this paper uses the instrumental variable (IV) method to solve it. The IVs used here are the monopolistic power log lag 1 (L1.ln*markup*), the state-owned equity vs monopoly power cross-term lag 1 (L1.1#c.ln*markup*), and the export vs monopoly power cross-term lag 1 (L1. 1.*export*#c.ln*markup*).

Variable	Name	Unit	Sample size	Mean	SD	Min.	Max.
tfp	TFP		2,189,163	88.6207	220.5151	0.0481	70,486.5000
markup	Monopoly power		3,189,619	1.2366	2.1497	0.0100	99.2070
state	State-owned equity		3,561,251	0.0950	0.2933	0.0000	1.0000
state_per	Proportion of state-owned equity	%	3,024,508	9.0220	27.4968	0.0000	100.0000
export	Export		3,803,182	0.2494	0.4327	0.0000	1.0000
export_den	Export density[a]	%	3,803,132	14.3519	31.5825	0.0000	100.0000
age	Survival time	Year	3,836,566	10.7271	10.4786	1.0000	414.0000
capital_liq	Liquidity of assets	%	3,773,088	57.1728	26.7143	0.0000	99.9999
diversity	Product diversity		3,827,896	0.3751	0.4841	0.0000	1.0000
new	New product		2,687,232	0.0734	0.2608	0.0000	1.0000

Notes: [a]The export density can be greater than 100 percent. Among them, there are 713,427 samples that are less than 100 percent, 224,889 samples equal to 100 percent, and 10,126 samples larger than 100 percent. To reduce the impact of extreme values, this paper has merged all export densities greater than 100 percent to the 100 percent group

Source: Calculated by the author

Table III.
Descriptive statistics of variables

Table IV shows the main quantitative regression results. Among them, Model (1) contains all the key explanatory and control variables, and is set as the reference group; Model (2) removes all the control variables except the fixed utility based on Model (1), and visually presents the regression of the three key explanatory variables; Model (3) eliminates the cross-terms of the state-owned equity monopoly power and the proportion of state-owned equity based on Model (1), mainly used to explore the TFP difference between the state-owned and non-state-owned equity firms; Model (4) removes the cross-terms of the export vs monopoly power, and export density on the basis of Model (1), and is mainly used to explore the TFP difference between export enterprises and domestic enterprises; and finally, Model (5) excludes the cross-term of the export vs monopoly power (1.*export*#c.ln*markup*) and the cross-term of state-owned equity vs monopoly power (1.*state*#c.ln*markup*) based on Model (1), and can directly give the basic judgment monopoly type (innovative or monopolistic) of Chinese manufacturing enterprises. Furthermore, this paper also calculates the correlation and exogeneity of the three tool variables of the reference group. The correlation coefficient between the monopolistic power lag 1 (L1.ln*markup*) and the monopoly power ln*markup* is 0.81. Moreover, the correlation coefficient of the cross-term lag1 (L1.1. #c.ln*markup*) of the state-owned equity vs monopoly power and that of the state-owned equity vs monopoly power cross-term (1.*state*#c.ln*markup*) is 0.80. The correlation coefficient of the cross-term lag 1 (L1.1.*export*#c.ln*markup*) of the export vs monopoly power and that of the export vs monopoly power cross-term (1.*export*#c.ln*markup*) is 0.73. As for exogeneity, the correlation coefficients between the residuals of Model (1) and monopoly power lag 1 (L1. ln*markup*), the state-owned equity vs monopoly power lag1 cross-term (L1.1.*state*#c.ln*markup*) and the export vs monopoly power lag 1 cross-term (L1.1.*export*#c.ln*markup*) are 0.02, –0.00, and 0.01, respectively. Hence, these results indicate that the three tool variables are all valid.

For the first question raised at the beginning of this paper, the observation Model (5) shows that, in general, the Chinese manufacturing enterprises are innovation-oriented monopolies. In other words, manufacturing companies with higher monopoly power tend to be more innovation-oriented rather than rent-seeking. This conclusion is based on the significant positive value of the monopolistic power ln*markup* coefficient in Model (5) (t value[36] = 345.9863).

For the second question raised at the beginning of this paper, the observation Model (1) shows that, China's state-owned equity monopolies are more inclined to innovate than the non-state-owned equity monopolies. This conclusion is based on the significant positive value of the coefficient of the state-owned equity vs monopoly power cross-term (1.*state*#c.ln*markup*) (t value = 17.51) in Model (1). There are several reasons for this phenomenon. First, it takes a long time from R&D investment to innovate. Non-state-owned equity monopolies are less far-sighted and less strategic than state-owned equity monopolies, and so they are not "disposed to" innovate. Second, R&D innovation is risky and does not guarantee 100 percent success. Non-state-owned equity monopolies have weaker risk-bearing ability than state-owned equity monopolies, and are thus not "bold enough" to innovate. China's export monopolies are more inclined to seek rent than domestic monopolies. This conclusion is based on the significant negative (t value = –22.17) value of the coefficient of the export vs monopoly power cross-term (1.*export*#c.ln*markup*) in Model (1). There are several reasons for this phenomenon, and to explain the first reason, a special historical background must be provided. At the end of the twentieth century, China implemented various preferential policies, including subsidies for export monopolies for the purpose of earning foreign exchange. Second, the export trade has to face more complicated examination and approval procedures than domestic trade does, rendering the export monopolies with more rent-seeking space. Third, the export decision-making power is on the exporter's side (for export customs) and the importer's side (for import customs), whereas the decision-making power over domestic sales is generally on the seller and the buyer. That is to say, exports are more vulnerable to administrative intervention (e.g. export customs, the State Administration of Foreign Exchange, etc.); thus, there is more room for rent-seeking, especially in export monopolies.

Table IV.
Quantitative regression results of the manufacturing enterprise monopoly types

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
ln*markup*	0.6742*** (267.7877)	0.7040*** (269.8141)	0.6999*** (299.2647)	0.6476*** (314.1425)	0.6664*** (345.9863)
1.*state*#c.ln*markup*	0.1146*** (17.5063)	0.1755*** (36.7390)		0.1318*** (20.3157)	
1.*export*#c.ln*markup*	–0.1115*** (–22.1691)	–0.1381*** (–29.5410)	–0.1293*** (–25.7354)		
state	0.1748*** (24.0350)		*–0.1109*** (*–33.1687*)	0.1765*** (24.5675)	0.1249*** (18.8313)
state_per	–0.0027*** ((–29.5177)			–0.0026*** (–28.5394)	–0.0033*** (–39.8028)
export	0.1047*** (31.0661)		0.1025*** (30.2883)	*0.1185*** (*58.8870*)	0.1409*** (48.5698)
export_den	–0.0006*** (–14.2250)		–0.0006*** (–13.8821)		–0.0004*** (–9.6838)
ln*age*	0.0127** (2.5349)		0.0259*** (5.1928)	0.0104** (2.0844)	0.0193*** (3.8816)
$\ln^2 age$	–0.0108*** (–9.3200)		–0.0156*** (–13.4434)	–0.0104*** (–9.0051)	–0.0130*** (–11.2771)
capital_liq	0.0095*** (226.5518)		0.0095*** (227.6293)	0.0094*** (225.3983)	0.0095*** (226.0898)
diversity	0.0168*** (8.9507)		0.0173*** (9.2101)	0.0167*** (8.9018)	0.0165*** (8.8317)
new	0.0944*** (35.5217)		0.0964*** (36.2350)	0.0917*** (35.1058)	0.0885*** (33.7216)
Intra-group R^2	0.2703	0.2320	0.2700	0.2719	0.2725
Observations	1,192,516	1,330,271	1,198,606	1,207,075	1,207,073
SD	Robust	Robust	Robust	Robust	Robust
Estimation method	Panel IV	Panel IV	Panel IV	Panel IV	Panel IV
Extreme value judgment	Median method	Median method	Median method	Median method	Median method
Extreme value processing	Replaced with null	Replaced with null	Replaced with null	Replaced with null	Replaced with null
Time series	1996–2013	1996–2013	1996–2013	1996–2013	1996–2013

Notes: The values of *t* are in parentheses. The interpreted variable is the TFP logarithm (ln*tfp*), and the industry fixed effect, regional fixed effect and time fixed effect are all controlled in the models. *,**,***Significance at 10, 5 and 1 percent levels, respectively
Source: Calculated by the author

In addition, according to Model (1), there are some other findings in this paper. First, the survival time of enterprises is "basically" negatively related to TFP. Here, the ln^2*age* coefficient is significantly negative, and the ln*age* coefficient is significantly positive. Although the curve "appears to be" an inverted U-shaped curve, the actual calculation indicates that when the inflection point appears, the establishment of most firms is less than one year, indicating that most firms' TFP is reduced over time[37]. Second, asset liquidity and new products are all positively correlated with TFP. Third, the coefficient of state-owned equity (*state*) is significantly positive, whereas that of state-owned equity proportion (*state_per*) is significantly negative. This shows that TFP has a jump increase with the change of the proportion of state-owned shares from 0 to positive infinitesimal, but with the further increase of the proportion of state-owned shares, the growth rate of TFP turns negative. That is to say, there is a critical point[38] of the proportion of state-owned shares, upon which the TFP of the state-owned equity enterprise becomes equal to that of the non-state-owned equity. When the equity ratio is lower than this point, the TFP of the state-owned equity enterprise becomes greater than that of the non-state-owned equity enterprise. This fits well with the reality in China. In the tide of state-owned enterprise reform, China's State-owned Assets Supervision and Administration Commission (SASAC) under the State Council has continuously reduced the state capital of the original state-owned enterprises. At the same time, various types of non-state-owned shares have been injected into the original state-owned enterprises, thus resulting in the continuous improvement of the TFP. Furthermore, the SASAC also selected a group of collectively owned enterprises, individual enterprises, and legal entities with high TFPs, to which it can inject a small amount of state capital. Directly judging whether the average TFP of the state-owned equity enterprise is less than (or greater than) the non-state-owned equity enterprise by Model (1) is notably difficult. In comparison, Model (3) can directly judge whether the TFP of the state-owned equity enterprise is smaller than that of the non-state-owned equity. The coefficients of the export (*export*) and export density (*export_den*) are significantly positive and significantly negative, respectively. This shows that, as the export density changes from 0 to positive infinitesimal, TFP also has a jump increase, but with the further increase of export density, the TFP growth rate becomes negative. Model (4) shows that the TFP of the export firms is still generally larger than that of domestic sales firms[39]. Unlike the findings presented by Li (2010), Fan and Feng (2013), and Yang and He (2014), among others, the conclusions of the current paper fully support new trade theory (Melitz, 2003; Ghironi and Melitz, 2005; Johnson, 2012; Kasahara and Lapham, 2013; Melitz and Redding, 2015; Bernard *et al.*, 2015), which argues that no significant "productivity paradox" exists in Chinese manufacturing enterprises. Even if some companies have "productivity paradoxes," they are mostly processing trade enterprises (Dai and Yu, 2014). Regarding the significantly negative export density, we believe that this can be attributed to the TFP of the export enterprises being higher than that of the domestic sales enterprises, but the export enterprises are internally different. Compared with enterprises with lower density, those with higher export density also have higher dependence on the international market and rely more heavily on a large number of export subsidies to maintain production (and the acquisition of subsidies is, to a certain extent, related to rent-seeking). This finding is in line with the reality in China, especially for processing companies and low-end manufacturing companies with overcapacity.

4. Robustness testing and further analysis

4.1 Robustness test

The key explanatory variables of this paper are the monopolistic power logarithm (ln*markup*), the state-owned equity vs monopoly power cross-term (1.state#c.ln*markup*), and the export vs monopoly power cross-term (1.*export*#c.ln*markup*). Therefore, the robustness test is also carried out around these three key variables, including sample selection, increase and decrease of control variables and key variables, replacement estimation methods, outlier replacement processing methods[40], and so on.

4.1.1 Sample selection. In Table V, Models (6) and (7) include samples from 1999–2007 to 2003–2007 on the basis of Model (1). Results shows that, even if only the 1999–2007 or 2003–2007 samples (currently used in most of the literature) are used, the coefficient symbols and significance of the three key variables and those of the control variables are not significantly changed[41].

4.1.2 Increase or decrease of control variables. Through the increase and decrease of the control variables, this paper finds that the sequential cumulative increase and decrease of the control variables do not significantly change the coefficient symbol and significance of the three key variables[42]; at the same time, the increase or decrease of the control variables does not significantly change the coefficient symbols and significance of the three key variables and even those of the control variables[43].

4.1.3 Increase or decrease of key variables. In Table V, Model (8) excludes the cross-term of the export vs monopoly powers (1.*export*#c.ln*markup*), and Model (9) excludes the cross-term of the state-owned equity vs monopoly powers (1.*state*#c.ln*markup*). Comparing Models (1), (5), (8), and (9), it can be found that the increase or decrease of key variables do not significantly change the coefficient symbol and significance of other key variables and even those of the control variables.

4.1.4 Replacement of estimation method. In Table V, the estimation method of Model (10) degenerates into a normal panel that does not use IVs. Similarly, the estimation method of Model (11) degenerates into a pooled regression that does not use IVs. Comparing Models (1), (10) and (11) reveals that the substitution of the estimation method does not significantly change the coefficient symbol and significance of the three key variables, and does not even significantly change those of the control variables.

4.1.5 Outliers replacement processing method. In Table V, the extreme value processing method of Model (12) adopts the merging method, that is, the extreme value exceeding the highest critical value is merged into the highest critical value class, and the extreme value lower than the lowest critical value is merged into the lowest critical value class. In the extreme value judgment of Model (1), two sets of median judgment methods are adopted for *tfp*, and three sets of median judgment methods are adopted for *markup*. The advantage of replacing the null value is demonstrated by the fact that many sets of median judgment methods can be used simultaneously. However, the extreme value merging method does not apply to multiple sets of median judgment methods, so in this Model (12), only the most effective set of median judgment methods are subjected to extreme value merging. Among them, the most effective median judgment method is as follows: to calculate the median *tfp* (or *markup*) of each enterprise in the time series, if a company's TFP (or *markup*) is greater than 10 times or less than 0.1 times the median in a certain year, it is judged to be an extreme value. Comparing Models (1) and (12), we can see that the outliers-substitution processing method does not significantly change the coefficient symbol and significance of the three key variables and even those of the control variables.

4.2 Further analysis

Table VI excludes the cross-terms of the state-owned equity vs monopoly power (1.*state*#c.ln*markup*), the export vs monopoly power cross-term (1.*export*#c.ln*markup*), the state-owned equity (*state*), the state-owned equity proportion (*state_per*), the export (*export*) the export density (*export_den*) and other variables[44], along with some added multiple-dimensional cross-terms. Among them, the "(*big*, *state*, *export*, *monopoly*)" in the first column corresponds to four dummy variables: big, state-owned, export, and monopoly. For big (*big*) dummy variables, the value is 1 when the company's main business income is greater than or equal to 50 percent quantile; otherwise, the value is 0. For a monopoly (*monopoly*) dummy variable, when the firm's monopoly power (*markup*) is greater than 1, the value is 1; otherwise, the value is 0. Comparing Table IV (1)

Table V.
Robustness test

	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)	Model (12)
ln*markup*	0.6694*** (263.0898)	0.6922*** (206.9731)	0.6465*** (312.6037)	0.6942*** (297.0569)	0.5212*** (473.1527)	0.5653*** (651.1704)	0.6780*** (258.7761)
1.*state*#c.ln*markup*	0.1001*** (14.2440)	0.0978*** (7.2417)	0.1329*** (20.4984)		0.0540*** (20.5601)	0.0715*** (32.0985)	0.1411*** (21.0418)
1.*export*#c.ln*markup*	–0.1071*** (–20.8867)	–0.1310*** (–17.9866)		–0.1242*** (–24.8440)	–0.0450*** (–24.7717)	–0.0565*** (–37.7481)	–0.1084*** (–20.8403)
state	0.1770*** (22.4713)	0.1772*** (13.5337)	0.1764*** (24.5534)	0.1306*** (19.3124)	0.1317*** (21.9982)	0.2737*** (50.1379)	0.1931*** (25.3871)
state_per	–0.0028*** (–27.8633)	–0.0016*** (–8.9359)	–0.0026*** (–28.5486)	–0.0033*** (–39.1770)	–0.0032*** (–43.0745)	–0.0052*** (–79.7974)	–0.0029*** (–29.6614)
export	0.1111*** (32.3296)	0.1120*** (26.7501)	0.1401*** (48.3069)	0.1009*** (29.9039)	0.1126*** (41.4910)	0.2275*** (94.9434)	0.1150*** (32.9391)
export_den	–0.0006*** (–15.0605)	–0.0007*** (–13.9079)	–0.0004*** (–10.7118)	–0.0006*** (–13.6677)	–0.0007*** (–20.5393)	–0.0016*** (–52.4426)	–0.0006*** (–15.1396)
ln*age*	0.0204*** (3.9422)	0.0409*** (6.0131)	0.0117** (2.3461)	0.0195*** (3.9122)	0.1926*** (64.4947)	0.1567*** (61.9225)	0.0145*** (2.7845)
$\ln^2 age$	–0.0121*** (–9.9985)	–0.0075*** (–4.6275)	–0.0108*** (–9.3265)	–0.0128*** (–11.0497)	–0.0528*** (–67.9555)	–0.0387*** (–63.2030)	–0.0114*** (–9.4489)
capital_liq	0.0094*** (220.6315)	0.0091*** (178.9080)	0.0094*** (225.5692)	0.0095*** (227.0621)	0.0100*** (276.0337)	0.0102*** (355.0768)	0.0097*** (223.2863)
diversity	0.0168*** (8.6724)	0.0140*** (5.4779)	0.0164*** (8.7515)	0.0170*** (9.0512)	0.0116*** (6.8799)	0.0188*** (13.8115)	0.0173*** (8.8761)
new	0.0956*** (34.8629)	0.0947*** (29.1310)	0.0887*** (33.7912)	0.0945*** (35.5767)	0.0764*** (32.4579)	0.1717*** (77.8436)	0.0999*** (35.9156)
Intra-group R^2	0.2668	0.2046	0.2719	0.2705	0.3009	0.5801 (R^2)	0.2753
Observations	1,089,191	646,151	1,207,073	1,192,516	1,609,229	1,609,229	1,216,912
SD	Robust	Robust	Robust	Robust	Robust	Robust	Robust
Estimation method	Panel IV	Panel IV	Panel IV	Panel IV	Panel	PA	Panel IV
Extreme value judgment	Median method	Median method	Median method	Median method	Median method	Median method	Median method
Extreme value processing	Replaced with null	Replaced with null	Replaced with null	Replaced with null	Replaced with null	Replaced with null	Merging
Time Series	1999–2007	2003–2007	1996–2013	1996–2013	1996–2013	1996–2013	1996–2013

Notes: The values of *t* are in parentheses. The interpreted variable is the TFP logarithm (*lntfp*), and the industry fixed effect, regional fixed effect and time fixed effect are all controlled in the models. *,**,***Significant at the 10, 5 and 10 percent levels, respectively

Source: Calculated by the author

Variable measure	Coefficient	*t* value		
(*big*, *state*, *export*, *monopoly*)				
(0, 0, 0, 1)	–0.4509***	(–101.8958)	Industry fixed effect	Yes
(0, 0, 1, 1)	–0.4363***	(–75.8145)	Regional fixed effect	Yes
(0, 1, 0, 1)	–0.6386***	(–59.0380)	Time fixed effect	Yes
(0, 1, 1, 1)	–0.5746***	(–21.3324)	Intra-group R^2	0.2718
(1, 0, 0, 1)	–0.1288***	(–26.0837)	Observations	1,212,706
(1, 0, 1, 1)	–0.1274***	(–25.3828)	SD	Robust
(1, 1, 0, 1)	–0.1711***	(–17.8450)	Estimation method	Panel IV
(1, 1, 1, 1)	–0.1227***	(–9.0082)	Extreme value judgment	Median method
ln*markup*	0.7509***	(236.1442)	Extreme value processing	Replaced with null
ln*age*	0.0300***	(6.0558)	Time series	1996–2013
$\ln^2$*age*	–0.0190***	(–16.5231)		
capital_liq	0.0096***	(231.3420)		
diversity	0.0128***	(6.8791)		
new	0.1132***	(43.5714)		

Notes: The value of *t* is in parentheses. The interpreted variable is the TFP logarithm (ln*tfp*). *,*,***Significant at the 10, 5 and 1 percent levels, respectively
Source: Calculated by the author

Table VI. Quantitative regression of cross-terms in multiple dimensions

and Table VI, there is no significant change in the coefficient symbol and significance of key variables and control variables. Moreover, observing the variables of "(*big*, *state*, *export*, *monopoly*)," we can see that, first, small monopolies, as compared with large monopolies, are more inclined to seek rent. This accords well with the reality of China. The traditional[45] small monopolies' product sales market is mostly segmented into local areas and surrounding areas, thus increasing their motivation to seek rent from local governments. Second, among large monopolies, state-owned equity export enterprises are most inclined to innovate; among small monopolies, state-owned equity domestic sales enterprises are most inclined to seek rent.

It should be noted that the monopoly in the multidimensional cross-terms "(*big*, *state*, *export*, *monopoly*)" in Table VI adopts the binary form, and the monopolistic power cross-term 1.*state*#c.ln*markup*, 0.*state*#c.ln*markup* (baseline) and 1.*export*#c.ln*markup*, 0.*export*#c.ln*markup* (baseline) in Model (1) adopt the continuous value form, thus retaining more information. Therefore, in the case of inconsistency between Table VI estimates and Model (1) estimates, the regression of Model (1) shall prevail.

5. Conclusions and implications

This paper studies the monopolistic behavior of Chinese manufacturing enterprises by measuring corporate TFP and corporate monopoly power. The study found that, on the whole, China's manufacturing monopolies are innovation-oriented monopolies and that rent-seeking behavior is not serious. However, there are certain differences between diversified types of monopolies. Differentiated by the shareholding structure, the state-owned equity monopolies are more inclined to innovate than their non-state-owned counterparts. Differentiated by product market, export monopolies are more inclined to seek rent than their domestic sales counterparts. Finally, differentiated by corporate scale, small monopolies are more inclined to seek rent than their large-scale counterparts. In addition, among large monopolies, state-owned equity export enterprises are most inclined to innovate, whereas among small monopolies, state-owned equity domestic sales enterprises are most inclined to rent-seeking. Thus, the following revelations are drawn.

China's current economic transition has been relatively successful. Although the short-term, uncertainty, and non-equilibrium nature of transitional institutional arrangements can easily trigger monopolies to seek rent, the improvement of laws, regulations and systems has also created a better environment for enterprise innovation. As per the empirical results of this

paper, the benefits of China's incremental system transformation outweigh its disadvantages, and the overall performance of monopoly in manufacturing enterprises is an innovation-oriented monopoly. Compared with Russia's "shock therapy" in the 1990s, the "whale-swallowing" rent-seeking in Russia did not arise in China.

Nevertheless, the Chinese government should curb the rent-seeking behavior of monopolies in a targeted manner. Pursuant to the empirical results of this paper, non-state-owned monopolies, export monopolies and small monopolies are more inclined to seek rent than the state-owned equity monopolies, domestic sales monopolies and large monopolies, respectively[46]. For the non-state-owned monopolies, the business operators directly control the private property without business scope restriction faced by the state-owned monopolies. Therefore, they mostly resort to rent-seeking behaviors, such as bribery and rule-bending activities, thus taking advantage of policy loopholes. For export monopolies, due to the abundance of export subsidies, the customs approval procedures are more complicated. Therefore, they mostly resort to deceptive and procedural "lubrication" rent-seeking behaviors. For small monopolies, products are mostly sold locally while crowding outsiders. Therefore, they mostly resort to regional and enact barrier-based, rent-seeking behaviors. Therefore, the government should formulate differentiated policies for different types of monopolies, fully reflecting the containment of rent-seeking, and of course, the encouragement and protection of innovation.

The Chinese government should also encourage state-owned equity monopolies to cooperate with each other and promote the "Going Global" strategy for in-depth development. According to the empirical results of this paper, among all the monopolies, the large-scale, state-owned equity export enterprises have the highest innovation ability, and the small-scale state-owned equity domestic sales enterprises have the least drive for innovation. This implies that small state-owned equity domestic monopolies can expand their scale through cooperation and enhance their innovation ability via exports. For example, at the end of 2014, the merger of the former CNR and CSR Groups into the China CRRC has promoted cooperation and innovation and laid an important foundation for China's high-speed rail to "go global." The Belt and Road Initiative has provided even more opportunities for small state-owned equity domestic sales companies to "go global," which means that in the future, China's innovation-oriented monopolies will be on the rise.

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Notes

1. Szidarovszky and Okuguchi (1997) also directly give proof of the existence and uniqueness of the rent-seeking equilibrium.
2. The innovative form of non-monopoly enterprises is mainly creative destruction. However, in reality, innovation comes mostly from the original monopolistic enterprises, and only relatively

few cases come from non-monopoly enterprises. For example, innovations in the software industry are mostly from companies, such as Microsoft and Oracle. The innovations in the hardware industry are mostly from IBM, Intel, Kingston, Logitech, Apple, Samsung, etc. The innovations in the transportation industry are mostly from Boeing, Airbus, China CRRC, Volkswagen, Toyota, GM and other companies.

3. Given that the innovation results are easily imitated, this has dampened the corporate innovation enthusiasm, leading to the prisoner's dilemma. To encourage innovation, the State promulgated the "Patent Law" to protect the innovation results of enterprises for a certain period of time. Once the protection period is expired, all companies can share the innovation fruits. That is to say, enterprises in the protection period will be in a monopolistic position and can obtain monopoly profits, whereas off-patent enterprises will face competition from other enterprises and profits will be diluted. For the continuous acquisition of monopoly profit streams, firms need to innovate constantly.

4. That is, $Markup = P/MC$, where P is the selling price and MC is the marginal cost. Another part of the literature (Li *et al.*, 2009; Coccorese, 2014) uses the price-to-margin ratio (Lerner Index, *LI)* to represent the monopoly power of the firm, i.e. $LI = (P\text{-}MC)/P$. The connotations of these two methods are the same, and they all directly represent the monopoly power of the enterprise.

5. Using the cross-identification method, this paper identifies three types of special enterprises: those with the same name but sharing dissimilar organization codes, covering 212,259 enterprises, accounting for 4.94 percent of the effective sample); those with the same organization code but sharing different names, covering 1,468,985 such samples and accounting for 34.18 percent of the valid samples; and those sharing different names and different organizational codes (these samples amount to 117,711, accounting for 2.74 percent of the valid samples). Given the above, the cross-identification method is 7.68 (= 4.94+2.74) percentage points more accurate than the sequential identification method.

6. The sequential identification method first uses the organization code to identify the enterprise, after which it uses the enterprise name to identify it, and finally refers to other auxiliary information.

7. The regional price index of this paper is provincial data derived from the China Statistical Yearbook over the years.

8. "Geometric" refers to the geometric mean, which is more realistic than linear interpolation. This is because fixed assets in the economy tend to grow exponentially, which is the same for rents related to fixed assets. Moreover, loan rates on fixed assets are also compounded.

9. There are two points to be explained. First, the 700,000 data contributions are limited to the marginal contributions of the "manufacturing" industry category. If the "non-manufacturing" industry category is taken into account, the marginal contribution will be greater; second, the 700,000 data are real interpolation only, if virtual interpolation is counted, the marginal contribution will be even greater.

10. In the Chinese Industrial Enterprises Database, because the industrial value-added field is missing data for 2008, 2009 and 2011–2013, the current-year depreciation field is missing the 2008–2010 data, so the actual final period for observation is 2007. Moreover, anonymous review experts pointed out that there are many outliers (extreme values) in the fixed asset field in 2010, which are deleted according to the recommendation. It is worth mentioning that the current-year depreciation field just misses the 2010 data, so we basically did not use the 2010 data while using the OP method (Olley and Pakes, 1996). Of course, it is technically possible to repair the extreme values of fixed assets in 2010 through the median method.

11. The sum of labor output elasticity and capital output elasticity estimated in this paper is higher than those of Lu and Lian (2012), and lower than those of Yang (2015). The attachments of results can be downloaded from the China Industrial Economics Website (www.ciejournal.org), as detailed in Appendix 1.

12. The median method is better than the front-to-back ratio method (e.g. 0.50 percent before and after). This is because the front-to-back ratio method is still enforced when there is no extreme

value at all, and the data of super-large enterprises may be determined as outliers. Moreover, the median method is also better than the averaging method because the extreme values affect the mean value almost without affecting the median.

13. The attachments of results can be downloaded from the China Industrial Economics Website (www.ciejournal.org), as detailed in Appendix 2.
14. This paper uses the term "Markup" to represent corporate monopoly power.
15. Similar to the previous OP method (Olley and Pakes, 1996), in the actual quantitative regression, this paper estimated 30 industry categories, respectively.
16. Strictly speaking, it means that after the processing of outliers in corporate time series, there remain 1,053 extreme values in the industry sub-categories.
17. Strictly speaking, a monopoly power greater than 100 or less than 0.01 is also likely to be a reasonable value. For example, some non-manufacturing software industries, companies that are in the process of being established or in bankruptcy.
18. Strictly speaking, it means that after the processing of outliers in corporate time series and industry sub-categories, there remain 837 outliers that are "unreasonable" extreme values.
19. It refers only to the original Chinese industrial enterprise data and excludes economic census data.
20. Most of the literature (Zhang *et al.*, 2011; Nie *et al.*, 2012; Lu and Lian, 2012) have misunderstandings about the concept of being "above the state designated scale." If the "above the state designated scale" has a larger impact on the quantitative regression results (especially the quantitative research literature), it must be given attention.
21. If you choose any year later than 2011 as a base year, it will easily lead to a situation wherein the definition of "above the state designated scale" becomes vague; for example, when 2013 is chosen as the base year for this, then the firms with main business income exactly at ¥20m in 2013 can hardly meet the threshold of ¥20m when moved to 2011 (assuming the inflation rate is positive).
22. The concepts of "state-owned equity enterprises" and "non-state-owned equity enterprises" are defined later.
23. The "withdraws" in the "the private sector withdraws" is more relative to the "state sector advances" rather than the "withdraw" in the absolute sense.
24. The attachments of results can be downloaded from the China Industrial Economics Website (www.ciejournal.org), as detailed in Appendix 2.
25. Strictly speaking, for the calculation of the cross-terms of the continuous numerical variables and factor variables, the two are not to be directly multiplied. Only when the factor variables are binary variables, and the binary values are only 0 and 1, can they be directly multiplied.
26. It is necessary to explain the arithmetic symbols in this paper in a uniform manner. The connector "#" indicates a cross-term, the prefix "c" emphasizes that the variable is a continuous variable, the prefix "i" indicates a factor variable, the prefix "0" indicates the portion of the factor variables assigned a value of 0, and the prefix "1" indicates the portion of factor variables assigned a value of 1, the prefix "L1" indicates that the variable lags a phase ($T-1$).
27. The value of the monopoly power may be greater than 0, equal to 0 or less than 0. Elaboration is hereby made to save further explanations.
28. The assigned value here is 0, and there is no inherent contradiction between the value of the monopoly power and the value of 0. Elaboration is hereby made to save further explanations.
29. It also shows that the state-owned equity non-monopoly enterprises are more inclined to seek rent than non-state-owned equity non-monopoly ones. As this paper mainly studies monopolistic behavior, it will not explain too much about the non-monopoly situation.

30. It also shows that exporting non-monopoly enterprises are more inclined to seek rent than domestically selling non-monopoly ones.

31. There are a lot of mistakes in the opening year of the enterprise in the Chinese Industrial Enterprises Database. This paper has made the corresponding corrections, specifically including the following: the first category with "established year in two digits (e.g. 96), while the mode is four digits (e.g. 1996), the difference between the two is integer multiples of 100," these years of establishment are directly fixed to four digits. The second category is the "three-digit year of establishment (e.g. 199), while the mode is four digits (e.g. 1996), the former is exactly equal to the first three digits of the latter," these years of establishment are directly fixed to four digits. The third category is that "the establishment year is null," while the mode is four digits. In this case, the year of establishment is directly filled with the mode. The fourth category is that the "code of established year is less than 1,600 or greater than the current year, and does not meet the first three categories of conditions," such a year of establishment is directly replaced by a null value. The fifth category is that "the mode of the years of establishment is greater than 1, and the year of establishment is an outlier," such cases are repaired case by case. The sixth category is composed of "other complex situations," such a year of establishment needs to be assisted by internet access.

32. This is because when the enterprise opened its business in the current year, the year of observation minus the opening year was 0, and the logarithm was meaningless, so we added 1 for positive monotonic transformation as a solution. Of course, it can also be directly understood as the nth year.

33. Anonymous review experts believe that the survival time can also be in non-logarithmic form, so this paper also made a non-logarithmic form of regression, the results can be downloaded from the China Industrial Economics Website (www.ciejournal.org), specifically, see Appendix 3 Model (21).

34. The industry category is based on GB/T4754-2002.

35. As the Chongqing Municipality was directly under the jurisdiction of the central government in 1997, this paper corrected the areas under the jurisdiction of Chongqing in 1996, including Wanxian City and the Qianjiang and Fuling Districts originally governed by Chongqing on behalf of the Sichuan Province. The "Province" was then adjusted as Chongqing.

36. All t values in this paper are calculated from the robust standard deviations. Elaboration is hereby made to save further explanations.

37. The attachments of results can be downloaded from the China Industrial Economics Website (www.ciejournal.org), the conclusion can be directly derived from the Appendix 3 Model (21).

38. In Model (1), using the state-owned equity and state-owned equity proportion coefficient, the critical point can be calculated to be 64.74 percent. Of course, the specific value does not matter much. The main concern of this paper is whether the value is less than 100 percent.

39. In Model (1), using the export and export density coefficients, although the critical point can be calculated as 174.50 percent (note: different from the maximum upper limit of 100 percent as to the proportion of state-owned shares, the export density can well be more than 100 percent), but this cannot lead to the conclusion that "the export enterprises' TFPs are generally greater than those of the domestic sales enterprises." This conclusion can only be drawn from Model (4), because the export trade variable therein contains only exports, and the effect of export density has been removed.

40. The review experts believe that there is still room for improvement in the method of replacing null values in extreme value processing. Therefore, the extreme value merging method is used in the robustness test, and the results are compared with those of the replacement null method.

41. Although the coefficient symbols and significance levels of ln*age* and $\ln^2 age$ do not change much, there are some changes in the survival time of enterprises and the inverted U-shaped inflection point of TFP. Results show that the inflection point of the enterprise inventory time in 2003–2007 is greater than that in 1998–2007.

42. In Appendix 3, Schedule 3 lists the sequential cumulative increase and decrease control variables, and this conclusion can be drawn via a horizontal comparison of Models (1), (13), (14), (15), (16), (17) and (2) in Table III. Appendix 3 can be downloaded from the China Industrial Economics website (www.ciejournal.org). In addition, the models in the tables are uniformly named, that is, Model (1), Model (2) in Table III, and Models (1) and (2) in Table IV are completely equivalent. Elaboration is hereby made to save further explanations.

43. In Appendix 3, Schedule 4 lists the increase and decrease of the control variables. The conclusion can be drawn by horizontally comparing Models (1), (18), (19), (20) and (13) in Schedule 4. Appendix 3 can be downloaded from the China Industrial Economics website (www.ciejournal.org).

44. To improve the estimation accuracy of cross-terms in multiple dimensions, Table VI excludes all variables related to the two dummy variables of state-owned equity and export.

45. Tradition is mainly directed against "internet +." This is because "internet +" can broaden the product sales market of small monopolies, and enable them to jump out of the local and surrounding markets, thus reducing the rent-seeking motivation of such enterprises to a certain extent.

46. Therefore, it is not possible to directly infer that small non-state-owned export monopolies are most inclined to seek rent. This is because there are complex non-linear relationships in real enterprises, and it can be directly seen from Table VI that the most serious type of rent-seeking enterprise is the small state-owned domestic sales monopolies. However, it can be directly inferred that small non-state-owned export monopolies are more inclined to seek rent than the large-scale state-owned domestic sales monopolies, which is basically consistent with the conclusion in Table VI.

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