EEG Experiment Research on the Effects of Neuroscience-Based Managerial Tax Avoidance on the Firm value

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ABSTRACT
This study designed an EEG experiment about the effects of managerial tax avoidance on firm value. A combination of behavioural experiment and neuroscience experiment (event-related potentials) was conducted to understand the cognitive psychological processes and related neural mechanisms of management personnel before and after-tax avoidance. By using the data of Chinese A-share listed companies in 2008-2015, this paper studied the effect of corporate tax avoidance behaviour on firm value and analysed its mechanism of action. Based on the analysis of behavioural data and EEG data, it concludes that the corporate tax avoidance behaviour can increase the firm value, and the well-governed firms can also increase the firm value by reducing the entrusted agency fees generated by tax avoidance. Therefore, it enriches the research on Chinese tax avoidance agency issue, being of a certain guiding significance for the firms and taxation departments.

Key Words: Tax Avoidance, Entrusted Agency, Rent-Seeking; Substitution Effect, Complementary Effect, EEG Experiment, Neuroscience

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Introduction
Tax burden is one of the driving factors for firm decision-making behaviour. With the increasingly fierce competition in the Chinese market, firms have gradually reduced their profit margins due to their own scale, financing environment, and competitive advantages. Tax avoidance, as an important factor affecting corporate investment and financing activities and one means of modern firm earnings management, can reduce tax burdens so as to increase corporate entity cash flow and enhance firm value. Therefore, how to minimize tax burden through reasonable tax avoidance has gradually become the key issue of management concern. In the traditional concept, investors believe that the corporate tax avoidance can enable the transfer of resources from the government to the shareholders, and this behaviour is usually without cost, so the tax avoidance behaviour can bring value to the shareholders.

The commonly used methods in neuroscience research include functional magnetic resonance imaging (fMRI) and event-related potentials (ERP). fMRI is characterized by high-spatial resolution, accurately locating the active brain areas in decision-making activities, such as the dorsolateral prefrontal cortex (DLPFC) involved in the planning, the insular cortex activated when experiencing negative emotions (such as pain and disgust), and the anterior cingulate cortex (ACC) with executive functions which often receives input from many regions and then resolves their conflicts. ERP is a non-invasive brain scan technique with high temporal resolution. Now the more mature
research is on the P3 component, which reflects attention bias towards important or unexpected events in the environment. In this paper, the event-related potential (ERP) technology is adopted as one research tool to study the relationship between managerial tax avoidance and firm value.

The research on the issue of tax avoidance agency originated from the study of American scholar Weisbach (2002). In his research on business behaviour, he found that under the existing US taxation and expropriation laws, there are more tax avoidance measures with the lower probability of being punished, but even in this situation, most American companies are still reluctant to choose tax avoidance (Liu and Ye, 2015). Desai and Dharmapala (2006) stated that if the scale of tax avoidance is large, the information quality will be reduced, which in turn will increase the risk of corporate information disclosure. This is mainly because the managers of tax avoidance firm would inevitably conceal from the shareholders about the tax avoidance facts and related transaction behaviours, in order to minimize the inspection risk, and avoid clues to tax agency investigations, so corporate tax avoidance activities are often complex and covert. In addition, other foreign studies also have showed that corporate tax avoidance is not conducive to long-term profits (Hanlon, 2005), but it is beneficial to manipulatable accruals (Frank et al., 2009; Mu, 2013). Also, Balakrishnan et al., (2012) and Hope et al., (2015) adopted different empirical indicators to define the corporate information quality and found that the corporate tax avoidance behaviour reduce the transparency of corporate information environments (Liu, 2013; Wen, 2012). Therefore, the foreign scholars believe that in addition to the positive effect of reducing tax costs, tax avoidance also has some negative effects, and this effect can cause the firm to abandon the tax avoidance. Crocker and Slemrod (2005) thought that the reason that tax avoidance does not necessarily enhance the firm value is: the traditional tax avoidance theory ignores the fact that the separation of ownership and management rights is a matter of “two rights separations”; the tax avoidance will increase the cost of entrusted agency and reduce the firm value (Cao et al., 2013).

There have been some domestic researches on tax avoidance agency issues. Chen (2011) believed that tax avoidance does not necessarily increase firm value; only the firms with relatively perfect corporate governance mechanisms can increase firm value through tax avoidance; Song (2009) put forward the model about stock company incentives and tax avoidance behaviours of listed companies, indicating that when there exist management equity incentives and tax avoidance will increase the cost of entrusted agency and reduce the firm value (Song, 2009; Chen, 2006).

Therefore, the corporate tax avoidance does not necessarily increase the firm value of the firm. Only in firm with better governance structure, avoidance of tax can increase the firm value; while in firm with worse governance structure, avoidance of tax will not increase the firm value, even damaging the firm value.

Theoretical analysis and research hypothesis

Through the study of shareholder value control, Desai and Dharmapala (2005) proposed a basic model and framework for evaluating management tax avoidance (Han, 2009; Wang, 2011; Gong, 2010; Yu, 2011; Biddle and Hilary, 2006). Suppose the actually generated revenue (including potential earnings) every year in one firm is Yt; during the period of t years, the managerial reported return to the firm’s shareholders is YTS, and the tax revenue reported to the tax authority is YtT. It is also given that the managerial rent-seeking effect level is Yt-YTS, and the tax avoidance effect level is Yt-YtT. Finally, according to the author’s assumption, the goal of management is not to maximize the value of the firm, but to maximize the after-tax value and its own rent-seeking income (Biddle et al., 2009; Chen et al., 2011; Chen, 2005; Crocker and Slemrod, 2005).

It is used to represent the corporate tax rate in the period t. Assuming there are no other tax liabilities, the post-tax value of the firm can simply be expressed below (where, δ is the discount rate) (Desai and Dharmapala, 2006; Desai et al., 2007; Desai and Dharmapala, 2009; Hanlon and Slemrod, 2009). Obviously, with other factors unchanged, improving the level of tax avoidance (due to the fact that Yt is generally...
difficult to manipulate, so reducing YtT) can enhance firm value V. This is in line with the traditional concept described in the previous section that the corporate tax avoidance is simply to make the resources to be transferred from government to shareholders (Hanlon and Heitzman, 2010).

However, in fact, the effect of tax avoidance on the firm value may not be so simple, but is determined by a series of complex factors, including the following two major effects:

Substitution effect: it has been mentioned above that the corporate tax avoidance behaviour might induce managerial rent-seeking behaviour; therefore, for the management, the generated costs of these two types of behaviours may influence on each other (Kim et al., 2011). Suppose that the cost of the two behaviours above is expressed by the function L(YtT, YtS, Yt- YtT), then during the period of t, the marginal cost of one certain behaviour selected by the management depends on the level of the other behaviour; assume that the management decision function has a constraint line related to time and energy, then according to the basic knowledge of economics, it can be seen that there is a substitution effect between tax avoidance behaviour and rent seeking behaviour: the higher the tax avoidance level, the more the marginal substitution cost of rent seeking behaviour, and the lower the optimal equilibrium solution of the function. In this case, due to the existence of substitution effects, as YtT decreases, YtS increases and the company value V increases.

Complementary effects: between tax avoidance behaviour and rent-seeking behaviour, there might also exist the positive effect. As mentioned above, the corporate tax avoidance behaviour involves a series of complex trading activities and the transfer of income through tax havens, which makes it more difficult for the shareholders to supervise managerial rent-seeking (i.e., lowering the cost of managerial rent-seeking). In addition, when the firm adopts equity incentives for management, the YtT shall be reduced, and also the disclosed YtS to public is decreased, further influencing the stock price; then managerial motivation of avoiding tax are reduced. Therefore, there is a complementary effect between managerial tax avoidance and rent-seeking behaviour. Increasing the tax avoidance effect-scale increases firm value V, but also increases management rent-seeking level and reduces YtS. When the complementary effect between the two kinds of behaviours predominates, increasing the scale of tax avoidance may damage the firm value (Myers and Majluf, 1984).

In summary, the information asymmetry caused by tax avoidance behaviour will affect managerial behavioural game process and thus influence the firm value. It is not easy to clarify which effect above dominates for the tax avoidance behaviour in producing a positive or negative effect on the firm value, because the total effect of tax avoidance on firm value is not clear. However, there is a direct relationship between the size of entrusted agency costs and corporate governance mechanisms. Assuming a firm with a well-developed governance mechanism, any tiny rent-seeking activity in this firm will bring huge costs to the management, that is, the marginal substitution cost tends to infinity. At this time, the substitution effect is 0, and any tax avoidance behaviour can directly increase the firm value V. Conversely, in a firm without a governance structure, the managerial rent seeking behaviour and tax avoidance behaviour are completely complementary, and the increased firm value with tax avoidance behaviour V is offset by the increase in rent seeking behaviour, even causing loss of firm value.

Therefore, a relatively accurate research hypothesis can be concluded: the corporate tax avoidance may increase firm value (the scale of tax avoidance is positively related to firm value), and its effect is positively related to the degree of corporate governance structure (according to Liu (2013), a comprehensive corporate governance index based on a series of indicators has been set to evaluate the improvement degree of corporate governance mechanisms) (Richardson, 2006).

Methods

Experimental objective

The EEG experiment is an important part of this paper. The paper aims to explore the neuroscience-based impact of managerial tax avoidance behaviours on firm value by making the following assumptions: 

H1: If the test subject of management chooses to carry out tax avoidance behaviour before the information is updated, then after the information updated, the information representation process of the subjects before and after information updated, reflecting in the difference of component P2.
H2: If the test subject of management chooses to carry out tax avoidance behaviour before the information is updated, then after the information updated, the value evaluation process of the participants before and after information updated, reflecting in the difference of component.

H3: If there is a difference in the cognitive process when the test subjects make selections before and after information updated, reflected in the amplitude of the component ERN.

In this paper, 100 healthy management personnel of Chinese A-share listed companies were selected as volunteer participants in the experiment, among which 50 males are right-handed and aged 40-60 years old. All subjects had normal vision or corrected vision, and they had no history of mental illness or mental illness. Before the formal experiment, each participant signed the Neuro Management Laboratory Testimony Informed Letter and Examination Process Confirmation Letter.

This paper uses all Chinese A-share listed company data in 2008-2015 (excluding GEM listed companies and financial industry listed companies). 2008 was chosen as the research starting point, mainly because in China the new Firm Income Tax Law was implemented on January 1, 2008, and major adjustments were made to corporate tax rates, tax bases, and preferential taxation policies; also, it is selected to ensure data comparable. Based on the samples above, by removing the sample with key indicators missing, finally a total of 9,119 observed values were obtained. The empirical data mainly comes from the following three aspects: basic financial and stock data from the Wind database, corporate governance data from the Guotai security CSMAR database, and other data from the listed company's annual report.

**Variable definition**

(1) Firm value

Based on the researches of Song (2009), Desai and Dharmapala (2005), Tobin's q value was used to measure firm value, representing the ratio of the firm net asset value and the replacement cost of net assets. It is measured in the model equation:

\[ Q = \frac{(BVa+MVa-BVs)}{BVa} \]  

(1)

(2) Scale of tax avoidance

There are two main kinds of indicators for tax avoidance scale in the literature on corporate tax avoidance: the first kind is the difference between the nominal tax rate and the actual tax rate; considering that the listed companies in China generally have tax incentives, and their preferential policies are relatively complex, so the simple use of the difference between the nominal tax rate and the actual tax rate might result in large errors or even erroneous conclusions. Therefore, we have not directly adopted this kind of indicators. Instead, we use the indicator to adjust the second kind of indicators; the second kind of indicators is the difference between firm accounting and tax. In order to accurately measure the scale of corporate tax avoidance effects, this paper draws on Desai and Dharmapala (2005) and Liu (2013) by using the BTD (Book-tax gap) for measurement, and TACC (Total accruals) and DACC (Discretionary accruals) for amending the BTD(DDBTD). Besides, to avoid the influence of industry and regional tax policies on the independent variables, the deviation of the firm BTD from the industry's average level is utilized to make correction. The measurement is made in model (2):

\[ BTD, t = a*\text{TACC}, t + b*U, i, t + N, i, t \]  

(2)

Where, BTD=(pre-tax accounting profit-taxable income)/total assets at the end of the period, taxable income amount=(income tax expense-deferred income tax)/nominal tax rate, TACC=(net profit-net cash flow from operating activities)/total assets at the end of the period, U, i, t is the deviation of the firm's BTD indicators from the average of the same industry and the same industry during the period t, Ni and t are the degree of deviation from the residual of the t year; it is defined that DDBTD=NI,t, representing the part that cannot be explained by the firm's internal earnings management and external tax environment in BTD.

(3) Model design

The following model was used to examine the relationship between tax avoidance activity and firm value in this paper:

\[ Q, i, t = a0 + a1*\text{DDBTD}, i, t + a2*\text{FCF}, i, t + a3*\text{SALES}, i, t + a4*\text{MANHO}, i, t + a5*\text{DAR}, i, t + a6*\text{ROA}, i, t - 1 + a7*\text{GROWTH}, i, t + \text{YEAR} + \text{INDUSTRY} + \theta_i, t \]  

(3)

where, Tobin's q value is the firm value variable, BTD (Book-tax gap), TACC (total accruals) are the measure index of the corporate
tax avoidance scale. Referring to Dyreng et al., (2010), Kang and Ko (2014) and other related researches, this paper also sets the following control variables in the model: FCF (physical free cash flow), SALES (firm scale), MANHO (equity value accounts for total management Remuneration ratio), DAR (asset-liability ratio), ROAt-1 (return on assets of the previous year), GROWTHt+1 (asset growth rate of the next year); in addition, industry and annual dummy variables are also included in the model.

According to the traditional concept of tax avoidance, tax avoidance behaviour can enhance firm value, so a1 should be significantly positive in the expected model (3). If it is significantly positive, it means that the tax avoidance behaviour exerts a "positive" regulatory effect on the firm value; if negative, it confirms that the tax avoidance behaviour exerts a "negative" regulatory effect on the firm value.

Results

EEG data analysis

In this study, SPSS data analysis was performed using a statistical process method with-subjects repeated-measure of ANOVA. According to the task type of the stimulus lock, the time period of data analysis is set to 1000 ms, from 200 ms before the stimulus is presented to 800 ms after the stimulus is presented. Then by making superimposition according to different conditions, the averaged data is filtered with low-pass 12Hz (24dB/Octave) to get two total average lines. The completed waveform is shown in Fig.1.

Figure 1. Two electrical-simulated total average lines

According to the EEG analysis, two components were selected in the stimuli presentation phase. The first component is the early positive component with the peak appearing around the stimulus presentation, mainly distributed in the forehead area; in this article, an analysis time window was adopted (different types of information have a slightly different incubation period, so the adopted time window will also vary slightly, to be explained later). The second component is an early negative component of the peak appearing around the presentation of the stimulus, mainly distributed in the frontal area and the central top area. The time window was used to analyses the component (for components, different types of information have a slightly different incubation period, so the adopted time window will also vary slightly, to be explained later).

Table 1 lists the descriptive statistical results of the main variables: for Tobin’s q value, the median and average values are 1.83 and 2.36 respectively, indicating that the asset premium on China’s capital market is relatively high; the standard deviation of 1.658 means that the difference in corporate market premium is more obvious, and the stock price fluctuates more; in addition, its maximum value is 22, for a high-tech firm whose net assets are lower than its share capital, but its future development prospect is considerable so as to have a higher market premium. Then, in terms of the indicator DDBTD, the median and average are 0.008 and 0.006 respectively, indicating that in China there may exist a certain degree of tax avoidance behaviour in listed companies; a standard deviation of 0.077 means that there is a big difference between tax avoidance scale and motivations among different companies, due to differences in tax policies between different industries and different regions.
as well as the support efforts by different local governments. For FCF indicator, the median and average are -0.043 and -0.062 respectively, which shows that the cash flow of listed companies in China is obviously insufficient; a standard deviation of 0.242 indicates that there is a big difference in profitability among different companies; in addition, the maximum value is 7, mainly due to the company's clearing inventory, resulting in a substantial decline in assets. Furthermore, MANHO index median and average are 0.042 and 0.28, indicating that there are equity incentives in listed companies in China; the maximum value is close to 100%, indicating that the main source of salary for some managements is the holding of shares. Finally, regarding other indicators such as DAR, SALES etc., their statistical results are generally consistent with the actual situation of listed companies in China and the conclusions of previous literature.

**Table 1.** Descriptive statistical results of main variables

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Median</th>
<th>Max value</th>
<th>Average</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>7117</td>
<td>1.83</td>
<td>22</td>
<td>2.36</td>
<td>1.658</td>
</tr>
<tr>
<td>DDBTD</td>
<td>7117</td>
<td>0.00</td>
<td>1</td>
<td>0.00</td>
<td>0.077</td>
</tr>
<tr>
<td>FCF</td>
<td>7117</td>
<td>-0.04</td>
<td>7</td>
<td>-0.06</td>
<td>0.242</td>
</tr>
<tr>
<td>MANHO</td>
<td>7117</td>
<td>0.04</td>
<td>1</td>
<td>0.28</td>
<td>0.385</td>
</tr>
<tr>
<td>DAR</td>
<td>7117</td>
<td>0.50</td>
<td>1</td>
<td>0.50</td>
<td>0.201</td>
</tr>
<tr>
<td>ROAt-1</td>
<td>7117</td>
<td>0.04</td>
<td>2</td>
<td>0.05</td>
<td>0.087</td>
</tr>
<tr>
<td>SALES</td>
<td>7117</td>
<td>1.58</td>
<td>2786</td>
<td>9.48</td>
<td>74.336</td>
</tr>
<tr>
<td>GROWTHt+1S</td>
<td>7117</td>
<td>1.11</td>
<td>368</td>
<td>.28</td>
<td>4.790</td>
</tr>
<tr>
<td>Valid N</td>
<td>7117</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Regression analysis**

The sample data above was input into SPSS software for multiple regression analysis, and the specific results are shown in Table 2. There is a significant positive correlation between DDBTD and Tobin's q value, so the corporate tax avoidance behaviour can enhance the firm value. However, there are still several major problems that have not yet been resolved: First, it's mentioned above that the dual effects of managerial tax avoidance behaviour are affected by the corporate governance structure, while the regression model only analyses the overall sample without studying whether the governance structure will affect the regression coefficient of DDBTD. Second, the tax policies of different industries and regions have large differences, resulting in different motivation and ways of avoiding taxation, so it is not sure whether the regional and industry differences will also have an impact on the DDBTD regression. Therefore, the robustness tests shall be made in the following section.

The regression equation is given as:

\[ Q_{i,t-0.089} = DDBTD_{i,t} + 0.640 * FCF_{i,t} - 0.048 * SALES_{i,t} + 0.083 * MANHO_{i,t} - 0.312 * DAR_{i,t} + 0.025 * ROA_{i,t-1} + 0.034 * GROWTH_{i,t+1} + YEAR + INDUSTRY + \Theta_{i,t} \]

**Table 2.** Regression results

<table>
<thead>
<tr>
<th>Model</th>
<th>Non-standard coefficient</th>
<th>Standard coefficient</th>
<th>Trial version</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>3.530</td>
<td>.059</td>
<td>60.301</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>DDBTD</td>
<td>1.929</td>
<td>.239</td>
<td>.089</td>
<td>8.063</td>
<td>.000</td>
</tr>
<tr>
<td>FCF</td>
<td>.440</td>
<td>.078</td>
<td>.064</td>
<td>5.645</td>
<td>.000</td>
</tr>
<tr>
<td>MANHO</td>
<td>.356</td>
<td>.049</td>
<td>.083</td>
<td>7.258</td>
<td>.000</td>
</tr>
<tr>
<td>DAR</td>
<td>2.576</td>
<td>.098</td>
<td>-3.122</td>
<td>26.265</td>
<td>.000</td>
</tr>
<tr>
<td>ROA_{t-1}</td>
<td>.477</td>
<td>.223</td>
<td>.025</td>
<td>2.136</td>
<td>.033</td>
</tr>
<tr>
<td>SALES</td>
<td>-0.001</td>
<td>.000</td>
<td>-0.048</td>
<td>4.329</td>
<td>.000</td>
</tr>
<tr>
<td>GROWTH_{t+1}</td>
<td>.012</td>
<td>.004</td>
<td>.034</td>
<td>3.137</td>
<td>.002</td>
</tr>
</tbody>
</table>

**Impact of corporate governance**

As mentioned above, SALES (total income) were used to measure the firm scale; it's believed that the larger the firm scale, the better its corporate governance structure. Here, a series of specific corporate governance indicators were applied by replacing the SALES indicator. In order to simplify the model, the principal component analysis was adopted to construct the comprehensive governance index GOVERANCE IT. The comprehensive index mainly includes the following indicators: IND, the ratio of independent directors to the total number of directors in the board of directors; the greater the proportion of independent directors, the stronger the supervision of the company and the better the governance structure. TOP1, the shareholding ratio of the firm's largest shareholder; with the greater shareholding ratio of the first shareholder, it indicates more concentration of equity, not conducive to the corporate governance for its supervisory role. BSIZE, the size of the board of directors, that is, the natural logarithm of the number of directors; with the greater size of the board of directors, it may be more difficult for the directors to communicate, not good for the corporate governance. DUAL, it should be confirmed whether the chairman and general manager have the separation of duties; if two positions held by one, then take 1, otherwise, taking 0; the same person in the position of the chairman and general manager indicates incomplete governance structure. INSIT, the...
The weighted average of the first principal component and the second principal component were selected as the comprehensive governance index, $G_{t,t}=0.5756*Z_{1}+0.4244*Z_{2}$ (The equation correlation coefficient is the weight coefficient of the variance for the respective principal components. Each indicator is converted into the standardized variables); $G_{t,t}$ descriptive statistics are as follows: the standard deviation of $G_{t,t}$ is 0.715, indicating that there is little difference in the governance structure of listed companies in China, which could be caused by the stricter requirements of the China Securities Regulatory Commission (CSRC) for the board of directors and board of supervisors in listed companies.

After replacing SALES with the comprehensive indicators above, the results of specific regression analysis are shown in Table 6.

It is found that after replacing SALES with the comprehensive governance index $G_{t,t}$, no significant changes have occurred in the regression coefficients and significance of other indicators. The newly-added index $G_{t,t}$ has a regression coefficient of 0.170, indicating that the comprehensive governance index is significantly positively related to the firm value. This may be due to the fact that the sound corporate governance structure has inhibited the managerial rent-seeking behaviour and increased the firm value, which shall be further elaborated in further studies.

**Data grouping analysis**

In terms of data reclassification, China’s corporate income tax has characteristics such as high tax rates, complex tax preferences, and local tax protection, so in China, the firms in different industries and regions have significant differences in their income tax liabilities, e.g. for the listed companies of the same size, firms with farming, forestry, animal husbandry and fishery as their main businesses, their income tax liability is significantly lower than the manufacturing firms, because China’s income from agriculture, forestry, animal husbandry and fishery is exempted from corporate income tax; the same is true for manufacturing companies; the actual tax burden of firms registered in the western region is significantly lower than that of the eastern region, because the firms in the western regions of China...
enjoy the country’s “two exemptions and three reductions” tax break. It can thus be seen that the uniform application of BTD for the tax avoidance of listed companies might have an impact on the empirical results. Therefore, in the robustness test, all sample data were reclassified by industry and region. The specific classification results are shown in Table 7 and Table 8:

Table 7. Sample data reclassified by industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>Number of samples</th>
<th>% of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining industry</td>
<td>251</td>
<td>3.53%</td>
</tr>
<tr>
<td>Power resources</td>
<td>346</td>
<td>4.86%</td>
</tr>
<tr>
<td>Real estate</td>
<td>593</td>
<td>8.19%</td>
</tr>
<tr>
<td>Construction</td>
<td>186</td>
<td>2.61%</td>
</tr>
<tr>
<td>Transportation</td>
<td>310</td>
<td>4.36%</td>
</tr>
<tr>
<td>Agriculture, forestry, animal</td>
<td>74</td>
<td>1.04%</td>
</tr>
<tr>
<td>husbandry and fishery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wholesale and retail</td>
<td>552</td>
<td>8.18%</td>
</tr>
<tr>
<td>Social services</td>
<td>197</td>
<td>2.77%</td>
</tr>
<tr>
<td>Culture and sports</td>
<td>43</td>
<td>0.60%</td>
</tr>
<tr>
<td>Information technology</td>
<td>194</td>
<td>2.73%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>4257</td>
<td>59.81%</td>
</tr>
<tr>
<td>Integrated industries</td>
<td>94</td>
<td>1.32%</td>
</tr>
<tr>
<td>Total</td>
<td>7117</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

According to the classification criteria of the China Securities Regulatory Commission, the industries is classified into a total of 12 sub-industries, including the mining industry, power resources, real estate, construction, transportation, agriculture, forestry, animal husbandry and fishery, wholesale and retail, social services, culture and sports, information technology, manufacturing and integrated industries. The four most representative industries, namely information technology, real estate, wholesale and retail, and manufacturing, were selected for grouping discussions. The results show: 1) Real estate: The regression coefficient of the DDBTD indicator is still positive, but the regression result not significant; 2) Wholesale and retail: The DDBTD indicator has a relatively small change, still positive, and the regression result is still significant; 3) Manufacturing: DDBTD indicator changes are small, and the regression result is significant; 4) Information technology: The regression results are still significant positive correlation.

The region is divided into North China, Northeast China, East China, Central South China, Southwest China, and Northwest China, with the province as the unit and the administrative region as the standard. The specific classification results are as follows:

The four regions with the largest proportion of samples were selected, namely, North China, East China, South Central China, and Southwest China. Then each set of data was resubmitted into an empirical model. The results show: 1) North China: DDBTD regression coefficients are still positive with significant regression results; 2) East China: No significant changes in regression coefficients and significance; 3) South-Central China: significant differences between independent and dependent variables; 4) Southwest: Regression results are still significantly positive.

In summary, after grouping regression of sample data, the regression results of each group are still significantly positive, with only several groups’ significance increased, so it passed the robustness test, and there is no strong evidence to prove that the basic conclusions above are unreasonable.

Conclusions and inspiration

From the perspective of tax avoidance agency, this paper focuses on the impact of corporate tax avoidance behaviour on firm value. In this paper, it is found that the reason for corporate tax avoidance behaviour affecting firm value is the result of game between rent-seeking behaviour and tax avoidance behaviour of management, besides, there exist both substitution effect and complementary effect between these two kinds of behaviours; these two effects together determine the firm value of the firm while the corporate governance structure directly affects the degree of influence of these two effects.

In conclusion, the corporate tax avoidance behaviour increases firm value, and a sound corporate governance structure does not inhibit corporate tax avoidance, but promoting managerial active tax avoidance behaviour, maybe due to the fact that a sound corporate governance structure affects the balance of the management game and allows the management to invest more effort in avoiding taxation in order to improve the current performance. The conclusion of this paper supplements the theory of China’s
tax avoidance agency and innovatively interprets the relationship between tax avoidance behaviour and firm value from the perspective of management behaviour. It is greatly helpful to guide firms in tax planning.

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