# Influence analysis of media supervision in corporate governance

*Weida He, Rong Hao*, Chuan Zhang and Fatima Zahra Ainou*

*This article presents the importance of the role of media supervision in corporate governance by adopting stochastic dynamic optimal method of analysis. It also studies the influence of media supervision on embezzlement behaviour of large shareholders. Research demonstrates that when the occupation ratio of large shareholders is low and the intensity of media exposure is not high, fall in the value of firm assets is not obvious and, large shareholders can continue to improve occupation ratio to achieve higher welfare. After the occupation ratio of large shareholders reaches a certain level, their welfare loss because of media exposure damages firm asset value more than their income by occupation. Then, large shareholders continue to improve occupation ratio which will not only prevent maintenance of welfare level, but will also result in welfare loss. If the occupation ratio is improved through unfair means, they must give up illicit occupation. In addition, it further demonstrates that conspiracy of large shareholders and media will make them more likely to improve their own welfare by encroaching upon the interests of small shareholder. Based on the corporate governance practices of listed biotechnology and pharmaceutical companies in China, this article analyses the impact of media supervision upon these entities, products and processes.*

**Keywords:** Conspiracy, corporate governance, large shareholder encroachment, media supervision.

In modern society, people get the required information from mass media such as newspapers, television, radio and the internet. This not only reduces the cost of information collected by the public, but also significantly enhances credibility of the information. These characteristics enable media to master the power to lead public discourse and mould public opinion. Thus, media becomes influential in uncovering social problems and arousing public attention. Media supervision is widely recognized as a type of external governance mechanism, which is seen as the fourth law – independent from legislation, administration and jurisdiction in the West. However, for sometime, scholars have been more attentive to media supervising governance, and this has become a general practice[1]. With more researches in law and finance in the theoretical circle, scholars find that the media also plays a major role in corporate governance as an important alternative mechanism of law[2–5]. The public increasingly recognize that modern media plays a role in exposure of business scandals, because of advancement of information technology, particularly in recent years[6–8]. Therefore, media supervision has become one of the most prevalent topics of research regarding corporate governance.

In corporate governance, larger shareholder status has always been taken seriously by scholars. According to Shleifer and Vishny[9], large shareholders can nearly control an entire company and obtain private benefits. This phenomenon is likely due to the lack of control that small shareholders have when the large shareholder ownership reaches a certain level. The wide range of research on Asian companies by Claessens *et al.*[10] shows that only Japanese companies conform to shareholding dispersion standards in general, and there are controlling shareholders in most of the other Asian companies. Large shareholders have enough power to control a listed company and seek personal interest through influencing the decisions of such a company, thus leading to the inference that large shareholders have strong motivation and the ability to plunder corporate wealth at the expense of small shareholder interests. Friedman *et al.*[11] argue that large shareholders can obtain more practical controlling power than nominal controlling power corresponding to their equity share by pyramid shareholding structure, cross-shareholding and issuing multiple shareholding stocks. Thus, large shareholders are likely to exhibit predatory behaviour.

Currently, management scholars in China and abroad primarily are focussing on empirical research, but only a few conduct theoretical research. Company production

The authors are in the Donlinks School of Economics and Management, University of Science and Technology Beijing, No. 30, Xueyuan Road, Haidian District, Beijing 100083, China; Rong Hao is also in the China Nonferrous Metal Industry's Foreign Engineering and Construction Co. Ltd, NFC Building, 10 Anding Road, Beijing 100029, China.
*For correspondence. (e-mail: haorongnfc@hotmail.com)

and management face many uncertainties in reality, and these may cause the firm value to be random. Meanwhile, occupation ratio of large shareholders will also change randomly. The stochastic dynamic optimum mathematical method, which is used to study the effect of media supervision on large shareholders, is closer to approximating a real business situation. Therefore, this article uses the above method to analyse the influence of media supervision of embezzlement by large shareholders. It not only introduces static research in empirical study, but also enriches and develops the corporate governance theory. China is one of the top ten largest biotechnology and pharmaceutical markets, which is a growing sector that includes not only pharmaceutical drugs, but also synthetic chemicals and drugs, prepared Chinese medicines, medical devices, apparatus and instruments, hygiene materials, packing materials, pharmaceutical machinery and biological products. Some of the top players in the Chinese biotechnology and pharmaceutical industry are the China National Pharmaceutical Group Corp (SINOPHARM), Beijing Genomics Institute (BGI), Harbin Pharmaceutical Group Co, Lanzhou Institute of Biological Products and Shanghai Institute of Pharmaceutical Industry. Many foreign firms such as AstraZeneca, Pfizer Inc, Bayer and GSK, have already established themselves firmly in the Chinese market and are expanding their services regularly within the country. Due to the entry of foreign players, the competition amongst domestic firms has significantly grown, along with the quality of pharmaceutical manufacturing processes. However, good governance can lead to good performance. Based on the corporate governance practices in SINOPHARM and BGI, this article analyses the impact of media supervision that plays an important role in enhancing the firm management, products and processes.

## Establishment of the theoretical model

First, this study constructs a company optimal decision model without media supervision as basis. Then, it adds short and sharp asset fall owing to media exposure of large shareholder embezzlement on the basis of the benchmark model. Finally, it analyses welfare gains and losses of large shareholders, small shareholders and overall shareholders caused by large shareholder embezzlement while under media supervision. Equations pertaining to the analysis are given in Appendix 1.

### *Benchmark model*

When a firm does not have large shareholder encroaching on the interests of small shareholders and media exposure, suppose that the firm asset volatility follows the ITO process according to Merton[12] and Black and Cox[13], as given in eq. (1). Here $W(t)$ is the asset value and $\mu$ is the expected rate of return, showing ratio that new added asset accounts for the original firm asset. $C(t)$ is the dividend of the firm in time $t$, also a random process; $z(t)$ is standard Brownian motion, showing the firm asset volatility due to internal and external uncertainties and $\sigma$ is the volatility rate of the firm value. In the above setting, $\mu$ and $\sigma$ are assumed as fixed constants[14]. Assuming that the initial asset of the firm $W(0) = W$, the utility function of shareholders is $u$, and the utility discount rate is $r$. Equation (2) continues Merton's[15] assertion of firm business objective. That is to say, the business objective of a firm is to make the expected discounted utility of dividend maximum within a certain period (from 0 to $\tau$), and we call cumulative discounted utility as shareholder welfare. $\tau$ is a stopping time, indicating random time that firm asset is below a constant level for the first time. It can be defined as $\tau_M = \inf\{t \geq 0,\ W(t) \leq M,\ W(s) > M,\ 0 \leq s \leq t\}$, where $M$ is firm debt. According to stochastic optimal control theory, firm business objective $L(W)$ satisfies the HJB (Hamilton–Jacobi–Bellman) equation (eq. (3)). Suppose shareholders tend to avoid risk, for processing convenience, power utility function could be taken as average utility function, namely $u(C) = C^\gamma$. $\gamma$ is the risk aversion coefficient of a shareholder. Bringing $u(C) = C^\gamma$ into eq. (3), we get the optimal dividend policy eq. (4). Thus, the dividend is a fixed proportion of firm asset under this strategy. The corresponding shareholder welfare is $L(W) = A_0^{\gamma-1} W^\gamma$. If the ratio of large shareholder stock holding is $a$, the expected discounted utility can be represented as

$$K(x) = E\int_0^\tau e^{-\gamma t} l(C_0^{**} * a)\mathrm{d}t.$$

Continuing previous assumptions, namely the utility function of large shareholders is $l(x) = x^\gamma$, we get eq. (5). Define

$$V(W) = E\int_0^\tau e^{-\gamma t} W(t)^\gamma\, \mathrm{d}t,$$

according to lemma Itó[16], $V(W)$ satisfies differential equation, i.e. eq. (6). The result from the differential equation is given in eq. (7). Therefore, welfare of large shareholders is $K(x) = (aA_0)^\gamma B_0 W^\gamma$, when there is no large shareholder occupation and media supervision.

### *Model under media supervision and large shareholder embezzlement*

Consider the optimal dividend policy when there is large shareholder embezzlement and media exposure based on the former model in this section. The following assumptions are considered for these points.

(a) Large shareholders and small shareholders are at different levels of mastering information of the firm, and large shareholders can hide information about the true situation in a firm, such as income and risk, from small shareholders.

(b) Media reports are objective. There is no negative exposure of firms that media fabricates to expand its influence. At the same time, there is no conspiracy behaviour between large shareholders and the media.

(c) Markets are efficient, and they will make reasonable reflections on media exposure of negative firm information. Random model equation (eq. (8)) predicts the value change of firm asset, when there is media supervision. Here $\mu$ is the real growth rate of the firm asset and $b$ is the ratio that the occupation part of large shareholder accounts for total firm asset. Of course, large shareholders will hide the true growth rate of the firm asset and declare that the growth rate of firm asset is only $\mu - b$ in front of small shareholders. $q(t)$ is a negative jumping process, demonstrating instantaneous and sharp fall of firm value caused by exogenous shock.

(d) In the firm operating process, only media supervision will cause a reduction in the firm value, when no other exogenous shock is apparent.

(e) Media exposure events are independent of each other, namely every media exposure will not be affected by another.

The time interval between two exposures obeys exponential distribution with the same parameter. Consider eq. (9) where $q(t)$ is a compound Poisson process. $N(t)$ is Poisson process reaching a certain intensity of $\Lambda$, recording the times of media exposure of the company until time $t$. $\{\Phi_i\}_{i=1,2,\ldots}$ is a series of random variables that are independent identically distributed, instructing the ratio that asset value loss caused by media exposure accounts for firm asset before exposure in times of $i$. Assume that the media exposure does not cause firm bankruptcy, namely $-1 < \Phi < 0$ $(i = 1, 2, \ldots)$, recording the average $\varphi$, namely $E\Phi_i = \varphi$ $(i = 1, 2, \ldots)$. In reality, the more the large shareholders occupy small shareholder interests, the more media will likely uncover it and thus more seriously damage firm asset value[17]. Therefore, $\Lambda$ and $\varphi$ should be strictly monotonically increasing functions of $b$. Here we assume that both are linearly correlated with $b$, for simplicity, say, $\Lambda = \lambda b$ and $\varphi = \phi b$, with $\lambda > 0$ and $\phi < 0$ as constant.

It can be seen that assumptions (a) and (c) are the basis of research, while (e) is a technical assumption for the asset meeting stochastic process; and assumptions (b) and (d) are made to highlight the main problem of this research. Of course, the goal of management is to maximize interest of large shareholders. However, they would declare that the purpose of management of the firm is still to maximize discounted utility of the whole shareholders $L(W)$ in front of the public or at least before all shareholders. According to the stochastic dynamic optimization theory, we can get HJB equation (eq. (10)) that $L(W)$ satisfies. Considering the utility function for shareholders as $u(C) = C^\gamma$, if we replace it in eq. (10) and solve the same, we get the optimal dividend policy equation, i.e. eq. (11). It can be seen that there is a positive linear relationship between the optimal dividend and the firm asset, which is the same as in the baseline model. The corresponding shareholder welfare is $L(W) = A_1^{\gamma-1} W^\gamma$. From eq. (11), if distribution function $F$ of $\Phi$ is the function of $b$, namely $F = F(b)$, put $\Lambda = \lambda b$ into it, then use $A_1$ to derive $b$, and obtain eq. (12). When $\gamma + \lambda \geq \lambda E[(1+\Phi)^\gamma + b\partial E(1+\Phi)^\gamma/\partial b]$, $\partial C\dagger^*/\partial b \geq 0$, dividend rate rises with increase in the occupation ratio of large shareholders, meaning that large shareholders will take initiative to increase all shareholder dividend to please all shareholders to cover embezzlement. When $\gamma + \lambda < \lambda E[(1+\Phi)^\gamma + b\partial E(1+\Phi)^\gamma/\partial b]$, $\partial C\dagger^*/\partial b < 0$, dividend rate falls with increase in the occupation ratio of large shareholders. At present, the large shareholders have little time to hide their embezzlement; instead, they will want only to invade small shareholder interests and occupy firm dividend. The results can be analysed with the following numerical process. The jumping height is kept constant for simplicity, namely $\Lambda = \lambda b$, $\Phi = \phi b$, to obtain eq. (13). Because $E(1+\phi b)^\gamma \leq 1$ and $\phi \leq 0$, then $\partial C\dagger^*/\partial b > 0$, parameter selection is $a = 0.4$, the ratio of large shareholder stock is 40%; coefficient of risk aversion is $1 - \gamma = 2/3$. Using a week as the unit of time, risk-free interest rate and average growth rate of firm value are $r = 0.11\%$ and $\mu = 0.3\%$ respectively, corresponding to annual risk-free interest rate of 5.8% and growth rate of firm value of 16.9%. Asset volatility rate is $\sigma^2 = 0.075 \times 0.075$; besides, select $\phi = -30$ and $\lambda = 15$, suppose that occupation ratio of large shareholders is between 0% and 0.3%, then jumping height is between –9% and 0%. The falling of firm asset value is between 0% and 9% after media exposure; the jumping intensity is between 0 and 0.045. As such, this article considers initial firm asset as 1 for simplicity. The relationship between firm dividend and large shareholder occupation is shown in Figure 1.

China's biotechnology and pharmaceutical industry is plagued by worrying incidents, sometimes resulting in deaths due to poor drug quality. While these pharmaceutical production problems are not exclusive to China, they have tarnished its reputation abroad. The media exposure has become real-time and dynamic as the information technology advances. Therefore, the occupation ratio of large shareholders should be optimized to prevent the falling of firm asset and maximize their interests.

## *Optimal occupation ratio of large shareholders*

The optimal dividend policy of a company depends on the optimal occupation ratio of large shareholders. Because large shareholder revenue results from the illegitimate dividend and income by occupying small shareholder interests, their actual decision-making must be to maximize their own total discounted utility, which is the objective function given in eq. (14). It is not difficult to see that, increasing occupation on small shareholder interests can make large shareholders achieve more earnings. Additionally, it causes more media exposure from eq. (8), further decreasing firm value and large shareholder income. Thus, the large shareholders must consider occupation ratio $b$ to maximize their own interest. Because utility function of large shareholders is $l(x) = x^{\gamma}$, then from eq. (15), it can be shown that $(aA + b)^{\gamma}$ and

$$E\int_{0}^{\tau} \mathrm{e}^{-\gamma t} W(t)^{\beta}\,\mathrm{d}t$$

are connected with $b$. The first part is easy; the analysis of this article focuses on the second part and defines

$$V(W) = E\int_{0}^{\tau} \mathrm{e}^{-\gamma t} W(t)^{\gamma}\,\mathrm{d}t.$$

Thus, the process of assessing firm asset is $\mathrm{d}W = aW\mathrm{d}t + W\sigma\,\mathrm{d}z + W\mathrm{d}q$, wherein $a = \mu - b - A_1$. According to lemma Itól, $V(W)$ satisfies the differential equation, i.e. eq. (16). Solving this differential equation obtains eq. (17), thus, eq. (18) is the welfare level of large shareholders.

Figure 2 shows the relationship between welfare of large shareholders and their occupation ratio. The horizontal line indicates large shareholder welfare level under no large shareholder occupation. Further, it can be seen that starting from point $A$, the welfare level of large shareholders is gradually rising with an increasing occupation ratio until it reaches the maximum point $B$ (the occupation ratio of large shareholders is 0.032%). Thereafter, the welfare level of large shareholders does not rise, but falls as the large shareholder occupation ratio continues increasing; thus, there is no advantage in their welfare whether the large shareholders occupy or not when the occupation ratio reaches point $C$ (the occupation ratio is 0.078%). Starting from point $C$, the welfare will continue to decrease and fall below the level when there is no embezzlement, if continue to increase the occupation ratio. At present, occupying the small shareholder interest is irrational for large shareholders. Large shareholder encroachment on small shareholder interests will have an influence in two ways, viz. (i) the redistribution of interests between large and small shareholders, the large shareholders improve their welfare at the expense of reducing small shareholder interests and (ii) the exposure of media supervision to large shareholder embezzlement will weaken firm asset value, thus damaging large and small shareholder welfare. When the occupation ratio of large shareholders is low and the intensity of media exposure is not high, fall in the value of firm asset is not obvious. Thus, large shareholders can improve welfare by continuing increasing occupation ratio. After the occupation ratio of large shareholders reaches a certain level, their welfare loss because of media exposure damages firm asset value more than their income by occupation. Then, large shareholders continue to improve occupation ratio which will not only prevent achieving higher welfare, but will also cause welfare loss. Moreover, this study indicates that at the left of point B (Figure 2), when the occupation ratio of large shareholders is less than the optimal level (0.032%), large shareholders can achieve a higher welfare level by raising occupation ratio. This is because welfare gain by occupying small shareholder interests is more than the welfare loss due to fall in value of firm asset caused by media exposure. Thus, large shareholders may not care about their reputation and will continue to encroach on small shareholder interests under the pressure of media exposure. In this case, media supervision does not work. When at the right of point B (Figure 2), when the occupation ratio of large shareholders is more than the optimal level (0.032%), the large shareholders cannot achieve higher welfare, but will reduce welfare by raising their occupation ratio. This is because, welfare gain by occupying small shareholder interests is less than welfare loss due to fall in value of firm asset caused by media exposure. Thus, big shareholders will care about their reputation and reduce their occupation ratio under media supervision. In this case, media supervision works.

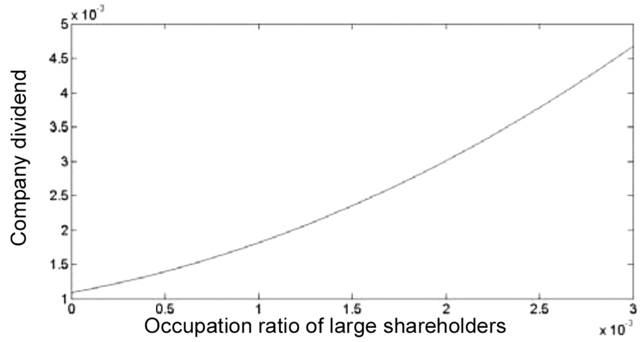


**Figure 1.** Relationship between company dividend and occupation ratio of large shareholders.

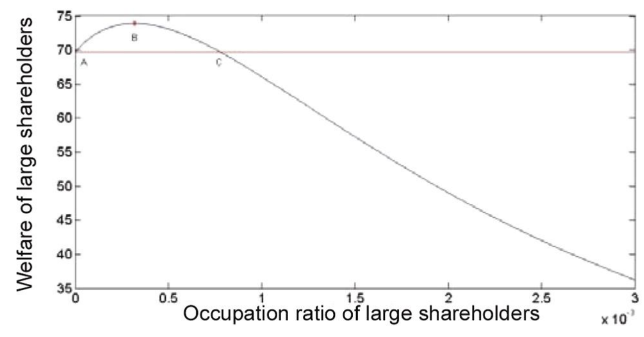


**Figure 2.** Relationship between welfare of large shareholders and their occupation ratio.

## *Influence of the occupation by large shareholders*

This article deduces the optimal dividend policy of the company and total discounted utility function of large shareholders in case of existing or not existing occupation in above parts. On this basis, this section will discuss the impact of large shareholder occupation on its welfare and also that of own, the small shareholder and the overall shareholder. From eqs (7) and (18), we can obtain the welfare change of large shareholders as $G(W) - K(W) = (aA_1 + b)^{\gamma} * B_1 W^{\gamma} - B_0 W^{\gamma} * (aA_0)^{\gamma}$, the welfare change of small shareholders as $(1 - a)^{\gamma} A_1^{\gamma} B_1 W^{\gamma} - (1 - a)^{\gamma} A_0^{\gamma} B_0 W^{\gamma}$ and the welfare change of overall shareholders as $(A_1 + b)^{\gamma} * B_1 W^{\gamma} - A_0^{\gamma-1} W^{\gamma}$. The results can be analysed as follows. Keeping the parameters $u$ and $b$, the results are shown in Figure 3, which is the welfare change of large shareholders. The analysis for small shareholders and overall shareholders could also be done in the same manner. $A$ (0.078%) is the critical point of large shareholder occupation in Figure 3. When the occupation ratio of large shareholders is less than the critical point, they can gain benefit by encroaching on the interests of small shareholders. There is an optimal occupation ratio (0.032%) to maximize their welfare. Furthermore, if the occupation ratio is higher than the critical point $A$, the welfare loss of large shareholders due to fall in value of firm asset caused by media exposure is higher than the gain obtained by big shareholders occupying small shareholder interests; thus, large shareholder embezzlement is irrational at this time. For small shareholders, although large shareholders raise dividend rate to hide their embezzlement in the short term, large shareholder occupation not only directly hinders the interest of small shareholders, but also causes their welfare loss because the media exposure will thereby damage firm asset value in the long run. It is worthwhile to note that small shareholder welfare first falls quickly, and then slows down with increase of the large shareholder occupation ratio. It illustrates that the harm which large shareholders inflict upon small shareholder welfare is serious initially. Thus, it is necessary to control large shareholder embezzlement in advance. Finally, overall shareholder welfare level falls as the large shareholder occupation ratio increases. This is primarily derived from two factors: viz. (i) the welfare level after the large shareholders privately change the way of profit distribution which is contrary to maximum welfare and (ii) media exposure causes fall in firm asset value. As such, because the overall welfare of shareholders contains the large shareholder welfare, the welfare level of overall shareholders falls slower than that of small shareholders.

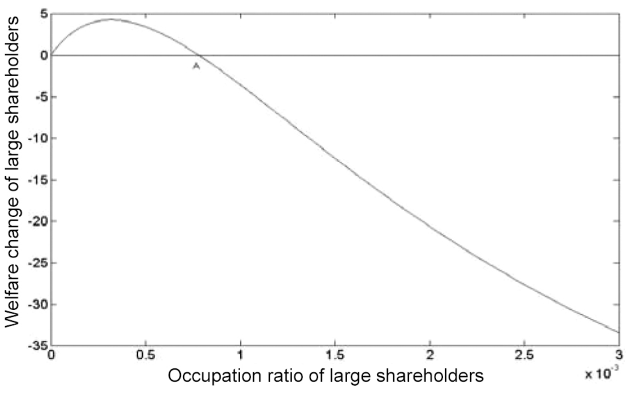


**Figure 3.** Relationship between welfare change of large shareholders and their occupation ratio.

China's largest pharmaceutical group company, SINOPHARM, is the largest distributor and a leading provider of supply-chain services for pharmaceutical and healthcare products. It operates the largest pharmaceutical distribution network within China. As it is sensitively related to the people's national livelihood, media supervision normally focuses on its internal corporate governance and external products and services. On 13 January 2014, due to an emergency announcement at SINOPHARM, on suspicion of corruption, its former Vice President Shi Jinming was taken in for questioning. This is the first case in which pharmaceutical executives are being investigated since China proposed to strengthen anti-corruption laws. Media exposure of this scandal caused sharp fall in the stock price within a short time. Later investigation demonstrated that the high ratio of large shareholders leads to their embezzlement, and large shareholders often hid important information such as income and risk from small shareholders. Finally, it resulted in the loss of dividend and welfare of overall shareholders.

## Results and discussion

### *Influence on optimal occupation ratio of large shareholders by frequency and intensity of media exposure*

From the above, one should be cautious of large shareholder embezzlement upon small shareholders. Combined with the above model of Figure 2, this article attempts to reduce the optimal occupation ratio of large shareholders or make optimal occupation ratio move towards zero; thus forcing large shareholders to reduce their occupation of small shareholders. To explore the function that media supervision reduces large shareholder occupation and strengthens the role in protecting small and medium-sized investors, this article analyses the relationship between media exposure frequency ($\lambda$), intensity ($\phi$) and welfare of large shareholders. The range of $\lambda$ and $\phi$ is selected [5, 60], [–60, –5] respectively. Keeping the parameters $u$ and $b$, the results are shown in Figure 4 *a*. Figure 4 *b* is the water-level diagram of Figure 4 *a*. The blue area in Figure 4 *b* is the deep water area, showing a low level of optimal occupation, whereas the red area is the shallow water area showing a high level of optimal occupation. From Figure 4 *a* and *b*, it is found that large shareholder optimal occupation ratio gradually decreases with jumping intensity and increasing height. It further demonstrates that improving sensitivity of media reaction to large shareholder occupation and strengthening the exposure intensity can force large shareholders to be aware of their reputation – ultimately reducing embezzlement upon the interest of small shareholders. It also demonstrates that strengthening media supervision on listed companies can perfect corporate governance and protect the interests of small and medium-sized investors. This is also reflected in national legislation. In 2004, the State Council issued 'several opinions about promoting capital market reform, opening up and promoting stable development', which especially focused on media function in improving supervision level of securities market and protecting the interests of investors.

### *Conspiracy of large shareholders and media*

From the analysis in the foregoing section, it can be seen that media supervision will cause large shareholders to reduce the occupation of small shareholders, thus reducing their welfare level. Thus, large shareholders, when compared to small shareholders, have motivation to collude with the media, thereby reducing the frequency and intensity of media exposure to the occupation behaviour to gain more interests and welfare. However, large shareholders must accept that they bear some cost in the process of collusion with the media. More precisely, they have shared interests with corrupt media regarding small shareholders. For example, the media could take bribes from large shareholders, with a conspiracy between media and large shareholder, and thus not playing the role of supervision by public opinion. Assume that the $(1-s)$ $(0 < s < 1)$ of gain coming from large shareholder occupation is given to the media. The media can reduce corresponding exposure frequency and intensity of the firm in return. That is to say $\tilde{\Lambda}(b) < \Lambda(b)$, $E\tilde{\Phi}(b) < E\Phi(b)$. In this case, the target function of large shareholders is modified to eq. (19). Because the utility function of large shareholders is $l(x) = x^{\gamma}$, we then refer to eq. (20). Using the same method in the second part, we obtain eqs (21)–(23). For simplicity, we still assume that jumping frequency parameter $\tilde{\Lambda}$ has a linear relation with $b$, namely $\tilde{\Lambda}(b) = n\lambda b$ $(0 < n < 1)$, and $E\tilde{\Phi}(b) = nE\Phi(b)$. In addition, we still take fixed jumping height as an example to carry out numerical simulation, continuing parameters described above, selecting $s = 0.95$, $n = 0.6$, namely large shareholders can bribe 5% of occupation revenue to the media in exchange for the media reducing 40% of the exposure level. Large shareholder welfare changes at this time are shown as a green line in Figure 5, and *D* is the top point. Blue line is the welfare curve without conspiracy between large shareholders and the media. Figure 5 reveals that the large shareholders reduce frequency and intensity of media exposure through bribes to obtain highest welfare level, promoting the irrational area to move to the right. Therefore, it can be regarded as advantageous for shareholders to bribe the media. Of course, large shareholder welfare level improves by reducing the interests of small shareholders. Additionally, it is apparent that the most reasonable occupation ratio improves (from *B* (0.0318%) to *D* (0.0402%)) for large shareholders, because degree of media supervision reduces after the large shareholders bribe the media. The green line in Figure 6 describes welfare loss of small shareholders under conspiracy between large shareholders and the media, and the blue line describes welfare change of small shareholders without conspiracy between large shareholders and the media. As can be seen from Figure 6, small shareholder welfare loss reduces under the same degree of large shareholder occupation. This is likely due to the reduction of frequency and intensity of media

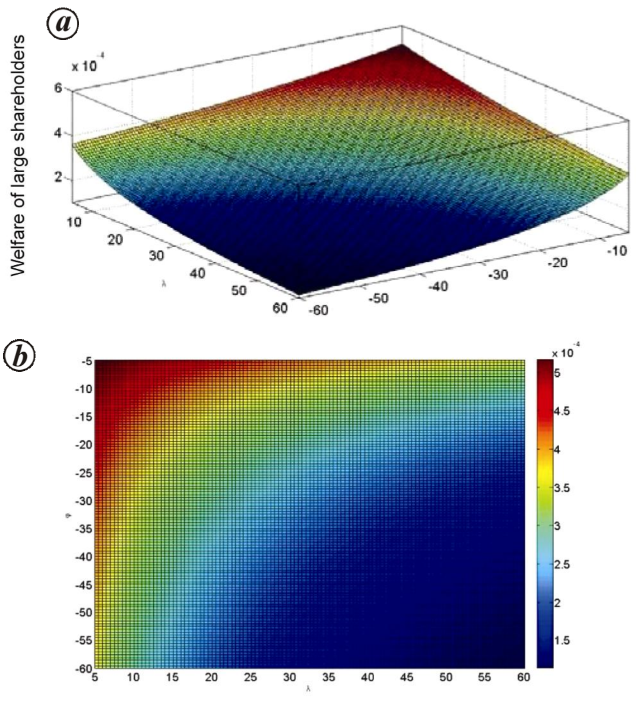


**Figure 4.** ***a***, Relationship between welfare of large shareholders and intensity and frequency of media exposure. ***b***, Water-level diagram of (***a***).

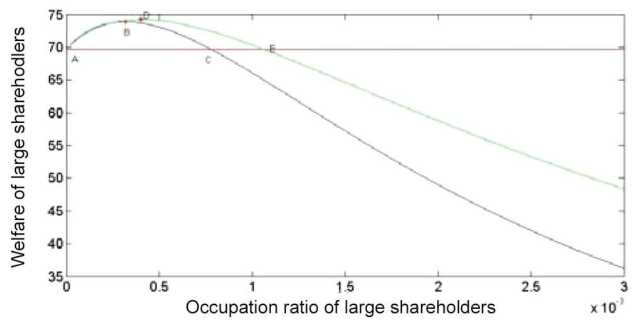


**Figure 5.** Relationship between welfare of large shareholders and their occupation ratio while in conspiracy with the media.

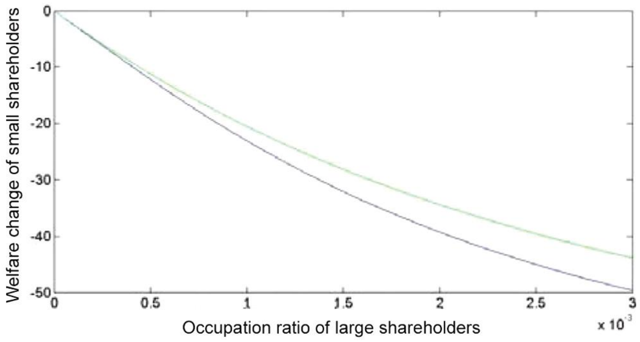


**Figure 6.** Relationship between welfare change of small shareholders and occupation ratio of large shareholder within conspiracy.

exposure. It seems that bribing the media not only improves the welfare level of large shareholders, but also produces a spillover effect, benefitting small shareholders. Furthermore, it also illustrates that media supervision not only fails to protect small shareholder rights and interests, but can even cause more damage. Therefore, media supervision is not reasonable. However, after enlarging part of Figure 6, it can be seen that the optimal occupation ratio is 0.032% without conspiracy, and the optimal occupation ratio increases to 0.040% with conspiracy. Contrasting the two points, it can be seen that the welfare of small shareholders further reduces after large shareholders bribe the media. It demonstrates that conspiracy makes large shareholders more likely to encroach on small shareholder interests, improving their benefit. Furthermore it demonstrates that media supervision can effectively prevent large shareholder occupation, protecting the rights and interests of small shareholders. In reality, one should make full use of media supervision on listed companies to improve the effectiveness of the market reacting to media supervision. Of course, to strengthen the supervision of the media, full attention must be paid to reduce corruption in the media itself.

### *Media supervision under multiple impacts*

As stated, to highlight the research question, this article assumes that the short and sharp decline of the firm asset value is caused by negative media exposure. This does not agree with the actual situation. In reality, it is likely to cause a sharp rise and fall of the stock price in a short time due of macro policy adjustment, the sudden change in performance of a firm, even analyst expectation adjustment and change in market sentiments. Thus, this model should be modified to make it more realistic. On the addition of jumping caused by other factors in eq. (8) we obtain eq. (24). $q(t)$ is still the firm asset jumping caused by media exposure, and assumptions are the same as above. According to the additive property of compound Poisson process (eq. (25)), $q_i(t)$ shows firm asset value jumping caused by factor $i$. Suppose that its arrival process $N_i(t)$ is a Poisson process, and intensity is $\lambda_i$; $\{\Phi_{ij}\}_{j=1,2,\ldots}$ shows the ratio which firm asset bouncing caused by impact $j$ accounts for firm asset before media exposure, $-1 < \Phi_{ij} < 1$; that is to say, it is likely to make a firm value take an upward leap by exogenous shocks. $Q(t)$ is still a compound Poisson process, and jumping intensity is $\tilde{\lambda} = \lambda_1 + \lambda_2 + \cdots + \lambda_n$; jumping height is

$$\tilde{\Phi}_j = \frac{\lambda_1\Phi_{1j} + \lambda_2\Phi_{2j} + \cdots + \lambda_n\Phi_{nj}}{\lambda_1 + \lambda_2 + \cdots + \lambda_n}.$$

So the firm asset process can be simplified as $\mathrm{d}W(t) = (W(t)(\mu - b) - C)\mathrm{d}t + W(t)\sigma\mathrm{d}z(t) + W\mathrm{d}q(t) + W\mathrm{d}Q(t)$. Under the assumptions of objective functions of overall shareholders and large shareholders, the HJB equation can be established as eq. (26). Still assuming the utility function of shareholders as $u(C) = C^{\gamma}$ and taking this into eq. (5) and solving the same, the optimal dividend policy is arrived as in eq. (27). The welfare of large shareholders is given by eq. (28). The welfare of small shareholders is $(1-a)^{\gamma}A_3^{\gamma}B_3W^{\gamma}$. The welfare of overall shareholders is $(A_3 + b)^{\gamma} * B_3W^{\gamma}$. The analysis and discussions under this situation are similar to only consider the impact of media exposure in this case, the same methods could be used for analysis in this article, but we will not discuss more here.

One of China's largest biotech company, BGI Shenzhen is a state company (http://www.genomics.cn/en/index). Along with the ratio of large shareholders increasing and the ownership is at nearly 80% in early stage, it became competitive – not only in China, but also in the international market. The effective management structure and optimal ratio of big shareholders made the corporate governance practical and efficient. As a result, positive media exposure caused a sharp rise of stock price. BGI acquired Genomics in early 2013 and found a route into the US market. The combined ownership of big shareholders owns 51% of the company, down from more than 80% before the merger with Genomics. Furthermore, BGI employees collectively own 49% through stock options. As it is one of the largest biotech companies in China, the dividend and welfare of the large shareholders will be maximized. Thus, already much more than early stages, the ratio of large shareholders was decreased to prevent the embezzlement, the media supervision is also important to highlight good quality products and advanced processes that help ensure good corporate governance and long-term performance.

## Conclusion

The stochastic dynamic optimal method is used to study the media supervision in restraining large shareholder embezzlement of small shareholder interest. A benchmark model is established to measure both large and small shareholder welfare levels, while considering that there is no large shareholder occupation and media supervision. This study further considered the optimal dividend policy and occupation ratio of large shareholders during occupation and short–sharp fall of firm asset value caused by media exposure on the afore-mentioned basis. Finally, this study analysed the welfare gain and loss of all parties caused by large shareholder embezzlement and media supervision. The article demonstrated that when occupation ratio of large shareholders is low and media exposure intensity is not high, the fall in the firm asset value is not obvious. As such, large shareholders may continue to improve occupation ratio to achieve higher welfare. After large shareholder occupation ratios reach a certain level, the large shareholder welfare loss caused by that media exposure damages the firm asset value more than the income by occupation. At that time, large shareholders cannot promote welfare level, but cause a decline in welfare. In addition, it further considers the influence of large shareholder occupation behaviour under conspiracy and multiple impacts. Research demonstrates that conspiracy of large shareholders and the media will make them more likely to encroach upon small shareholder interests to improve their own welfare.

In reality, the mechanism in which media supervision restrains large shareholder behaviour and plays a role in protecting investors is complex. When media uncovers the firm behaviour of damaging small to medium-sized investors, it has a certain influence on firm asset value. If investors fail to recognize decision-making behaviour of large shareholders, they also often suffer losses. This article studied the media exposure of large shareholder embezzlement of some Chinese listed companies. It can help investors better understand large shareholder embezzlement. Meanwhile, it also demonstrated the role of media in securities regulation and investor protection, thus providing the reference to identify a media supervision path, and to develop laws and regulations.

**Appendix 1.** Equations used in the present analysis.

$$\mathrm{d}W(t) = (W(t)\mu - C(t))\mathrm{d}t + W(t)\sigma \mathrm{d}z(t), \tag{1}$$

$$L(W) = \max_{C} E\int_0^{\tau} \mathrm{e}^{-rt} u(C)\mathrm{d}t, \tag{2}$$

$$rL(W) = \max_{C}\left\{u(C) + (W\mu - C)L_{\mathrm{W}} + \frac{1}{2}L_{\mathrm{WW}}\sigma^2 W^2\right\}, \tag{3}$$

$$\begin{cases} C_0^{**} = A_0 W \\ A_0 = \dfrac{r-\gamma\mu}{1-\gamma} + \dfrac{\gamma\sigma^2}{2}, \end{cases} \tag{4}$$

$$K(x) = E\int_0^{\tau} \mathrm{e}^{-rt} l(a * A_0 W(t))\mathrm{d}t = (aA_0)^{\gamma} E\int_0^{\tau} \mathrm{e}^{-rt} W(t)^{\gamma}\,\mathrm{d}t, \tag{5}$$

$$rV(W) = (\mu - A_1)WV'(W) + \frac{1}{2}\sigma^2 W^2 V''(W) + W^{\gamma}, \tag{6}$$

$$\begin{cases} V(x) = B_0 W^{\gamma}, \\ B_0 = \dfrac{1}{r - (\mu - A_1)\gamma - \dfrac{1}{2}\sigma^2\gamma(\gamma-1)}, \end{cases} \tag{7}$$

$$\mathrm{d}W(t) = (W(t)(\mu - b) - C(t))\mathrm{d}t + W(t)\sigma \mathrm{d}z(t) + W\mathrm{d}q(t), \tag{8}$$

$$q(t) = \sum_{i=1}^{N(t)} \Phi_i, \tag{9}$$

$$\begin{aligned} rL(W) = \max_{C} \{&u(C) + [W(\mu - b) - C]L_W \\ &+ \frac{1}{2}L_{WW}\sigma^2 W^2 + \Lambda(EL((1+\Phi)W) - L(W))\}, \end{aligned} \tag{10}$$

$$\begin{cases} C_1^{**} = A_1 W \\ A_1 = \dfrac{r - (\mu - \mathrm{b}) * \gamma - \dfrac{1}{2}\sigma^2\gamma(\gamma-1) - \Lambda(\mathrm{E}(1+\Phi)^{\gamma} - 1)}{1-\gamma}, \end{cases} \tag{11}$$

$$\begin{aligned} \frac{\partial C_1^{**}}{\partial b} &= \frac{\gamma - \lambda(E(1+\Phi)^{\gamma} - 1) - \lambda b \partial E(1+\Phi)^{\gamma}/\partial b}{1-\gamma} W \\ &= \frac{\gamma + \lambda - \lambda E[(1+\Phi)^{\gamma} + b\partial E(1+\Phi)^{\gamma}/\partial b]}{1-\gamma} W, \end{aligned} \tag{12}$$

$$\begin{aligned} \frac{\partial C_1^{**}}{\partial b} &= \frac{\gamma - \lambda(E(1+\phi b)^{\gamma} - 1) - \lambda b \partial E(1+\phi b)^{\gamma}/\partial b}{1-\gamma} W \\ &= \frac{\gamma - \lambda(E(1+\phi b)^{\gamma} - 1) - \lambda b\phi \partial E(1+\phi b)^{\gamma-1}}{1-\gamma} W, \end{aligned} \tag{13}$$

$$J(x) = \max_{b} E\int_0^{\infty} \mathrm{e}^{-rt} l(C_1^{**} * a + bW)\mathrm{d}t \triangleq \max_{b} G(W), \tag{14}$$

$$\begin{aligned} J(x) &= \max_{b} E\int_0^{\tau} \mathrm{e}^{-rt} l((aA_1 + b)W(t))\mathrm{d}t \\ &= \max_{b} (aA_1 + b)^{\gamma} E\int_0^{\tau} \mathrm{e}^{-rt} W(t)^{\gamma}\,\mathrm{d}t, \end{aligned} \tag{15}$$

$$\begin{aligned} rV(W) = &aWV'(W) + \frac{1}{2}\sigma^2 W^2 V''(W) \\ &+ \Lambda[EV((1+\Phi)W) - V(W)] + W^{\gamma}, \end{aligned} \tag{16}$$

$$\begin{cases} V(W) = B_1 W^{\gamma} \\ B_1 = \dfrac{1}{r-(\mu-b-A_2)\gamma-\frac{1}{2}\sigma^2\gamma(\gamma-1)-\lambda b(E(1+\Phi)^{\gamma}-1)}, \end{cases} \tag{17}$$

$$G(W) = (aA_1+b)^{\gamma} E\int_0^{\tau} \mathrm{e}^{-rt} W(t)^{\gamma}\,\mathrm{d}t = (aA_1+b)^{\gamma} * B_1 W^{\gamma}, \tag{18}$$

$$J(x) = \max_b E\int_0^{\infty} \mathrm{e}^{-rt} l(C*a+bW)\mathrm{d}t \triangleq \max_b \tilde{G}(W), \tag{19}$$

$$\begin{aligned} J(x) &= \max_b E\int_0^{\tau} \mathrm{e}^{-rt} l((aA_2+sb)W(t))\mathrm{d}t \\ &= \max_b (aA_2+sb)^{\gamma} E\int_0^{\tau} \mathrm{e}^{-rt} W(t)^{\gamma}\,\mathrm{d}t, \end{aligned} \tag{20}$$

$$A_2 = \frac{r-(\mu-b)*\gamma-\frac{1}{2}\sigma^2\gamma(\gamma-1)-\tilde{\Lambda}(E(1+\tilde{\Phi})^{\gamma}-1)}{1-\gamma}, \tag{21}$$

$$B_2 = \frac{1}{r-(\mu-b-A_2)\gamma-\frac{1}{2}\sigma^2\gamma(\gamma-1)-\tilde{\Lambda}(E(1+\tilde{\Phi})^{\gamma}-1)}, \tag{22}$$

$$\tilde{G}(W) = (aA_2+b)^{\gamma} E\int_0^{\tau} \mathrm{e}^{-rt} W(t)^{\gamma}\,\mathrm{d}t = (aA_2+b)^{\gamma} * B_2 W^{\gamma}, \tag{23}$$

$$\begin{aligned} \mathrm{d}W(t) &= (W(t)(\mu-b)-C))\mathrm{d}t + W(t)\sigma\mathrm{d}z(t) \\ &\quad + W\mathrm{d}q(t) + W\sum_{i=1}^{n} \mathrm{d}q_i(t), \end{aligned} \tag{24}$$

$$\begin{cases} q_i(t) = \sum_{j=1}^{N_i(t)} \Phi_{ij}, \\ \sum_{i=1}^{n} \mathrm{d}q_i(t) = \mathrm{d}Q(t), \end{cases} \tag{25}$$

$$\begin{aligned} rL(W) &= \max_C \{u(C) + [W(\mu-b)-C]L_W \\ &\quad + \frac{1}{2}L_{WW}\sigma^2 W^2 + \Lambda(EL((1+\Phi)W - L(W))\} \\ &\quad + \tilde{\lambda}(EL((1+\tilde{\Phi})W) - L(W)), \end{aligned} \tag{26}$$

$$\begin{cases} C^{**} = A_3 W, \\ A_3 = \dfrac{\left[\begin{array}{l} r-(\mu-b)*\gamma-\frac{1}{2}\sigma^2\gamma(\gamma-1) \\ -\tilde{\lambda}(E(1+\tilde{\Phi})^{\gamma}-1)-\Lambda(E(1+\Phi)^{\gamma}-1) \end{array}\right]}{1-\gamma}, \end{cases} \tag{27}$$

$$\begin{cases} G(W) = (aA_3+b)^{\gamma} E\int_0^{\tau} \mathrm{e}^{-rt} W(t)^{\gamma}\,\mathrm{d}t = (aA_3+b)^{\gamma} * B_3 W^{\gamma} \\ B_3 = \dfrac{1}{\left[\begin{array}{l} r-(\mu-b-A_3)\gamma-\frac{1}{2}\sigma^2\gamma(\gamma-1) \\ -\tilde{\lambda}(E(1+\tilde{\Phi})^{\gamma}-1)-\lambda b(E(1+\Phi)^{\gamma}-1) \end{array}\right]}. \end{cases} \tag{28}$$


1. Besley, T. and Andrea, P., Handcuffs for the grabbing hand: the role of the media in political accountability. *Am. Econ. Rev.*, 2006, **96**, 720–736.
2. Zheng, Z. G., The role of company governance outside the law system: a review. *Manage. World*, 2007, **9**, 136–159.
3. Hilary, G. and Kai, W. H., Does religion matter in corporate decision making in America? *J. Financ. Econ.*, 2009, **93**, 455–473.
4. Monks, R. and Nell, M., *Corporate Governance*, Blackwell, Cambridge, MA, 2004.
5. Miller, G., The press as a watchdog for accounting fraud. *J. Account. Res.*, 2006, **44**, 1001–1033.
6. Dyck, A., Volchkova, N. and Zingales, L., The corporate governance role of the media: evidence from Russia. *J. Finance*, 2008, **63**, 1093–1135.
7. Dyck, A., Morse. A. and Zingales, L., Who blows the whistle on corporate fraud? *J. Finance*, 2010, **65**, 2213–2253.
8. Li, P. G. and Shen, Y. F., The corporate governance role of media: empirical evidence from China. *Econ. Res. J.*, 2010, **4**, 14–27.
9. Shleifer, A. and Vishny, R. W., Big shareholders and corporate control. *J. Polit. Econ.*, 1986, **94**, 466–488.
10. Claessens, S., Djankov, S., Fan, J. and Lang, L., Expropriation of small shareholders: evidence from East Asia. World Bank, Washington DC, 1999.
11. Friedman, E., Johnson, S. and Mitton, T., Propping and tunneling. *J. Comp. Econ.*, 2003, **31**, 732–750.
12. Merton, R., On the pricing of corporate debt: the risk structure of interest rate. *J. Finance*, 1974, **29**, 449–470.
13. Black, F. and Cox, J., Valuing corporate securities: some effects of bond indenture provisions. *J. Finance*, 1976, **31**, 351–367.
14. Demsetz, H. and Lehn, K., The structure of corporate ownership. *J. Polit. Econ.*, 1985, **93**, 1155–1177.
15. Merton, R., *Continuous Time Finance*, Blackwell Press, Cambridge, 1990.
16. Revuz, D. and Yor, M., *Continuous Martingales and Brownian Motion*, Springer, Berlin, 1990.
17. Fang, L. and Joel, P., Media coverage and the cross-section of stock returns. *J. Finance*, 2009, **64**, 2023–2052.


ACKNOWLEDGEMENTS. We thank to two anonymous reviewers for their constructive comments and suggestions. We also thank the National Social Science Foundation of China for providing financial support under Grant No. 14ZDA088; the Social Science Foundation of Beijing under Grant No. 14JGA014 and the fundamental research funds for the Central Universities under Grant No. 06106117.

Received 18 August 2014; revised accepted 28 November 2014