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On the relationship between protection of proprietary information and transparency of accounting information

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ABSTRACT

This paper explores the interplay between proprietary information leakage, intellectual property protection, and accounting transparency using data from A-share listed manufacturing companies (2019–2021). Findings include: 1) Firms with a higher risk of R&D information leakage show less accounting transparency, as management seeks to protect proprietary information and uphold their interests. 2) In regions with strong intellectual property protection, the incentive for management to reduce accounting transparency to safeguard proprietary information intensifies. Intellectual property protection level significantly impacts corporate accounting information disclosure.

1. Introduction

Information asymmetry has been one of the problems plaguing modern capital markets. Information disclosure by listed companies is a crucial way to reduce information asymmetry. Disclosing transparent accounting information to the capital market can help improve the efficiency of resource allocation and promote the effective operation of the capital market (McCallig et al., 2019). Therefore, transparency in information disclosure is fundamental to the effective functioning of capital markets and is directly related to the healthy development of capital markets and economic growth. However, in modern capital markets, opaque accounting information is relatively common, and the implications and consequences of poor information transparency are severe (Callen et al., 2020).

The information disclosure system in China's capital market could be better. The concrete implementation should be more effective, leading to problems of untruthful, incomplete, and untimely information disclosure. The transparency of information disclosure is a cause for concern (Demirkan et al., 2020). A standardized accounting information disclosure system and strict information disclosure regulation can reduce the degree of information asymmetry in the capital market, protect investors' interests, and help enhance investor confidence, thus promoting the healthy development of China's capital market (Alsalmi et al., 2023). Therefore, it is imperative to standardize the information disclosure system and improve the transparency of accounting information to promote the development of China's capital market.

Accounting information transparency has also attracted the attention of academics, and many valuable findings have been obtained from both normative and empirical studies. Many domestic and international scholars have studied the factors influencing the transparency of accounting information, and such studies are divided into two main categories: one is to study the institutional

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environment, such as legal, cultural, political, and market forces from an external perspective (Shan et al., 2021), and the other is to study company characteristics, internal corporate governance and financial characteristics of companies from an internal perspective (Haleem et al., 2021). However, the literature examining the relationship between protecting proprietary information and the transparency of accounting information is scarce. Proprietary information can bring significant benefits to a company and generate endless losses if leaked. Disclosure practices can exacerbate the leakage of proprietary information, but less transparent accounting information can prevent leakage (Kassen, 2022). Therefore, it is worth examining whether firms are incentivized to reduce the transparency of accounting information to protect proprietary information and maintain their economic interests and whether this incentive diminishes in regions with high levels of proprietary information protection.

This paper examines the relationship between proprietary information leakage, the level of intellectual property protection, and accounting information transparency, where the measures of accounting information transparency include three: Earnings aggressiveness, Earnings smoothing, and total accounting information transparency, and the proxy variable for proprietary information leakage is R&D information leakage. This paper analyses the relationship between proprietary information protection and accounting information transparency using a sample of Chinese-listed manufacturing companies and draws the following conclusions: Firstly, companies with a higher likelihood of R&D information leakage have lower accounting information transparency. In order to protect proprietary information and maintain their interests, company management has an incentive to reduce the transparency of accounting information. Secondly, the incentive for company management to reduce the transparency of accounting information to protect proprietary information is reduced in regions with high levels of IP protection. The level of intellectual property protection is an essential factor affecting the disclosure of a company's accounting information.

The contribution of this paper is to consider the regional differences in the level of intellectual property protection unique to China, to introduce the cross variable of intellectual property protection index based on the study of leakage of proprietary information and transparency of accounting information, to provide empirical evidence of the relationship between the protection of proprietary information and the transparency of accounting information in China, to analyze the impact of the protection of external proprietary information on the relationship between the leakage of proprietary information and the transparency of information, and to provide empirical evidence for the increase of transparency of the accounting information of listed companies in China from the point of view of increasing the level of protection of intellectual property rights.

2. Hypotheses development

A breach of proprietary information can be costly to a business, and accounting disclosure may exacerbate a breach of proprietary information. Does the protection of proprietary information affect the disclosure decisions of company management? Does reducing the transparency of accounting information mitigate proprietary information leakage? Furthermore, is the incentive for management to reduce transparency to protect proprietary information diminished in regions with high levels of proprietary information protection? This paper empirically investigates the relationship between proprietary information protection and accounting information transparency by replacing proprietary information leakage with R&D information leakage and using the intellectual property protection index as a proxy variable for proprietary information protection.

Xu et al. (2020) identify three primary channels of technology information leakage: patent licensing, technology transfer, and imitation. Patent licensing refers to patented technology owned by the patentee to others, and technology transfer generally refers to the transfer of technology from multinational companies to subsidiaries or joint venture partners (Stockburger et al., 2021). Imitation involves learning about a competitor's R&D activities before it launches a new product and then imitating it. Proprietary information leakage is often associated with R&D information leakage (Boiko et al., 2019).

Information has a cost-benefit problem like any other good, and information producers will produce information only when the benefits outweigh the costs. A significant cost of proprietary information disclosure that cannot be ignored is the cost of competitive disadvantage. For example, disclosing an enterprise's R&D expenditures in the current period may allow competitors to learn about the enterprise's R&D of new products or projects, which puts the enterprise at a competitive disadvantage and generates the cost of disclosing the proprietary nature of the information (Zheng et al., 2022). Yang et al. (2022) argue that when an enterprise makes an R&D decision, the information will be in the hands of rivals within 12 – 18 months. An essential channel to get hold of rivals' R&D information quickly is their publicly disclosed R&D expenditure information.

Competitors can also obtain information related to R&D expenditures from surplus information. Large R&D expenditures lead to a certain degree of surplus volatility, as firms' profits decline somewhat in the period of R&D investment and increase when the R&D investment starts to pay off (Bonsón et al., 2021). Smooth profits make it difficult for competitors to obtain information about R&D expenditures and reduce the likelihood of information leakage. Thus, surplus management or surplus manipulation behavior that reduces information transparency can reduce the likelihood of proprietary information flowing to potential competitors. Accounting disclosures can exacerbate the leakage of R&D expenditure-related information (Agrawal et al., 2021).

In summary, by reducing the transparency of accounting information, by disclosing less information about company characteristics, or by smoother Earnings information, company management can limit the ability of potential competitors to obtain proprietary information through publicly disclosed accounting information and reduce the likelihood of competitors undermining the company's interests. Therefore, companies with a higher likelihood of R&D information leakage are more likely to have management reduce the transparency of accounting information to prevent proprietary information leakage.

Therefore, this paper proposes the following hypothesis:

H1: The higher the likelihood of R&D information leakage, the lower the transparency of accounting information.

Proprietary information disclosure is a double-edged sword, and companies will only disclose proprietary information if the

increase in firm value from disclosure outweighs the cost of disclosing the information (Ciupa & Zalik, 2020). In regions with lower levels of IP protection, the likelihood of R&D information leakage is greater (Pei & Vasarhelyi, 2020), resulting in higher costs of competitive disadvantage and influencing the disclosure behavior of company management.

Leakage of proprietary information will bring huge losses to enterprises, and accounting information disclosure may exacerbate the leakage of proprietary information. China is a vast country, and there are significant differences in the level of economic development, traditional cultural habits, legal awareness and other institutional environments in various regions. The level of IP protection varies across regions in China, as evidenced by Zeng et al. (2021) marketability index. In regions where IP protection is weak, proprietary information is stolen, which causes significant losses to the company, so companies with significant R&D activities are reluctant to operate in these regions. However, it is costly for companies to relocate, with some local government-controlled or owned companies, which are prominent contributors to local employment and economic development, not easily relocated, and some private companies, whose owners may have personal economic resources or political connections in the area, being even more costly to relocate (Roychowdhury et al., 2019). Thus, management of firms in regions with weak IP protection have more substantial incentives to reduce the transparency of accounting information in order to prevent proprietary information leakage; conversely, regions with high levels of IP protection are less likely to have R&D information leakage, have lower costs of competitive disadvantage, and have less incentive for management to provide less transparent accounting information (Xue et al., 2020).

Therefore, this paper proposes the hypothesis that:

H2: The level of IPR protection attenuates the negative relationship between R&D information leakage and accounting information transparency.

3. Data and empirical methodology

3.1. Data

This paper selects data on A-share listed manufacturing companies from 2019 to 2021 as the research object. Among them, R&D expenditure data were collected manually; the IPR protection index was taken from the marketization index of Fan et al. (2021); other data were taken from the CSMAR database, which are frequently uses in studies in China's stock markets (Kong et al., 2022a, 2022b, 2022c, 2023). We also complement the data from financial websites such as Financial Sector and Phoenix Finance. After excluding samples with missing data, 4398 samples were obtained, including 1327 in 2019, 1478 in 2020, and 1593 in 2021. In addition, to eliminate the effect of extreme values, we Winsorize the main continuous variables used in this paper by 2.5% up and down.

3.2. Variable definitions

3.2.1. Dependent variable

Accounting information transparency (*Trans*): This paper draws on the methodology of Setyowati et al. (2023) to measure accounting information transparency using Earnings aggressiveness (*EA*) and Earnings smoothing (*ES*) and to construct an index of total accounting information transparency (*OAIT*) by summing the two.

Earnings Aggressiveness (*EA*) describes the extent to which a company delays the recognition of losses and accelerates the recognition of revenues. In this paper, we adopt the approach of Ravi et al. (2022) and use manipulable accrued profits as a measure of Earnings aggressiveness. As for the calculation of manipulable accrued profits, this paper uses the Jones model with industry cross-sectional correction.

Earnings smoothing (*ES*) describes how a firm's Earnings fluctuations deviate from normal levels and explains the relationship between a firm's reported and actual Earnings. Drawing on Chen et al. (2022), this paper uses the following formula to calculate Earnings smoothing:

$$ES_{i,t} = \frac{SD\left(CFO_{i,t-3}/TA_{i,t-4}, CFO_{i,t-2}/TA_{i,t-3}, CFO_{i,t-1}/TA_{i,t-2}, CFO_{i,t}/TA_{i,t-1}\right)}{SD\left(NI_{i,t-3}/TA_{i,t-4}, NI_{i,t-2}/TA_{i,t-3}, NI_{i,t-1}/TA_{i,t-2}, NI_{i,t}/TA_{i,t-1}\right)} \tag{1}$$

Where ES_{it} denotes Earnings smoothing for period t of the company i, SD denotes standard deviation, $CF_{i,t\text{-}k}$ ($k = 0,1,2,3$) denotes net cash flow from operating activities for period t-k of company i, $NI_{i,t\text{-}k}$ ($k = 0,1,2,3$) denotes net profit for period t-k of company i, and $TA_{i,t\text{-}k}$ ($k = 1,2,3,4$) denotes total assets at the end of period t-k of company i.

Total Accounting Information Transparency (*OAIT*), calculated by the following formula:

$$OAIT_{i,t} = \frac{Deciles\left(EA_{i,t}\right) + Deciles\left(ES_{i,t}\right)}{2} \tag{2}$$

Where $OAIT_{i,t}$ is the total accounting information transparency of company i in year t, *Deciles* denotes deciles, $EA_{i,t}$, and $ES_{i,t}$ denote the Earnings aggressiveness and Earnings smoothing of the company i in year t, respectively.

3.2.2. Independent variables

The explanatory variables include R&D information leakage (*Spillover*) and the intellectual property protection index (*IPR*).

R&D information leakage (*Spillover*) is a proxy variable for proprietary information leakage and is calculated using a linear transformation of the Cobb-Douglas production function following Zhang et al. (2021).

$$LnSales_{ijt} = \alpha_0 + \alpha_1 LnRD_{it} + \alpha_2 LnRDpool_{jt} + \alpha_3 LnFixedassets_{i,t-1} + \alpha_4 LnEmployment_{i,t-1} + \varepsilon \quad (3)$$

Where $LnSales_{ijt}$ denotes the natural logarithm of sales revenue of company i in industry *j* in year *t*, $LnRD_{it}$ denotes the natural logarithm of R&D expenditure of company *i* in year *t*, $LnRDpool_{jt}$ denotes the natural logarithm of the weighted average of R&D expenditure in industry *j* in year *t*, $LnFixedassets_{i,t-1}$ and $LnEmployment_{i,t-1}$ respectively denote the natural logarithm of net fixed assets and the number of employees in firm *i* in year *t-1*. The coefficient α_2 of the regression equation is the proxy variable for R&D information leakage (*Spillover*) across industries.

The Intellectual Property Protection Index (*IPR*) is taken from the book Marketization Index Report by Provinces in China (2021) compiled by Fan et al. (2021). This index is currently only compiled up to 2020, and drawing on Liu et al. (2023), we use the IPR protection index 2020 from the 2021 report on the relative marketization process by region compiled by Fan et al. (2021).

3.2.3. Control variables

This paper considers the impact of other factors on the transparency of accounting information by including control variables in the model, including three categories: firm financial characteristics (*Fin*), firm governance characteristics (*Gov*), and firm characteristics (*Cha*). According to Jiang et al. (2021) and others, the financial characteristics of the firm include three variables: return on total assets (Roa), financial leverage (*Lev*), and growth (*Growth*). Corporate governance characteristics include two variables: whether the chairman and the managing director have two positions (*Dual*) and the proportion of independent directors (*Dir*). Firm characteristics include three variables: firm size (*Size*), industry concentration (*HHI*), and firm location (*Zone*). In summary, the names of the variables and the associated descriptions are shown in Table 1.

3.3. Regression models

To test the above hypothesis, the following model is constructed in this paper:

$$Trans = \alpha_0 + \alpha_1 Spillover + \alpha_2 IPR + \alpha_3 Fin + \alpha_4 Gov + \alpha_5 Cha + \sum Ind + \varepsilon \quad (4)$$

$$Trans = \beta_0 + \beta_1 Spillover + \beta_2 IPR\_dum + \beta_3 Spillover * IPR\_dum + \beta_4 Fin + \alpha_5 Gov + \alpha_6 Cha + \sum Ind + \varepsilon \quad (5)$$

4. Empirical analysis

4.1. Summary statistics

Descriptive statistics for the sample variables are shown in Table 2. The mean value of *EA* is 0.095 with a median of 0.057, and the mean value of *ES* is 3.137 with a median of 1.946, both showing a right-hand bias. The maximum value of *ES* reaches 14.723, indicating that the reported Earnings of listed companies deviates significantly from the actual Earnings, and there is a severe Earnings smoothing behavior. The minimum value of *Spillover* is −46.25, and the maximum value is only 0.873 with a standard deviation of 13.47, indicating a significant difference in the possibility of R&D information leakage in different regions of China. The maximum value of *IPR* is 52.69, and the minimum value is 1.23, which shows that the IPR protection index of different regions in China varies greatly. Among the control variables, the mean value of whether the chairman and general manager have two positions (Dual) is 0.289,

Table 1
Variable definition table.

	Variable name		Variable description
Explained variables	Earnings Aggressiveness (*EA*)		Absolute value of manipulable accrued profit
	Earnings Smoothing (*ES*)		Ratio of net cash flow from operating activities to variance of net income
	Total Accounting Information Transparency (*OAIT*)		Means of EA and ES deciles
Explanatory variables	R&D information leakage (*Spillover*)		The larger the Spillover, the greater the likelihood of R&D information leakage
	Intellectual Property Protection Index (*IPR*)		The larger the IPR, the higher the level of IP protection
	Dummy variable (*IPR_dum*)		IPR greater than the median is taken as 1, otherwise it is taken as 0
Control variables	Corporate Finance Special (*Fin*)	Return on Total Assets (*Roa*)	Net income / Total assets at year-end
		Financial Leverage (*Lev*)	Liabilities / Assets
		Growth (*Growth*)	Total assets growth rate
	Corporate Governance Special (*Gov*)	Whether two jobs in one (*Dual*)	Whether the general manager and the chairman are one person, 1 means yes, 0 means no
		Independent Director Ratio (*Dir*)	Number of independent directors / Total number of directors
	Company Characteristics (*Cha*)	Size (*Size*)	Natural logarithm of total assets
		Industry concentration (*HHI*)	Herfindahl index, the larger the index, the more concentrated the industry
		Company Zone (*Zone*)	Companies in the East1; Central2; West3
	Industry (*Ind*)		Industry dummy variables

Table 2
Descriptive statistical analysis.

	N	Mean	Median	Std	Min	Max
EA	4398	0.095	0.057	0.093	0.003	0.416
ES	4398	3.137	1.946	3.263	0.315	14.723
OAIT	4398	5.5028	5.5	2.0952	1	10
Spillover	4398	−18.93	−16.52	13,47	−46.25	0.873
IPR	4398	22.75	13.16	18.35	1.23	52.69
Roa	4398	0.073	0.052	0.063	−0.117	0.183
Lev	4398	0.429	0.417	0.239	0.057	0.913
Growth	4398	0.182	0.116	0.275	−0.193	1.327
Dual	4398	0.289	0	0.457	0	1
Dir	4398	0.396	0.327	0.063	0.195	0.673
Size	4398	21.682	21.471	1.153	19.756	24.839
HHI	4398	0.057	0.063	0.029	0.036	0.084
Zone	4398	1.527	1	0.836	1	3

indicating that most of the listed companies in China are separated into two positions.

4.2. Main results

The regression analysis with *EA* as the dependent variable is shown in Table 3. Eq. (1) in Table 3 indicates a significant positive correlation between *Spillover* and *EA* in the total sample, indicating that the greater the threat of information leakage, the lower the transparency. Table 3, Eq. (2) uses a sample where R&D is equal to zero, and the results show that the positive correlation between *Spillover* and *EA* is insignificant. In Eq. (3) of Table 3, the sample with R&D greater than zero, *Spillover* is significantly and positively correlated with *EA*, indicating that the greater the R&D expenditure, the stronger the incentive for management to reduce the

Table 3
EA is the regression result of the dependent variable.

	(1) Total sample	(2) R&D = 0	(3) R&D > 0	(4) Total sample	(5) R&D = 0	(6) R&D > 0
Cons	0.237***	0.452***	0.169***	0.273***	0.469***	0.214***
	(7.26)	(3.93)	(7.32)	(6.29)	(4.75)	(5.39)
Spillover	0.004***	0.003	0.012***	0.015***	0.017	0.019***
	(3.63)	(0.27)	(3.94)	(4.36)	(0.57)	(4.13)
IPR	−0.032***	−0.015	−0.027***			
	(−5.76)	(−1.34)	(−4.73)			
IPR_dum				−0.217***	−0.318	−0.349***
				(−5.47)	(−1.36)	(−3.87)
Spill_ipr				−0.012*	−0.023	−0.016
				(−1.79)	(−0.21)	(−1.16)
Roa	−0.015	0.096	0.013	−0.027	0.121	0.027
	(−0.23)	(1.35)	(0.07)	(−0.36)	(1.17)	(0.16)
Lev	−0.027***	−0.013	−0.024***	−0.029***	−0.018	−0.037***
	(−3.59	(−1.03)	(−3.65)	(−3.74)	(−1.05)	(−3.97)
Growth	0.032	0.021	0.014	0.024	0.015	0.027
	(0.73)	(0.64)	(0.75)	(0.83)	(0.12)	(0.65)
Dual	0.035	0.029	0.016	0.037	0.025	0.017
	(0.83)	(1.07)	(0.74)	(0.95)	(1.26)	(1.19)
Dir	0.053	0.086	−0.027	0.019	0.074	−0.025
	(0.26)	(0.37)	(−0.45)	(0.36)	(0.87)	(−0.75)
Size	−0.025***	−0.032***	−0.013***	−0.026***	−0.034***	−0.023***
	(−7.27)	(−4.53)	(−4.69)	(−7.39)	(−4.56)	(−4.73)
HHI	0.367	1.153	0.367	0.359	1.137	0.368
	(0.83)	(0.69)	(0.73)	(0.83)	(0.59)	(0.73)
Zone	−0.039**	−0.083	−0.046*	−0.039**	−0.023	−0.037
	(−3.75)	(−1.05)	(−1.82)	(−3.73)	(−1.05)	(−1.43)
Ind	Yes	Yes	Yes	Yes	Yes	Yes
N	4398	635	3763	4398	635	3763
R^2	0.316	0.309	0.318	0.373	0.364	0.329
F	30.453	31.542	32.783	32.765	32.747	36.946
VIF	1.58	1.89	1.56	1.81	2.06	1.81

t statistics in parentheses.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

transparency of accounting information in order to protect R&D information, validating hypothesis H1 of this paper.

IPR is significantly negatively related to *EA* in both the total sample and the sample with R&D > 0, indicating that regions with high levels of IPR protection have more transparent accounting information. To further test the effect of IPR protection on the relationship between information leakage and transparency, this paper adds a dummy variable for the IPR protection index (*IPR_dum*) and a cross term for R&D information leakage (*Spillover*) (*Spill_ipr*) to the regression model. Eq. (4) in Table 3 shows that both *IPR_dum* and *Spill_ipr* are significantly negatively related to *EA* in the total sample, indicating that higher levels of IPR protection are associated with more transparent accounting information; at the same time, the IPR protection index weakens the positive relationship between information leakage and Earnings aggressiveness. However, Eq. (5) shows that in the sample where R&D is equal to zero, the effect of the IPR protection index in weakening the positive relationship between information leakage and Earnings aggressiveness is insignificant. This regression result suggests that in regions with high levels of IP protection, proprietary information is more protected from outside parties. Management's incentive to reduce information transparency to avoid information leakage is weaker, and the larger the R&D, the more pronounced this phenomenon is, confirming hypothesis H2.

The regression analysis with *ES* as the dependent variable is shown in Table 4. In the total sample (Table 3 Eq. (1)), *Spillover* has no significant correlation with *ES*. However, in the sample with R&D > 0, the two showed a significant positive correlation, with the greater the likelihood of R&D information leakage, the smoother the Earnings, and the less transparent the accounting information, still validating hypothesis H1. The regression results after adding the IPR protection index dummy variable (*IPR_dum*) with the R&D information leakage (*Spillover*) cross-product term showed that the cross-product term (*Spill_ ipr*) is negatively related to Earnings smoothing, both in the total sample, in the R&D greater than zero samples and the R&D equal to zero samples. However, unfortunately, this negative relationship is not significant.

The regression analysis with *OAIT* as the dependent variable is presented in Table 5. Eq. (1) of Table 5 shows that Spillover has a significant positive relationship with *OAIT* in the total sample, also in the sample with R&D > 0 (Eq. (3) of Table 5), but in the sample with R&D = 0 (Eq. (2) of Table 5), Spillover does not show a significant relationship with *OAIT*. This is consistent with the regression results for Earnings aggressiveness (*EA*) as an explanatory variable, indicating that the greater the likelihood of R&D information leakage, the lower the transparency of accounting information, and this relationship is more pronounced for companies with R&D expenditure, more significant than zero than for companies with R&D expenditure equal to zero, validating hypothesis H1.

Table 4
ES is the regression result of the dependent variable.

	(1) Total sample	(2) R&D = 0	(3) R&D > 0	(4) Total sample	(5) R&D = 0	(6) R&D > 0
Cons	−1.863	−1.0e+01***	−0.225	−1.767	−1.0e+01***	−0.123
	(−1.52)	(−2.97)	(−0.23)	(−1.41)	(−2.89)	(−0.08)
Spillover	0.073	−0.026	0.029*	0.083	−0.029	0.036*
	(1.22)	(−1.09)	(1.83)	(1.27)	(−0.93)	(1.85)
IPR	0.001	0.017	0.036			
	(0.95)	(1.42)	(0.73)			
IPR_dum				0.036	0.273	−0.045
				(0.18)	(0.58)	(−0.18)
Spill_ipr				−0.031	−0.029	−0.033
				(−0.47)	(−0.59)	(−0.67)
Roa	−0.472	0.463	−1.127	−0.536	0.639	−1.217
	(−0.57)	(0.26)	(−0.93)	(−0.69)	(0.37)	(−0.83)
Lev	−0.043*	−0.059	−0.042*	−0.037*	−0.076	−0.043*
	(−1.76)	(−1.09)	(−1.75)	(−1.79)	(−1.04)	(−1.73)
Growth	−0.072	−0.065	−0.049	−0.083	−0.057	−0.036
	(−0.93)	(−1.27)	(−0.46)	(−0.88)	(−1.29)	(−0.53)
Dual	0.067	0.603*	−0.037	0.065	0.525*	−0.037
	(0.46)	(1.73)	(−0.33)	(0.53)	(1.72)	(−0.20)
Dir	−0.069	−0.612	0.134	−0.073	−0.618	0.115
	(−0.16)	(−0.39)	(0.16)	(−0.13)	(−0.22)	(0.12)
Size	0.237***	0.565***	0.1427***	0.359***	0.546***	0.142***
	(3.95)	(4.13)	(2.86)	(4.73)	(4.65)	(2.84)
HHI	3.162	6.653	5.764	4.395	7.546	6.294
	(0.46)	(0.47)	(0.52)	(0.63)	(0.47)	(0.53)
Zone	0.081	0.125	0.084	0.069	0.027	0.085
	(0.76)	(0.35)	(1.24)	(0.74)	(0.42)	(0.59)
Ind	Yes	Yes	Yes	Yes	Yes	Yes
N	4398	635	3763	4398	635	3763
R^2	0.273	0.329	0.316	0.257	0.293	0.316
F	31.661	32.123	32.218	33.449	32.947	32.257
VIF	1.58	1.89	1.56	1.81	2.07	1.81

t statistics in parentheses.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table 5
OAIT is the regression result of the dependent variable.

	(1) Total sample	(3) R&D = 0	(2) R&D > 0	(4) Total sample	(5) R&D = 0	(6) R&D > 0
Cons	3.382***	−1.836	5.175***	4.219***	−1.375	5.275***
	(5.83)	(−0.86)	(4.32)	(6.73)	(−0.63)	(5.63)
Spillover	0.013**	−0.017	0.023***	0.027***	0.025	0.0139***
	(2.43)	(−0.39)	(2.97)	(3.18)	(0.35)	(3.47)
IPR	−0.025	0.027*	−0.015			
	(−0.69)	(1.75)	(−1.31)			
IPR_dum				−0.273*	−0.065	−0.294*
				(−1.73)	(−0.36)	(−1.92)
Spill_ipr				−0.017	−0.029	−0.016*
				(−1.27)	(−1.23)	(−1.65)
Roa	0.713	0.703	0.735	0.369	1.035	0.543
	(1.32)	(0.66)	(1.01)	(1.30)	(0.70)	(0.87)
Lev	−0.057***	−0.069	−0.032***	−0.063***	−0.072	−0.089**
	(−3.75)	(−1.01)	(−3.89)	(−3.69)	(−1.07)	(−2.26)
Growth	−0.031	−0.029	−0.017	−0.013	−0.035	−0.017
	(−0.53)	(−1.26)	(−0.39)	(−0.57)	(−1.36)	(−0.49)
Dual	0.172**	0.239	0.185**	0.176**	0.239	0.184**
	(2.15)	(0.75)	(2.16)	(2.19)	(0.75)	(2.03)
Dir	0.421	0.832	0.263	0.315	0.843	0.246
	(0.56)	(0.75)	(0.42)	(0.62)	(0.42)	(0.64)
Size	0.025	0.232***	−0.037	0.082	0.262***	−0.043
	(0.36)	(3.71)	(−0.93)	(0.26)	(3.58)	(−0.72)
HHI	7.735	8.257	9.227	8.535	7.956	8.136
	(0.87)	(0.74)	(1.14)	(1.15)	(0.96)	(1.15)
Zone	−0.351	0.245	−0.237	−0.258	−0.422	−0.187
	(−0.58)	(0.37)	(−0.32)	(−0.57)	(−0.25)	(−0.23)
Ind	Yes	Yes	Yes	Yes	Yes	Yes
N	4398	635	3763	4398	635	3763
R^2	0.393	0.317	0.339	0.341	0.309	0.346
F	27.623	22.276	27.417	27.375	32.112	37.214
VIF	1.58	1.89	1.56	1.81	2.06	1.81

t statistics in parentheses.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table 5, Eq. (1) and Table 5, Eq. (3) show that IPR is negatively, but statistically insignificantly, related to OAIT in the total sample and the sample with R&D > 0. Table 5 Eq. (4) shows that *IPR_dum* is significantly and negatively correlated with *OAIT*, indicating that the higher the level of IPR protection, the more transparent the accounting information. Further, equation (6) in Table 5 demonstrates that Spill_ipr is significantly negatively correlated with *OAIT* in the sample with R&D > 0. This suggests that the IPR protection index weakens the positive relationship between Spillover and *OAIT* and that the higher the level of IPR protection, the weaker the incentive for company management to reduce the transparency of accounting information to protect proprietary information, testing hypothesis H2. Consistent with the regression results for Earnings aggressiveness (*EA*) as an explanatory variable, the effect of IPR in weakening the positive relationship between Spillover and *OAIT* is not reflected in the sample with R&D = 0 (see Eq. (5) in Table 5).

4.3. Robustness tests

In the empirical tests, the *IPR* protection index used is the data for 2020 from the 2021 Marketization Process Report by Fan et al., (2021). This has the advantage of ensuring the authority and accuracy of the data source, but the IPR protection index for each region has remained unchanged during the study period. In this paper, following Khan et al., (2022), the current year's level of IPR protection is replaced by the average of the previous four years of the IPR protection index, denoted as *IPR1*. The regression analysis in Table 6 using *IPR1* with the previous explanatory variables shows that the regression results are consistent with the previous findings, indicating that the conclusions of this paper are robust.

5. Conclusion

This paper examines the relationship between proprietary information leakage, the level of intellectual property protection, and the transparency of accounting information. By selecting data from A-share-listed manufacturing companies from 2019 to 2021 as the subject of the study, the following conclusions are drawn. The main conclusions of this paper are as follows:

First, the more likely the R&D information leakage is, the less transparent the accounting information is. A firm's competitors may obtain proprietary information through publicly disclosed accounting information, and the firm's interests may be damaged as a result.

Table 6
Robustness tests.

	(1) EA	(2) EA	(3) ES	(4) ES	(5) OAIT	(6) OAIT
Cons	0.276***	0.236***	−1.721	−1.636	4.754***	4.816***
	(8.28)	(8.35)	(−1.36)	(−1.32)	(5.73)	(5.59)
Spillover	0.013***	0.021***	0.012	0.017	0.018**	0.0124**
	(3.93)	(3.76)	(1.12)	(1.12)	(2.45)	(2.53)
IPR1	−0.036***		0.027		−0.018*	
	(−5.69)		(0.43)		(−1.67)	
IPR1_dum		−0.018***		0.027		−0.139
		(−3.75)		(0.63)		(−1.02)
Spill_ipr1		−0.010		−0.021		−0.031
		(−0.61)		(−0.45)		(−0.63)
Roa	−0.0301	−0.034	−0.416	−0.407	0.812	0.832
	(−0.12)	(−0.18)	(−0.48)	(−0.50)	(1.38)	(1.26)
Lev	−0.037***	−0.017***	−0.025*	−0.035*	−0.017***	−0.035***
	(−3.67)	(−3.49)	(−1.73)	(−1.72)	(−3.63)	(−3.57)
Growth	0.012	0.032	−0.073	−0.053	−0.032	−0.017
	(0.61)	(0.73)	(−0.82)	(−0.67)	(−0.39)	(−0.76)
Dual	0.012	0.034	0.077	0.056	0.145**	0.134**
	(0.69)	(0.27)	(0.36)	(0.52)	(2.03)	(2.18)
Dir	0.015	0.023	−0.052	−0.073	0.346	0.365
	(0.27)	(0.42)	(−0.19)	(−0.12)	(0.54)	(0.77)
Size	−0.075***	−0.066***	0.232***	0.234***	0.079	0.065
	(−7.52)	(−7.16)	(4.35)	(4.28)	(0.27)	(0.32)
HHI	0.316	0.327	5.863	5.429	11.026	10.573
	(1.15)	(0.86)	(0.31)	(0.33)	(1.05)	(1.02)
Zone	−0.018***	−0.031**	0.045	0.075	−0.078	−0.069
	(−3.93)	(−1.87)	(0.38)	(0.71)	(−1.12)	(−0.74)
Ind	Yes	Yes	Yes	Yes	Yes	Yes
N	4398	4398	4398	4398	4398	4398
R^2	0.342	0.340	0.392	0.393	0.399	0.395
F	30.871	28.802	33.640	3.485	27.742	27.263
VIF	1.59	1.81	1.59	1.81	1.59	1.81

t statistics in parentheses.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

In order to protect proprietary information, management may choose to disclose less information about the firm's attributes or smoother Earningses, which reduces the transparency of accounting information.

Secondly, the level of intellectual property protection is an important influencing factor in disclosing a company's accounting information. Protecting proprietary information is essential for companies with significant R&D expenditures, as a breach could generate significant losses. Suppose the level of external protection is low. In that case, the company's management will seek alternative forms of protection, such as disclosing more obscure accounting information and reducing the likelihood that competitors will gain access to the company's proprietary information through publicly disclosed accounting information. Conversely, suppose the level of protection of proprietary information is high and external protection against disclosure of proprietary information is vital. In that case, companies will disclose accounting information with less concern about theft of proprietary information, and the transparency of accounting information will be higher.

Data availability

Data will be made available on request.

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