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Property rights, R&D spillovers, and corporate accounting transparency in China ☆

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We explore how property rights protections across different regions in China affect the flow of proprietary information and managers' incentives to disclose details of financial and operating performance. Our focus on research and development spillovers as a proxy for information leakages to competitors allows an examination of whether or not opacity (low transparency) is employed as a mechanism to attenuate such leakages. We find that when the threat of proprietary information leakage is high, information reported by firms is opaque. This relation appears in regions suffering from weak intellectual property rights protections, but not in those with stronger property rights protections. After taking into account the incentive to protect sensitive information, we also document that firm value is no longer related to accounting transparency. Our focus on accounting opacity to protect proprietary information differs from the agency cost explanation of most prior work. Thus we provide evidence of a cost of enhanced disclosure along with new insights on specific channels through which institutional factors influence the costs and benefits of firm disclosure policies.

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1. Introduction

A growing body of research suggests that corporate decisions and policies are largely influenced by the formal institutions under which companies operate. Cross-country variation in the attributes of firm accounting numbers and information disclosures can be explained by institutional characteristics. That is, the institutional environment in which firms operate affects the reporting incentives of managers and the demand for reporting quality by investors, regulators, and other users of financial information (Ball et al., 2000).[3] Prior studies typically focus on the relation between features of the institutional environment and accounting from an agency cost perspective, specifically agency problems between investors and managers (e.g., Ball et al., 2003; Bushman and Piotroski, 2006; DeFond et al., 2007; Leuz et al., 2003). We examine an important yet understudied aspect of the institutional environment: the potential leakage of proprietary information to competitors. Prior research shows that weak property rights protections adversely affect a firm's ability to fully capture the benefits of its investments. As a result, managers have incentives to avoid disclosing financial or operating information of a proprietary nature, since it may convey an advantage to the firm's competitors.

Most of the literature focuses on the potential benefits of transparency, such as lower cost of capital and higher stock liquidity (Bhattacharya et al., 2003) and greater analyst following and institutional holdings (Healy et al., 1999). Our analysis is unique in that it focuses on potential costs of transparency resulting from competitors learning about a firm's innovations. We suggest that a different aspect of the institutional environment affects accounting numbers and information disclosures: the potentially harmful leakage of propriety information to competitors in environments with weak property rights protections.

Central to our analysis is an explicit consideration of how property rights protections are associated with the nature of accounting disclosures. We investigate whether or not the transparency of accounting numbers differs depending on the nature of institutions that affect the leakage of proprietary information. Consistent with Jin and Myers (2006), we define transparency (opacity) as disclosing more (less) firm-specific information about the firm's underlying economic performance to the public.[4] Fan and Wong (2002) and Leuz and Oberholzer-Gee (2006) argue that protecting proprietary information is an important explanation for limited disclosure and low earnings informativeness in emerging markets. Complementing these arguments, we contend that opaque earnings and limited firm-specific disclosures can be used strategically by management to restrict the leakage of proprietary information. This in turn limits the ability of competitors to learn about the firm's operations and performance, thus protecting the firm's intellectual property and preventing competitors from free-riding on the firm's investment activities.

Focusing on research and development (R&D) spillovers as a proxy for information leakage to competitors, we investigate whether or not accounting opacity (low transparency) is employed as a mechanism to attenuate such leakages. Jaffe (1996) defines R&D spillovers as the idea that some of the economic benefits of R&D activities accrue to economic agents other than those that undertake the research. Of note, when property rights protections are weak, spillovers are likely uncompensated. That is, through imitation or theft, competitors can potentially benefit at the expense of firms that innovate.

Prior studies of institutional effects on accounting policy choice typically employ cross-country data and demonstrate that accounting quality and information disclosure are determined by the complex interplay of many institutional factors, including accounting standards and their enforcement, tax regimes, legal systems, market forces, and political pressures. In contrast, we focus on companies in one country, China, where firms face the same accounting standards and similar tax regimes but are subject to different levels of local intellectual property rights (IPR) protections. This single-country focus allows us to concentrate on a specific dimension of the institutional environment—IPR protections—while holding general institutional

[3] See also Alford et al. (1993), Ali and Hwang (2000), Ball et al. (2003), Hung (2001), Leuz et al. (2003), Bushman et al. (2004), Bushman and Piotroski (2006), and DeFond et al. (2007).

[4] Several concepts of accounting transparency exist. For example, Jin and Myers (2006) define more opaque firms as those with greater hidden firm-specific information. Bushman et al. (2004) define corporate transparency as the availability of firm-specific information to those outside the firm. Bhattacharya et al. (2003) define earnings opacity as the extent to which the reported earnings of firms fail to provide information about the distribution of the true, but unobservable, economic earnings.

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factors constant. At the same time, evidence about the influence of legal protections on disclosure is mainly from developed markets. For example, Guo et al. (2004) report a positive association between product-related disclosures in the prospectuses of biotech initial public offerings and the presence of product patents in the US. However, it is unclear whether the results of such studies can be generalized to emerging markets. In this regard, our paper contributes to a better understanding of information disclosure behavior in emerging markets where legal protections for property rights are relatively poor.

We find that firms in regions within China where there are greater R&D spillovers have lower transparency than firms in regions with smaller R&D spillovers. We also explore how IPR protections across different geographic regions affect the flow of proprietary information, and thus managers' incentives to disclose details of financial and operational performance. We find that the negative association between transparency and R&D spillovers is attenuated in regions with stronger IPR protections. When separating the sample by levels of regional IPR protections, we find a positive relation between transparency and R&D spillovers in regions with strong protections. That is, when IPR protections are strong, firms do not use opacity (low transparency) to prevent R&D spillovers. This suggests that the benefits of corporate transparency offset the potential losses due to R&D spillovers in highly innovative regions. Alternatively, it is possible that property rights protections in such regions alleviative the need to obfuscate corporate disclosures.

Finally, we examine the association between transparency and firm value, controlling for the effects of spillovers on firm transparency. Consistent with prior work, we initially find a positive association between firm value and transparency. However, this relation disappears once we endogenize transparency in a two-stage instrumental variables regression. These results suggest that firm accounting policies are endogenously determined by the tradeoff between the benefits associated with reductions in the firm's cost of capital resulting from enhanced disclosure and the costs associated with revealing proprietary information.

Our study is closely related to several prior papers on the role of competition in accounting disclosure. Several theoretical papers suggest that firms with superior knowledge choose to limit the disclosure of information when there are competitive threats (Bhattacharya and Chiesa, 1995; Verrecchia, 1983; Yosha, 1995). Empirical evidence in developed markets, primarily the US, supports this view. Hayes and Lundholm (1996) and Harris (1998) report that firms' segment disclosure policies are related to the level of industry competition. Cohen (2008) finds that higher proprietary costs (measured using capital intensity, product market competition, and growth opportunities) are associated with lower-quality financial information. Our paper complements this work in that it provides the first evidence from emerging markets in which the potential for expropriation of proprietary information poses critical challenges to firm investment and accounting reporting policies.

Our paper is also related to several cross-country studies that examine how proprietary information affects transparency. Bushman et al. (2004) examine the connection between corporate transparency and patent protection. They argue that patent protection reduces firms' proprietary costs of revealing profitable opportunities to competitors and document a positive relation between corporate transparency and the strength of patent protection. From an agency cost perspective, Leuz et al. (2003) assume that insiders use earnings management to conceal firm performance from outsiders, thus protecting their private benefits of control. They find that earnings management decreases in investor protection. Of note, prior studies often interpret the relationship between institutional factors and accounting from an agency cost perspective. We suggest that a different aspect of the institutional environment, the potentially harmful leakage of propriety information to competitors due to weak property rights protections, also influences information disclosures and accounting numbers.

Our paper also adds to the corporate governance literature. Disclosure is usually considered an important element of corporate governance in that greater disclosure lowers information asymmetry (Verrecchia 2001). For example, Mitton (2002) finds that firms with higher disclosure quality have better stock price performance during the East Asian financial crisis of 1997–1998, arguably because high-quality disclosure is a mechanism to protect minority shareholders from expropriation by controlling shareholders. Our study complements this literature by showing that opaque disclosures may be used as a governance mechanism to protect proprietary information from competitors when property rights protections are weak.

The remainder of the paper is organized as follows. Section 2 develops our hypotheses and presents background on the connections between R&D spillovers, the leakage of proprietary information, IPR

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protections, and how these translate into accounting transparency. Data and summary statistics are presented in Section 3. Section 4 presents the empirical results and Section 5 concludes the paper.

2. Hypothesis development

2.1. R&D spillovers and transparency

Examples of spillovers include purchasers of better or cheaper products, competing firms that copy a successful innovation, and firms whose own research benefits from observation of the outcomes of others' research efforts (Jaffe, 1996). Shapiro (1985) highlights three basic channels through which technology spillovers take place: patent licensing, technology transfer from multinational corporations to local subsidiaries (or joint ventures), and imitation. Licensing and technology transfer are voluntary forms of dissemination that allow inventors to enjoy at least some of the gains from trade resulting from the distribution of superior technology. Imitation, on the other hand, is a form of diffusion over which the inventor has little control.

With regard to imitation, survey evidence indicates that firms learn about rivals' R&D activities before new products are introduced, suggesting that R&D information spillovers typically involve the leakage of proprietary information (e.g., Cohen et al., 2002; Mansfield, 1985).[5] However, competitors also learn from public information contained in, for example, finished products, patent licensing, and other forms of technical transfer. In an attempt to discern the effects of proprietary information leakages, and thus exclude public information, we emphasize contemporaneous R&D expenditures in the spillover pool as a measure of aggregate R&D activity in an industry. Our rationale is that current R&D expenditures have not been incorporated into finished products or patents and are less likely to be discovered via public channels. At the same time, we recognize that there may be leakage from prior R&D expenditures. However, in an unreported additional analysis, we find that our results are robust to specifications that include a time-series dimension when estimating the spillover pool.[6]

Fan et al. (2011) find that R&D spillovers are larger in Chinese regions with weaker property rights protections and smaller in those with stronger property rights protections. Such spillovers, or leakages of proprietary information are, in turn, negatively associated with firms' R&D expenditures. The authors' findings suggest that spillovers in China tend to be uncompensated (i.e., take the form of imitation or theft) because property rights protections are weak. One can then expect R&D-intensive firms to avoid operating in regions where intellectual property protections are low and uncompensated spillovers are high. However, many firms owned and controlled by local government are unlikely to move, particularly given their role in promoting local employment and economic development. Moreover, it is costly for privately owned companies to relocate, particularly when the owner's personal business network and political connections are largely local. The fact that we observe very few firms in the database moving between regions further suggests that relocation is difficult. Thus, when managers operate in an environment with weak property rights protections, they have incentives to prevent spillovers to capture the gains from their investments. Accordingly, we investigate whether or not, and how, firm information disclosures are affected by managers' incentives to prevent spillovers when proprietary information is at risk by way of R&D spillovers.

Admati and Pfleiderer (2000) show theoretically that information disclosure is costly and the cost increases with the precision of the information disclosed. For example, the disclosure of current R&D expenditures has the potential to provide insights to rivals about the development of new projects. Previous studies show that competitors learn about product development decisions within 12 to 18 months after they are made (Cohen et al., 2002; Mansfield, 1985). The short time period suggests that current R&D expenditures are a potentially important channel through which rivals can learn about new projects. Throughout our sample period firms were required to expense R&D but not report it as a separate

[5] Moreover, several theory papers model information related to R&D activities as being proprietary, e.g., Bhattacharya and Ritter (1983), and Yosha (1995).

[6] These results are available on request.

line item.[7] Other accounting information can also provide insights to competitors on firm investment activities and performance. For example, increased profitability can convey information to the marketplace, including competitors, about the viability of ongoing projects.

Similarly, large investments in R&D reduce current earnings and may prove informative to competitors. With regard to earnings, even if R&D were constant, earnings will increase once the R&D projects start to pay off. Thus earnings smoothing makes it difficult for competitors to track both the amount of new R&D investment and the profitability of projects in place. As a result, managed or manipulated earnings can reduce the precision of information that is disclosed and thus reduce the flow of information to potential imitators. Moreover, in conjunction with other channels of R&D information spillovers (such as employees leaving the firm or dealings with other companies), firms' accounting disclosures can exacerbate the leakage of R&D-related information (Frischmann and Lemley, 2007). If managers adopt a policy of opacity (low transparency), one would expect fewer firm-specific disclosures and smoothed earnings. This, in turn, has the potential to limit competitors' ability to learn about a firm's innovations through publicly disclosed information.

We hypothesize that firms operating in environments with more R&D spillovers are more likely to use accounting opacity (low transparency) to avoid information leakage.

H1. *Firms in environments with more R&D spillovers have lower transparency than firms in environments with fewer R&D spillovers.*

2.2. The influence of IPR

The disclosure of proprietary information can adversely affect firm value if competitors use that knowledge to the detriment of the disclosing firm. At the same time, such disclosures can be value enhancing if they reduce information asymmetry and thus lower the cost of capital (Guo et al., 2004). Therefore, managers will disclose information about innovative activities when the benefits are expected to outweigh the associated costs (Verrecchia, 1983). However, the costs of disclosure can be larger in some of China's regions relative to others. The Special 301 Report, prepared annually by the Office of the US Trade Representative, examines the adequacy and effectiveness of IPR protections in some 90 countries. The report recognizes that enforcement of intellectual property rights is inconsistent across different regions within China. Similarly, the National Economic Research Institute (NERI) Index of Marketization (IM) of China's provinces, conducted by Fan and Wang (2007), shows that the institutional environment varies dramatically across China. Exploring this variation, Fan et al. (2011) document that weak regional property rights protections are associated with high R&D spillovers. As highlighted above, R&D spillovers increase the cost of proprietary information leakage. Thus, we expect that weak IPR protections provide incentives to managers in industries with more R&D spillovers to be less transparent in their accounting disclosures. Conversely, when property rights protections are stronger, the costs of R&D spillovers are lower and thus the need to obfuscate financial performance is attenuated.

H2. *Strong IPR protections attenuate the negative association between transparency and R&D spillovers.*

3. Data and descriptive statistics

This section describes our sampling procedure and the data and provides basic univariate statistics for key variables.

[7] Prior to 2001, publicly traded firms in China could expense or capitalize R&D; however the accounting treatment of R&D has changed over time. During 2001, and throughout our sample, firms were required to expense R&D investment according to the Accounting Standard for Business Enterprises—Intangible Assets. More recently, in Accounting Standard for Business Enterprises No. 6—Intangible Assets promulgated in 2006, costs during the research stage should be expensed, while costs during the development stage can be capitalized only when they meet specific criteria. Despite the changes, publicly traded firms in China were not required to disclose a separate line item for R&D expenditures. Indeed, Xue and Wang (2001) report no R&D disclosures between 1995 and 1999, but Liang and Xiong (2005) find that between 2001 and 2003 some 15% of listed firms disclosed R&D expenditures. Disclosing firms reported R&D in one of four accounting classifications: accrued expenses (5.7%), long-term deferred expenses (2.3%), management expenses (3.4%), and cash payments for other operating-related activities (88.6%). Of note, other than for R&D expenses reported under management expenses, it is difficult to ascertain the exact amount of R&D expenditures. For example, in accrued expenses R&D is usually reported as a proportion of sales or as an aggregate amount, not a line item number. Similarly, cash payments for other operating-related activities do not include depreciation, amortization, or other accruals related to R&D activities.

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3.1. Sample selection

To estimate R&D spillovers, firm-level R&D expenditure data are required. As discussed above, R&D expenditures are not reported in annual reports for most publicly traded firms on the China A-share market. Thus we collect firm R&D expenditure data from the annual census of Chinese industrial enterprises conducted by the National Bureau of Statistics of China (NBSC). These data are available for 2001, 2002, and 2005 to 2007. The census covers all state-owned industrial enterprises and non-state-owned industrial enterprises with sales above 5 million RMB (USD 731,936 based on the official exchange rate at the end of August 2009). The sample comprises 1,008,226 observations from 2001 to 2007, with 315,241 in 2007 alone.

We identify 733 publicly traded industrial firms on the A-share market whose R&D expenditure information is available from the NBSC. These companies account for approximately half of all publicly traded firms in China.[8] Given that we measure R&D spillovers on the basis of industry and location, we exclude 196 firms that changed industry or registration location during the sample period. This results in a sample of 537 firms. The time period is from 1998 through 2007.[9] Financial and stock price data are from the China Stock Market Accounting Research (CSMAR) database.[10]

3.2. Variable measurement

3.2.1. R&D spillovers

Prior evidence suggests that R&D spillovers are generally limited to firms operating in related industries in close geographical proximity (Jaffe et al., 1993; Keller, 2002; Marshall, 1920). As a result, we use the universe of firms for which financial and R&D data are available in the NBSC database and measure R&D spillovers conditioned on location and industry. Furthermore, we employ the widely used log-linear transformation of a Cobb–Douglas production function to measure R&D spillovers for each industry within each region (see, e.g., Aitken and Harrison, 1999; Coe and Helpman, 1995; Griliches, 1992; Javorcik, 2004):

$$\begin{aligned} LogSales_{ijt} = \alpha_0 + \alpha_1 LogRD_{it} + \alpha_2 LogRDpool_{jt} + \alpha_3 LogFixedassets_{it-1} \\ + \alpha_4 LogEmployment_{it-1} + \varepsilon \end{aligned} \tag{1}$$

For all renminbi-denominated variables, we deflate values by the industrial product factory price index for firm i for industry j for the corresponding year t.[11] The variable $LogSales_{ijt}$ is the natural logarithm of sales of firm i in industry j for the year in question and $LogRD_{it}$ is the natural logarithm of the R&D expenditures of firm i. We add one to R&D expenditures to ensure a positive value of R&D investment for those with zero R&D, although our results are qualitatively similar if we measure R&D spillovers using only observations with nonzero R&D expenditures.[12] As is common in the literature, the aggregation of R&D for all firms in the same industry (excluding the firm of interest) is referred to as the R&D spillover pool. The intuition is that the aggregate spending on R&D by other firms in the same industry (net of the firm's own spending) is indicative of the pool of R&D knowledge from which a particular firm could potentially learn. Thus, $LogRDpool_{jt}$ is the natural logarithm of the equal-weighted sum of R&D expenditures of firms in the same two-digit industry code j, excluding the R&D expenditures of firm i. Griliches (1979) and Raut (1995) measure the R&D pool with R&D lagged four periods as they argue that the effects of R&D investment persist for at most this long. However, our goal is to capture proprietary information contained in R&D spillovers, rather than the overall

[8] The number of publicly listed firms increased from 1112 in 2001 to 1527 in 2007.

[9] The data of cash flow from operations started being available in 1998 due to new disclosure requirements.

[10] We compare the sample firms with other publicly traded industrial firms for which R&D data are not available and find no systematic differences between the two groups in terms of size, profitability, and leverage.

[11] The price index is available from the NBSC website (www.stats.gov.cn).

[12] Approximately 89% of the sample report zero R&D expenditures. The percentage of observations reporting nonzero R&D expenditures also varies greatly among industries, from 40% in medicals and pharmaceuticals to 2% in piped water suppliers. Discussions with NBSC staff suggest that the large number of zero R&D values is not surprising and that 1) reporting this data is compulsory, 2) there is no obvious incentive not to report it, 3) most firms do not have R&D activity, and 4) many firms acquire technologies instead of investing in R&D. Further confidence that the zero R&D expenditures reported in our sample are not indicative of missing data is gained from the fact that our sample, covering all state-owned industrial firms and medium to large non-state-owned firms, represents almost 75% of total firm R&D investment according to the *China Statistics Yearbook*.

R&D spillovers. In an attempt to discern the effects of proprietary information leakages, and thus exclude public information, we emphasize contemporaneous R&D expenditures in the spillover pool as a measure of aggregate R&D activity in an industry. The variable $LogFixedAssets_{it-1}$ is the natural logarithm of fixed assets for firm i in year $t-1$, $LogEmployment_{it-1}$ is the natural logarithm of the number of employees for firm i in year $t-1$, and *LogFixedassets* and *LogEmployment* proxy for physical capital input and labor input, respectively.

We estimate Eq. (1) at the regional level. Therefore, α_2 reflects how the sales of a single firm in that region are related to the R&D expenditures of the industry as a whole (both within and outside the region). This is our estimate of *R&D Spillovers.* Consistent with prior research (e.g., Coe and Helpman, 1995; Raut, 1995), all available data are used to estimate spillovers, and thus we assume that spillovers are constant for an industry/region.[13] When there are fewer than 10 observations in an industry/region, they are omitted.

Our primary focus is on aggregate R&D investment within an industry across all regions, effectively placing equal weight on the R&D expenditures of all competitors. The rationale is that our focus is on how local IPR affect local firms' ability to learn from both local competitors and competitors outside the region. According to the Rules for the Implementation of the Patent Law of China (Rule No. 81), when a firm is indicted for patent infringement, the dispute should be handled by the administrative authority for patent affairs of the region in which the infringement took place or in which the firm is located. That is, local property rights protections can affect R&D spillovers between firms within the region and from firms outside the region as well. However, prior studies (e.g., Jaffe et al., 1993; Keller, 2002) find that benefits from spillovers decline with distance. Consistent with prior work, we recognize that proximity may be important. To examine this issue, we conduct robustness tests where we reduced the weight in the spillover pool calculation for R&D pools in distant regions in Section 4.4 and find that our main results persist.

Griliches (1979) and Raut (1995) measure the R&D spillover pool with R&D lagged 4 years as they argue that the effects of R&D investment persist for, at most, four periods. Our prior is to focus on contemporaneous R&D investment because knowledge generated by R&D investment in previous years is more likely to be derived from public channels, including finished products, patent licensing, and other forms of technical transfer. While this approach certainly captures the flow of information, it does not capture the leakage of proprietary information that we are trying to measure in this study. That is, as discussed in Section 2.1, our goal is to capture proprietary information contained in contemporaneous R&D spillovers. However, we recognize that there may be leakage associated with prior R&D, and thus in our robustness tests we include a time-series dimension and find qualitatively similar results. Based on the above discussion, in our main analyses we report results using contemporaneous R&D expenditures in the spillover pool.

3.2.2. Accounting transparency

We discuss our measures of accounting transparency below.

3.2.2.1. Stock price asynchronicity. Our main proxy for opacity (low transparency) is based on a measure of stock price synchronicity. Morck et al. (2000) find that stock prices move together more in emerging markets than in developed markets, suggesting that less firm-specific information is produced in emerging markets. Durnev et al. (2003) show that firms and industries with lower market model R^2 statistics exhibit higher associations between current returns and future earnings. This suggests that more information about future earnings is present in current stock returns, that is, there is more transparency. Jin and Myers (2006) document that high R^2 is positively correlated with several measures of opaqueness. The specific measure we use is based on Morck et al. (2000) and Chan and Hameed (2006). Using weekly return data, we estimate the following model for each sample firm for each year:

$$R_{it} = \beta_{io} + \beta_{i1} R_{mt} + \varepsilon_{it} \tag{2}$$

where R_{it} is the return of stock i at week t and R_{mt} is the market return during week t. The R^2 from the estimation of Eq. (2) for firm i in year t represents the proportion of the firm's return movement attributable

[13] The results are qualitatively similar when R&D spillovers are measured with data for 3 or 4 years.

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to market-wide changes. A higher R^2 indicates that less firm-specific information is incorporated into stock prices, which implies lower corporate transparency. To conform to the definition of transparency, we use the negative R^2 so that larger values of *Asyn* correspond to more transparent earnings:

$$Asyn = -R^2$$

3.2.2.2. Earnings smoothing. We contend that managers in environments with severe R&D spillovers will attempt to mask firm performance to prevent the outflow of proprietary information, thus impeding the spillover or leakage of R&D information to competitors. Thus, we also focus on other measures that may capture actions taken to attenuate the flow of information to competitors. Bhattacharya et al. (2003) argue that if accounting earnings are artificially smoothed, then they will not depict the true swings in underlying firm performance, thus reducing earnings transparency (increasing earnings opacity). Leuz et al. (2003) use earnings smoothness to examine how managers mask firm performance to acquire private benefits of control. Similarly, Burgstahler et al. (2006) use earnings smoothness to capture the extent to which firms use reporting discretion to make earnings less informative about underlying economic performance. Consistent with this view, Goel and Thakor (2003) argue that when a firm's earnings volatility is high, private information about the firm is more valuable and more investors become informed. Put somewhat differently, when earnings are smoothed (less volatile) they contain less private information.

We use three different proxies for earnings smoothing. First, we estimate the correlation between the change in accounting accruals (ΔAcc_{it}) and the change in cash flow from operations (ΔCFO_{it}). This is the most widely used variable measuring earnings smoothness (e.g., Bhattacharya et al., 2003; Francis et al., 2004; Leuz et al., 2003). Leuz et al. (2003) argue that managers may underreport strong performance to create reserves for the future. Alternatively, they may delay reporting costs to hide poor current performance. Thus, accounting accruals buffer cash flow shocks, which results in a negative correlation between changes in accruals and operating cash flows. The more negative the correlation, the lower the earnings transparency.

Our inputs are measured as follows:

$$\Delta Acc_{it} = (Acc_{it} - Acc_{it-1})/TA_{it-1}$$

$$\Delta CFO_{it} = (CFO_{it} - CFO_{it-1})/TA_{it-1}$$

where ΔAcc is the change in accruals, ΔCFO is the change in cash flow from operations, and TA is total assets. Following Bhattacharya et al. (2003), we define accruals as

$$Acc_{it} = \Delta CA_{it} - \Delta CL_{it} - \Delta Cash_{it} + \Delta STD_{it} - DEP_{it} + \Delta TP_{it}$$

where ΔCA is the change in current assets, ΔCL is the change in current liabilities, $\Delta Cash$ is the change in cash, ΔSTD is the change in the current portion of long-term debt, *DEP* is depreciation expenses, and ΔTP is the change in income tax payable.

Our other measures capture aspects of both cash- and accrual-based smoothing.[14] The second earnings smoothing proxy is the variability of net income measured as the standard deviation of changes in net income scaled by total assets:

$$\sigma(NI_t) = \sigma(\Delta(NI_t/TA_{it}))$$

where *NI* is net income and *TA* is total assets. Prior work (e.g., Dechow and Dichev, 2002; Francis et al., 2004) considers earnings variability as an instrument for smoothness. Similarly, Lang et al. (2006) argue that if firms smooth earnings, then the earnings variability should be lower and thus smaller values of earnings variability are consistent with increased opacity.[15]

[14] Jian and Wong (2010) report evidence of cash-based earnings management in emerging economies.

[15] Lang et al. (2006) also use the variance of the residuals from a regression of the change in annual net income scaled by total assets on a set of control variables.

The third proxy is earnings predictability. Francis et al. (2004) use several earnings-based measures to proxy for information risk, including earnings predictability, the ability of earnings to predict itself. The authors also argue that predictability is desirable because it makes earnings more value relevant. We argue that a higher ability of earnings to predict itself indicates higher earnings smoothing. Following Francis et al. (2004), predictability is measured as the square root of the error variance from the equation

$$X_{i,t} = \alpha_i + \beta_i X_{i,t-1} + \varepsilon_{i,t}$$

where X_{it} is defined as operating income deflated by total assets at the beginning of the year:

$$Error = \sqrt{\sigma^2(\hat{\varepsilon}_i)}.$$

A smaller value of this measure implies more predictable earnings, indicating greater earnings smoothing and less accounting transparency.

The earnings smoothing proxies for each firm are estimated over windows of at least 7 years. The three variables are constructed such that higher values are indicative of increased accounting transparency.

3.3. Intellectual property rights protections

Our measure of IPR protections is the Intellectual Property Rights Index (*IPR Index*), a sub-index of the NERI IM of Chinese provinces (Fan and Wang, 2007). The index is a simple average of 1) the number of patents applications divided by the number of science and technology personnel in a region (province) and 2) the number of patents approved divided by the number of science and technology personnel in a region (province). A higher index is indicative of stronger IPR protections (Wang et al., 2008). We use the time-series average of the 2001 to 2005 indices as our proxy for IPR.[16]

3.4. Descriptive statistics

Panel A of Table 1 contains descriptive statistics of the key variables (variable definitions are presented in the Appendix A). The IPR indices are measured at the provincial level. We use industry concentration measured using a Herfindahl index as a control variable. Other variables are measured at the firm level and are Winsorized at the top and bottom 1%.[17] Of the 537 firms, 97 report zero R&D expenditures for all years.

The correlations between the proxies for earnings smoothing are significantly positive. The Spearman correlation between $\sigma(NI_t)$ and *Error* is 0.864, while other correlations are not particularly high. The correlations between *IPR Index* and firm-level *Asyn* are positive and significant but not very high. The correlations between *IPR index* and other earnings smoothing measures (*Correlation*, $\sigma(NI_t)$, and *Error*) are not significant.

[16] We also use two other measures. The first is the Market Intermediaries and Legal Enforcement Index, one of the five sub-indices of the NERI IM. This sub-index provides a different focus, in that it proxies for the general legal environment for each province or province-level region. It is measured using a simple average of 1) the number of lawyers as a percentage of the population, 2) the number of certified public accountants as a percentage of the population, 3) the number of economic dispute cases accepted by the courts scaled by the gross domestic product, 4) the number of economic dispute cases resolved by the courts as a proportion of cases accepted, Intellectual Property Rights Index, and 5) the number of customer complaints solved as a percentage of customer complaints accepted by the Administration for Industry and Commerce. Again, a higher index is indicative of stronger IPR protections. The second is the transaction volume of technology transfers and exchange in a province (including licensing fees for patents, royalties, and paid use of other intellectual properties) divided by the provincial gross domestic product, as in Ang et al. (2009). In markets with strong property rights protections, knowledge transfers resulting from R&D activities typically occur through contractual means, particularly patents (Shapiro, 1985), but imitation and information leakage are more prevalent when property rights protections are weak (Helpman, 1993). Thus, larger compensated technology transfers are a proxy for stronger property rights protections. The regressions with these alternative measures produce qualitatively similar results. To conserve space, we only report the regression results with IPR; however, results with the two alternative measures are available upon request.

[17] The results are robust when the firm-level variables are Winsorized at 5% and 10%.

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Table 1
Descriptive statistics.

Panel A Descriptive statistics

Variable	Number	Mean	Median	Std	Min	Max
IPR Index	31	3.203	1.494	4.207	−0.112	16.710
Concentration	39	0.004	0.001	0.012	0.0001	0.072
$Asyn_{it}$	4455	−0.413	−0.411	0.187	−0.820	−0.013
$LogTA_{it}$	4455	21.129	21.047	0.930	19.040	24.040
$Salesgrowth_{it}$	4455	0.202	0.138	0.439	−0.716	2.581
$Subsidies_{it}$	4455	0.002	0.000	0.006	0.000	0.042
$Correlation_i$	400	−0.273	−0.341	0.445	−0.987	0.958
$\sigma(NI_t)_i$	417	0.093	0.048	0.171	0.005	1.375
$Error_i$	374	0.066	0.044	0.090	0.004	0.858
$Spillover\_IR_i$	537	0.390	0.356	0.249	−0.464	1.352
RD_i	537	0.011	0.003	0.020	0.000	0.113
$Financing_i$	537	0.399	0.000	0.490	0.000	1.000

Panel B Correlations between regional property rights protections and firm-level measures of transparency

Variable	*IPR Index*	$Asyn_i$	$Correlation_i$	$\sigma(NI_t)$	$Error_i$
IPR Index	1.000	0.110**	−0.026	0.023	−0.007
$Asyn_i$	0.110***	1.000	0.038	0.322***	0.274***
$Correlation_i$	0.000	0.018	1.000	0.205***	0.184***
$\sigma(NI_t)$	0.012	0.369***	0.150***	1.000	0.749***
$Error_i$	0.020	0.353***	0.153***	0.864***	1.000*

This table presents descriptive statistics for key variables. *IPR Index* is the Intellectual Property Rights Index at the provincial level and *Concentration* is the Herfindahl index of the industry. In Panel A, $Asyn_{it}$ is the negative R^2 statistic from the market model (Eq. (2)) of firm *i* in year *t*. In Panel B, $Asyn_i$ is the mean of $Asyn_{it}$ from 1998 through 2007 for each firm; $LogTA_{it}$, firm size, the natural logarithm of total assets; $LogAge_{it}$, is the natural logarithm of firm age; $Grossprofit_{it}$, measures profitability as revenue minus cost of goods sold divided by total assets; $Salesgrowth_{it}$, is a proxy for growth, measured by sales in year *t* minus sales in year $t-1$, divided by sales in year $t-1$; $Subsidies_{it}$ is subsidies from the government divided by total assets; *Correlation* is the correlation between the change in accruals and the change in cash from operations; $\sigma(NI_t)$ is the standard deviation of change in net income scaled by total assets; *Error* is the square root of the error variance from the autoregression equation of operating income; $Spillover\_IR_i$, is the level of R&D spillovers for the two-digit industry code in the region where firm *i* is located; RD_i is R&D expenditures divided by sales of firm *i*, averaged over 2001–2007 (R&D data in 2003 and 2004 are not available); and $Financing_i$ is a dummy variable that equals one if firm *i* had seasoned equity offerings between 1998 and 2008, and zero otherwise. In Panel B, the upper (lower) triangular shows the Pearson (Spearman) correlation coefficients.

*** Significance at the 0.001 level.
** Significance at the 0.01 level.
* Significance at the 0.1 level.

4. Empirical methodology and results

4.1. Main approach

In our main empirical approach we model the transparency proxies as a function of R&D spillovers. Since higher values for both *Asyn* and the earnings smoothing measures are indicative of increased accounting transparency, a significant negative association between measures of transparency and R&D spillovers supports the hypothesis that information disclosures are less transparent when R&D spillovers are severe. In Eq. (3.1), *Asyn* is the dependent variable, and in Eq. (3.2) the accounting transparency measures are the dependent variables. The independent variables employed in the two models are the same. Note that in modeling *Asyn* we have a time-series dimension, while for the transparency specification we do not. Recall that *Asyn* is measured yearly, so we have multiple annual observations of the dependent variable for each firm. However, the other earnings smoothness proxies are measured using a long window (at least 7 years) and thus there is only one observation of each of these dependent variables for each firm. There are similar differences in the time dimension between the independent variables of the two equations. The time-series average values of the independent variables in Eq. (3.1) are used in Eq. (3.2):

$$\begin{aligned} Asyn_{i,t,j,r} = {} & \alpha_0 + \alpha_1 Spillover\_IR_{j,r} + \alpha_2 RD_i + \alpha_3 LogTA_{i,t} + \alpha_4 Salesgrowth_{i,t} + \alpha_5 Financing_i \\ & + \alpha_6 Subsidies_{i,t} + \alpha_7 Concentration_{j,t} + Yeardummies + Industrydummies + \varepsilon \end{aligned} \tag{3.1}$$

$$\begin{aligned} Transparency_{i,j,r} = {} & \alpha_0 + \alpha_1 Spillover\_IR_{j,r} + \alpha_2 RD_i + \alpha_3 LogTA_i + \alpha_4 Salesgrowth_i \\ & + \alpha_5 Financing_i + \alpha_6 Subsidies_i + \alpha_7 Concentration_j + Industrydummies + \varepsilon \end{aligned} \tag{3.2}$$

where $Spillover\_IR_{jr}$ is the coefficient of *logR&Dpool* (α_2) from Eq. (1), estimated for industry *j* based on firm *i*'s two-digit Standard Industry Classification level and the region *r* where firm *i* is located. The variable *Asyn* is the negative R^2 statistic of the market model (Eq. (2)) measured yearly. Eq. (3.1) is estimated using panel data. The variable *Transparency* in Eq. (3.2) refers to the earnings smoothing measures (*Correlation*, $\sigma(NI)$, and *Error*), that are estimated for each firm over the sample period. The earnings smoothing measures for each firm are estimated over windows of at least 7 years.

We also include several control variables that prior studies suggest may affect transparency. Penman and Zhang (2002) find that expensing R&D is an important determinant of conservatism, thus we include *RD*, the time-series average of a firm's R&D expenditures divided by firm sales.[18] Dechow and Dichev (2002) find that the quality of accruals (the relation between accruals and cash flow realizations) is inversely associated with firm size. Large firms usually have superior information environments, and thus may have more firm-specific information incorporated in price (Collins and Kothari, 1989). However, Gul et al. (2010) find that large firms have less firm-specific information and their stock prices tend to move together with the market to a greater extent than those of small firms in China. To control for any of these effects we include *LogTA*, measured as the natural logarithm of total assets. Skinner and Sloan (2002) provide evidence that high-growth firms are more likely to be more aggressive in reporting earnings. To proxy for growth, we use *Salesgrowth*, measured by Sales in year t minus Sales in year $t-1$, divided by Sales in year $t-1$.[19] Firms raising funds from the market have incentives to lower their cost of capital by way of more transparent earnings (Francis et al., 2004). To capture this, we use *Financing* as an indicator variable equal to one if the firm had seasoned equity offerings between 1998 and 2008, and zero otherwise.[20] We include *Subsidies*, subsidies from the government divided by total assets, as an additional control variable. In China, government subsidies could be a source of R&D financing. Chen et al. (2009) find that firms are more likely to build political connections when local governments grant business subsidies. It has also been suggested that firms that have strong connections with the government are less willing to disclose transparently (Leuz and Oberholzer-Gee, 2006). Finally, Dye and Sridhar (1995) theoretically show that increasing competition increases disclosure, and Balakrishnan and Cohen (2011) find that product market competition constrains managers from misreporting accounting information. However, the literature also suggests that firms in competitive industries use opacity to protect proprietary information (Cohen, 2008; Fan and Wong, 2002; Hayes and Lundholm, 1996; Verrecchia, 1990). In China, Yu et al. (2012) report that the contagion effect of scandals is pronounced in highly competitive industries because firms in these industries tend to adopt unethical and/or illegal practices to improve profitability.[21]

[18] We did not use time-series R&D data in Eq. (3.1) because some firms have no R&D data in some years. Using time-series R&D data would reduce the number of observations greatly.

[19] Eq. (1) implies that *Salesgrowth* is endogenous to *RD*. The Pearson (Spearman) correlation between *Salesgrowth* and *RD* is 0.1 (0.07), significant at 0.02 (0.09), consistent with the endogeneity. The correlation is low, showing that *Salesgrowth* is a proxy for growth that is broader than the sales-growing effect from R&D investment.

[20] Our sample period is from 1998 to 2007. We also examine financing activities in 2008 because these can affect firm disclosures in previous years.

[21] Yu et al. (2012): "An astonishing case of distortion induced by high competition pressure is the 2008 Chinese milk scandal, in which melamine-tainted milk was found in products from 22 companies, including well known milk companies such as Mengniu and Yili. *The Wall Street Journal* (December 2008) reported that the tainting of milk was an open secret in China's milk industry, which is a highly competitive industry in China."

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These firms may have higher incentives to make less transparent disclosures to avoid public scrutiny. Notwithstanding the inconclusive evidence in the literature, we include *Concentration*, the Herfindahl index for the industry to which firm *i* belongs to measure industry concentration.

4.2. Asynchronicity and R&D spillovers

We first estimate Eq. (3.1) for *Asyn*, which is measured for each firm and each year. All independent variables, other than *Spillover_IR*, are also measured at the firm–year level. The panel data cover up to 10 years; thus standard errors may be correlated across firms and time periods. Following Petersen (2009), we employ robust standard errors with clustering by firm. We also include year and industry fixed effects.

The results are reported in Table 2. We first examine the association between asynchronicity and R&D spillovers. Column (1) of Table 2, labeled All, reports the results for the full sample; column (2), labeled R&D = 0, reports results for firms with zero R&D investment; and column (3), R&D > 0, focuses on the subsample of firms that have positive R&D investment. The negative coefficients of *Spillover_IR* in columns All and R&D > 0 indicate that firms in industries with higher R&D spillovers have lower values of *Asyn*. Recall that lower *Asyn* values correspond to lower transparency; thus the negative coefficient is consistent with H1, that firms in high-spillover environments obfuscate their financials. The disclosure policies of firms with zero R&D expenditures should be less affected by R&D spillovers, and the insignificant coefficient for *Spillover_IR* is consistent with this view. The significant negative coefficients for *LogTA* suggest that

Table 2
Asynchronicity and R&D spillovers.

	(1) All	(2) R&D = 0	(3) R&D > 0	(4)
Intercept	0.129	0.466	0.159	0.112
	(1.53)	(2.22)**	(1.27)	(1.32)
IPR Index				−0.001
				(−0.03)
$Spillover\_IR_{jr}$	−0.039	−0.052	−0.041	−0.027
	(−2.39)**	(−1.50)	(−2.14)**	(−1.40)
$Spillover\_IR_{jr} * IPR\ Index$				0.009
				(2.27)**
RD_i	−0.100		−0.120	−0.139
	(−0.58)		(−0.68)	(−0.81)
$LogTA_{it}$	−0.029	−0.048	−0.025	−0.031
	(−7.57)***	(−4.51)***	(−6.05)***	(−7.94)***
$Salesgrowth_{it}$	0.034	0.030	0.035	0.035
	(6.10)***	(2.88)**	(5.23)***	(6.36)***
$Financing_i$	−0.005	−0.018	−0.005	−0.002
	(−0.73)	(−1.06)	(−0.63)	(−0.33)
$Subsidies_{it}$	1.075	0.422	1.252	1.099
	(2.03)**	(0.38)	(2.11)**	(2.09)**
$Concentration_j$	33.517	54.405	−6.618	43.545
	(2.95)***	(8.80)***	(−0.42)	(3.45)***
Year dummies	Included	Included	Included	Included
Industry dummies	Included	Included	Included	Included
Obs.	4455	792	3663	4455
R^2	0.330	0.352	0.337	0.333*

This table presents the relation between asynchronicity and R&D spillovers. The dependent variable, $Asyn_{itjr}$, is the negative R^2 statistic of the market model (Eq. (2)) of firm *i* in year *t*; $Spillover\_IR_{jr}$ is the level of R&D spillovers for the two-digit industry code in the region firm *i* is located; *IPR Index* refers to the Intellectual Property Rights Index at the provincial level; RD_i is R&D expenditures divided by sales of firm *i*, averaged over 2001–2007 (R&D data in 2003 and 2004 are not available); $LogTA_{it}$ is firm size, measured as the natural logarithm of total assets; $Salesgrowth_{it}$ is a proxy for growth, measured by sales in year *t* minus sales in year *t* − 1 divided by sales in year *t* − 1; $Financing_i$ is a dummy variable that equals one if firm *i* had seasoned equity offerings between 1998 and 2008, and zero otherwise; $Subsidies_{it}$ is subsidies from the government divided by total assets; $Concentration_j$ is the Herfindahl index of the industry in which firm *i* belongs; and *IPR* is the Intellectual Property Rights Index. Robust t-statistics clustering by firm are reported in parentheses.

*** Significance at the 0.001 level in a two-tailed *t*-test.
** Significance at the 0.05 level in a two-tailed *t*-test.
* Significance at the 0.1 level in a two-tailed *t*-test.

larger firms have lower *Asyn*, corresponding to lower transparency than small firms, consistent with Gul et al. (2010). Firms with government *Subsidies* are associated with higher transparency.

Transparency increases with industry *Salesgrowth* and *Concentration*. It is unclear why the evidence based on the asynchronicity measure is inconsistent with our prediction. However, as we will report later, when we use the several accounting earnings based measures of transparency, the relation between transparency and growth are generally insignificant. It is also unclear why firms in less concentrated industries are less likely to disclose firm-specific information. As discuss earlier, one possibility is that firms in highly competitive industries may disclose less for protection of proprietary information.

It is possible that both transparency and spillovers are endogenous to local IPR protections; that is, instead of a causal relation, both transparency and spillovers can be affected by property rights protections. To address this issue, we examine whether or not property rights affect the association between transparency and spillovers by adding measures of local IPR protections and interaction between the measure and R&D spillovers. We expect weak IPR protections to increase the incentives to obfuscate in industries with more R&D spillovers. Put somewhat differently, we expect a positive coefficient for the interaction term between R&D spillovers and *IPR Index*, since the negative association between transparency and R&D spillovers will be attenuated when property rights protections are stronger. The results are presented in column (4) of Table 2.

Table 3
Earnings smoothing and R&D spillovers.

	Correlation		$\sigma(NI_t)$		*Error*	
	(1)	(2)	(1)	(2)	(1)	(2)
Intercept	0.628	0.673	1.159	1.165	0.433	0.444
	(0.82)	(0.88)	(4.15)***	(4.20)***	(2.81)***	(2.90)**
IPR		−0.018		−0.002		−0.001
		(−2.18)**		(−0.80)		(−0.56)
$Spillover\_IR_{jr}$	−0.012	−0.179	−0.017	−0.020	0.007	0.010
	(−0.11)	(−1.26)	(−0.44)	(−0.41)	(0.30)	(0.36)
$Spillover\_IR_{jr}$ *IPR		0.060		0.022		0.011
		(2.14)**		(2.12)**		(1.88)*
RD_i	2.715	2.572	−0.307	−0.384	−0.191	−0.242
	(2.01)**	(1.90)*	(−0.61)	(−0.77)	(−0.65)	(−0.83)
$LogTA_i$	−0.009	−0.009	−0.055	−0.059	−0.021	−0.023
	(−0.29)	(−0.29)	(−5.01)***	(−5.32)***	(−3.36)***	(−3.72)***
$Salesgrowth_i$	−0.027	−0.049	−0.082	−0.071	0.017	0.024
	(−0.18)	(−0.32)	(−1.60)*	(−1.39)	(0.60)	(0.83)
$Financing_i$	−0.038	−0.028	−0.002	0.030	0.013	0.016
	(−0.83)	(−0.62)	(−0.14)	(0.17)	(1.38)	(1.73)*
$Subsidies_i$	1.043	1.651	4.366	4.531	2.743	2.860
	(0.14)	(0.22)	(1.64)*	(1.72)*	(1.75)*	(1.83)*
$Concentration_j$	−203.210	−206.920	15.794	30.511	8.784	17.037
	(−1.45)	(−1.47)	(0.30)	(0.58)	(0.32)	(0.63)
Industry dummies	Included	Included	Included	Included	Included	Included
Obs.	400	400	417	417	374	374
Adj. R^2	0.029	0.037	0.086	0.098	0.110	0.121

This table presents the relation between earnings smoothing and R&D spillovers. The dependent variables are three measures on earnings smoothing: $Correlation_i$, $\sigma(NI_t)_i$, and $Error_i$, estimated for each firm over long windows of at least 7 years. The variable $Correlation_i$ is the correlation between the change in accruals and the change in cash from operations; $\sigma(NI_t)_i$ is the standard deviation of change in net income scaled by total assets; $Error_i$ is the square root of the error variance from the autoregression equation of operating income; $Spillover\_IR_{jr}$ is the level of R&D spillovers for the two-digit industry code in the region where firm *i* is located; *IPR Index* refers to the Intellectual Property Rights Index at the provincial level; RD_i is R&D expenditures divided by sales of firm *i*, averaged over 2001 − 2007 (R&D data in 2003 and 2004 are not available); $LogTA_i$ is firm size, measured as the mean natural logarithm of total assets; $Salesgrowth_i$ is a proxy for growth, measured by sales in year *t* minus sales in year $t-1$ divided by sales in year $t-1$; $Financing_i$ is a dummy variable equal to one if firm *i* had seasoned equity offerings between 1998 and 2008, and zero otherwise; $Subsidies_i$ is subsidies from the government divided by total assets; and $Concentration_j$ is the Herfindahl index of the industry to which firm *i* belongs. The financial variables (*LogTA*, *Salesgrowth*, and *Subsidies*) and $Concentration_i$ are the mean from 1998 through 2007. The t-statistics are in parentheses.

*** Significance at the 0.001 level in a two-tailed *t*-test.
** Significance at the 0.05 level in a two-tailed *t*-test.
* Significance at the 0.1 level in a two-tailed *t*-test.

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The coefficient for *Spillover_IR* remains negative but becomes insignificant; however, the coefficient of the interaction of *Spillover_IR* and *IPR Index* is positive and statistically significant. The findings suggest that, on average, stronger local IPR weaken the negative association between synchronicity and R&D spillovers, consistent with H2.

4.3. Earnings smoothing and R&D spillovers

This section estimates Eq. (3.2), where earnings smoothing is measured using 1) the correlation between the change in accruals and the change in cash from operations, 2) variability of net income (the standard deviation of change in net income scaled by total assets), and then 3) earnings predictability (the square root of the error variance from the autoregression equation of operating income). Larger values of each indicate less earnings smoothing, or more transparency.

The results are reported in Table 3.[22] In column (1) of Table 3 for each measure we estimate a base specification focusing on the link between transparency and R&D Spillovers. Of note, for all measures the associations between earnings smoothing and R&D spillovers do not differ significantly from zero (an issue explored in further detail below). When we include *IPR Index* and an interaction between *IPR Index* and *Spillover_IR* in column (2) of Table 3, we find that the coefficients for the interaction terms are positive and statistically significant. The positive coefficients for the interaction terms are consistent with the view that strong property rights protections attenuate firms' need to use accounting opacity to deter the expropriation of proprietary information. In the regression results without the interactions of *IPR Index* and spillovers (not tabulated), the coefficients of *IPR Index* are positive and significantly different from zero when transparency is measured with standard deviation of changes in net income ($\sigma(NI)$) and earnings predictability (*Error*). When we include *IPR Index* and interaction between *IPR Index* and *Spillover_IR*, we find that the coefficient of *IPR Index* is negative. This is attributable to the correlation between *IPR Index* and *IPR Index*∗*Spillover_IR*. The Pearson (Spearman) correlation between *IPR Index* and *IPR Index*∗*Spillover_IR* is 0.688 (0.797), significant at the 0.001 level.

We also find some interesting patterns for the coefficients on the control variables in Tables 2 and 3. When earnings transparency is measured by *Correlation*, the coefficient for average R&D expenditures (*RD*) is significantly positive. This suggests that firms with more R&D investment are less likely to use accruals to smooth earnings. However, when earnings transparency is measured using the variability of net income or earnings predictability, the coefficients for *RD* are negative but insignificant. Overall, including R&D expenditures as a control variable suggests that it is not the *level* of R&D investment but, rather, R&D spillovers that drive our findings. The coefficients of *LogTA* are generally negative, and significantly so in a majority of specifications, again suggesting that in China large firms' disclosures are less transparent than those of small firms.

The coefficients of *Salesgrowth* tend to be negative when transparency is measured by earnings smoothness proxies, but these coefficients are typically not significant. The coefficients for *Subsidies* again tend to be positive, inconsistent with our prior. It could be that government requires transparent reporting of subsidized firms. However, we acknowledge that this is only a speculation. The coefficients for *Concentration* are mostly insignificant. However, when transparency is measured by *Asyn*, the coefficient for *Concentration* is significantly positive, consistent with the view that competition induces opacity for protection of proprietary information. However, the overall evidence on the effects of industry concentration based on the different transparency measures is inconclusive.

To further examine the absence of a significant association between earnings smoothing and R&D spillovers, we partition the sample into three groups based on regional IPR protection levels. We then compare results for firms in the highest ranking of *IPR Index* with those in the other two groups combined. Here *strong* refers to firms in regions with the highest *IPR Indices*, while *weak* contains the remainder of the sample. The sample firms are partitioned by thirds rather than by splitting at the median, since more firms are located in regions with strong IPR and this split balances the sample size in the weak and strong groups.[23] The results are presented in Table 4.

[22] The sample size varies for different measures due to the availability of financial data to construct each measure.
[23] We also conduct tests using the top and bottom terciles to classify strong versus weak protection groups and find similar results.

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Table 4
Earnings smoothing and R&D spillovers: weak versus strong property rights regions.

	Correlation			$\sigma(NI_t)$			*Error*		
	Weak	Strong	Dif.	Weak	Strong	Dif.	Weak	Strong	Dif.
Intercept	1.940	−1.220		1.689	1.006		0.914	0.304	
	(1.93)*	(−1.59)		(4.83)***	(3.71)***		(3.93)***	(2.19)**	
$Spillover\_IR_{jr}$	−0.104	−0.048	0.056	−0.072	0.098	0.171	−0.039	0.055	0.094
	(−0.79)	(−0.27)	(0.25)	(−1.63)*	(1.57)	(2.23)**	(−1.32)	(1.72)*	(2.10)**
RD_i	2.397	1.574		−0.933	−0.035		−0.488	−0.275	
	(1.03)	(1.04)		(−1.13)	(−0.06)		(−0.87)	(−0.94)	
$LogTA_i$	−0.106	0.047		−0.074	−0.044		−0.041	−0.012	
	(−2.19)**	(1.27)		(−4.37)**	(−3.31)***		(−3.63)***	(−1.78)*	
$Salesgrowth_i$	−0.044	−0.150		−0.102	−0.076		0.049	0.002	
	(−0.21)	(−0.75)		(−1.40)	(−1.15)		(1.02)	(0.06)	
$Financing_i$	0.020	−0.118		−0.0001	−0.005		0.026	0.004	
	(0.30)	(−1.89)*		(−0.01)	(−0.24)		(1.74)*	(0.39)	
$Subsidies_i$	3.392	2.313		12.809	−2.726		5.248	−0.342	
	(0.27)	(0.25)		(3.03)**	(−0.84)		(1.98)**	(−0.19)	
$Concentration_j$	43.929	9.931		−3.615	3.701		−2.777	−0.445	
	(1.39)	(0.31)		(−0.32)	(0.33)		(−0.40)	(−0.08)	
Obs.	188	212		198	219		177	197	
Adj. R^2	0.011	0.001		0.164	0.055		0.094	0.003	

This table presents the relation between earnings smoothing and R&D spillovers in regions with weak versus strong IPR protections. The strong regions refer to regions in the top third of the Intellectual Property Rights Index (*IPR Index*), and the rest are weak regions. The dependent variables are three measures on earnings smoothing: $Correlation_i$, $\sigma(NI_t)_i$, and $Error_i$, estimated for each firm over long windows of at least 7 years. The variable $Correlation_i$ is the correlation between the change in accruals and the change in cash from operations; $\sigma(NI_t)_i$ is the standard deviation of change in net income scaled by total assets; $Error_i$ is the square root of the error variance from the autoregression equation of operating income; $Spillover\_IR_{jr}$ is the level of R&D spillovers for the two-digit industry code in the region where firm *i* is located; RD_i is R&D expenditures divided by sales of firm *i*, averaged over 2001–2007 (R&D data in 2003 and 2004 are not available); $LogTA_i$ is the average of firm size, measured as the natural logarithm of total assets; $Salesgrowth_i$ is a proxy for growth, measured by the average number of sales in year t minus sales in year $t-1$ divided by sales in year $t-1$; $Financing_i$ is a dummy variable equal to one if firm *i* had seasoned equity offerings between 1998 and 2008, and zero otherwise; $Subsidies_i$ is subsidies from the government divided by total assets; and $Concentration_j$ is the Herfindahl index of the industry to which firm *i* belongs. The financial variables ($LogTA_i$, $Salesgrowth_i$, and $Subsidies_i$) and $Concentration_j$ are the averages from 1998 through 2007. The t-statistics are in parentheses.

*** Significance at the 0.001 level in a two-tailed *t*-test.
** Significance at the 0.05 level in a two-tailed *t*-test.
* Significance at the 0.1 level in a two-tailed *t*-test.

The associations between R&D spillovers and transparency measured by earnings smoothness are negative in weak regions, but differ from zero only when transparency is measured with $\sigma(NI_t)$. In contrast, the association is positive in strong regions when transparency is measured with $\sigma(NI_t)$ and *Error*, and differs significantly from zero for the latter. Testing for differences in the coefficients between weak and strong regions we find that all differences are positive, and those for $\sigma(NI_t)$ and *Error* are significantly different across the groups. The different results between the two groups may explain the insignificant coefficients of *Spillover_IR* for the full-sample analysis in Table 3.

The positive relation between transparency and R&D spillovers in regions with strong IPR suggests that when IPR protections are strong, firms do not use opacity (low transparency) to prevent R&D spillovers. Rather, R&D spillovers are associated with increased corporate transparency. This suggests that the benefits of corporate transparency offset the potential losses due to R&D spillovers in regions with strong IPR, or that property rights protections in such regions alleviate the need to obfuscate corporate disclosures.

4.4. Robustness tests

This section conducts several robustness checks. To conserve space, the results in the paper are not tabulated but are available upon request.

First, to mitigate the potential that extreme values affect our results, and to further focus on the relation between earnings smoothing and R&D spillovers, we rank *Spillover_IR* and form deciles analogous

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to the approach of Francis et al. (2004). Firms in the top decile (decile 1) have the smallest values of *Spillover_IR*, while firms in the bottom decile (decile 10) have the largest. Using the decile ranks of *Spillover_IR* rather than the raw values attenuates the effect of extreme observations. The results are qualitatively similar to those reported in Table 4. The associations between R&D spillovers and smoothing are significantly negative in weak regions, and significantly positive in strong regions. The coefficients of *Spillover_IR* and their differences are larger and more significant than those in Table 4.

Second, when we include industry controls, the coefficients for *Spillover_IR* do not differ significantly between the weak and strong groups. We suggest that this is attributable to two factors: 1) we lose power due to the small sample size and 2) *Spillover_IR*, which is measured for each industry in a region, already captures variation across industries.[24]

Third, Section 3.2.1 estimates R&D spillovers for an industry within a region based on contemporaneous R&D expenditures for the whole industry. However, there may be lagged effects. That is, if R&D investment is increasing over time but finished products have not yet been produced, proprietary information could be obtained from information about current or previous R&D investments. Thus our findings may be attributable to lag effects. To address this concern we estimate the level of R&D spillover for an industry within a region using revised Eq. (1) including the lagged R&D expenditures for the previous 2 years in the R&D spillover pools.[25]

The R&D spillover pool of firm i in industry j and period t is measured as

$$\sum_{\tau=0}^{2}\lambda^{\tau}\left(\sum_{i=1}^{N_j}RD_{ijt-\tau}-RD_{it-\tau}\right)$$

where λ is the discount factor that takes the depreciation of R&D capital into account. Following Griliches (1979) and Raut (1995), we use a value of $\lambda=0.85$, and N is the number of firms in industry j.

The R&D spillover for industries within regions estimated using the R&D pool including lagged R&D expenditures is highly correlated with the spillover levels estimated using contemporaneous R&D expenditures. The Spearman correlation is 0.698, significant at the 0.1 level. Nonetheless, we use this alternative R&D spillover measure and find that the results are qualitatively similar to those reported above.

Fourth, in Section 3.2.1, when calculating the R&D pools, we effectively place equal weights on the R&D expenditures of competitors, irrespective of the region in which they operate. We conduct two sets of robustness tests here. First, we separate the R&D spillover pool into two components, one for the R&D expenditures of competitors in the firm's own region and adjoining regions and the other for R&D expenditures of competitors in regions farther away. The spillover pool of firm i in industry j, region r, and period t is measured as

$$\begin{aligned}RD\,\text{spillover pool} = {}& \left(\sum RD \text{ of competitors in region } r \text{ and adjoining regions} - RD \text{ of firm } i\right)\\ &+\varphi * \sum RD \text{ of competitors in other regions.}\end{aligned}$$

We apply a discount factor $\varphi=0.5$ to the R&D pool in other regions to account for distance. The new spillover values are very highly correlated with the spillover levels estimated using contemporaneous R&D expenditures. Using values for φ of 0, 0.2, 0.5, and 0.8, the results are qualitatively similar to our main analysis (which effectively sets $\varphi=1$ for all regions). Additionally, there are currently 54 national-level special economic zones and 53 national high-tech industrial development zones in China, and such zones tend to attract investment from foreign and high-tech firms. To address the concern that the spillover effect is mainly driven by firms clustering in special economic zones or high-tech industrial development zones, we conduct a similar test and apply a discount factor to the sum of R&D expenditures of firms located in cities that contain special economic zones or high-tech industrial development zones. The spillover pool is measured as follows:

$$\begin{aligned}RD\,\text{spillover pool} = {}& \Big(\sum RD \text{ of competitors in region } r \text{ and adjoining regions excluding cities with zones}\\ &+\rho * \sum RD \text{ of competitors in cities with zones in region } r \text{ and adjoining regions} - RD \text{ of firm } i\Big)\\ &+\varphi * \sum RD \text{ of competitors in other regions}\end{aligned}$$

[24] The results in Tables 2 and 3 are robust when omitting industry fixed effects.

[25] We did not use the R&D pool lagged for 4 years as in Griliches (1979) and Raut (1995) because of the short sample period.

As above, we apply a discount factor of ρ to the R&D pool of firms in cities with special economic zones or high-tech industrial development zones. Using values for ρ of 0.2, 0.5, and 0.8, the results are qualitatively similar to our main analysis.

The results thus far are suggestive of a negative association between corporate transparency and R&D spillovers. This is consistent with the view that firms facing high R&D spillovers use opacity (low transparency) to prevent information outflow, especially when IPR are weak and the costs of proprietary information leakage are high. However, the causality between transparency and spillovers can run both ways. It is possible that firms use opacity (low transparency) to prevent R&D spillovers and thus we would observe a positive association between transparency (negative association between opacity) and R&D spillovers, a reverse causality. Indeed, R&D spillovers are determined by many factors, including the nature of the industry, regional clustering of R&D intensive industries, regional property rights protections, and even firm-level governance mechanisms. Our prior is that industry and institutional factors will have first-order effects on the level of R&D spillovers. Firm-level mechanisms are likely to be of second-order importance and not strong enough to change the negative relation between transparency and the level of R&D spillover as found in Sections 4.2 and 4.3.

4.5. Firm value and corporate transparency

As discussed, transparency may affect firm value. For example, if increased transparency reduces information asymmetries and lowers the cost of equity, capital market valuation will increase (e.g., Bhattacharya et al., 2003; Francis et al., 2004; Healy et al., 1999). However, we document that opacity (low transparency) is a mechanism to prevent leakages of proprietary information when IPR protections are weak, thus protecting against value losses. If opacity does play a role in preventing R&D spillovers, we would observe an association between increased opacity and capital market valuation and/or lower cost of equity contrary to that seen in the literature cited above.

To reconcile these views consider that, with few exceptions, most papers investigating how transparency affects firm valuation and cost of equity consider transparency exogenous. Cohen (2008) finds that reporting quality is not significantly associated with a firm's equity cost of capital, controlling for the endogenous character of financial reporting quality. Consistent with this view, our results suggest that transparency is endogenously determined. That is, firms operating in high R&D spillover environments use opacity (low transparency) to protect proprietary information. As a result, we do not expect to observe a significant association between transparency and firm valuation when taking spillovers into account.

To investigate this idea empirically, we use a two-stage estimation procedure where the first-stage regression is

$$\begin{aligned} Transparency_{i,j,r,t} = {} & \alpha_0 + \alpha_1 Spillover\_IR_{j,r} + \alpha_2 RD_i + \alpha_3 LogTA_{i,t} + \alpha_4 Salesgrowth_{i,t} + \alpha_5 Financing_i \\ & + \alpha_6 Subsidies_{i,t} + \alpha_7 Concentration_{i,t} + \varepsilon. \end{aligned} \tag{4}$$

The spillover measure, *Spillover_IR*, is a good instrument to the extent that it affects transparency but not firm performance. The second-stage regression is

$$\begin{aligned} Tobin'sq_{i,t} = {} & \alpha_0 + \alpha_1 Transparency_{i,t} + \alpha_2 RD_i + \alpha_3 LogTA_{i,t} + \alpha_4 Salesgrowth_{i,t} + \alpha_5 Financing_i \\ & + \alpha_6 Subsidies_{i,t} + \alpha_7 Leverage_{i,t} + \alpha_8 Tangibility_{i,t} + Industrydummies + \varepsilon. \end{aligned} \tag{5}$$

Firm value is measured by Tobin's q (measured as the sum of the market value of equity and the book value of liabilities divided by total assets). The variable *Transparency* is one of the four measures defined earlier (*Asyn* and the three proxies for earnings smoothness) for each firm. Year indicators are also included in both Eqs. (4) and (5) when $Transparency_i$ is measured by *Asyn*. The term *RD* is the mean of R&D expenditures divided by sales; $LogTA_i$ is the natural logarithm of total assets, controlling for the size effect on performance; $Salesgrowth_i$, is a proxy for growth, measured by the average number of sales in year t minus sales in year $t-1$, divided by sales in year $t-1$; $Financing_i$ is an indicator variable equal to one if firm i had seasoned equity offerings between 1998 and 2008, and zero otherwise; *Subsidies* is measured by subsidies deflated by sales; *Leverage* is total liabilities divided by total assets at the beginning of the year;

and $Tangibility_i$ is the ratio of property, plant, and equipment to total assets, controlling for asset tangibility. Industry indicators are also included. When $Transparency_i$ is measured by *Asyn*, yearly performance and the financial data (except *RD* and *Financing*) are used in both of the equations. The variable $Transparency_i$ is measured using the earnings smoothness proxies, while the performance and financial data are averages for 1998–2007.

Panel A of Table 5 reports the single-stage ordinary least squares regression results for Eq. (5). Consistent with the literature, we generally observe a significant positive association between Tobin's *q* and transparency.[26] While these findings suggest that more transparency is associated with higher firm value, the results in the second-stage regression presented in panel B of Table 5 differ markedly. When using the instrumental variables approach, the positive association between transparency and Tobin's *q* disappears, suggesting that transparency is endogenously determined.

Broadly speaking, these findings support the idea that firms use opacity (low transparency) to protect proprietary information when they operate in a high R&D spillover environment, and that increasing transparency will not increase firm value due to the associated costs of revealing proprietary information. Although a lower cost of capital is a benefit of transparency, there are also potential costs. Our findings suggest that transparency can hurt firm value in that it can lead to the leakage of proprietary information to competitors. The cost of transparency is likely large for firms that depend on R&D and operate in environments with large R&D spillovers. Importantly, our insignificant result suggests that the net effect to firm values is unclear. A natural interpretation of this result is that firms choose their transparency levels in an optimal manner, depending on their institutional environments. In equilibrium, costs of transparency offset benefits, and thus the transparency levels have no relation with firm value.

One potential issue of our instrumental variable choice is that institutional development at the regional level may drive both R&D spillovers and firm value, and therefore R&D spillover is not a valid instrument. Our prior is that the association between individual firm performance and R&D spillovers should be lower than the association between transparency and R&D spillovers. The coefficients of *Spillover_IR* are significant at least at the 0.1 level in the first-stage regressions, indicating a strong association between *Transparency* and *Spillover_IR*. This suggests that, although not perfect, our instrument meets the criteria of choosing instrumental variables suggested by Larcker and Rusticus (2010). At the same time, the potential problem with the instrument would work against us finding evidence of no relation between the instrumented transparency measure and firm performance. For example, if strong property rights protections lead to smaller spillovers, more transparency, and higher firm value, this would suggest a correlation between instrumented transparency and firm performance. However, we find no such effect.

4.6. Transparency estimated by alternative data

As discussed above, the R&D investment data are obtained from the NBSC census database while financial data and trading data are obtained from the CSMAR database, which contains data collected from publicly disclosed annual reports. Financial data are also collected for use in the NBSC census database. There are many reasons to expect differences in the financial data between the two data resources. First, the data reported in the NBSC census need not be audited. Second, there is no incentive to manage NBSC disclosures for tax purposes since these data are not publicly available and are actually kept confidential for a certain period. Third, given the confidentiality, there is no pressure to manage these numbers to meet investor expectations. Finally, as we argue above, managers are not concerned about information leakage when reporting financial data to the NBSC and thus have no incentive to smooth earnings.

To investigate this further, we first examine the differences in several key ratios between the two databases using the following approach for the difference in total assets:

$$D\_TA = (Total\ Assets\_NBSC - Total\ Assets\_CSMAR)/Total\ Assets\_CSMAR$$

The difference in sales (*D_Sales*), difference in operating income (*D_OI*) and difference in net income (*D_NI*) are calculated in the same way.

[26] The exception is when transparency is measured by correlation.

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Table 5
Firm value and transparency.

	$Asyn_{it}$	$Correlation_i$	$\sigma(NI_t)_i$	$Error_i$
Panel A Ordinary least squares regression results (Eq. (5))				
Intercept	18.405	17.223	16.407	17.549
	(30.86)***	(15.11)***	(13.43)***	(15.05)***
Transparency	1.645	0.032	1.597	3.060
	(11.87)***	(0.36)	(5.02)***	(6.30)***
RD	6.188	3.593	3.412	4.598
	(4.97)***	(1.58)	(1.41)	(1.90)*
LogTA	−0.758	−0.742	−0.699	−0.747
	(−29.69)***	(−14.61)***	(−12.73)***	(−14.30)***
Salesgrowth	0.342	0.643	0.676	0.568
	(7.06)***	(2.60)**	(2.77)**	(2.38)**
Financing	0.140	0.183	0.165	0.114
	(3.16)**	(2.39)**	(2.05)**	(1.45)
Subsidies	4.938	9.180	1.155	−4.153
	(1.29)	(0.73)	(0.09)	(−0.32)
Leverage	0.734	0.711	0.322	0.187
	(8.60)***	(3.44)**	(1.25)	(0.88)
Tangibility	0.204	0.158	0.238	0.007
	(1.38)	(0.43)	(0.65)	(0.02)
Industry dummies	Included	Included	Included	Included
Year dummies	Included			
Obs.	4455	400	417	374
Adj. R^2	0.422	0.464	0.469	0.514
Panel B Firm value and instrumented transparency (second-stage regression results)				
Intercept	21.658	20.876	16.266	−21.465
	(9.32)***	(2.31)***	(9.15)***	(−1.52)
Transparency	5.503	7.696	3.451	−42.784
	(1.04)	(0.35)	(0.40)	(−0.24)
RD	5.473	4.351	4.362	4.464
	(3.51)***	(0.35)	(1.39)	(0.32)
LogTA	−0.836	−0.810	−0.736	−0.811
	(−27.31)***	(−3.01)**	(−10.58)***	(−2.60)**
Salesgrowth	0.478	0.826	0.607	0.680
	(7.94)***	(0.62)	(1.84)*	(0.47)
Financing	0.236	0.157	0.205	0.201
	(4.31)***	(0.39)	(1.89)*	(0.45)
Subsidies	−4.736	−3.105	1.076	−0.048
	(−1.02)	(−0.04)	(0.06)	(−0.01)
Leverage	0.840	0.667	1.025	0.646
	(8.14)***	(0.63)	(3.76)***	(0.60)
Tangibility	−0.312	0.162	0.416	0.285
	(−1.70)*	(0.09)	(0.84)	(0.14)
Industry dummies	Included	Included	Included	Included
Year dummies	Included			
Obs.	4455	400	417	374
Adj. R^2	0.190	0.001	0.291	0.001

This table presents the relation between firm value and corporate transparency. The dependent variable is Tobin's q, measured as the sum of the market value of equity and the book value of liability divided by total assets. The variable $Asyn_{it}$ is the negative R^2 statistic of the market model (Eq. (2)) of firm i in year t; $Correlation_i$ is the correlation between the change in accruals and the change in cash from operations; $\sigma(NI_t)_i$ is the standard deviation of change in net income scaled by total assets; $Error_i$ is the square root of the error variance from the autoregression equation of operating income; RD_i is the mean of R&D expenditures divided by sales; $LogTA_i$ is the natural logarithm of total assets, controlling for the size effect on performance; $Salesgrowth_i$ is measured by the average number of sales in year t minus sales in year $t-1$ divided by sales in year $t-1$; $Financing_i$, a dummy variable, equals one if firm i had seasoned equity offerings between 1998 and 2008, and zero otherwise; $Subsidies_i$ is measured by subsidies deflated by sales; $Leverage_i$ is the total liability divided by total assets at the year beginning; and $Tangibility_i$ is the ratio of property, plants, and equipment to total assets. Industry dummies are included. When transparency is measured by *Asyn*, financial data are measured for each year, and year dummies are included in the regressions. When transparency is measured by the three variables on earnings smoothing, Tobin's q and the financial data are averages from 1998 to 2007. The t-statistics are in parentheses.

*** Significance at the 0.001 level in a two-tailed t-test.
** Significance at the 0.05 level in a two-tailed t-test.
* Significance at the 0.1 level in a two-tailed t-test.

Table 6
Difference in key ratios between publicly disclosed annual reports and the NBSC census database.

	Median	Mean
D_TA	−0.034***	−0.077***
D_Sales	−0.056***	−0.024
D_OI	−0.104***	−0.893*
D_NI**	0.132***	0.327***

This table presents the difference in key ratios between publicly disclosed annual reports and the NBSC census database. The median difference is tested by the Wilcoxon rank sum test and the mean difference is tested by the *t*-test.
*** Significance at the 0.001 level.
** Significance at the 0.05 level.
* Significance at the 0.1 level.

The mean and median of the difference are presented in Table 6. The statistics of tests of differences between means and medians are all significant, other than for the mean of the difference in sales. Specifically, we find that in annual reports total assets, sales, and operating income are larger than reported in the NBSC database, while net income is smaller. These differences may be explained in part by the fact that public accounts are audited or there is pressure for conservatism from the public stock market.

We next calculate the transparency measures using data from the census database. Since managers are not concerned about information leakage when reporting financial data to the NBSC, they have no incentive to smooth earnings. As a result, we do not expect to observe a systematic association between transparency and R&D spillovers when measuring transparency using financial data from the census database. Unfortunately, the financial data collected by the NBSC are less comprehensive relative to data in annual reports, and we do not have sufficient information to calculate accruals. As an alternative, we focus on transparency as measured by the variability of net income, $\sigma(\Delta NI_t)$, and earnings predictability, *Error*, using the same approach as described in Section 3.2.2.2. We then repeat the main tests (Tables 3 and 4) with these two transparency measures. As expected, we find no significant correlation between transparency and R&D spillovers when transparency is estimated using the non-public data.[27]

5. Conclusion

Prior research documents that information disclosure and the properties of accounting numbers are influenced by the institutional environment in which firms operate. Often the nature of the institutional environment is viewed from an agency cost perspective, namely, the potential for conflicts of interest between managers and users of financial information outside the firm. We provide a new channel through which institutions can shape transparency. Specifically, we contend that there is a link between property rights protections and transparency in that the leakage of proprietary information to competitors (R&D spillovers) reduces a firm's ability to capture gains from investing, thus reducing managers' incentives to disclose financial and operational information.

When the threat of information leakage is high, managers have incentives to improve their ability to reap the benefits of their investment activities by employing mechanisms that prevent information leakage. We argue that managers mask their firm's true economic performance and make earnings and financial disclosures less informative to protect proprietary information, especially when the firm is located in a region suffering from weak property rights protections. Our findings support this view. When corporate transparency is measured with both earnings smoothing (which reduces the volatility of reported earnings) and the R^2 from a market model (which captures firm-specific information) we find evidence that firms in environments with more R&D spillovers tend to have less transparent disclosures. Conversely, if spillovers are large but property rights protections are strong, firms appear to have more transparent disclosures.

Our findings have implications for market regulators and accounting standard setters alike. The new accounting standards in China, in force since 2007, are closer to International Financial Reporting Standards

[27] To conserve space we have not tabulated these results. They are available on request.

and require greater disclosure than in the past. While a large body of work argues that firms committing to increased levels of disclosure obtain significant benefits, our analysis provides insights as to the potential costs of increased disclosure. When property rights protections are weak and R&D spillovers are large, greater disclosure can damage firm value as proprietary information is leaked to competitors through public disclosures. However, we also find that transparency is greater for firms operating in regions with stronger property rights protections, suggesting that, at a fundamental level, such protections are also important for innovation and growth.

Appendix A. Variable definitions

Variable	Definition
IPR Index	The intellectual property rights index, a sub-index of the National Economic Research Institute (NERI) Index of Marketization (IM) of Chinese provinces
Asyn	Negative R^2 statistic of the market model (Eq. (2))
Correlation	Correlation between the change in accruals and the change in cash from operations
$\sigma(NI_t)$	Standard deviation of the change in net income scaled by total assets
Error	Square root of the error variance from the autoregression equation of operating income
Spillover_IR	Level of R&D spillover for the two-digit industry code in the region where firm *i* is located
RD	R&D expenditures divided by sales of firm *i* averaged from 2001 to 2007 (R&D data in 2003 and 2004 not available)
LogTA	The natural logarithm of total assets
Salesgrowth	Sales in year t minus sales in year $t-1$, divided by sales in year $t-1$
Financing	A dummy variable equals one if firm *i* had seasoned equity offerings between 1998 and 2008, and zero otherwise
Subsidies	Subsidies from the government divided by total assets
Concentration	Herfindahl index of the industry, calculated as the sum of the squares of the market shares of each firms within the industry, where the market shares are expressed as the sales of one firm divided by the sum of sales of the industry
Leverage	The total liability divided by total assets at the year beginning
Tangibility	The ratio of property, plants, and equipment to total assets

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