The provincial border, information costs, and stock price crash risk

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ABSTRACT
Based on externalities in the allocation of interprovincial resources, we examine how geographic location affects firms' access to resources and thus their information disclosure and stock price crash risk. The results show that border firms have a higher stock price crash risk than non-border firms. Mechanism tests find that border firms have lower available credit, higher financing costs, smaller fiscal subsidies, higher accrual earnings management, lower accounting conservatism, and a more positive tone in the management discussion and analysis section of the annual report. This indicates that resource shortages and aggressive information disclosure are important drivers of their higher stock price crash risk. Additional tests find no border effect in the borders of integrated areas or borders of areas adjacent to municipalities. Accelerating the digital transformation of the government and the information infrastructure construction, and strengthening external governance can partially alleviate the stock price crash risk of border firms.

KEYWORDS
Provincial border; externality; resource allocation; information cost; stock price crash risk

1. Introduction

The report of the 19th National Congress of the Communist Party of China pointed out that in this new era, the main contradiction in society is between people's need for a better life and unbalanced and insufficient development. How to solve the problem of unbalanced development is a major task facing philosophers and social science researchers (Xu et al., 2019). Unbalanced regional development is an important spatial manifestation of unbalanced development. It encompasses the imbalance in both urban–rural development and interprovincial development. In recent years, with the gradual increase in the economic gap between border areas and non-border areas in the same province, the latter has become more serious.

Researchers of political economics find that regional economic competition and promotion by government officials jointly create strong externalities in the allocation of public resources between provinces. Moreover, this is responsible for the strategic allocation of public resources within a province and leads to imbalances in regional economic development. Specifically, the supply of public resources (or public goods)
has the characteristics of externalities. This prevents economic agents from enjoying the full benefits or bearing the full costs of their actions, and it means that other nonparticipants gain observable benefits (profit spillovers) or suffer observable losses (cost spillovers) from them. The externalities of public resources at the provincial border are particularly obvious. For example, because of the payment rules of public goods (territorial tax principle) and consumption characteristics (non-exclusivity and non-competitiveness), border areas need to bear the full cost of investing in public facilities, social security, education, and other public welfare, but they cannot share the return on their investment with their neighbours. As another example, environmental pollution from production activities in border areas can be transferred to neighbouring areas through the air, rivers, and other means, thereby reallocating part of the environmental control costs borne by the local area.

Against an institutional backdrop of fiscal decentralisation and political centralisation, local government officials in China must consider not only regional economic growth but also their own political careers. First, to pursue economic growth within their jurisdictions, local officials compete fiercely to protect local resources, markets, and tax bases, which results in insufficient coordination among regions. Public investment in border areas has obvious spillover effects, so local governments are more inclined to invest resources in non-border areas to obtain full benefits and to prevent free riding in neighbouring regions (Duvivier & Xiong, 2013). Tang (2019) uses county-level economic data and nighttime lighting data to prove this point. He finds that provincial governments strategically reduce traffic facilities (such as provincial roads and expressways) in border counties within their jurisdictions. Second, under the promotion tournament system, the promotion of local officials depends on the relative rank of their region in terms of economic growth (Li & Zhou, 2005). In a pyramid administrative hierarchy, the promotion opportunity of local officials is limited. The promotion of one person directly crowds out the promotion opportunity of another, and this zero-sum game leads to limited cooperation between regions. Local officials have little incentive to promote economic development in border areas, as what is good for their rivals is bad for themselves. For example, Zhou and Tao (2011) find that the per capita gross domestic product of border counties is significantly lower than that of non-border counties. Moreover, the smaller the economic gap between two provinces along the provincial border (the more intense the competition), the more backward the economic development of the counties. Therefore, both fiscal decentralisation and political promotion lead to spatial characteristics of strong externalities in border areas and spillovers of benefits and costs. According to Olson's (1973) free-riding theory, such externalities encourage local governments to share less and benefit more in terms of the supply of public goods. The supply of public goods in border regions has stagnated at a low and inefficacious level for a long time, resulting in an unbalanced distribution of public resources in these regions and the basic fact of being ‘trapped’ at the border.

Previous studies on the border trap focus more on the existence and causes of the border effect at the regional level and reach a consensus on the externalities between provinces and the scarcity of public resources in border areas. Firms are the micro-components of the national economy and the main promoters of high-quality economic development. To solve the border problem and promote coordinated regional development, it is necessary to further clarify the specific manifestation and channel of influence.
of the border effect at the microlevel. Data on the geographic distribution of listed companies collected manually reveal nearly 400 listed companies located at a provincial border in China, accounting for about 15% of the total number of listed companies. However, research has not yet provided a systematic answer to the question of whether and how a provincial border with fewer public resources affects these micro-firms. Information disclosure is an important decision-making behaviour of listed companies. A good information disclosure mechanism is a lifeline of the capital market and determines the pricing efficiency of the capital market and its ability to serve the development of the real economy (Yang et al., 2018; Yang et al., 2020). As an important consequence of adverse information disclosure, a stock price crash greatly affects the health and stable development of the capital market and has a great negative impact on the regional social economy, which is a focus of research in the field of finance. Managers may selectively disclose good news and conceal bad news out of self-interest, such as to maintain income smoothing, a high salary, excessive investments, and executive status (Khurana et al., 2018; Bao et al., 2018; Jiang et al., 2018a). The sudden release of bad news that has been hidden over time will damage the company’s share price and lead to a crash (Kothari et al., 2009). Numerous relevant studies discuss the internal and external determinants of stock price crash risk, such as multiple blockholders (Jiang et al., 2018b), the institutional environment (Luo & Du, 2014), and infrastructure (Zhao et al., 2018). However, no study discusses the impact of geographic location, especially the boundary location, on firms’ information disclosure and stock price crash risk.

This paper extends the research on the border effect from the perspective of stock price crash risk. Based on the realistic scenario of unbalanced allocation of public resources under a strong provincial border externality, we construct the logical framework of border resource allocation → information disclosure → stock price crash risk and attempt to reveal the microscopic formation mechanism and potential consequence of the border effect. Our study provides new ideas for resolving the imbalance in regional development. In theory, a lack of public resources will limit the flow of production factors, high-quality talent, commodities, and other factors and ultimately affect the flow of information and capital at the firm level. Therefore, we investigate whether stock price crash risk differs between border and non-border firms within the same province and whether these differences are caused by resource constraints or the information disclosure choices of border firms. Specifically, we discuss the capital flow of border firms from two perspectives: credit resources and fiscal subsidies. In terms of credit resources, the lack of public goods in border regions not only directly affects the operating costs and competitive advantage of border firms but also makes it difficult for financial institutions (such as creditors) to obtain border debtors’ soft information (Stigler, 1961), which leads to disadvantages in external financing among border firms. In terms of fiscal subsidies, as important parts of local fiscal expenditures, fiscal subsidies also have externalities similar to public resources such as education and roads. Moreover, local governments lack competition and a self-punishment mechanism. As a result, they are faced with high information costs when identifying high-quality firms and tend to allocate limited fiscal subsidies to regions, industries, and firms with low information costs and high returns (Zhou & Pan, 2019). Therefore, we infer that border firms may have severe resource constraints.
Furthermore, we discuss how the capital flow of border firms affects their information flow. Border firms faced with resource constraints have two choices. First, they may selectively disclose good news and conceal bad news and send positive signals to the outside to reduce financing costs and obtain valuable capital. However, the long-term concealment of bad news will aggravate the risk of a stock price crash (Kim & Zhang, 2014). Second, they may adopt timely, integrated, and authentic information disclosure strategies to alleviate information asymmetry with providers of financial resources and reduce the stock price crash risk. Indeed, which information disclosure policy do border firms adopt? How does the disclosure policy affect the stock price crash risk of border firms? These important questions can reveal the formation mechanism behind the micro-border effect and need to be tested empirically.

To test our proposition, we take A-share companies listed on the Shanghai and Shenzhen Stock Exchanges from 2004 to 2016 as the initial research sample, manually collect corporate geographic information, and examine whether and how a firm’s geographic location affects its stock price crash risk. Our empirical results show that border firms have a significantly higher stock price crash risk than non-border firms. The effect holds in all robustness tests, such as the design of a difference-in-differences (DID) model that considers firm relocation, the use of an alternative measure of stock price crash risk, and the use of alternative samples. Further examination finds that border firms suffer from lower available credit, higher financing costs, and smaller fiscal subsidies than non-border firms. Moreover, border firms have higher accrual earnings management, lower accounting conservatism, and a more positive accrual tone in the management discussion and analysis (MD&A) section of the annual report. These findings confirm that border firms tend to adopt aggressive information disclosure strategies when faced with severe resource constraints, which may lead to their higher risk of a stock price crash. Additional tests find no border effect in the borders of integrated areas or in the borders of areas adjacent to municipalities. Accelerating the digital transformation of the government, constructing new infrastructure, as well as strengthening external governance (such as analyst following, media attention, and high-quality auditing) can partially alleviate the stock price crash risk of border firms.

Our paper contributes to the literature in the following ways. First, our study contributes to a growing literature in the field of border effects. Focusing on stock price crash risk, it provides microlevel evidence for the border effect and verifies that the border effect is reflected not only in imbalances in regional macroeconomic development but also in the different information disclosure behaviours of micro-firms. Second, starting from the spatial externality characteristics of provincial borders, we find that local governments strategically allocate fiscal subsidies like general public goods and discuss how unbalanced allocation of two types of resources – local general public goods and fiscal subsidies – leads border firms to selectively disclose information to deal with disadvantages in resource acquisition. Third, this paper enriches the research on the determinants of stock price crash risk. Prior studies mainly use agency theory (Jin & Myers, 2006) to investigate internal and external corporate governance mechanisms that affect corporate information disclosure, such as managers’ compensation, accounting standards, and media reports. Our paper focuses on the impact of geographic location on crash risk, a topic often neglected in the literature, to provide reference empirical evidence for capital market regulators and investors.
2. Literature review and theoretical analysis

2.1. Unbalanced allocation of public resources and the financing predicament in border areas

2.1.1. Public resources at the border and firm financing constraints

Perspectives on the consequences of the allocation of public resources can be divided into two categories: the resource view and the information view. The resource view argues that the construction of infrastructure and the supply of public goods can alleviate distortions and restrictions in the market resource allocation; break barriers to market entry; and accelerate the flow of production factors, commodities, senior talent, capital resources, and so on. This ultimately increases the production and operating efficiency of micro-firms and helps them transform and upgrade. For example, a series of studies find that the construction of a high-speed railway significantly promotes the flow of high-quality talent and capital resources (Du & Peng, 2017; Ma et al., 2020) and improves regional innovation (Bian et al., 2019). Liu and Liu (2011) also find that the construction of transportation infrastructure can reduce the time needed to transport commodities, reduce inventory costs, and increase the export volume of firms.

The information view holds that good allocation of public resources can reduce the cost of communicating and transmitting information between economic subjects; accelerate the trans-regional flow of soft and hard information; enhance the timeliness, effectiveness, and authenticity of information transmission; and reduce capital market risks (Zhao et al., 2018). For example, Rao et al. (2019) show that the construction of a high-speed railway reduces information and transportation costs between firms and suppliers, prompting firms to seek more distant and more dispersed high-quality suppliers. Kang and Kim (2008) also find that improved infrastructure enables stakeholders and regulators to search for real information about companies by formal or informal means, reduces the costs of external supervision, and thus improves asset pricing efficiency.

Therefore, firms located at a provincial border with fewer public resources may face severe resource constraints and high information costs. For example, firms located at a provincial border have higher operating and production costs and less high-quality production factors and talent. This means that financial institutions (especially creditors) may not be optimistic about border firms and may be unwilling to allocate financial resources to them. In other words, the restricted flow of production factors, talent, and commodities at the provincial border leads to a financing predicament among border firms. Moreover, the provincial border location may increase the information costs of financial institutions willing to allocate financial resources to these border firms. These information costs include the search cost and contract signing cost before the allocation of financial resources as well as the supervision cost and execution cost afterwards (Stigler, 1961). Because they need to balance costs and benefits, financial institutions cannot allocate financial resources to border firms; if they do, they will charge a premium to compensate for the higher risk of default under information asymmetry. That is, the lack of information flow at the provincial border leads to a financing predicament among border firms.
2.1.2. Fiscal subsidy at the border and firm subsidies

In transition economies, fiscal subsidy is a direct intervention by which local governments allocate financial resources to specific firms and industries to promote employment, ensure social stability, and achieve industrial upgrading. Compared to other fiscal instruments, fiscal subsidy is more dominated by local governments and their fiscal departments. Therefore, it is not only a commonly used macrolevel policy tool but also a kind of special public resource (Liu, 2016).

From the perspective of fiscal subsidy as a policy tool, local governments need to set the expected targets, objects, scope, amount, and time of fiscal subsidy. They also need to timely and accurately allocate limited subsidy resources to specific regions, industries, and firms according to changing political and economic landscapes to achieve the policy objectives and effects (Liu, 2016). The policy timeliness of fiscal subsidies requires local governments to obtain and approve specific firm-level information in a short period of time. Given the unbalanced allocation of general public resources at the provincial border, local governments are more inclined to allocate subsidy resources to non-border firms with lower information costs to ensure the timeliness and effectiveness of policies.

Local fiscal subsidy can also be regarded as a public resource, as it reflects the political will of local governments and is influenced by their strategic behaviours. For example, Guo & Jia (2009) find significant strategic interactions among total fiscal expenditures and other expenditures (including economic, social, and maintenance expenditures) within the same administrative system. Li and Zhu (2019) find alternative regional strategies for competing for research and development (R&D) subsidies among different administrative systems. That is, when one region increases R&D subsidies to firms, the R&D subsidies in other regions decrease accordingly. Therefore, under the incentive of fiscal decentralisation and official promotion, local governments are able and motivated to distort the regional allocation of fiscal subsidies, which makes it more difficult for border firms to obtain subsidy support compared to non-border firms.

From this analysis, it can be seen that fiscal subsidy, whether used as a policy tool or a kind of public resource, is likely to be allocated unequally to border and non-border firms, which is reflected in the fact that border firms receive smaller government subsidies.

2.2. The financial predicament and information disclosure among border firms

Faced with financial difficulties, border firms may choose to report good news but not bad news, or they may disclose good news in advance and delay the disclosure of bad news. Through the active transmission of information, they can obtain valuable financial resources and reduce financing costs, but long-term concealment of bad news will aggravate their stock price crash risk. We call this the bad news concealment effect.

Previous research on stock price crash risk supports the effect, which suggests that stock price crash risk arises from the opportunistic behaviour of managers who deliberately conceal bad news (Jin & Myers, 2006). Motivated by salary, reputation, political promotion, and other factors, managers are inclined to report good news rather than bad news when disclosing information and prefer to disclose good news in advance while concealing or delaying the disclosure of bad news (Kothari et al., 2009). When bad news is hidden for some time and then suddenly released, it can be a big shock to the firm’s stock price and lead to a crash.
Moreover, compared to firms with a lower demand for financing, firms with a higher demand for financing have a higher utility level for each unit of financing demand. Managers are more motivated to engage in earnings management and other behaviours and are even willing to pay more to obtain financing (Teoh et al., 1998). This greatly reduces the transparency of financial information and provides more space for managers to conceal bad news (Kim & Zhang, 2014). For example, Sun et al. (2016) find that in firms with a higher demand for financing, managers conceal adverse information to obtain financing more easily, which results in a higher stock price crash risk. Therefore, border firms with financing disadvantages have a strong incentive to selectively disclose good news and conceal bad news to influence the selection of financial resource providers.

The literature on fiscal subsidies also finds that firms may manipulate their earnings to obtain subsidies. Information asymmetry with firms makes it difficult for local governments to monitor the operations and financial status of firms. At the same time, local governments have set a series of standards for the rational allocation of subsidy resources, and accounting profit is one of the most important. Managers are motivated to manipulate earnings to meet these standards and obtain more subsidies. However, the ways in which firms manipulate earnings to obtain subsidies vary. Wang et al. (2014) find that listed Chinese companies manipulated negative earnings to obtain more government subsidies during the financial crisis. However, the purpose of providing fiscal subsidy is to achieve specific political, economic, and social development goals. The government designates and guides the use of subsidy income to induce investment, financing, and market strategy selection among firms rather than just to help firms recover losses (Liu, 2016). Therefore, when the government faces high information costs and has difficulty identifying the advantages and disadvantages of firms, it is more likely to favour firms with expected earnings growth. For example, Zhou & Pan (2019) find that to increase the efficiency of subsidy, the government generally gives the funds only after the firm has achieved a certain target. When considering whether to adjust the subsidy policy, the government usually takes economic value added, market share, the transformation rate of innovation achievements, and other measures into account in their evaluation. It can be expected that, compared to non-border firms, border firms may have a stronger incentive to selectively disclose good news and conceal bad news to stand out from the subsidy crowd and obtain valuable financial support.

However, faced with financial disadvantages, firms’ choice to voluntarily disclose information can help them effectively alleviate information asymmetry (Zhang & Lv, 2007). Border firms may also choose to ‘meet with sincerity’ and voluntarily disclose more transparent and stable information to alleviate information asymmetry with financial resource providers, thus reducing information costs and improving the possibility of obtaining funds. In other words, the provincial border may also affect information transparency and reduce the risk of a stock price crash for border firms. Research on information disclosure and corporate financing supports the effect of information transparency. For example, Watts (2003) proposes that robust disclosure of accounting information can reduce agency conflicts between contract parties, help firms obtain external financing, and effectively alleviate financing constraints. As a result, border firms with resource disadvantages can timely disclose corporate information and improve information quality to acquire the capital needed for their development. Similar speculations can apply to the effect of fiscal subsidies.
Transparent and robust information disclosure can reduce the government’s information costs for screening subsidy objects, which can help it more timely understand the difficulties and challenges faced by firms, better identify the development prospects of firms, and increase the effectiveness of subsidy resources. This in turn will increase the possibility that border firms will obtain funds, thus reducing their risk of a stock price crash.

In sum, to cope with financial disadvantages, border firms may choose to report good news but not bad news or to be honest with each other. Different ways of disclosing information have different effects on the risk of a stock price crash. We thus propose the following two competing hypotheses:

**Hypothesis 1a**: Compared to stock prices of non-border firms, stock prices of border firms have a higher crash risk.

**Hypothesis 1b**: Compared to stock prices of non-border firms, stock prices of border firms have a lower crash risk.

### 3. Research design

#### 3.1. Research sample and data sources

We use data from A-share companies listed on the Shanghai and Shenzhen Stock Exchanges from 2004 to 2016 as the initial research sample. Financial data for these companies are downloaded from the CSMAR database, the WIND database, and the CNRDS database. Information about the geographic locations of the sample firms is manually collected through an online search of Baidu Map. We exclude companies in the financial industry because their financial characteristics are significantly different from those of companies in other industries. Then, to ensure the reliability of the indicator of stock price crash risk, we eliminate listed companies with fewer than 30 annual trading weeks. Next we exclude companies with missing data and companies with abnormal operations, such as those required to be delisted. After excluding these firms, we obtain 19,854 firm-year observations. Of the sample firms, 2953 are located at a provincial border. To eliminate the interference of sample differences in our test results, we use propensity score matching to match border and non-border firms and obtain 5906 firm-year observations after 1:1 nearest neighbour matching. The detailed matching process is described in section 3.2.2. We winsorise continuous variables at 1% and 99% to control the impact of outliers on our regression results.

#### 3.2. Definitions of variables and model design

**3.2.1. Stock price crash risk**

Following Kim & Zhang (2016) and Song et al. (2017), we use the negative conditional return skewness and the down-to-up volatility in firm-specific weekly returns to measure stock price collapse. First, we estimate firm-specific weekly returns using the following index model regression:
\[ R_{i,t} = \beta_0 + \beta_1 R_{m,t-2} + \beta_2 R_{m,t-1} + \beta_3 R_{m,t} + \beta_4 R_{m,t+1} + \beta_5 R_{m,t+2} + \epsilon_{i,t} \]  

(1)

where \( R_{i,t} \) is the return on stock \( i \) in week \( t \) and \( R_{m,t} \) is the value-weighted market index for that week. We include lead and lag variables for the market index to allow for nonsynchronous trading. This regression is chosen to separate firm returns into two components: returns due to market-wide movement, measured using the fitted value of the regression; and firm-specific returns, captured by the residuals of the regression. Our focus is on the residuals of the regression. Following the precedent in the literature, we calculate firm-specific weekly returns for firm \( i \) in week \( t \) (\( W_{i,t} \)) as the natural logarithm of 1 plus the residual: \( W_{i,t} = \ln(1 + \epsilon_{i,t}) \).

Second, we choose the negative conditional return skewness (NCSKEW) as our first measure of the likelihood of a crash. We calculate NCSKEW for a given firm in a fiscal year by dividing the negative of the third moment of firm-specific weekly returns during the same fiscal year by the standard deviation of firm-specific weekly returns, raised to the third power. Specifically, for each firm \( i \) in year \( t \), we derive NCSKEW using Eq. (2):

\[ \text{NCSKEW}_{i,t} = -\frac{n(n-1)^{3/2} \sum W_{i,t}^3}{[(n - 1)(n - 2)\sum W_{i,t}^3]^{3/2}} \]  

(2)

Our other crash risk variable, \( \text{DUVOL}_{i,t} \), is used to measure the down-to-up volatility in firm-specific weekly returns and denotes the degree of asymmetry in volatility between negative and positive stock returns. We calculate \( \text{DUVOL} \) by taking the natural logarithm of the ratio of the standard deviation of down-week firm-specific weekly returns to the standard deviation of up-week firm-specific weekly returns. A firm week is defined as an up (down) week if the firm-specific weekly return is above (below) its annual mean. Specifically, \( \text{DUVOL} \) is calculated using Eq. (3):

\[ \text{DUVOL}_{i,t} = \log \left\{ \frac{\sum_{\text{Down}} W_{i,t}^2}{\left( \sum_{\text{Up}} W_{i,t}^2 \right)} \right\} \]  

(3)

The larger \( \text{NCSKEW}_{i,t} \) and \( \text{DUVOL}_{i,t} \), the greater the negative conditional return skewness and down-to-up volatility and the higher the crash risk.

### 3.2.2. Geographic location of the firm

Following Long and Hu (2018), we manually collect data on firms’ geographic location and set the main independent variable as \( \text{Border} \). First, we initially try to define the indicator variable \( \text{Border} \) by judging whether the city where a firm is registered is located at the provincial border, but we find that more than 75% of cities are located at the provincial border. These data are obviously too rough to support our research. Therefore, we reset the indicator variable \( \text{Border} \) by judging whether the county where the firm is registered, rather than the city where the firm is registered, is located at the provincial border. \( \text{Border} \) equals 1 if the firm is at the provincial border and 0 otherwise.\(^1\) We obtain 2953 border samples and 16,901 non-border samples.

\(^1\)There are three types of provincial border: provincial, national, and coastal. Because the latter two do not involve provincial externalities leading to biased resource allocation, we follow Zhou and Tao (2011) and assume that county-level cities located at national or coastal borders are not located at provincial borders. For similar reasons, counties adjacent to Hong Kong or Macau are also excluded from the provincial border.
Second, characteristics of the area where the firm is registered, such as geographic environment, cultural differences, and so on, may influence our test results. To address the potential for unknown factors, we calculate the shortest distance\(^2\) between the firm and the provincial border line. Furthermore, we select border and non-border firms with similar shortest distances to the border using 1:1 nearest neighbour matching.\(^3\) Ultimately the research sample contains 5906 firm-year observations.

### 3.3. Empirical model

To test whether the firm’s geographic location affects its stock price crash risk, we follow Kim & Zhang (2016) and design the following model:

\[
Crash_{t+1} = a_0 + a_1 \text{Border}_t + \text{Control Variable}_t + YR + \text{FIRM} + \epsilon
\]  

(4)

where \(Crash_{t+1}\) represents the stock price crash risk of the firm, which is measured by \(NCSKEW\) and \(DUVOL\) in the period \(t + 1\), respectively, and \(\text{Border}\) represents whether the firm is located at the provincial border. We use a set of control variables that are widely considered potential predictors of stock price crash risk, that is, detrended share turnover \((\text{Dtturn})\), the negative skewness of firm-specific weekly returns \((\text{NCSKEW})\), standard deviations of firm-specific weekly returns \((\text{Sigma})\), firm-specific average weekly returns \((\text{Return})\), firm size \((\text{Size})\), the market-to-book ratio \((\text{MTB})\), financial leverage \((\text{LEV})\), return on assets \((\text{ROA})\), and information transparency \((\text{Absacc})\). Referring to Long and Hu (2018), we also control for characteristics of the area where the firm is registered, such as the geographic distance between the address where the firm is registered and the capital city of the same province \((\text{Distance})\) and whether there is high-speed rail \((\text{HSR})\) in the area where the firm is registered. \(YR\) and \(\text{FIRM}\) represent year and firm fixed effects, respectively. \(\epsilon\) is the residual. Detailed definitions of variables are provided in Table 1.

### 4. Baseline results and analysis

#### 4.1. Descriptive statistics

Table 2 presents descriptive statistics for the dependent and independent variables, as well as the control variables, based on the sample of 5906 observations. The mean (median) \(NCSKEW\) and \(DUVOL\) for stock price crash risk are \(-0.3210 \ (-0.2778)\) and \(-0.2641 \ (-0.2613)\), respectively, which are similar to results reported in other studies on Chinese markets. The standard deviations are 0.6814 and 0.4656, respectively, which indicates large individual differences in the stock price crash risk of sample companies. The distributions of other control variables are within a reasonable range.

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\(^2\)To calculate the shortest distance to the provincial borders, we first obtain the latitude and longitude of the listed company. Then we divide the provincial boundary line of the Baidu map into a set of 2000 points on average and obtain the latitude and longitude of these points. Finally, we calculate the set of distances between the listed company and each point on the provincial borders and take the minimum value as the shortest distance between the listed company and the provincial borders.

\(^3\)To save space, some results are not tabulated, but can be obtained by contacting the corresponding author.
Table 1. Definitions and measurement of main variables.

| Variable | Measure |
|----------|---------|
| NCSKEW   | The negative coefficient of the skewness of firm-specific weekly returns in the fiscal year |
| DUVOL    | The log of the ratio of the standard deviation of firm-specific weekly returns for down weeks to the standard deviation of firm-specific weekly returns for up weeks |
| Border   | Equals 1 if the firm is at the provincial border and 0 otherwise |
| Dturn    | The average monthly turnover in the fiscal year minus the average monthly turnover in the year before the fiscal year |
| Sigma    | The standard deviation of firm-specific weekly returns in the fiscal year |
| Return   | The average firm-specific weekly return in the fiscal year |
| Size     | The log of total assets |
| MTB      | The market-to-book ratio |
| LEV      | Financial leverage, which is total long-term debt divided by total assets |
| ROA      | Return on assets |
| Absacc   | The absolute value of the residual of the modified Jones model |
| Distance | The distance between the address where the firm is registered and the capital city of the same province in kilometres, plus 1 to get the natural logarithm |
| HSR      | Equals 1 if the city where the firm is located has high-speed rail and 0 otherwise |

Table 2. Descriptive statistics.

| Variable | N   | Mean      | SD   | Min     | Median | Max     |
|----------|-----|-----------|------|---------|--------|---------|
| NCSKEW   | 5906| -0.3210   | 0.6814| -2.4362 | -0.2778| 1.6320  |
| DUVOL    | 5906| -0.2641   | 0.4656| -1.9693 | -0.2613| 1.6537  |
| Border   | 5906| 0.5000    | 0.5000| 0.0000  | 0.5000 | 1.0000  |
| Dturn    | 5906| -0.0024   | 0.0599| -0.4957 | -0.0012| 0.2528  |
| Sigma    | 5906| 0.0700    | 0.0271| 0.0271  | 0.0630 | 0.1792  |
| Return   | 5906| 0.0062    | 0.0130| -0.0220 | 0.0047 | 0.0522  |
| ROA      | 5906| 0.0368    | 0.0608| -0.2929 | 0.0358 | 0.2057  |
| Size     | 5906| 21.8140   | 1.2900| 19.0429 | 21.6470| 25.6590 |
| MTB      | 5906| 2.0894    | 1.9788| 0.1629  | 1.4734 | 11.551  |
| LEV      | 5906| 0.4594    | 0.2271| 0.0474  | 0.4620 | 1.4672  |
| Absacc   | 5906| 0.0519    | 0.0697| 0.0006  | 0.0328 | 0.5032  |
| Distance | 5906| 3.9833    | 1.4815| 0.0000  | 4.5142 | 9.4504  |
| HSR      | 5906| 0.4074    | 0.4914| 0.0000  | 0.0000 | 1.0000  |

4.2. Baseline analysis

Table 3 reports the results of estimating model (4). Columns (1) and (2) control for conventional variables that affect stock price crash risk, such as Size, LEV, ROA, Absacc, and so on. Border is positively associated with both NCSKEW and DUVOL at least at the 5% level, which suggests that the stock prices of firms located at a provincial border have higher crash risk. In columns (3) and (4), we further control Distance, and the regression results are consistent with those reported in columns (1) and (2). This suggests that the difference in stock price crash risk between border and non-border firms is not caused by the agglomeration of economically developed provincial capital cities. Overall, the results reported in Table 3 support Hypothesis 1a. That is, compared to non-border firms, border firms have higher risk of a stock price crash.
Table 3. Provincial border and stock price crash risk.

|                  | (1) $NCSKEW_{t+1}$ | (2) $DUVOL_{t+1}$ | (3) $NCSKEW_{t+1}$ | (4) $DUVOL_{t+1}$ |
|------------------|---------------------|-------------------|---------------------|-------------------|
| Border           | 0.2928***           | 0.1587***         | 0.3021***           | 0.1652***         |
|                  | (2.8447)            | (2.3707)          | (3.1216)            | (2.6034)          |
| Distance         |                     |                   | 0.0407              | 0.0286            |
|                  |                     |                   | (1.5423)            | (1.5183)          |
| HSR              | -0.0324             | -0.0604***        | -0.0318             | -0.0600**         |
|                  | (-0.8516)           | (-2.3158)         | (-0.8360)           | (-2.2991)         |
| Dturn            | -0.1420             | -0.0687           | -0.1431             | -0.0695           |
|                  | (-0.8109)           | (-0.5435)         | (-0.8175)           | (-0.5501)         |
| Return           | 4.8334***           | 2.5487**          | 4.8174***           | 2.5375**          |
|                  | (3.1472)            | (2.3319)          | (3.1380)            | (2.3245)          |
| LEV              | 0.0318              | -0.0390           | 0.0395              | -0.0336           |
|                  | (0.3645)            | (-0.6302)         | (0.4533)            | (-0.5417)         |
| ROA              | 0.1303              | 0.0476            | 0.1136              | 0.0359            |
|                  | (0.5797)            | (0.3065)          | (0.5055)            | (0.2305)          |
| Sigma            | 1.5355**            | 1.2664**          | 1.5617**            | 1.2848**          |
|                  | (2.0496)            | (2.3984)          | (2.0799)            | (2.4277)          |
| Size             | -0.0143             | 0.0006            | -0.0200             | -0.0034           |
|                  | (-0.5309)           | (0.0329)          | (-0.7290)           | (-0.1820)         |
| MTB              | 0.0194*             | 0.0134*           | 0.0193*             | 0.0134*           |
|                  | (1.8299)            | (1.9111)          | (1.8205)            | (1.9034)          |
| Absacc           | -0.0682             | -0.1513           | -0.0593             | -0.1451           |
|                  | (-0.4855)           | (-1.5287)         | (-0.4206)           | (-1.4588)         |
| NCSKEW           | -0.0871***          | -0.0489***        | -0.0871***          | -0.0489***        |
|                  | (-5.9822)           | (-4.6839)         | (-5.9836)           | (-4.6863)         |
| Constant         | -0.0048             | -0.2846           | -0.0531             | -0.3185           |
|                  | (-0.0085)           | (-0.7419)         | (-0.0942)           | (-0.8347)         |
| Year effect      | Yes                 | Yes               | Yes                 | Yes               |
| Firm effect      | Yes                 | Yes               | Yes                 | Yes               |
| N                | 5906                | 5906              | 5906                | 5906              |
| Adjusted R²      | 0.0556              | 0.0467            | 0.0557              | 0.0468            |

Notes: (1) t statistics in parentheses. (2) * p < 0.1, ** p < 0.05, *** p < 0.01. (3) This note also applies to the following tables.

4.3. Robustness tests

4.3.1. DID test of firm relocation

A total of 455 listed companies in our sample change their registration addresses, including 14 firms that move from border areas to non-border areas (126 observations) and 9 firms that move from non-border areas to border areas (97 observations). This allows us to use a DID approach to explore the causal relationship between a firm's geographic location and its stock price crash risk.

Specifically, we design the move-in DID model and the move-out DID model. We take the border firms that move out of the provincial border area as the treatment group and the firms that have always been in the provincial border area as the control group to design the move-out DID model. We introduce the dummy variable $TreatPost_out$, which equals 1 if the border firms move out of the provincial border area and 0 otherwise. Similarly, we take the non-border firms that move into the provincial border area as the treatment group and the firms that have never been in the provincial border area as the control group to design the move-in DID model. We introduce another dummy variable, $TreatPost_in$, which equals 1 if the non-border firms move into the provincial border area and 0
4.3.4. **An extended prediction window**
Following Song et al. (2017), we extend the measurement window of stock price crash risk to \( t + 2 \) to test whether the results remain consistent. The untabulated results suggest that our results are robust to sample specifications.

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Table 4. Difference-in-differences (DID) test based on firm relocation.

| TreatPost_out | Move-out DID model | Move-in DID model |
|---------------|-------------------|------------------|
| \( \text{TreatPost}_{out} \) | (1) NCSKEW_{t+1} | (3) NCSKEW_{t+1} |
| | –0.2824* | 0.5132*** |
| | (–1.6936) | (2.7892) |
| TreatPost_in | (2) DUVOL_{t+1} | (4) DUVOL_{t+1} |
| | –0.0825 | 0.4176*** |
| | (–0.6804) | (3.5751) |
| Control/Firm/Year effect | Yes | Yes |
| N | 252 | 252 |
| Adjusted R\(^2\) | 0.1187 | 0.1481 |

otherwise.\(^4\) We add \( \text{TreatPost}_{out} \) and \( \text{TreatPost}_{in} \), respectively, to model (4) to test the difference in stock price crash risk before and after the relocation of the firms. The results of the DID test in Table 4 provide strong support for our main hypothesis that the stock price crash risk of border firms is higher than that of non-border firms.

### 4.3.2. Sensitivity to the measure of stock price crash risk
Following Pan et al. (2011), we use an alternative measure of the likelihood of a crash for each firm in each year in Eq. (5):

\[
W_{i,t} \leq \text{Average}(W_{i,t}) - 3.09\sigma_i
\]

where \( W_{i,t} \) represents firm-specific weekly returns for firm \( i \) in week \( t \), \( \text{Average}(W_{i,t}) \) is the annual average of firm-specific weekly returns for firm \( i \) in the fiscal year, and \( \sigma_i \) is the standard deviation of firm-specific weekly returns for firm \( i \) in the corresponding year. Under a standard normal distribution, 3.09 SD corresponds to a probability interval of 0.1%. We introduce the indicator variable \( \text{CRASH} \), which equals 1 if the weekly return \( W_{i,t} \) satisfies Eq. (5) at least once within the fiscal year and 0 otherwise. We use a logit regression model for the empirical analysis. The untabulated results are significantly positively correlated with \( \text{CRASH} \) at the 10% level.

### 4.3.3. Alternative samples
First, we select non-border firms within 20 kilometres of border firms as the control sample for a robustness test. Second, since resource constraints may not be a significant issue, as national and maritime boundaries are affected by environmental factors such as international trade. We exclude provinces with national or maritime boundaries from the original sample and rerun the regression model. The untabulated results are consistent with our main results.

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\(^4\)Each pair of treatment group and control group in the two DID models is matched on financial characteristics with propensity score matching. Financial characteristics include firm size, financial leverage, return on assets, state ownership, corporate governance, industry, and year.
4.3.5. An alternative measure of geographic distance

In some provinces, the most economically developed cities are not the capital of the province. For example, the most economically developed city in Shandong province in 2020 was Qingdao rather than Jinan. Thus, we redefine the variable Distance as the distance between the address where the firm is registered and the most economically developed city in the same province. The untabulated results show that the relationship between the provincial boundary location of firms and stock price crash risk still holds.

4.3.6. Controlling for macrolevel regional factors

Regional characteristics (e.g. regional marketisation, the legal environment, cultural differences) as well as differences in the economic development of adjacent prefecture-level cities and the strength of regional environmental regulation may affect the research conclusions. Therefore, we control for environmental regulation, cultural difference index, market index, legal environment index, as well as the difference in per capita gross domestic product between neighbouring cities. The untabulated results show that the conclusions are robust.

5. Mechanism analysis

According to the theoretical framework of this paper, unequal allocation of public resources in border areas increases information asymmetry between stakeholders (such as creditors, the government, etc.) and firms. This may not only hinder border firms’ access to resources but also lead to their aggressive disclosure of information. Therefore, we extend the channel test from the perspective of resource constraints (credit constraints and government subsidies) and information disclosure strategies of border firms.

5.1. Resource constraints of border firms

We test whether the geographic location of border firms is related to their higher resource constraints. The model is designed as follows:

\[
Resource = a_0 + a_1 \text{border}_1 + \text{control variable}_t + \text{YR}_t + \text{FIRM}_t + \epsilon
\]

where Resource is the dependent variable that measures the resource constraints of firms. It is represented by annual new loans, debt financing costs, and government subsidies, respectively. Annual new loans (\textit{Debt Raise}) is measured as the difference between bank borrowings at the end of year \(t\) and the beginning of year \(t\) divided by total assets at the beginning of year \(t\), debt financing costs (\textit{Debt Cost}) is measured as annual interest expenses divided by the total amount of bank borrowings, and government subsidies (\textit{Sub}) is equal to the government subsidy obtained by the firm in the current year plus 1 to get the logarithm. Following Wang et al. (2014), we control firm size, financial leverage, growth in operating income, return on assets, the proportion of fixed assets, state ownership, the age of the firm, geographic distance, year fixed effects and firm fixed effects.

\textbf{Table 5} reports the regression results for model (6). In column (1), annual new loans (\textit{Debt Raise}) is the dependent variable. \textit{Border} is significantly negatively correlated with \textit{Debt Raise} at the 10% level, which indicates that border firms obtain fewer new loans
Table 5. Provincial border and stock price crash risk: Resource constraints.

|               | (1) Debt Raise | (2) Debt Cost | (3) Sub |
|---------------|----------------|---------------|--------|
| Border        | −0.0529*       | 0.2399**      | −4.3085*** |
| (−1.8503)     | (2.2303)       | (−5.4123)     |
| Control/Firm/Year effect | Yes            | Yes           | Yes    |
| N             | 5411           | 4943          | 5567   |
| Adjusted R²   | 0.1304         | 0.0191        | 0.6901 |

each year than non-border firms. Debt_Cost is the dependent variable in column (2). Border is significantly positively correlated with Debt_Cost at the 5% level, which indicates that the bank credit costs of border firms are higher than those of non-border firms. In the regression of government subsidies (Sub) in column (3), Border is significantly negatively correlated with Sub at the 1% level, which indicates that local governments may allocate their fiscal subsidy resources strategically. On the whole, the results in Table 5 show that capital resources are more prevalent among firms in non-border areas, whereas border firms face more serious resource constraints.

5.2. Aggressive information disclosure of border firms

Furthermore, we investigate whether border firms that face higher financing constraints adopt more aggressive information disclosure policies because of financing demand, which leads to a higher stock price crash risk. The following model is tested:

$$AccountPolicy_i = \alpha_0 + \alpha_1 \text{Border}_i + \text{Control Variable}_i + YR + FIRM + \epsilon \quad (7)$$

where AccountPolicy is corporate information disclosure, which mainly includes accrual earnings management (Absacc), accounting conservatism (Cscore), and the tone of the MD&A section of the annual report (Tone). Control variables include firm size, financial leverage, growth in operating income, return on assets, state ownership, external auditing, the market-to-book ratio, asset turnover, firm age, geographic distance, year fixed effects and firm fixed effects.

Table 6 reports the regression results for model (7). In column (1), accrual earnings management (Absacc) is the dependent variable. Border is significantly positively associated with Absacc at the 1% level, which indicates that border firms engage in more accrual earnings management than non-border firms. In column (2), the accounting

Table 6. Provincial border and stock price crash risk: Information disclosure.

|               | (1) Absacc      | (2) Cscore     | (3) Tone     |
|---------------|----------------|---------------|--------------|
| Border        | 0.0523***      | −0.0311*      | 0.0273*      |
| (4.3381)      | (−2.0848)      | (1.8970)      |
| Control/Firm/Year effect | Yes            | Yes           | Yes          |
| N             | 5672           | 5718          | 5623         |
| Adjusted R²   | 0.0658         | 0.6439        | 0.2683       |

5We quantify accounting conservatism using the Cscore model of Khan and Watts (2009) and calculate accrual earnings management using the adjusted Jones model.

6Referring to Di et al. (2020), we calculate the net positive tone of the MD&A section of the annual report.
 conservatism index (CScore) is the dependent variable. Border is significantly negatively correlated with CScore at the 10% level, which indicates that the accounting conservatism of border firms is lower than that of non-border firms (i.e. border firms tend to disclose good news in advance and delay the disclosure of bad news). Border in column (3) is significantly positively associated with Tone at the 10% level, which indicates that the MD&A sections of border firms use more positive words. Combining the results of Tables 5 and 6, we can verify the theoretical logic of our argument: Because border companies are more likely than non-border companies to face resource constraints, they tend to use more aggressive disclosure strategies to mitigate constraints, including manipulating accruals, reducing accounting conservatism, and using a more positive tone in MD&A. This is an important mechanism that leads to their higher risk of a stock price crash.

6. Further analyses

6.1. Heterogeneity of the border

Heterogeneous regional development strategies and interregional differences in economic development may lead to different degrees of interprovincial externalities. Thus, we analyse the heterogeneity of border effects by considering the borders of integrated areas and the borders of areas adjacent to municipalities.

Regional integration is an important strategy for improving the spatial efficiency of economic development and realising coordinated regional development, which is conducive to changing the relationship between regions from a competitive one to a cooperative one. Compared to general border areas, border areas in regional integrations may not have the problems of externality and lack of public resources, and there may be no border effect at the borders of integrated areas. We define Beijing–Tianjin–Hebei and Jiangsu–Zhejiang–Shanghai as integrated regions and substitute Border with two new variables, Border_Integration (the border of integrated areas) and Border_NonIntegration (the border of non-integrated areas).

In addition, we assume that provincial externalities are consistent, but a difference in economic development between two adjacent regions may lead to heterogeneous externalities. In other words, the economic development of adjacent areas may affect local governments’ strategies for allocating public resources and the information efficiency of border areas. For example, economically developed border areas may improve the allocation of public resources and information efficiency of neighbouring economically backward border areas and thereby reduce the stock price crash risk of firms located in these backward areas. However, this may also produce siphon effect, absorbing all kinds of high-quality production factors and talent from the economically backward border areas, intensifying the resource constraints and reducing the information efficiency of firms located in these backward areas, and finally increasing their stock price crash risk. Therefore, we redefine the border variables according to China’s unique administrative regionalisation

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7 We focus on bias in interprovincial resource allocation and information costs, so the strategic deployment of regional integration within the Pearl River Delta province is not taken into account.

8 Border_Integration equals 1 if the province in which the border firm is located and the neighbouring province are regionally integrated and 0 otherwise. Border_NonIntegration equals 1 if the province in which the border firm is located and the neighbouring province are not regionally integrated and 0 otherwise.
system and replace the border variable (Border) with variables for the adjacent (Border_ZXS) and nonadjacent (Border_NonZXS) borders of municipalities with a high level of economic development (including Beijing, Tianjin, Shanghai, and Chongqing).9

Table 7 presents the results of a heterogeneity test of the border effect. The coefficients of Border_Integration in columns (1) and (2) are positive but nonsignificant, whereas the coefficients of Border_NonIntegration are positive and significant at the 1% level. There is no significant difference in the stock price crash risk of border and non-border firms in integrated regions, and the border effect is mainly reflected in non-integrated regions. The coefficients of Border_ZXS in columns (3) and (4) are not significant; the coefficient in column (4) is negative, whereas the coefficient of Border_NonZXS is positive and significant, which indicates that the border effect is not obvious in the borders of areas adjacent to municipalities. These results support the improving effect to some extent and rule out the siphon effect.

6.2. Government-level governance: digital empowerment

Digital economy can significantly reduce costs, improve quality, and increase efficiency (Goldfarb & Tucker, 2019). As specific forms of the digital economy, the digital transformation of the government and the construction of information infrastructure (such as 5 G construction) can reduce information costs between border firms and financial resource providers. Therefore, accelerating the digital transformation of the government and the infrastructure construction of information in border areas may help the government and creditors obtain relevant information on border firms more easily and accurately before allocating capital (ex ante investigation) and monitor and manage the use of capital resources more effectively afterwards (ex post management). This will improve the allocation efficiency of government subsidies and credit resources and prevent biased resource allocation due to the information disadvantage of border firms.

Therefore, it can be reasonably expected that digital transformation and the information infrastructure construction can effectively reduce information asymmetry between border firms and the financial resource providers, alleviate the resource constraints of border firms, and thus reduce their risk of a stock price crash. We use model (8) to test these expectations:

\*Border_ZXS equals 1 if the border firm is adjacent to the municipality and 0 otherwise. Border_NonZXS equals 1 if the border firm is not adjacent to the municipality and 0 otherwise.
where \( \text{Moderator} \) is the moderator variable for the digital transformation of the government (\( \text{DigitalGov} \)) and the information infrastructure construction (\( \text{NewInfrastru} \)). \( \text{DigitalGov} \) is a dummy variable that equals 1 if the city appears in the 2020 Digital Government Development Index Report (i.e. the listed company is located in Shenzhen, Hangzhou, Guangzhou, Ningbo, Qingdao, Xiamen, Suzhou, Wuhan, Nanjing, Chengdu, Jinan, Shenyang, Dalian, Harbin, or Changchun) and 0 otherwise. \( \text{NewInfrastru} \) is the Urban Internet Development Index, which is measured logarithmically by adding 1 to the number of broadband Internet access ports at the city level.

Table 8 shows the results for model (8). The variables of interest (\( \text{Border} \_\text{DigitalGov} \) and \( \text{Border} \_\text{NewInfrastru} \)) are negatively associated with two variables of stock price crash risk at least at the 10% level. This indicates that the digital transformation of the government and the information infrastructure construction in border areas can reduce the stock price crash risk of border firms to a certain extent.

### 6.3. Firm-level governance: improvements in the information environment

Securities analysts, media, and auditors are important intermediaries and disseminators of information in the financial market. They can use their expertise and skills to find and process firm information, then transmit this information to key stakeholders (in this paper, this mainly refers to the government and creditors) through the media. This improves the comprehensiveness and accuracy of understanding of the company’s soft information, reduces information asymmetry with the firm, and plays an external governance role by reducing the information cost of the high stock price crash risk of border firms.

We use analyst following (\( \text{Analyst} \)), media attention (\( \text{Media} \)), and domestic top 10 accounting firm (\( \text{Big10} \)) as proxy variables for the corporate information environment and introduce these variables as moderators into model (8). \( \text{Analyst} \) is the logarithm of the number of analysts who track the listed company plus 1. \( \text{Media} \) is the natural logarithm of

### Table 8. Provincial border and stock price crash risk: Digital empowerment.

|                         | Digital transformation of the government | Information infrastructure construction |
|-------------------------|------------------------------------------|---------------------------------------|
|                         | (1) \( NCSKEW_{t+1} \)                  | (2) \( DUVOL_{t+1} \)                | (3) \( NCSKEW_{t+1} \)                  | (4) \( DUVOL_{t+1} \)                |
| Border                  | 0.2897** (2.5456)                        | 0.1462* (1.9556)                      | 0.3557*** (3.1152)                      | 0.1884*** (2.6360)                   |
| Border_DigitalGov       | -0.4887* (-1.7299)                      | -0.3045* (-1.9468)                    | -0.0901*** (-4.6161)                    | -0.1018*** (-5.7142)                 |
| DigitalGov              | -0.1540 (-0.8968)                       | -0.1707** (-2.1749)                   | -0.0717*** (4.2095)                     | 0.0718*** (7.9404)                   |
| Border_NewInfrastru     |                                         |                                       | -0.0901*** (-4.6161)                    | -0.1018*** (-5.7142)                 |
| NewInfrastru            |                                         |                                       | 0.0717*** (4.2095)                      | 0.0718*** (7.9404)                   |
| Control/Firm/Year effect| Yes                                      | Yes                                   | Yes                                   | Yes                                   |
| N                       | 5906                                     | 5906                                  | 5513                                  | 5513                                  |
| Adjusted \( R^2 \)      | 0.0556                                   | 0.0469                                | 0.0498                                | 0.0467                                |
Table 9. Provincial border and stock price crash risk: The information environment.

|                          | Big 10 accounting firm | Media attention | Analyst following |
|--------------------------|------------------------|-----------------|-------------------|
|                          | (1) NCSKEW<sub>t+1</sub> | (2) DUVOL<sub>t+1</sub> | (3) NCSKEW<sub>t+1</sub> | (4) DUVOL<sub>t+1</sub> | (5) NCSKEW<sub>t+1</sub> | (6) DUVOL<sub>t+1</sub> |
| Border                   | 0.3070***               | 0.1676***       | 0.4651***         | 0.3152***         | 0.4089***               | 0.2589***               |
|                          | (3.1140)                | (2.5955)       | (3.9400)          | (4.0807)          | (3.5819)                | (3.2841)                |
| Border_Big10             | –0.2952***              | –0.1436*       | –0.1179**         | –0.1152***        | –0.0601**               | –0.0564***               |
|                          | (–2.7136)               | (–1.9473)      | (–2.3359)         | (–3.4164)         | (–2.1133)               | (–2.8394)               |
| Big10                    | 0.0126                  | 0.0039         | 0.0084*           | 0.0062            | 0.0780***               | 0.0310*                |
|                          | (0.1509)                | (0.0678)       | (–1.7343)         | (–0.1954)         | (–3.0835)               | (–1.7304)               |
| Border_Media             | –0.1179**               | –0.1152***     | –0.0848*          | –0.062            | –0.0601**               | –0.0564***               |
| Media                    |                        |                |                   |                  | (–2.3359)               | (–3.4164)               |
|                          |                        |                | (–1.7343)         | (–0.1954)         |                        |                        |
| Border_Analyst           |                        |                |                   |                  | –0.0601**               | –0.0564***               |
|                         |                        |                |                   |                  | (–2.1133)               | (–2.8394)               |
| Analyst                  |                        |                |                   |                  | –0.0780***               | –0.0310*                |
|                          |                        |                |                   |                  | (–3.0835)               | (–1.7304)               |
| Control/Firm/Year effect | Yes                    | Yes            | Yes               | Yes              | Yes                    | Yes                    |
| N                        | 5906                   | 5906           | 5906              | 5906             | 5906                   | 5906                   |
| Adjusted R<sup>2</sup>   | 0.0589                 | 0.0484         | 0.0604            | 0.0510           | 0.0673                 | 0.0561                 |

the cumulative annual news coverage of the listed company plus 1. Big10 is a dummy variable that equals 1 if the company is audited by a top 10 audit institution and 0 otherwise. It can be expected that an improved information environment will help alleviate the stock price crash risk of border firms as analyst following, media attention, and auditing quality improve. In columns (1) to (6) of Table 9, the coefficients of the three interaction terms Border_Big10, Border_Media, and Border_Analyst are all negative and significant, which supports this expectation. That is, improving the information environment of border firms can effectively reduce their risk of a stock price crash.

7. Research conclusions and implications

Unbalanced regional development is a major issue in China today. Studies have focused on the imbalance between urban and rural development and interprovincial development but pay less attention to the border effect and how it causes wide economic gaps between border and non-border areas within the same province. From the perspective of firm stock price crash risk, we explore how the high information cost caused by asymmetry in the allocation of public resources induces the selective disclosure of information among border firms against the realistic backdrop of the existence of a border effect. We find that border firms have a higher stock price crash risk than non-border firms. Further analyses show that border firms have lower available credit, higher financing costs, and smaller government subsidies; at the same time, they have higher accrual earnings management, lower accounting conservatism, and a more positive tone in the MD&A section of the annual report. These results support the theoretical analysis in this paper, that is, that the aggressive information disclosure of border firms in resource-constrained environments is an important cause of their higher stock price crash risk. Furthermore, there is no border effect in the borders of integrated areas or in the borders of areas adjacent to municipalities. Moreover, digital empowerment and external governance can effectively reduce information costs, thus mitigating the stock price crash risk of border
firms. Specifically, we find that accelerating the digital transformation of the government and the information infrastructure construction, as well as strengthening external governance (such as analyst following, media attention, and high-quality auditing) can partially alleviate the stock price crash risk of border firms.

From the perspective of resource constraints and information disclosure at the firm level, this paper provides new evidence and explanations for the phenomenon and causes of the border effect, which has important policy implications for improving the coordination of regional development and the healthy development of the capital market. First, reducing transaction costs among stakeholders is an important aspect of promoting institutional reform. Against the backdrop of China’s fiscal decentralisation and political centralisation, the externality of border areas leads to unbalanced allocation of regional public resources by local governments. This not only leads to lower economic development in border areas but also reduces the information efficiency of economic subjects in these areas and the resource allocation efficiency of the market. However, measures taken by border economic subjects to deal with their disadvantages in information and resources will in turn strengthen the border effect. Local governments should establish a coordination mechanism rather than a competition mechanism to solve this external problem, which can trap the economy in a vicious cycle.

Second, strengthening external governance, such as analyst following, media attention, and high-quality auditing, can improve the information environment of border firms, alleviate information asymmetry between financial resource providers and border firms, and reduce aggressive information disclosure among border firms to a certain extent. This suggests that reducing information costs is an important mechanism for alleviating the micro-border effect and that strengthening intermediary governance is effective for solving the border trap.

Finally, the resource demands of border firms lead to asymmetric information disclosure and higher market risk. In September 2016, the China Securities Regulatory Commission issued A Guideline on Developing the Role of the Capital Market in Poverty Alleviation Services, which aims to support firms in specific poor regions (most located in border areas) in using the capital market for financing, but the policy ignores potential market risks. Therefore, regulators need to pay more attention to the quality of information disclosure among border firms and timely give investors warning to promote the healthy development of the capital market.

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