

High-speed rail and dividend smoothing

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Abstract

Purpose – This study enriches our comprehension of the broader consequences of high-speed rail expansion and offers empirical evidence to the ongoing discourse surrounding cash dividend smoothing.

Design/methodology/approach – This study investigates the impact of transportation infrastructure, specifically high-speed rail, on the smoothness of cash dividends within firms. It employs a quasi-natural experiment approach with the difference-in-difference method.

Findings – Results reveal a significant decrease in cash dividend smoothness following the introduction of high-speed railways in the city where the firm is registered. The influence of high-speed rail on cash dividend volatility is attributed to three primary channels: mitigating information asymmetry, reducing reliance on shareholder dividends, and easing financing constraints. Heterogeneity analysis indicates that the opening of high-speed rail is more likely to induce cash dividend volatility in companies with higher levels of institutional investor shareholdings and in more competitive markets.

Research limitations/implications – This study highlights varying impacts of cash dividend volatility on analyst forecast accuracy and individual stock turnover based on the firm's dividend payout level.

Practical implications – This research contributes to new geographic economics and offers empirical insights into dividend smoothing research, as well as regulatory policies, such as those set forth by the CSRC (China Securities Regulatory Commission).

Social implications – The study provides valuable insights for management in crafting dividend policies. In instances where a company struggles to inspire investor confidence through high dividend payouts or maintain stability with low dividends, it may contemplate increasing dividend volatility to capture investor attention.

Originality/value – The study highlights that cash dividend volatility yields varied economic outcomes depending on the level of dividend payout ratios. Tailoring smoothing guidelines based on dividend levels could better align with investor interests and enhance the overall information environment. These insights offer novel perspectives on regulatory guidelines, such as those set forth by the CSRC, pertaining to dividend regulation.

Keywords High-speed railway, Dividend smoothing, Information asymmetry

Paper type Research article

1. Introduction

Determining when to increase or decrease dividends depends on various factors, particularly in mature and emerging markets. In mature markets, companies typically aim to maintain stable dividend distributions even when facing positive or negative earnings shocks, as consistent cash dividends have become a financial guideline (Larkin *et al.*, 2017). However, in emerging markets, dividend variability among listed companies tends to be higher. To enhance dividend payouts among listed firms, China's Securities Regulatory Commission (CSRC) issued guidelines such as "Supervisory Guideline for Listed Companies No. 3 - Cash Dividends for Listed Companies" in 2013, with subsequent revisions in 2022 and 2023. While these regulations address the level of cash dividends, they also stress the importance of consistency, reasonableness, and stability in dividend payments. The concept of dividend smoothing, first



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introduced by [Lintner \(1956\)](#), has been a significant topic in financial research, with studies exploring various factors influencing cash dividend smoothing. These factors include management characteristics, cross-listing, agency conflicts, information asymmetry, reference points, dividend tax rates, among others. However, differences in national culture, equity structure design, and investor protection levels across countries lead to variations in the explanations for cash dividend smoothing by these factors. Despite extensive research, it remains uncertain whether maintaining a stable cash dividend policy can effectively serve as a governance mechanism and enhance the corporate information environment. ([Brockman et al., 2022](#)).

The accessibility of information for shareholders significantly influences a company's cash dividend policy. Shareholders of companies situated in geographically remote areas often demand consistent and substantial cash dividends, whereas companies located closer to urban centers tend to experience more frequent changes in their dividend policies ([John et al., 2008](#)). The establishment of high-speed railways serves as a vital mechanism to bridge spatial and temporal distances, facilitating shareholder oversight of management practices. Moreover, it fosters improved internal communication within companies and facilitates access to company information for potential investors, banks, and other financial institutions. Since the initiation of China's "eight vertical and eight horizontal" strategy by the government, factors such as "manpower," "material resources," "capital," and "information" have gained increasing significance. Notably, the rapid flow of information across different regions has been facilitated by the introduction of high-speed rail networks. While the development of high-speed railways is known to stimulate economic growth ([Liu and Yan, 2017](#)), it can also lead to resource imbalances, creating a drain on resources and potentially impeding the development of neighboring cities ([Qin, 2017](#)).

In the frictionless perfect market described by MM (Modigliani-Miller), cash dividend distribution is viewed as a residual outcome subsequent to investment decisions, with dividend policy considered independent of the financing environment. However, empirical evidence suggests that management often prioritizes maintaining long-term financial flexibility ([Graham, 2022](#)). To mitigate potential cash shortages due to future mismanagement and reduce capital risk, firms employ various strategies to uphold financial slack, combining capital retention, investment, and external financing sources proactively. When facing high external financing costs, some firms opt for a conservative approach, choosing low and consistent dividend payouts as a precautionary measure ([Bates et al., 2009](#)). Conversely, others pursue high and sustained dividend distributions to lower the threshold for accessing capital ([DeAngelo and DeAngelo, 2007](#)). To preserve long-term financial flexibility, firms may refrain from significant alterations in dividend policy, favoring stability instead. According to [John et al. \(2008\)](#), equity financing costs decrease as the distance between financial institutions and firms diminishes. Therefore, we hypothesize that changes in the financing environment, prompted by the introduction of high-speed rail (HSR), may influence cash dividend policy dynamics. Leveraging the quasi-natural experiment of HSR introduction, this paper investigates its impact on cash dividend smoothness using data from A-share listed companies in China's Shanghai and Shenzhen markets from 2013 to 2022. Our results indicate that the introduction of high-speed rail significantly increases cash dividend volatility among companies. This finding persists even after robustness tests, including dynamic effects analysis, sample replacement, placebo tests, and instrumental variables methods. HSR introduction influences cash dividend smoothness through three primary channels: mitigating information asymmetry, reducing shareholder reliance on dividends, and lowering financing costs. Moreover, in firms with higher levels of institutional investor shareholding and in competitive markets, HSR exerts a more pronounced effect on cash dividend volatility. Consequence analysis reveals that increased cash dividend volatility heightens investor attention to the stock and reduces analysts' forecast bias in companies with lower dividend levels. However, such volatility does not yield significant consequences in firms with higher cash dividend payout ratios.

This paper offers potential contributions in two key areas. Firstly, it enhances our understanding of the economic implications of high-speed rail development. By delving into the impact of transportation infrastructure on internal dividend decisions within firms, this study enriches our comprehension of the broader consequences of high-speed rail expansion. Secondly, in evaluating the significance of cash dividends, this research contributes fresh empirical evidence to the ongoing discourse surrounding cash dividend smoothing. In contrast to classical agency theory and management rent-seeking behavior perspectives, which may not fully explain the outcomes of cash dividend smoothing, this study also considers theories such as information asymmetry and adverse selection. The findings highlight that cash dividend volatility yields varied economic outcomes depending on the level of dividend payout ratios. Tailoring smoothing guidelines based on dividend levels could better align with investor interests and enhance the overall information environment. These insights offer novel perspectives on regulatory guidelines, such as those set forth by the CSRC, pertaining to dividend regulation.

2. Literature review and hypothesis 1

The literature concerning geographic location, the influence of high-speed rail on financial decision-making, and cash dividend smoothness are the primary areas of relevance to our research. Thus, we provide a summary of each in sequence.

2.1 Geographic location, high-speed railway, and financial decisions

The theoretical foundation of geographic segmentation's influence on financial decisions lies in information asymmetry. According to the information dominance theory, investors' local preferences result in higher equity financing costs for firms situated in rural or remote areas, distant from financial centers (Ghoul El *et al.*, 2013). Similarly, research on equity financing costs suggests that financial institutions, predominantly located in urban centers, lead to higher debt yield spreads and limited access to debt funding for firms in remote areas (Arena and Dewally, 2012). Almazan *et al.* (2010) find that firms within industrial clusters tend to adopt more relaxed financial policies, such as maintaining higher cash balances and lower leverage, due to ample opportunities for M&A investment. Relevant to this study, John *et al.* (2008) discover that firms located in urban centers are more inclined to adopt a low rate of cash dividend and frequently adjust cash dividends, reflecting the information asymmetry between shareholders and management. Shareholders situated farther away from the company often demand high and stable dividends to safeguard their interests, driven by the high cost of gathering inside information, thus highlighting the principal-agent conflict.

The introduction of high-speed rail breaks down the information barrier associated with geographical location. Regarded as a pivotal infrastructure in China, high-speed rail plays a crucial role in fostering industrial upgrading and economic development (Ahlfeldt and Feddersen, 2010). On one hand, high-speed rail mitigates information asymmetry resulting from geographic location, alleviates financing constraints (Kuang *et al.*, 2021), reduces the cost of debt financing (Guo and Wu, 2020), facilitates information exchange among stakeholders, and promotes integration and development among cities (Zheng and Kahn, 2013). Conversely, some scholars argue that cities with high-speed rail networks may disproportionately attract production factors from surrounding smaller cities, leading to imbalanced regional economic development (Qin, 2017).

2.2 Cash dividend smoothing and hypothesis 1 development

Classical signaling theory, as proposed by Miller and Rock (1985), suggests that consistent dividends can communicate both present and future cash flow information, thereby alleviating the information asymmetry surrounding a company. However, viewed through the lens of adverse selection, many researchers argue that a steady dividend policy serves as a tactic

employed by management to obscure performance and intentionally dilute information content. The more pronounced the firm's inclination to obscure accurate information, the smoother the dividend. Consequently, companies capable of capitalizing on information asymmetry tend to adopt highly smoothed cash dividend policies (Guttman *et al.*, 2010). Both signaling and information-hiding motivations propose a positive correlation between the extent of information asymmetry and the smoothness of cash dividends. Nevertheless, due to the distinct motivations at play, there exists a debate regarding whether smoothing dividends can effectively mitigate information asymmetry.

Another significant perspective is agency theory, which provides a fundamental framework for investigating principal-agent conflicts. According to this theory, shareholders rely on financial reports and dividend proposals to oversee managers, as acquiring detailed information about the firm's internal operations is challenging and resource-intensive. The greater the expense associated with shareholders collecting information, the more likely dividends will be smoothed. Traditional agency theory contends that maintaining high and stable cash dividends can restrict the company's capacity to accumulate excess cash flow and mitigate opportunistic behavior by management (Knyazeva and Knyazeva, 2014). Furthermore, a consistent dividend policy can create a "client effect," attracting institutional investors and leveraging the oversight role of external investors to curb further self-interested actions by management (Allen *et al.*, 2000).

In contrast to prior research, which emphasizes shareholders' evaluation of management's current performance without considering historical dividend levels, the reference point effect posits that shareholders typically assess management's performance by comparing it to past dividend distributions (Baker *et al.*, 2015; Bai *et al.*, 2025). This perspective suggests that managers may refrain from increasing dividends even when performance warrants it, fearing potential backlash from shareholders and investors in the future (Fudenberg and Tirole, 1995).

Lambrecht and Myers (2012) argue that shareholders prefer consistent and substantial cash dividends, creating an incentive for management to engage in rent-seeking behavior. Risk-averse managers may exploit this preference by smoothing cash dividends to avoid scrutiny and safeguard their job security, ultimately diminishing shareholder value. The economic implications of smoothing cash dividends can thus vary significantly depending on whether management's actions are driven by rent-seeking motives, despite starting from the same logical premise.

Delving into financing constraints, research typically commences with the premise that a company prioritizes financial flexibility in its decision-making. CFO surveys have highlighted management's explicit emphasis on the significance of financial flexibility for the firm's capital structure (Graham, 2022; Bai *et al.*, 2024). DeAngelo and DeAngelo (2007) posit that a firm's financial flexibility is rooted in low leverage and a low cost of equity financing, thus advocating for a high and consistent dividend policy to ease financing constraints. This suggests a positive correlation between financial flexibility and the smoothness of cash dividends. However, maintaining adequate cash reserves is also crucial for preserving financial flexibility. In the face of financing constraints, some firms are hesitant to boost dividends even amid profit growth due to precautionary savings motives (Bates *et al.*, 2009), resulting in a policy of low and steady cash dividends. Thus, both "externally financed" and "precautionary saving" firms adopt a similar strategy of smoothing cash dividends, despite differing attitudes toward financing constraints.

Thus, despite originating from consistent logical points based on information asymmetry and shareholders' costs, researchers have not arrived at a unified perspective on the motivation behind dividend smoothing. The idea that cash dividend smoothing can alleviate information asymmetry and agency conflicts remains contentious. While the China Securities Regulatory Commission (CSRC) has made progress in regulating cash dividend payout ratios in recent years, guidelines on smoothing are still evolving. Therefore, it is crucial to examine the economic implications of cash dividend smoothing under various dividend levels, considering China's actual dividend regulation policy.

Returning to the earlier discussion, it is evident that the implementation of High-Speed Rail (HSR) can mitigate corporate information asymmetry, diversify corporate financing avenues, reduce shareholders' information acquisition costs, and decrease reliance on financial statements and dividend policies. Building on this premise, the following [hypothesis 1](#) is proposed:

- H1.* The volatility of cash dividends tends to increase following the introduction of high-speed railways in the vicinity of listed companies.

3. Research design

3.1 Sample selection

The CSRC introduced a more targeted and regulated policy on cash dividends in 2013, mandating companies to clearly define the priority of cash dividends in their articles of association. This policy reinforces dividend stability, imposes differentiated requirements on all firms, broadens the regulatory scope of semi-mandatory dividend policies, and significantly influences cash dividend policies ([Liu and Ren, 2023](#)). In this study, all listed companies in Shanghai and Shenzhen from 2013 to 2022 are selected as samples. To measure the smoothness of cash dividends, data from 2010 and 2011 are also utilized. Sample screening involves excluding insolvent companies, those with administrative levels below the prefecture-level city, and entities in the financial industry and ST-listed companies. Ultimately, 15,494 annual firm samples are obtained. For this paper, continuous variables' data at the 1st and 99th percentiles are shrink-tailed. Heteroskedasticity robust standard errors of all regressions are processed with clustering at the company level. Financial and high-speed rail opening data are sourced from the CSMAR database and the China Research Data Service Platform CNRDS, while rail passenger data are obtained from the City Statistical Yearbook.

3.2 Model and definition of main variables

We use the asymptotic difference-in-difference method to construct the model (1) to analyze the impact of the opening of high-speed rail on the smoothness of cash dividends:

$$SOA = \alpha_0 + \alpha_1 HSRA + \alpha_2 Control + \varepsilon \quad (1)$$

Firstly, following [Wu et al. \(2022\)](#), HSRA denotes whether the firm operates within the vicinity of high-speed rail. If the rail becomes operational in the firm's registered location, it is assigned a value of 1 in the opening year and subsequent years; conversely, it is assigned a value of 0. If the rail remains non-operational throughout the sample period, it is consistently assigned a value of 0.

Secondly, the primary dependent variable is cash dividend smoothing (SOA). Presently, there are two predominant methods to measure SOA. The first employs a two-step approach, which initially calculates the deviation from the target dividend payout ratio and subsequently regresses this deviation against changes in cash dividends to determine adjustment speed. The second method involves nonparametric calculation using a free model ([Leary and Michaely, 2011](#)). Given the categorical nature of the core explanatory variables in this study, the first method fails to depict longitudinal fluctuations in cash dividend volatility and to capture the influence of HSRA. Consequently, this study adopts the latter measure.

Lastly, building upon [Bates et al.'s \(2009\)](#) investigation, this paper incorporates the net debt ratio as a control variable. Additionally, it includes firm size (SIZE), listing age (LISTAGE), firm profitability (EBITA), cash dividend payout ratio (POR), risk of return (RISK), dual positions (DUAL), proportion of independent directors (INDEP), shareholding checks and balances (BALANCE), degree of separation of powers (SEPARATE), and nature of ownership (SOE) as control variables. Furthermore, to mitigate the influence of individual characteristics and temporal factors on the regression outcomes, this study employs two-way fixed effects for

individual firms and years. Detailed definitions of the specific variables are provided in Table 1 below.

4. Empirical results

4.1 Descriptive statistical analysis

Table 2 presents descriptive statistics for the main variables. The median value of cash dividend smoothness (SOA) is 0.304, indicating a wide variation in cash dividend smoothing across enterprises. The mean value of high-speed rail opening (HSRA) is 0.935, suggesting that, in line with China’s “eight vertical and eight horizontal” strategy, high-speed rail has been opened in the majority of company locations between 2013 and 2022.

4.2 Baseline regression results

Table 3 reports the results of the baseline regression of cash dividend smoothing is regressed on HSRA. In column (1), the regression includes controls for individual firms’ and years’ two-way fixed effects. The regression coefficient of HSRA is significant at the 1% level,

Table 1. Variables and definitions

Classification	Name	Definition
Explained variable	SOA	Cash dividend smoothing, the standard deviation of (pre-tax cash dividends per share for the last three years)/(standard deviation of earnings per share for the last three years)
Explanatory variable	HSRA	Dummy variable. The high-speed rail accessibility variable (HSRA) is the interaction term $HSR \times After$, HSR equals 1 if the city in which a firm is located introduced HSR service during the sample period (2013–2022), and 0 otherwise. The After variable equals 1 for all years following the opening of HSR in that city (including the year of opening), and 0 for years prior
Control Variables	SIZE	The scale of a firm. The natural logarithm of total assets at the end of the period
	NPND	(Total liabilities – money funds – trading financial assets)/total assets
	LISTAGE	Listing age, the natural logarithm of years the company has been listed
	EBITA	EBIT/total assets
	POR	Cash dividend payout ratio, pre-tax cash dividends per share/earnings per share
	RISK	Earnings risk, standard deviation of EBITA for the last three years
	DUAL	If the chairman and general manager are the same person, it will be recorded as 1, and vice versa as 0
	INDEP	Percentage of independent directors on the board of directors
	BALANCE	The sum of the shareholdings of the second to fifth largest shareholders divided by the shareholding of the first largest shareholder
	SEPERATE SOE	Difference between effective control and beneficial ownership 1 for state-owned enterprises, 0 for non-state-owned enterprises

Source(s): Authors’ own work

Table 2. Summary statistics of key variables

Variable	Observations	Mean	SD	P50	Min	Max
SOA	15,494	0.562	0.835	0.304	0	6.300
HSRA	15,494	0.935	0.246	0	0	1

Source(s): Authors’ own work

Table 3. The effect of HSRA on dividend smoothing: baseline regression results

Variable	(1) SOA	(2) SOA1	(3) SOA
HSRA	0.117*** (2.72)	0.116** (2.08)	0.099** (2.21)
Controls	Yes	Yes	Yes
Constant	1.497** (2.46)	1.984** (2.16)	0.485* (1.93)
Ind and city FE	No	No	Yes
Firm FE	Yes	Yes	No
Year FE	Yes	Yes	Yes
Observations	15,092	12,500	15,370
R ²	0.293	0.214	0.192

Note(s): (1)*, **, *** indicate significance at the 10%, 5%, and 1% levels respectively; (2) *t*-value in parentheses. The same is below
Source(s): Authors' own work

confirming the previous [hypothesis 1](#). This suggests that firms with HSRA experience a significant increase in dividend volatility following the opening of HSRA relative to firms without HSRA in their domicile. To address potential lagged effects, the regression is repeated with SOA in the next period (SOA1), as shown in column (2). Column (3) displays the regression results after controlling for industry, city, and year-fixed effects, all supporting the conclusion that high-speed rail opening enhances the volatility of cash dividends.

4.3 Robustness test

(1) Test of the Dynamic Effect of HSRA

The asymptotic difference-in-difference method relies on satisfying the parallel trend test. This means that the smoothness of cash dividends among companies must exhibit a similar performance trend before the opening of high-speed rail. In this study, we define two years before the opening of HSR as BEFORE2+, one year after the opening as PRESENT, and two years after the opening as AFTER1 and AFTER2+, respectively. Dummy variables are generated accordingly. To avoid multicollinearity, we do not generate a time dummy variable for the year before the opening of the high-speed rail.

Next, these four variables are multiplied by the dummy variable indicating whether the city where the company is located opened high-speed rail during the sample period, denoted as HSR. The following model is introduced:

$$\text{SOA} = \beta_0 + \beta_1 \text{HBEFORE2}^+ + \beta_2 \text{HPRESENT} + \beta_3 \text{HAFTER1} + \beta_4 \text{HAFTER2}^+ + \beta_5 \text{Control} + \varepsilon \quad (2)$$

Based on the regression results in [Table 4](#), β_1 is insignificant, indicating that before the opening of the high-speed railroad in the city where the company is located, the changing trend of cash dividend smoothness is the same, and it passes the parallel trend test. The regression coefficients of HAFTER1 and HAFTER2+ are significant at 5% and 1% levels successively, which indicates that the smoothness of the company's cash dividend changes significantly after the opening of high-speed rail. It is worth noting that the regression coefficients before the opening of HSR are negative. In contrast, the regression coefficients in the period of the opening of HSR and later are positive. The coefficients are getting bigger and bigger, and the significance is getting stronger and stronger, which suggests that HSRA gradually enhances the volatility of cash dividends, and the effect continues to exist.

Table 4. Dynamic effect test

Variable	SOA
<i>HBEFORE2</i> ⁺	−0.022 (−0.46)
<i>HPRESENT</i>	0.025 (1.16)
<i>HAFTER1</i>	0.106** (2.46)
<i>HAFTER2</i> ⁺	0.129*** (2.97)
Controls	Yes
Constant	−47.957 (−1.13)
Firm FE	Yes
Year FE	Yes
Observations	15,092
<i>R</i> ²	0.293

Source(s): Authors' own work

(2) Placebo Test

The above findings indicate that opening high-speed rail can significantly affect cash dividend smoothing. However, in addition to the variables in the model, other factors may affect the volatility of cash dividends. These unobserved factors will also affect the opening of high-speed rail at the same time, which will cause interference in the findings of this paper. Therefore, this paper continues to use the placebo test to eliminate the effects of these unobserved factors. Specifically, we artificially push the actual opening time of HSR opening by 2 or 5 years, replace HSRA in model (1) with the new HSR opening dummy variables HSRA_2 and HSRA_5 to participate in the regression and observe their regression coefficients. Suppose the regression results of HSRA_2 and HSRA_5 are significant. In that case, it indicates that in addition to the inherent differences between the control and experimental groups of high-speed rail opening, other variables are not controlled for in the model that will impact the study findings. Conversely, if the regression results of HSRA_2 and HSRA_5 are not significant, it means that the primary regression results of this paper are robust. The data in columns (1) and (2) of Table 5 show that the regression coefficients of the artificially set dummy variables for HSRA are insignificant, indicating that this paper's findings pass the placebo test.

(3) Alternative Sample

The demand for rail travel tends to be higher in densely populated areas, where people are more mobile due to higher levels of economic development. Consequently, governments often consider population density and economic development levels when planning high-speed rail lines. Additionally, cities with dense population concentrations and higher economic development are more attractive to analysts and investors, influencing the firm's information environment and financing channels. To mitigate the potential influence of these factors on cash dividend policy, this study conducts a secondary screening of the sample.

Beijing, Shanghai, Guangzhou, and Shenzhen have consistently ranked among the top cities in China in terms of population size and economic development. Therefore, this study re-regresses the model after excluding these four first-tier cities (1). The data presented in column (3) of Table 5 demonstrate that the findings of this study remain unchanged. To address potential sample time selection bias, this study extends the data to include listed companies

Table 5. Placebo testing and alternative sample testing

Variable	(1) 2 years in advance SOA	(2) 5 years in advance SOA	(3) Excluding first-tier cities SOA	(4) From 2008 to 2021 SOA
HSRA_2	0.065 (0.72)			
HSRA_5		−0.019 (−0.18)		
HSRA			0.097** (2.15)	0.060** (2.04)
Controls	Yes	Yes	Yes	Yes
Constant	0.948 (1.22)	2.596** (2.15)	2.061*** (2.78)	1.580*** (2.94)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	10,740	5,325	10,270	17,928
R ²	0.300	0.289	0.313	0.264

Source(s): Authors' own work

from 2008 to 2021 for regression analysis. The results presented in column (4) of Table 5 show that the conclusions of this study remain robust after adjusting the time interval.

(4) Instrumental Variable

To mitigate potential interference from omitted variables or selectivity errors on the model's explanatory power, this study employs the instrumental variable method of two-stage regression to address the endogeneity issue. Specifically, total historical railroad passenger traffic is utilized as an instrumental variable, reflecting both travel demand and economic development in local cities. This variable provides geographical context for the subsequent opening of high-speed railways.

Importantly, past historical passenger capacity does not influence any firms' financial decisions in the future, making passenger capacity in 1990 an appropriate instrumental variable. Firstly, dummy variables are generated for each year during the sample period. Secondly, these ten dummy variables are multiplied by the total railroad passenger traffic of each city in China in 1990, respectively, to be included in the regression [14].

Columns (1) and (2) of Table 6 present the results of the two-stage regression, showing that the core explanatory variable HSRA has a significant positive effect on cash dividend smoothing. This further reinforces the reliability of the previous findings.

5. Additional research

The above empirical analysis tests the robustness of this paper's main findings. However, by what means does HSR affect cash dividend smoothness? What are the economic consequences of reduced cash dividend smoothness and fluctuations in dividend distribution? These questions still need to be clarified. Therefore, this paper continues to discuss the mechanism, heterogeneity, and economic consequences of the impact of high-speed rail on the smoothness of cash dividends. The regression results are presented in the updated Table 7 as follows: in Columns (2), (4), and (6), the coefficients for HSRA are 0.112, 0.113, and 0.094, respectively. These values are smaller and statistically less significant than the coefficient reported in Column (1) of Table 3 (0.117). This attenuation suggests that the negative effect of HSR opening on cash dividend smoothing is weakened when controlling for information

Table 6. Regression results of instrumental variable test

Variable	(1) HSRA	(2) SOA
IV2013	0.0002*** (4.62)	
IV2014	0.0002*** (3.88)	
IV2015	0.0001*** (2.80)	
IV2016	0.0001** (2.52)	
IV2017	0.0001** (2.33)	
IV2018	0.00009** (2.07)	
IV2019	0.00009* (1.92)	
IV2020	0.00007 (1.59)	
IV2021	0.00007 (1.48)	
IV2022	0.00007 (1.48)	
HSRA		0.439*** (2.59)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	13,294	13,294

Note(s): The *F*-test statistic is 31.67; the Kleibergen-Paap rk LM statistic for the under-recognition test is 228.716; the Cragg-Donald Wald F-statistic for the weak recognition test is 139.531; and the *p*-value for the over-recognition test is 0.118

Source(s): Authors' own work

asymmetry (ASY), investor/shareholder dividend dependence (ISD), and financing constraints (FC), respectively.

These findings support the proposed mechanisms and indicate that HSR influences firms' dividend policies by mitigating information asymmetry, reducing reliance on dividends among shareholders, and alleviating firms' external financing constraints.

5.1 Analysis of the mechanism

First, information effect. According to the previous analysis, information asymmetry is the logical starting point of signaling motivation and signal hiding motivation. The higher the information asymmetry, the smoother the cash dividend. The opening of a high-speed railway brings the time-space distance between outsiders and insiders of the company closer and strengthens the company's information exchange. As outsiders get hold of more soft information about the company that is not easy to observe, the information asymmetry is gradually alleviated. Therefore, we predict that opening high-speed rail can cause cash dividend volatility by exerting the information effect. This paper draws on the research method (Song *et al.*, 2021) to construct the information asymmetry index ASY. If the information effect works, opening high-speed rail can significantly reduce information asymmetry. As shown in the regression results in column (1) of Table 7, the opening of high-speed rail can enhance cash dividend volatility by mitigating information asymmetry.

Table 7. High-speed rail opening and cash dividend smoothing: a mechanistic analysis

Variable	(1) Information effect ASY	(2) SOA	(3) Governance effect ISD	(4) SOA	(5) Financing effect FC	(6) SOA
HSRA	−0.027** (−2.29)	0.112* (1.74)	0.090*** (2.86)	0.113* (1.72)	−0.013*** (−2.82)	0.094** (2.23)
ASY		−0.086* (1.90)				
ISD				0.041** (2.32)		
FC						−0.573*** (−3.33)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	6.021*** (28.62)	2.278** (1.96)	−2.531*** (−5.01)	2.842*** (2.60)	4.983*** (51.46)	5.340*** (4.54)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,801	16,801	16,719	16,719	16,529	16,529
R ²	0.194	0.174	0.039	0.196	0.375	0.238

Source(s): Authors' own work

Second, governance effect. The logic based on the corporate governance is that due to the existence of information barriers between shareholders and managers, shareholders utilize the smoothing dividend policy to force free cash to flow out of the company as a way to monitor managers. The higher the cost for shareholders to gather internal information about the firm, the stronger the cash dividend smoothing. The opening of high-speed rail can accelerate the flow of institutional investors and provide new ways for institutional investors to conduct research. Therefore, opening high-speed rail can enhance cash dividend volatility by reducing the cost of shareholder information collection. This paper selects the number of institutional investors' field research ISD as the mechanism variable to study the governance effect. The HSRA can promote institutional investors' field research and help obtain internal soft information. After providing new information for other shareholders, shareholders' information collection cost is reduced. At the same time, they can also play other monitoring roles to reduce shareholders' dividend dependence. The regression results in column (2) of Table 7 show that the HSRA significantly increases the number of institutional investors' field research. It confirms that high-speed rail plays a governance effect and promotes the volatility of cash dividends by mitigating shareholders' dividend dependence.

Third, the financing effect. As mentioned earlier, firms choose a stable cash dividend policy based on the motive of precautionary savings or getting an easier access to capital funds when facing external financing constraints. For firms that are geographically remote and far from financial centers, transportation infrastructure extends the information radiation distance of banks and removes the information asymmetry between firms and financial institutions. The opening of the high-speed railway strengthens the connection between managers and financial institutions. It promotes communication between management and analysts or investors in the field, alleviating the company's financing constraints. Using the FC index as a measure of financing constraints, we explore the mechanism role of financing constraints. The regression results in column (3) of Table 7 show that after the opening of HSR, the firm's financing constraints are significantly alleviated, and the cash dividend policy generates volatility.

5.2 Heterogeneity analysis

The preceding section demonstrates that High-Speed Rail (HSR) increases the variability of cash dividends by reducing information asymmetry, enabling institutional investors to conduct

field research more easily, and easing financing constraints. Now, we turn to examining the factors that influence the impact of transportation infrastructure on the stability of cash dividends. This paper examines both market competition and the level of institutional investor ownership.

To begin with, heightened market competition intensifies the uncertainty surrounding company earnings (Liu *et al.*, 2018). In response to fierce competition, companies tend to bolster their cash reserves, maintain lower debt levels, and adopt more conservative financial strategies. Driven by a precautionary savings motive, intensified market competition often leads companies to adhere to a more stable cash dividend policy. The introduction of high-speed rail facilitates the movement of production factors, aids companies in accessing new markets, enhances profitability, and augments internal cash flow. Consequently, the impact of high-speed rail infrastructure on cash dividend volatility is particularly pronounced in companies operating within fiercely competitive environments.

Next, in contrast to individual investors, institutional investors possess enhanced capabilities for interpreting specialized information and effectively monitoring managerial activities. Their investment behavior often serves as a leading indicator in the capital market, prompting other investors to follow suit. Consequently, given the amplified information integration and governance advantages wielded by institutional investors, we anticipate that the influence of high-speed rail expansion on the stability of cash dividends will be more pronounced in companies with a significant proportion of shares held by institutional investors.

In this study, we categorize the firms into four groups based on annual median values: the intense market competition group, the moderate market competition group, the high institutional investor shareholding group, and the low institutional investor shareholding group. Market competition is gauged using the industry Lerner index. The regression outcomes outlined in Table 8 affirm our earlier analysis, revealing that the dampening impact of high-speed rail inauguration on cash dividend stability is notably more pronounced within subgroups characterized by high market competition and substantial institutional investor shareholding.

5.3 Analysis of economic consequences

The literature on cash dividend smoothing’s economic implications primarily focuses on investor preferences and agency efficiency, yielding inconsistent findings. Studies by Chen *et al.* (2017) and Larkin *et al.* (2017) in Chinese and U.S. markets, respectively, suggest that a

Table 8. High-speed rail opening and cash dividend smoothing: a heterogeneity analysis

Variable	(1) Fierce market competition SOA	(2) Reduced market competition SOA	(3) High institutional investor holdings SOA	(4) Low institutional investor holdings SOA
HSRA	0.237*** (3.37)	0.038 (0.56)	0.213*** (3.55)	−0.014 (−0.21)
Contorls	Yes	Yes	Yes	Yes
Constant	1.426 (1.46)	1.960** (2.13)	1.951** (1.97)	1.267 (1.18)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	6,522	8,058	7,614	7,217
R ²	0.319	0.316	0.286	0.318
p-value	0.025		0.005	
Source(s): Authors’ own work				

smooth cash dividend policy attracts only specific institutional investors, with limited impact on returns or market value. Despite originating from information asymmetry and agency theory, cash dividend smoothing has received less attention compared to the cash dividend payout ratio. While regulations on dividend levels are established by the CSRC, guidance on smoothness remains nascent. Thus, investigating the economic consequences of cash dividend smoothing, alongside dividend payout levels, is crucial.

Our study employs a methodology creating a dummy variable, RSOA, based on cash dividend smoothness (SOA) median values. RSOA is multiplied by HSRA to derive HSRARSOA, and the sample is divided into high and low dividend payout rate groups. Regression analysis incorporates HSRARSOA and RSOA in both groups to assess cash dividend volatility's economic consequences. Results in Table 9 suggest that cash dividend volatility diminishes forecast bias and increases investor attention in firms with lower dividend payouts, aligning with the signaling content hypothesis 1 of dividend changes. Conversely, in companies with high dividend payouts, cash dividend volatility shows no significant effects, indicating its potential signaling content is more relevant in firms with lower dividend payout ratios. This aligns with the signaling content hypothesis 1 of dividend changes proposed by Nissim and Ziv (2001), indicating that volatility can enhance the information environment.

To further validate the robustness and credibility of our empirical results, we conduct an additional univariate event study analysis. This approach allows us to isolate and observe the potential impact of high-speed rail (HSR) service introduction on the behavior of corporate cash dividend policies over time. Specifically, we analyze the degree of dividend smoothness by comparing the volatility of firms' cash dividends during the three years preceding and following the year when HSR service began operating in each respective city where the firm is located.

Table 10 summarizes the results of this analysis. Columns (1) and (2) present the findings based on our primary sample period spanning from 2013 to 2022, while Columns (3) and (4) extend the examination to a broader timeframe covering 2008 to 2022. This extended period enables a more comprehensive robustness check, ensuring that the observed effects are not confined to a narrow window of time or influenced by short-term fluctuations.

Across both sample intervals, the results consistently reveal a notable increase in the volatility of corporate cash dividends after the introduction of HSR service. The observed

Table 9. The effect of cash dividend volatility on turnover and analyst forecast accuracy

Variable	(1) High dividend payout ratio DTURN	(2) Low dividend payout ratio DTURN	(3) High dividend payout ratio FERROR	(4) Low dividend payout ratio FERROR
HSRARSOA	29.205 (1.08)	101.960*** (3.43)	−0.339 (−0.76)	−1.734*** (−3.36)
HSRA	21.385 (0.75)	6.368 (0.24)	−0.060 (−0.15)	0.672** (1.97)
RSOA	−21.586 (−0.82)	−97.714*** (−3.46)	−0.113 (−0.26)	1.295** (2.55)
Controls	Yes	Yes	Yes	Yes
Constant	2158.024*** (5.88)	2198.793*** (6.56)	16.824*** (3.49)	7.940 (1.46)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	8,240	7,844	6,932	7,021
R ²	0.571	0.520	0.411	0.360
p-value	0.082		0.021	

Source(s): Authors' own work

Table 10. Univariate test for SOA during the window before and after the opening of HSR

	2013–2022 SOA BEFORE (1)	AFTER (2)	2008–2022 SOA BEFORE (3)	AFTER (4)
Mean	0.521	0.952	0.548	0.749
BEFORE-AFTER	–1.634**		–1.662***	
Test of difference in mean				
Source(s): Authors’ own work				

changes are not only economically meaningful but also statistically significant, reinforcing the conclusion that the arrival of HSR infrastructure has a destabilizing effect on firms’ dividend payout behavior. These findings lend additional support to our core argument and highlight the broader implications of infrastructure development on corporate financial decisions.

6. Conclusion and implication

While existing studies have extensively examined cash dividends, they often overlook the phenomenon of dividend smoothing, which is also prevalent globally. Due to variations in tax policies and regulatory environments, the extent of cash dividend smoothing differs across capital markets. In China, the rapid development of high-speed rail (HSR) has significantly reduced information asymmetry and financing constraints, while also strengthening investor connectivity by compressing time and space. This cross-regional integration of information and capital inevitably affects firms’ financial policies. Drawing on China’s unique context, this study investigates the impact of transportation infrastructure—specifically, the introduction of HSR—on the smoothness of corporate cash dividends, employing a natural experiment framework. Our findings indicate that the opening of HSR increases the volatility of cash dividends, primarily through three channels: the mitigation of information asymmetry, reduced shareholder dependence on dividends, and the alleviation of financing constraints.

Moreover, the effect of HSR on dividend volatility is more pronounced in firms operating in highly competitive industries and those with greater institutional investor ownership. Departing from prior literature, this paper also examines the economic consequences of dividend volatility. Specifically, we find that firms with relatively low dividend levels can, by adopting more volatile dividend policies, reduce analyst forecast bias and attract greater investor attention. This suggests that dividend volatility may serve as a supplementary signal in cases where the absolute level of cash payouts is low.

Overall, these findings enrich the understanding of how information asymmetry, signaling, and corporate governance dynamics interact with dividend smoothing behavior, offering new insights into the financial implications of infrastructure development.

Data available on request from the authors

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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