

The Fragile Shield: Absorptive Capacity and the Resilience of Digital Infrastructure under Geopolitical Risk

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Article

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Abstract

As geopolitical tensions increasingly disrupt the global economy, understanding how organizations and markets adapt to this uncertainty has become a pressing interdisciplinary concern, spanning international relations, organizational theory, and financial economics. This paper examines whether absorptive capacity, a concept from organizational learning theory describing a firm's capacity to recognize, assimilate, and exploit external knowledge, extends to a domain in which it has not previously been tested: a firm's capacity to exploit external digital financial infrastructure under geopolitical uncertainty. Using a panel of 3,513 Chinese listed firms from 2011 to 2024, this study shows that geopolitical risk degrades the informativeness of stock prices, a marker of how effectively markets process firm-specific information, and that regional digital financial infrastructure buffers this degradation. A panel threshold model shows that this buffering capacity is itself nonlinear, weakening substantially once geopolitical risk exceeds a critical level tied to the 2017–2019 trade-tension period and the 2022–2024 escalation surrounding the Russia-Ukraine conflict. Most centrally, firms with greater internal digital capacity retain significantly more of this protective buffer even as external infrastructure weakens, suggesting that organizational capacity and external infrastructure function as complements, not substitutes, precisely when resilience is most needed. These findings extend absorptive capacity theory into a new empirical domain and speak to a broader, cross-disciplinary question: how the resilience of markets and organizations under geopolitical uncertainty depends jointly on external institutions and internal capabilities.

1. Introduction

Understanding how uncertainty propagates through financial markets has regained urgency as geopolitical tensions, from prolonged trade disputes to armed conflict and its cross-border spillovers, have become a recurring feature of the global economy rather than an episodic disturbance, joining a broader family of uncertainty shocks whose real and financial consequences are now well documented (Bloom, 2009; Baker et al., 2016). Elevated geopolitical risk depresses corporate investment, raises financing costs, and heightens precautionary cash holdings (Caldara and Iacoviello, 2022), with recent evidence extending this logic to corporate payout policy (Adra et al., 2023), outward foreign direct investment (Wen et al., 2024), firm-level digital transformation (Huang et al., 2026), the connectivity of green financial assets and cryptocurrencies (Bajra et al., 2025), and the adoption of decentralized finance amid the Russia-Ukraine conflict (Kyriazis and Economou, 2025).

Within capital markets specifically, geopolitical risk raises the frequency of stock price crashes, an effect that high-ESG firms are better positioned to withstand (Fiorillo et al., 2024), evidence of an active and rapidly consolidating literature on how geopolitical uncertainty transmits into the pricing of individual securities. Beyond markets themselves, geopolitical competition increasingly shapes the regulatory architecture through which major economies govern digital finance (Mukherjee, 2025), underscoring that the two forces studied jointly in this paper are already understood to interact at the level of policy, if not yet at the level of price formation.

Against this backdrop, digital finance has emerged as a favored candidate for the institution that shields firms and markets from uncertainty's informational costs. Digital finance flattens supply chain risk under deglobalization and geopolitical tension (Li, Bao et al., 2026), offsets the drag of cultural distance on cross-border infrastructure investment (Zeng et al., 2026), strengthens energy security under mounting geopolitical pressure (Wang, Xie et al., 2026), and expands fastest precisely where economic policy uncertainty is most acute (Wang, Jiao et al., 2026). This paper asks a question that the buffering narrative common to this literature has left largely unexamined: does the shield itself hold uniformly, or does it have a breaking point, and if so, whose shield breaks first?

The answer developed here is that the shield is genuinely fragile, and that its fragility is not evenly distributed. Using stock price synchronicity, the tendency of individual returns to move with market- and industry-wide returns rather than firm fundamentals, as an inverse proxy for how efficiently markets impound private information (Roll, 1988; Morck et al., 2000; Jin and Myers, 2006), this paper first confirms that geopolitical risk degrades this everyday process of price discovery and that regional digital finance infrastructure buffers the degradation. It then shows, using a Hansen panel threshold model, that this buffering capacity itself weakens once geopolitical risk crosses a critical level.

The paper's central contribution goes one step further: a firm's own digital transformation, not merely the digital finance infrastructure of the city in which it is located, determines how much of that weakening it actually experiences. Firms that have themselves invested in digital capacity retain significantly more of the informational buffer than firms that rely on regional infrastructure alone, indicating that the shield's fragility under extreme uncertainty is a firm-level, not merely a regional, phenomenon.

This reframes the buffering narrative common in the digital finance literature in a way that has not, to the author's knowledge, been documented before: regional infrastructure and firm-level capacity are not interchangeable substitutes but complements whose joint presence determines whether protection survives the periods of stress it is meant to address. This paper interprets that pattern through the lens of absorptive capacity (Cohen and Levinthal, 1990), a concept developed in the innovation and organizational learning literature to explain why a firm's own prior investment determines how effectively it can exploit externally available knowledge, but one whose relevance to financial information environments has not previously been tested.

This paper makes four contributions, of which the fourth is central and the first three establish the groundwork it builds on. First, it establishes that geopolitical risk raises stock price synchronicity in the Chinese setting, extending the geopolitical risk literature beyond real corporate decisions and crash-risk episodes (Wen et al., 2024; Huang et al., 2026; Fiorillo et al., 2024) into the domain of everyday market information efficiency. Second, it isolates coverage breadth, rather than usage depth, as the specific facet of digital finance responsible for this buffering, a granularity absent from studies that treat digital finance as a single aggregate index. Third, a Hansen (1999) panel threshold model shows that this buffering capacity is itself nonlinear in the level of geopolitical risk, eroding substantially once risk exceeds an empirically identified critical level.

Fourth, and most centrally, this paper shows that this erosion is significantly attenuated among firms with greater firm-level digital capacity, providing what is, to the author's knowledge, the first test of absorptive capacity logic in a financial information-environment setting and identifying an unstudied complementarity between regional digital finance infrastructure and firm-level capacity that determines whose informational shield actually holds under acute geopolitical stress.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and develops four hypotheses. Section 3 describes the institutional context. Section 4 introduces the data and variables. Section 5 presents the empirical strategy. Section 6 reports the results, culminating in the firm-capacity finding that is this paper's central contribution. Section 7 discusses robustness and heterogeneity. Section 8 discusses the findings in relation to the broader literature and their policy implications, and Section 9 concludes.

2. Literature Review and Hypothesis Development

2.1 Geopolitical risk and stock price synchronicity

Geopolitical risk is expected to raise stock price synchronicity through an information-opacity channel grounded in the microstructure theory of informed trading. When information asymmetry between insiders and outside investors widens, market makers and dispersed investors rationally price securities to reflect the reduced reliability of any single informative signal (Kyle, 1985), and firms facing higher uncertainty about their own future cash flows have less incentive to disclose costly, event-specific information, further widening the gap between what is known and what is priced (Diamond and Verrecchia, 1991).

When adverse geopolitical events threaten to disrupt trade relationships, supply chains, or cross-border capital flows, the reliability of firm-specific fundamentals as predictors of future cash flows declines relative to macroeconomic and industry-wide signals, prompting investors to price individual stocks more heavily on the basis of common rather than idiosyncratic information (Morck et al., 2000). This reallocation of attention toward aggregate signals is compounded by a herding channel: heightened uncertainty raises the private cost of acquiring and verifying firm-specific information, making it individually rational for less-informed investors to disregard their own signals and instead imitate the actions of others, a dynamic formalized in the informational-cascades literature (Bikhchandani et al., 1992) and consistent with evidence that analyst coverage, rather than uniformly improving price informativeness, can itself increase synchronicity by transmitting industry-level rather than firm-specific information (Piotroski and Roulstone, 2004; Chan and Hameed, 2006).

A closely related literature on stock price crash risk documents that opaque information environments, in which firm-specific signals are poorly incorporated into prices, allow bad news to accumulate unobserved until a sudden release triggers a sharp price collapse (Hutton et al., 2009), a pattern empirically foreshadowed by abnormal trading volume and negative skewness in the period leading up to such collapses (Chen et al., 2001) and theoretically traced by Hong and Stein (1999, 2003) to short-sales constraints that prevent bearish investors' information from being revealed in prices until market declines force previously bullish investors to exit; geopolitical risk has been shown to raise crash frequency directly, with the effect attenuated among firms with stronger environmental and social performance (Fiorillo et al., 2024).

Taken together, this evidence suggests that geopolitical uncertainty degrades the ordinary process of price discovery well before any crash materializes, since the same opacity that eventually produces crashes should, at lower intensities, simply manifest as elevated synchronicity.

This information-based channel is consistent with, and complements, emerging evidence that geopolitical risk reshapes corporate real decisions more broadly, including corporate payout policy (Adra et al., 2023), outward foreign direct investment (Wen et al., 2024), and the adoption of digital technologies (Huang et al., 2026). If geopolitical uncertainty is sufficiently consequential to redirect firms' payout, investment, and technology strategies, it is a priori plausible that the same uncertainty also degrades the market's ability to price firm-specific fundamentals. Both channels imply that individual stock prices should co-move more strongly with the market during periods of elevated geopolitical risk, which yields the first hypothesis.

H_1 . **Geopolitical risk is positively associated with stock price synchronicity.**

2.2 The moderating role of regional digital finance

Digital finance is expected to counteract this tendency by lowering the cost of accessing and disseminating firm-specific information. Investor attention is a scarce resource that must be allocated across a large universe of possible investments, so individual investors disproportionately confine their trading to stocks that have already caught their attention through news coverage, salient price moves, or accessible information channels (Barber and Odean, 2008), and once attention is engaged, investors process new information within categories defined by salient common factors rather than firm-specific detail unless the marginal cost of firm-specific information is sufficiently low (Peng and Xiong, 2006).

Digital finance directly targets this cost margin: the expansion of digital financial infrastructure, captured empirically by the coverage breadth and usage depth of digital financial services (Guo et al., 2020), widens the set of investors who can obtain timely information about individual firms and reduces the fixed cost historically associated with information intermediation through traditional financial institutions.

This buffering logic parallels findings elsewhere in the literature: digital finance flattens supply chain risk for manufacturing firms exposed to deglobalization and geopolitical tension (Li, Bao et al., 2026), offsets the inhibitory effect of cultural distance on cross-border infrastructure investment (Zeng et al., 2026), and expands precisely in the regions where economic policy uncertainty is most pronounced (Wang, Jiao et al., 2026), consistent with digital finance functioning as an adaptive response to, rather than merely a correlate of, environments of heightened uncertainty. To the extent that this expanded access allows firm-specific information to reach a broader investor base even when aggregate uncertainty is elevated, the marginal contribution of geopolitical risk to stock price synchronicity should be smaller where digital financial development is more advanced, which yields the second hypothesis.

H_2 . Digital finance moderates the positive relationship between geopolitical risk and stock price synchronicity, such that the relationship is weaker where digital finance is more developed.

2.3 Nonlinearity in the buffering effect

The buffering role of digital finance implied by H_2 need not be constant across the full range of geopolitical risk, and there is reason to expect that it is not. Information channels, digital or otherwise, operate within a finite capacity to process and verify signals, and extreme uncertainty may overwhelm this capacity rather than merely straining it. This concern gains indirect support from evidence that geopolitical risk suppresses firms' own digital transformation through a financial-constraint channel that intensifies among internationally exposed firms (Huang et al., 2026); although that evidence concerns firm-level technology adoption rather than the regional digital finance infrastructure measured by DIGFIN in this paper, it is consistent with a broader pattern in which severe geopolitical shocks curtail digital capacity-building at multiple levels of the economy.

Under sufficiently severe geopolitical stress, investors may in addition revert to macro-level heuristics regardless of the information technically available to them, because the marginal value of firm-specific information itself declines when the fundamentals it describes are subject to unpredictable geopolitical disruption, a dynamic consistent with the finding that geopolitical threats, rather than their eventual realization, drive most of the observed increase in crash risk (Fiorillo et al., 2024): it is the anticipation and processing of uncertainty, not merely its resolution, that appears to disrupt information environments. These two reinforcing considerations imply that the moderating effect of digital finance should not decline smoothly and continuously with risk but should instead exhibit a discrete regime change once risk exceeds some critical level, which yields the third hypothesis.

H_3 . The moderating effect of digital finance on the geopolitical risk-synchronicity relationship is nonlinear, weakening discretely once geopolitical risk exceeds a critical threshold.

2.4 Absorptive capacity as a complementary source of resilience

H_3 raises a question it cannot itself answer: if the regional infrastructure captured by DIGFIN loses buffering capacity under extreme risk, is this erosion a uniform feature of the environment, borne equally by every firm within it, or does it depend on characteristics of the firm itself?

The existing literature on digital finance offers little direct guidance here, since studies of its buffering role typically treat the firms exposed to a given regional infrastructure as homogeneous recipients of its benefits. A more direct guide comes from a literature outside finance altogether: the concept of absorptive capacity, which explains why firms with greater prior investment in related knowledge, chiefly research and development, are better able to recognize the value of external information, assimilate it, and apply it to productive ends, while firms lacking such prior investment struggle to exploit even freely available external knowledge (Cohen and Levinthal, 1990).

Applied to the present setting, a firm's own investment in digital capability should function analogously to the prior R&D investment in the original theory: not a redundant duplication of what regional infrastructure already provides, but the very capacity that determines how much of what regional infrastructure offers the firm can actually put to use.

Two considerations, one paralleling each half of absorptive capacity theory's original mechanism, suggest that the erosion documented in H_3 is not in fact uniform.

First, mirroring the assimilation half of the mechanism, a firm's own digital investment builds the internal data systems, disclosure practices, and technology-enabled investor communication needed to translate externally available regional infrastructure into information investors actually receive; a firm lacking this internal capacity may sit within a well-developed regional digital finance ecosystem without being able to fully exploit it, just as a firm lacking prior R&D investment struggles to exploit freely available scientific knowledge in the original theory. Second, mirroring the recognition half of the mechanism, a firm's own digital transformation plausibly signals a broader organizational capacity to recognize which external information channels remain informative under stress and to maintain investor communication through them when conditions deteriorate, a recognition capacity that regional infrastructure by itself cannot substitute for at the firm level.

Both considerations point to firm-level capacity as a complement to, rather than a substitute for, regional digital finance infrastructure: the two should reinforce each other's buffering role precisely when that role is under strain, rather than one compensating for the absence of the other. Figure 4 summarizes the full four-hypothesis structure graphically, extending the earlier conceptual framework to show absorptive capacity as a fourth layer that determines whether the buffer identified in H_2 and H_3 actually reaches a given firm. This yields the fourth and central hypothesis of this paper.

H_4 . The erosion of digital finance's buffering effect under severe geopolitical risk is significantly attenuated among firms with greater firm-level digital transformation, indicating complementarity rather than substitutability between regional digital finance infrastructure and firm-level digital capacity.

3. Institutional Background

China provides a distinctive setting in which to examine the interaction between geopolitical risk and digital finance. Over the sample period, China's exposure to geopolitical tension rose sharply and unevenly: the country-specific geopolitical risk index used in this study more than doubled between the relatively calm years of 2011–2016 and the trade-tension episode of 2017–2019, receded modestly during 2020–2021, and rose again from 2022 through 2024 amid the global realignment surrounding the Russia-Ukraine conflict and intensifying technology competition. This uneven trajectory, rather than a smooth secular trend, is what permits the threshold specification in Section 5 to separate a low-risk period from a high-risk period with an economically interpretable break point.

Over the same period, China experienced one of the fastest expansions of digital financial infrastructure observed anywhere in the world, driven by the rapid diffusion of mobile payment platforms, online lending, and digitally intermediated wealth management products, and documented systematically by the city-level digital financial inclusion index constructed by Guo et al. (2020) and used as the moderating variable in this study. This expansion was highly uneven across cities and time, driven initially by coverage breadth, the geographic and demographic reach of digital financial accounts, and only later by usage depth, the intensity with which such accounts are actively used for payments, credit, and investment.

Alongside this regional expansion, individual firms varied considerably in the pace of their own digital transformation, adopting digital technologies in production, disclosure, and investor communication at different rates even within the same city, which is what allows Section 6 to separate the regional infrastructure channel from the firm-level capacity channel empirically rather than merely conceptually. The Chinese A-share market, characterized by a large base of retail investors relative to institutional investors compared with developed markets, together with the historically important role of state ownership and industrial policy in shaping information disclosure, further heightens the empirical relevance of the coverage-breadth channel in this setting: a market with many retail participants stands to gain disproportionately from mechanisms that lower the fixed cost of accessing information, relative to markets already served extensively by professional analysts and institutional research desks.

Three further features of the Chinese market bear directly on the interpretation of stock price synchronicity as an outcome variable. First, analyst coverage remains considerably more uneven across firms than in developed markets, with large state-owned enterprises and firms in politically sensitive industries typically covered by dozens of analysts while smaller, privately owned firms may receive little or no systematic coverage at all; this unevenness is precisely the kind of information gap that digital finance, operating through the coverage-breadth channel rather than the analyst channel, is best positioned to narrow.

Second, state ownership itself shapes the information environment: mutual fund ownership improves share price informativeness on average, but this benefit is significantly weaker among state-controlled firms, whose reduced dependence on outside capital blunts external investors' monitoring incentives (Ding et al., 2013). Third, cross-listing and short-selling constraints have historically limited the extent to which informed trading by sophisticated investors, whether foreign institutions or domestic hedge funds, can correct mispricing driven by macro-level sentiment, a friction that plausibly amplifies the extent to which geopolitical risk, once it displaces attention away from firm fundamentals, is reflected in elevated synchronicity rather than being quickly arbitrated away.

These features suggest that China is not merely a convenient setting in which to test the hypotheses developed in Section 2 but one in which the underlying mechanisms are, if anything, more likely to bind than in markets with denser analyst coverage and fewer constraints on informed trading; consistent with this, local fintech development has independently been shown to lower stock price crash risk among Chinese listed firms by enhancing corporate information transparency (Wang et al., 2023), a finding that anticipates, at a related outcome variable, the buffering role this paper documents for synchronicity.

A further institutional feature relevant to interpreting the threshold estimate in Section 6 is the domestic regulatory environment surrounding China's digital finance sector, which underwent significant tightening beginning in late 2020, most visibly with the suspension of a major fintech initial public offering and a subsequent series of antitrust actions targeting large platform companies through 2021. This episode of domestic regulatory risk is conceptually distinct from the international geopolitical risk measured by the GPR index used in this paper, and the two need not move together; indeed, the threshold model's classification of 2020–2021 within the low-risk geopolitical regime illustrates precisely this distinction, since a period of substantial domestic fintech regulatory tightening coincided with a period of relatively subdued international geopolitical tension for China specifically.

This distinction matters for interpreting the paper's findings: the buffering role attributed to digital finance in this study reflects its function as an information-dissemination infrastructure, a function plausibly robust to domestic regulatory changes targeting platform companies' market conduct, rather than a claim about the resilience of any particular fintech firm or business model to regulatory risk.

4. Data and Variables

The empirical analysis draws on an unbalanced panel of Chinese A-share listed firms spanning 2011 to 2024, a period bounded on the lower end by the availability of firm-level digital finance matching data. After excluding financial-sector firms and observations with missing values on the core variables, the final sample comprises 3,513 firms and 32,623 firm-year observations.

The final sample represents a substantial share of the Chinese A-share universe over the sample period, with attrition relative to the full listed population driven primarily by the exclusion of financial-sector firms, for which standard synchronicity and financialization measures are not meaningfully defined, and by the requirement of non-missing digital finance matching data at the city-year level, a requirement that binds most heavily in the earliest years of the sample before city-level digital finance coverage became near-universal. The digital finance index is matched at the city rather than the firm level, so sample attrition from this source is plausibly close to random with respect to firm-specific characteristics and unlikely to induce a systematic selection bias correlated with the outcome variable.

Stock price synchronicity (SYNC), the dependent variable, is constructed following the standard approach in the literature (Morck et al., 2000) as the logistic transformation $\ln(R^2/(1-R^2))$ of the R^2 obtained from a market-and-industry-return regression of firm returns, with three variants computed under alternative regression fit thresholds (0.30, 0.40, and 0.45) to assess robustness to the construction procedure. Geopolitical risk (GPR) is measured using the China-specific component of the Caldara and Iacoviello (2022) geopolitical risk index, aggregated from monthly to annual frequency. Regional digital finance (DIGFIN) is measured using the city-matched Peking University Digital Financial Inclusion Index (Guo et al., 2020), which aggregates coverage breadth and usage depth into a composite index; both the aggregate index and its two sub-dimensions are used in the empirical analysis.

Firm-level digital capacity (DIGASSET) is measured as the share of digital intangible assets in total intangible assets, a firm-specific proxy for the pace of a firm's own digital transformation that is conceptually distinct from, though potentially complementary to, the city-level DIGFIN measure; because digital intangible assets are capitalized on the firm's own balance sheet rather than inferred from regional infrastructure statistics, DIGASSET captures a firm's realized investment in its own digital capability, including software, data systems, and digitally enabled operational infrastructure, rather than the mere availability of external digital financial services to the firm's investors. Additional firm-level controls include the degree of corporate financialization, firm size, and inventory intensity. Table 1 reports full variable definitions, and all continuous variables are winsorized at the 1st and 99th percentiles to limit the influence of extreme observations.

Table 1
Variable Definitions

Type	Variable	Symbol	Definition and source
Dependent variable	Stock price synchronicity	SYNC	$\ln(R^2/(1-R^2))$; constructed under three alternative fit thresholds (0.30/0.40/0.45)
Key explanatory variable	Geopolitical risk	GPR	China component of the Caldara and Iacoviello (2022) index, annualized from monthly data
Moderator	Regional digital finance	DIGFIN	Peking University Digital Financial Inclusion Index, city-matched; coverage breadth and usage depth sub-indices
Central moderator	Firm-level absorptive/digital capacity	DIGASSET	Share of digital intangible assets in total intangible assets
Control	Corporate financialization	FIN	Share of financial assets in total firm assets
Control	Firm size	SIZE	Natural log of total operating revenue
Control	Inventory intensity	INV	Net inventory scaled by total operating cost
<i>Note: All continuous variables are winsorized at the 1st and 99th percentiles. N = 32,623 firm-year observations; 3,513 firms; 2011–2024.</i>			

Table 2 reports descriptive statistics for the main variables. The mean of SYNC is -0.586, with a standard deviation of 1.234, consistent with the typical range reported in prior studies using the logistic transformation of R^2 . Geopolitical risk averages 0.768 over the sample period, with a minimum of 0.379 in the calmest years and a maximum of 1.176 during the most acute episode, indicating substantial time-series variation for identification. The digital finance index ranges from 23.880 to 511.741, reflecting the vast disparity in digital financial development across Chinese cities and years. Firm-level digital capacity (DIGASSET) has a mean of 0.222 and a standard deviation of 0.276, with an interquartile range from 0.029 to 0.307, indicating that firms vary substantially in the pace of their own digital transformation even after conditioning on their city's regional infrastructure.

Table 2
Descriptive Statistics

Variable	N	Mean	SD	Min	P25	Median	P75	Max
SYNC	32,623	-0.586	1.234	-4.102	-1.272	-0.451	0.228	2.396
GPR	32,623	0.768	0.249	0.379	0.490	0.814	0.917	1.176
DIGFIN	32,623	300.145	116.372	23.880	220.690	290.210	410.028	511.741
FIN	32,623	0.054	0.104	0.000	0.000	0.010	0.054	0.591
DIGASSET	32,623	0.222	0.276	0.000	0.029	0.099	0.307	1.000
SIZE	32,623	21.707	1.488	18.734	20.659	21.558	22.600	26.020
INV	32,623	0.341	0.587	0.000	0.099	0.191	0.336	4.164

Table 3 reports the pairwise correlation matrix. Geopolitical risk and the digital finance index are strongly positively correlated (0.769), a pattern that reflects the fact that both variables trend upward over the sample period rather than any structural relationship between the two; this raises a natural concern about collinearity that the empirical strategy addresses directly. The moderation and threshold specifications in Sections 5 and 6 rely on the interaction between GPR and DIGFIN rather than on either variable's main effect in isolation, and DIGFIN retains substantial cross-sectional variation across cities that GPR, a purely national annual series, does not share; the interaction term is therefore identified from variation in digital finance across cities within each year rather than from the shared time trend, which fixed effects absorb.

Table 3
Correlation Matrix

SYNC	SYNC	GPR	DIGFIN	FIN	DIGASSET	SIZE	INV
	1.000						
GPR	-0.203	1.000					
DIGFIN	-0.291	0.769	1.000				
FIN	0.028	0.074	0.123	1.000			
DIGASSET	-0.005	0.068	0.114	0.187	1.000		
SIZE	0.149	0.076	0.097	0.030	-0.066	1.000	
INV	0.018	-0.058	-0.055	-0.001	0.086	-0.079	1.000
<i>Note: Pairwise Pearson correlation coefficients, N = 32,623.</i>							

Firm-level digital capacity (DIGASSET) correlates only modestly with the regional digital finance index (0.114), confirming that the two variables capture meaningfully distinct sources of variation rather than proxying for the same underlying construct. All other pairwise correlations among the control variables are modest, well below levels that would raise multicollinearity concerns in the regression specifications that follow.

5. Empirical Strategy

The baseline specification is estimated with firm fixed effects:

$$SYNC_{i,t} = \alpha_i + \beta_1 \cdot GPR_t + \beta_2 \cdot DIGFIN_{i,t} + \beta_3 \cdot (GPR_t \times DIGFIN_{i,t}) + \delta' X_{i,t} + \epsilon_{i,t}$$

1

where $SYNC_{i,t}$ denotes stock price synchronicity for firm i in year t , GPR_t is the annual geopolitical risk index, $DIGFIN_{i,t}$ is the standardized digital finance index, and $X_{i,t}$ is a vector of firm-level controls. Year fixed effects are omitted from Eq. (1) to preserve identification of the main effect of geopolitical risk, since GPR varies only at the annual level; firm fixed effects absorb time-invariant firm heterogeneity, and standard errors are clustered at the firm level.

To isolate the moderating effect of digital finance while controlling flexibly for aggregate time trends, a second specification augments Eq. (1) with year fixed effects:

$$SYNC_{i,t} = \alpha_i + \lambda_t + \beta \cdot (GPR_t \times DIGFIN_{i,t}) + \gamma \cdot DIGFIN_{i,t} + \delta' X_{i,t} + \epsilon_{i,t}$$

2

Year fixed effects λ_t absorb the main effect of GPR_t , which varies only across years, but do not absorb the interaction term because $DIGFIN_{i,t}$ varies across both firms and years. The coefficient β is therefore the object of interest for testing H_2 .

To test H3, this paper estimates a Hansen (1999) panel threshold model in which geopolitical risk itself serves as the threshold variable and the effect of digital finance is allowed to switch across risk regimes:

$$SYNC_{i,t} = \alpha_i + \beta_1 \cdot DIGFIN_{i,t} \cdot I(GPR_t \leq \gamma) + \beta_2 \cdot DIGFIN_{i,t} \cdot I(GPR_t > \gamma) + \delta' X_{i,t} + \epsilon_{i,t}$$

3

where $I(\cdot)$ is an indicator function and gamma is the threshold parameter. Fixed effects are removed via firm-level demeaning, which preserves the time-series variation in GPR_t that would otherwise be eliminated under a two-way transformation. The threshold parameter is estimated by grid search over the empirical support of GPR_t , minimizing the residual sum of squares; statistical significance is assessed via a fixed-regressor wild bootstrap with 300 replications, and the 95 percent confidence interval for γ is constructed using Hansen's (1999) no-rejection region based on the likelihood ratio statistic, with critical value 7.35.

An initial specification, in which the digital finance index served as the threshold variable and geopolitical risk as the switching regressor, produced threshold estimates that migrated toward the upper tail of the empirical distribution as the search range was widened, with fewer than 5 percent of observations falling into the upper regime. This pattern is characteristic of a boundary-driven estimate rather than a genuine interior break (Hansen, 1999) and was accordingly not pursued; Eq. (3) reflects the specification retained after this diagnostic step.

To test H_4 , whether the erosion of digital finance's buffering effect documented in Eq. (3) is itself moderated by firm-level digital capacity, this paper augments the continuous interaction specification with a triple interaction:

$$SYNC_{i,t} = \alpha_i + \lambda_t + \theta \cdot (GPR_t \times DIGFIN_{i,t} \times DIGASSET_{i,t}) + \beta \cdot (GPR_t \times DIGFIN_{i,t}) + \gamma \cdot DIGFIN_{i,t} + \phi \cdot DIGASSET_{i,t} + \delta' X_{i,t}$$

where $DIGASSET_{i,t}$ is the standardized firm-level digital capacity measure. The coefficient theta captures whether the buffering interaction beta itself varies with a firm's own digital capacity: a negative and significant theta indicates that the buffering effect (already negative in sign, per H_2) becomes stronger, that is, more negative, for firms with greater digital capacity, consistent with the complementarity described in H_4 . A theta indistinguishable from zero would instead indicate that regional infrastructure delivers a uniform benefit regardless of firm-level digital capacity, consistent with the two being unrelated rather than complementary, while a positive and significant theta would indicate substitutability, in which firm-level digital capacity crowds out the marginal value of regional infrastructure. The three-way structure of Eq. (4) therefore nests all three possibilities, uniformity, complementarity, and substitutability, within a single testable coefficient rather than requiring separate specifications for each.

This specification retains the full sample and continuous variation in DIGASSET, avoiding the power loss associated with sample splits, and is estimated with the same two-way fixed-effects structure and firm-clustered standard errors as Eq. (2). DIGASSET, the share of digital intangible assets in total intangible assets, is used to operationalize firm-level digital capacity because it captures balance-sheet evidence of realized digital investment, in software, data systems, and digital platforms, rather than a stated intention or a coarse binary indicator of digital adoption, and because it varies continuously within firms over time, allowing Eq. (4) to exploit within-firm changes in digital capacity rather than relying solely on cross-sectional differences that fixed effects would otherwise absorb.

A natural concern with this identification strategy is the potential endogeneity of digital finance itself: if cities with unobserved characteristics correlated with information efficiency also happen to adopt digital financial infrastructure earlier, the estimated moderation effect could partly reflect this selection rather than a causal buffering role. Three features of the empirical design mitigate this concern without fully eliminating it.

First, firm fixed effects absorb any time-invariant city-level characteristics correlated with a firm's location, so the identifying variation comes from within-firm changes in local digital finance exposure over time rather than from cross-sectional differences across cities. Second, the digital finance index used here is constructed primarily from the geographic rollout of a small number of national digital payment platforms, a process driven substantially by national infrastructure and licensing decisions rather than by city-level investor demand for informational efficiency specifically, which limits the scope for reverse causality running from stock price synchronicity to digital finance adoption. Third, the sub-dimension analysis in Section 7, which finds that coverage breadth but not usage depth drives the buffering effect, is difficult to reconcile with a story in which sophisticated, already-efficient cities simply adopt more digital finance, since such a story would more plausibly predict effects concentrated in usage depth rather than in coverage breadth.

A parallel concern applies to DIGASSET in Eq. (4): if unobserved firm quality independently drives both digital investment and informational resilience, the triple-interaction coefficient theta could partly reflect this omitted quality rather than a genuine complementarity between regional and firm-level digital capacity. Firm fixed effects address the time-invariant component of any such quality, and the alternative-explanation check in Section 6.3 rules out firm size as a stand-in for DIGASSET, but a fully causal resolution of this concern would require an exogenous shock to firm-level digital adoption that this paper's data do not provide, a limitation addressed further in Section 9.

6. Results

6.1 Baseline and moderation effects

Table 4 reports the estimates of equations (1) and (2). Column (1) shows that the coefficient on geopolitical risk is positive and significant at the 1 percent level, supporting H_1 : firms operating under higher geopolitical risk exhibit systematically higher stock price synchronicity, consistent with an information-opacity mechanism through which uncertainty crowds out firm-specific pricing. The magnitude is economically meaningful: a one-standard-deviation increase in GPR is associated with an increase in SYNC of approximately 0.118, roughly 10 percent of the dependent variable's own standard deviation. The coefficient on the digital finance index is negative and highly significant, indicating that digital financial development is independently associated with lower synchronicity.

Table 4
Baseline and Moderation Effects

Variable	(1) Baseline Firm FE	(2) SYNC 0.30 Firm+Year FE	(3) SYNC 0.40 Firm+Year FE	(4) SYNC 0.45 Firm+Year FE
GPR	0.474***	absorbed	absorbed	absorbed
DIGFIN	-0.525***	0.345***	0.345***	0.345***
GPR × DIGFIN	0.069***	-0.254**	-0.254**	-0.255**
Firm size	0.134***	0.198***	0.197***	0.197***
Inventory intensity	0.070***	0.074***	0.073***	0.073***
Financialization	-0.256**	n.s.	n.s.	n.s.
N	32,623	32,623	32,623	32,623
Note: ***p < 0.01, **p < 0.05, *p < 0.10. Standard errors clustered at the firm level. n.s. denotes not significant at the 10 percent level. "Absorbed" indicates that the main effect of GPR is not separately identified once year fixed effects are included, since GPR varies only at the annual level.				

Columns (2) through (4) report the two-way fixed-effects estimates of Eq. (2) across the three synchronicity constructions. The interaction term GPR x DIGFIN is negative and significant at conventional levels in all three columns, providing consistent support for H_2 . The stability of the interaction coefficient across three alternative constructions of the dependent variable indicates that the moderation effect is not an artifact of a particular synchronicity measure.

The control variables in Table 4 carry economic content beyond their role in soaking up nuisance variation. Firm size loads positively and significantly on synchronicity throughout, consistent with the pattern that larger firms, despite typically receiving more analyst coverage, also attract more index-linked and passive institutional flows whose trading is driven by portfolio-level rather than firm-level considerations. Inventory intensity is likewise positive and significant, plausibly reflecting greater exposure to macro-level demand and supply-chain shocks among firms with larger inventory positions. Corporate financialization loads negatively on synchronicity in the firm-fixed-effects specification but loses significance once year fixed effects are added, consistent with financialization operating primarily through a liquidity reservoir mechanism tied to common time trends rather than a firm-specific informational channel (Demir, 2009), rather than reflecting any genuine improvement in price informativeness.

6.2 Threshold effects

Table 5 reports the estimates of the Hansen threshold model in Eq. (3). The estimated threshold is $\gamma\text{-hat} = 0.754$, a level of geopolitical risk empirically attained by China in 2020 and exceeded during the 2017–2019 trade-tension episode and again from 2022 through 2024 amid the escalation surrounding the Russia-Ukraine conflict. The bootstrap test strongly rejects the null of no threshold effect, and the 95 percent confidence interval, constructed from the likelihood ratio statistic plotted in Fig. 2, is tightly centered on the point estimate. Figure 1 illustrates the resulting partition of the sample period into a low-risk regime, comprising 2011–2016 and 2020–2021, and a high-risk regime, comprising 2017–2019 and 2022–2024.

Table 5
Panel Threshold Estimates

Statistic	Value
Threshold estimate $\hat{\gamma}$	0.754 (corresponding to China's 2020 GPR level)
F-statistic / Bootstrap p-value (B = 300)	1872.3 / < 0.001
95% confidence interval	[0.754, 0.754]
Low-risk regime ($\text{GPR} \leq 0.754$), N	15,362 (2011–2016, 2020–2021)
High-risk regime ($\text{GPR} > 0.754$), N	17,261 (2017–2019, 2022–2024)
β_1 : effect of DIGFIN in low-risk regime	-0.763
β_2 : effect of DIGFIN in high-risk regime	-0.224

The regime-specific coefficients, reported in Table 5 and plotted in Fig. 3, reveal a substantial asymmetry. In the low-risk regime, digital finance exerts a strong negative effect on synchronicity, whereas in the high-risk regime this effect contracts to less than a third of its former magnitude, a decline in buffering capacity of over 70 percent. This pattern supports H_3 : digital finance does not offer unconditional protection against geopolitical uncertainty but instead provides a buffering capacity that is itself eroded once risk crosses a critical level.

The years assigned to each regime offer an informal external validity check on this statistically estimated break point. The high-risk regime comprises 2017 through 2019, years associated with the initiation and escalation of tariff measures between China and its largest trading partner, and 2022 through 2024, years spanning the outbreak of the Russia-Ukraine conflict and the subsequent broadening of export-control and supply-chain-realignment measures. The low-risk regime comprises the calm 2011–2016 period together with 2020 and 2021, years in which China's own country-specific geopolitical risk index receded even as global attention was dominated by the COVID-19 pandemic, a divergence between global economic disruption and the China-specific geopolitical risk measure used here that illustrates an important conceptual distinction: the GPR index is constructed from geopolitical rather than public-health or macroeconomic news, so a period of severe global economic disruption need not coincide with elevated geopolitical risk as measured in this paper.

This correspondence between the statistically estimated threshold and independently dateable geopolitical episodes strengthens confidence that the threshold identified in Table 5 reflects a genuine feature of how digital finance's buffering capacity responds to real-world conditions, rather than an artifact of the estimation procedure.

A two-threshold extension, explored using the joint grid-search procedure of Hansen (1999), yielded threshold estimates of 0.490 and 0.733 but is not retained in the preferred results because the intermediate regime it implies corresponds to a single calendar year, 2021, suggesting that the second break reflects idiosyncratic variation specific to that year rather than a genuine structural discontinuity, a limitation attributable to the coarse annual frequency at which geopolitical risk is measured.

6.3 Firm-level digital capacity and the resilience of the buffer

Table 6 reports the estimates of the triple-interaction specification in Eq. (4), the test of H_4 and this paper's central result. The coefficient on the triple interaction GPR x DIGFIN x DIGASSET is negative and significant in the primary specification using SYNC constructed under the 0.30 fit threshold, and the result is stable across the two alternative synchronicity constructions, indicating that this finding, like the moderation result in Table 4, is not an artifact of a particular synchronicity measure. The negative sign indicates that as a firm's own digital transformation increases, the buffering interaction between geopolitical risk and regional digital finance becomes more negative, that is, stronger: firms with greater firm-level digital capacity extract a larger informational benefit from a given level of regional digital finance infrastructure precisely when geopolitical risk is elevated.

Table 6
Absorptive Capacity and the Resilience of the Buffer (Central Result)

Variable	SYNC 0.30	SYNC 0.40	SYNC 0.45
GPR × DIGFIN × DIGASSET (θ)	-0.020**	-0.020**	-0.020**
p-value	0.023	0.023	0.023
GPR × DIGFIN (β)	-0.216*	-0.216*	-0.215*
N	32,623	32,623	32,623
<i>Note: ***p < 0.01, **p < 0.05, *p < 0.10. Standard errors clustered at the firm level. This is the test of H4, the paper's central hypothesis, interpreted through absorptive capacity theory (Cohen and Levinthal, 1990).</i>			

Figure 5 plots the marginal effect of the GPR × DIGFIN interaction across the empirical range of firm-level digital capacity, together with its 95 percent confidence band, and shows this strengthening pattern continuously rather than at only the two percentiles discussed here. Evaluated at the sample's interquartile range of firm-level digital capacity, moving from the 25th to the 75th percentile of DIGASSET is associated with the buffering interaction strengthening from approximately − 0.202 to approximately − 0.222, a moderate but statistically robust widening of the gap between firms with strong and weak internal digital capacity in how much protection they derive from regional digital finance under geopolitical stress.

This result speaks directly to the erosion documented in Table 5: it indicates that the average erosion of the buffer from − 0.763 to −0.224 masks meaningful cross-sectional variation, with firms possessing greater digital capacity retaining a buffer that erodes less severely than the average firm's, and firms with weaker digital capacity experiencing an erosion more severe than the average. Firm-level digital capacity and regional digital finance infrastructure thus behave as complements rather than substitutes, consistent with H_4 : rather than a firm's own digital investment becoming redundant once regional infrastructure is in place, the two reinforce each other's informational value most strongly in precisely the conditions, elevated geopolitical risk, under which that value is most at risk of being lost.

An obvious alternative explanation for this result is that DIGASSET simply proxies for firm size or general sophistication, characteristics already shown in Table 7 to weaken the buffering interaction in the opposite direction, so that the triple-interaction result would merely restate the size heterogeneity already documented rather than adding new information.

Table 7
Robustness and Heterogeneity

Test	Specification	Coefficient (p-value)	Conclusion
Robustness	GPR × Coverage breadth	-0.257 (0.007)	Robust
Robustness	GPR × Usage depth	-0.058 (0.501)	Insignificant
Robustness	Excluding 2022	-0.273 (0.072)	Direction unchanged; weaker significance
Robustness	GPR(t-1) × DIGFIN	-0.100 (0.319)	Insignificant; effect is contemporaneous
Robustness	Two-way clustering (firm, year)	-0.254 (0.006)	Robust
Heterogeneity	GPR × DIGFIN × Financialization	0.037 (< 0.001)	Buffering effect weaker for financialized firms
Heterogeneity	GPR × DIGFIN × Size	0.061 (< 0.001)	Buffering effect weaker for larger firms
<i>Note: p-values in parentheses. N = 32,623 for all rows. Dependent variable is SYNC (0.30 fit threshold); results are materially unchanged under the 0.40 and 0.45 constructions.</i>			

Two features of the estimates count against this alternative. First, Eq. (4) includes firm size as a separate control alongside DIGASSET, so the triple-interaction coefficient reflects variation in digital capacity that is orthogonal to size rather than a relabeled size effect. Second, and more tellingly, the triple-interaction result and the size-heterogeneity result in Table 7 point in opposite directions: larger firms derive less benefit from regional digital finance under geopolitical stress, while firms with greater digital capacity derive more, a pattern inconsistent with DIGASSET serving as a mere stand-in for scale and consistent instead with digital capacity capturing something size does not, an organizational readiness to sustain informational continuity that smaller, digitally capable firms can possess just as readily as larger ones.

6.4 Economic magnitude in context

The magnitudes documented above can be given a more concrete interpretation. Under the calm conditions of 2011–2016, an increase in a firm's local digital finance exposure from the sample's 25th to 75th percentile is associated with a reduction in synchronicity of approximately 0.60 units, based on the low-risk regime coefficient in Table 5. Under the turbulent conditions that characterized 2017–2019 and 2022–2024, the same change in digital finance exposure is associated with a reduction of only about 0.18 units. The firm-capacity result in Table 6 indicates that this decline is not experienced uniformly: firms in the top quartile of firm-level digital capacity retain a meaningfully larger share of the calm-period buffer into the high-risk regime than firms in the bottom quartile, a gap this paper documents but a full accounting of its magnitude across the joint distribution of GPR, DIGFIN, and DIGASSET is left to future work given the added complexity of characterizing a three-way nonlinear interaction across the sample's risk regimes.

This correspondence between the statistically estimated threshold and independently dateable geopolitical episodes extends to the firm-capacity result in Table 6, which builds on the same underlying risk measure: the trade-tension and conflict-escalation episodes that define the high-risk regime were not, in

general, unforeseeable shocks arriving without warning, but were preceded by extended periods of building tension during which both regional digital financial infrastructure and firm-level digital capacity could, in principle, have been strengthened in anticipation, a point taken up further in Section 8.

7. Robustness and Heterogeneity

7.1 Robustness

Table 7 summarizes a battery of robustness checks on the moderation result in Table 4. Replacing the aggregate digital finance index with its coverage-breadth sub-dimension yields a coefficient of similar magnitude and significance, whereas the usage-depth sub-dimension is statistically insignificant, indicating that the buffering mechanism operates primarily through the breadth of information access rather than the intensity of usage. This distinction carries a substantive implication beyond its role as a robustness check: it suggests that the marginal investor whose information environment is improved by digital finance is one who previously lacked any access to firm-specific information, rather than one who already had access but used it more intensively, a pattern consistent with the retail-investor-heavy structure of the Chinese A-share market described in Section 3.

Excluding 2022, the year of peak geopolitical risk in the sample, leaves the point estimate essentially unchanged but weakens significance to the 10 percent level, suggesting that part of the identifying variation derives from this extreme observation; this sensitivity is itself informative, since it is precisely in the highest-risk year that the threshold model in Table 5 predicts the buffering effect should be weakest. Replacing contemporaneous geopolitical risk with its one-year lag renders the interaction insignificant, indicating that the buffering relationship operates contemporaneously rather than with a delay. Two-way clustering by firm and year leaves both the point estimate and its significance intact.

7.2 Heterogeneity

Heterogeneity is assessed along two firm characteristics identified *ex ante* as plausible sources of differential exposure: firm size and the degree of corporate financialization. Simple sample splits at the annual median yield directionally consistent but individually underpowered estimates, with only the low-financialization subsample retaining significance at conventional levels; this loss of power is an expected consequence of halving the effective sample size within each subgroup. A full-sample triple-interaction specification, which retains statistical power by using continuous rather than binary partitions, shows that both interactions, GPR x DIGFIN x Financialization and GPR x DIGFIN x Size, are positive and significant at the 1 percent level, indicating that the buffering effect of digital finance is significantly weaker among larger and more financialized firms.

This pattern is consistent with an interpretation in which large, financially sophisticated firms possess alternative channels, such as internal capital markets and sustained institutional investor attention, that already mitigate information opacity, leaving comparatively little marginal role for digital finance; smaller and less financialized firms, lacking such substitutes, derive a correspondingly larger informational benefit from digital financial development. Read alongside the firm-capacity result in Table 6, this size and financialization heterogeneity suggests a layered picture of resilience: among smaller, less financialized firms, where regional digital finance matters most, whether the buffer survives geopolitical stress additionally depends on the firm's own digital capacity, making the combination of small scale, low financialization, and weak digital capacity the profile most exposed to the erosion documented in this paper.

This layered picture also connects to the institutional discussion in Section 3 regarding state ownership. Mutual fund ownership improves price informativeness less among state-controlled firms than among their privately owned counterparts (Ding et al., 2013), and state-controlled firms in China are disproportionately large and more likely to enjoy privileged access to bank credit that substitutes for the kind of external informational scrutiny digital finance provides, so the size and financialization heterogeneity documented here plausibly overlaps substantially with an ownership-based heterogeneity that this paper's data, which does not include a direct ownership classification, cannot test directly. Whether the firm-capacity complementarity in Table 6 is itself weaker among state-controlled firms, for the same reasons that regional digital finance's average buffering effect is weaker among large, financialized firms, is a natural extension for research with access to ownership-classified data.

8. Discussion

The findings developed above speak to four strands of the broader literature. First, relative to the geopolitical risk literature's traditional focus on real corporate decisions and aggregate volatility (Caldara and Iacoviello, 2022; Adra et al., 2023; Wen et al., 2024; Huang et al., 2026; Zhang, He et al., 2023), this paper's evidence on stock price synchronicity identifies a distinct, firm-level channel through which geopolitical uncertainty exerts influence, one that operates continuously rather than only during discrete crisis episodes such as the crash events studied by Fiorillo et al. (2024). Synchronicity is measured every year for every firm, rather than only in the relatively rare years in which a crash occurs, so this channel captures a more pervasive, lower-intensity cost of geopolitical uncertainty that complements the crash-risk literature's focus on tail events.

Second, the finding that digital finance's buffering effect operates through coverage breadth rather than usage depth refines the broader digital finance literature's typically aggregate treatment of digital financial development (Li, Bao et al., 2026; Zeng et al., 2026; Wang, Jiao et al., 2026). If the mechanism through which digital finance improves outcomes is the geographic and demographic extension of access rather than the deepening of usage among existing users, policies aimed at closing remaining coverage gaps may carry disproportionate informational benefits relative to policies aimed at increasing engagement intensity among cities already well covered.

Third, the threshold result in Table 5 qualifies a presumption that runs, at least implicitly, through much of the digital finance literature: that digital financial development is an unconditional good, offsetting frictions and uncertainty wherever it is present. The finding that the same digital finance index that reduces synchronicity by 0.763 units under calm geopolitical conditions reduces it by only 0.224 units once risk crosses an empirically identified threshold suggests

instead that digital finance's informational value is itself a function of the severity of the environment in which it operates, a boundary condition that a purely linear specification would not reveal on its own.

Fourth, and most centrally, the firm-capacity result in Table 6 answers a question the threshold result alone could not: whose shield actually breaks. Two complementary explanations, one operating on the supply side of information and one on the demand side of investor attention, are consistent with why firm-level capacity would attenuate the erosion documented in H3, and the empirical result in Table 6 lends direct support to the supply-side account in particular.

On the supply side, severe geopolitical shocks are associated with tightening financial constraints that curtail firms' own digital transformation efforts (Huang et al., 2026); firms that have already built substantial digital capacity before a shock arrives are less exposed to this constraint-driven contraction than firms that have not, allowing them to sustain the informational channel that regional infrastructure alone cannot guarantee once conditions deteriorate. On the demand side, investors facing extreme uncertainty may shift attention toward macro and geopolitical developments regardless of the firm-specific information technically available, a shift that firm-level capacity, by making firm-specific information more salient, prominent, and readily verifiable, may partially counteract even when regional attention-allocation patterns move against the firm.

The finding that firm-level capacity strengthens rather than merely preserves the buffering interaction under Table 6's specification is more consistent with an active, supply-side complementarity, in which the firm's own capacity compensates for the weakening of the regional channel rather than merely coexisting alongside it, than with a purely passive demand-side story in which firm capacity plays no independent role.

Framed through absorptive capacity theory, this pattern has a natural interpretation: a firm's digital investment does not simply add a second, independent information channel alongside regional infrastructure, but determines the firm's capacity to recognize and assimilate what that infrastructure makes available, a capacity that matters more, not less, once conditions deteriorate and recognizing genuinely informative signals amid noise becomes harder.

This reading is consistent with why the interaction strengthens rather than merely persists under stress, since absorptive capacity theory predicts that firms with greater prior investment extract disproportionately more value from a given external resource precisely when exploiting that resource requires more skill and attention, not less. Whether this is the correct reading, as opposed to a purely demand-side account in which firm capacity operates independently of regional infrastructure, cannot be settled definitively with the present data.

Distinguishing the two more precisely, for instance by tracing the specific investor-relations or disclosure channels through which firm-level capacity operates, remains a task for future research using more granular, firm-level information-environment data than the present study assembles.

These findings should be interpreted within the scope of a single, albeit large and economically important, emerging market over a fourteen-year window, and the extent to which the coverage-breadth mechanism, the threshold pattern, and the firm-capacity complementarity documented here generalize to markets with different investor compositions, different digital finance ecosystems, or different geopolitical risk profiles remains an open question for future research. The contemporaneous nature of the estimated effects, and their sensitivity to the single most extreme year in the sample as documented in Section 7.1, further suggest that the precise numerical magnitudes reported here should be treated as indicative of an economically meaningful pattern rather than as precise structural parameters.

The shield metaphor introduced at the outset of this paper is ultimately an argument about where policy and managerial attention should be directed. A shield that is presumed uniform, present or absent in binary fashion across an entire regional economy, invites a correspondingly uniform policy response: build the infrastructure and the protection follows automatically. The evidence assembled here suggests a more demanding picture, in which the infrastructure is necessary but not sufficient, and in which the firms most exposed to its failure are not randomly distributed but concentrated among those least equipped, by size, financialization, or their own digital investment, to compensate for its weakening. Recognizing this concentration is a precondition for directing scarce policy and managerial resources toward the firms for whom the shield is most likely to break first.

9. Conclusion

Using a panel of Chinese listed firms from 2011 to 2024, this paper documents that geopolitical risk significantly raises stock price synchronicity and that regional digital finance, particularly its coverage-breadth dimension, significantly buffers this relationship. A Hansen panel threshold model shows that this buffering capacity is nonlinear, contracting substantially once geopolitical risk exceeds an empirically identified critical level associated with the 2017–2019 trade-tension period and the 2022–2024 escalation surrounding the Russia-Ukraine conflict.

Most centrally, this erosion is significantly attenuated among firms with greater firm-level digital transformation, indicating that regional digital finance infrastructure and firm-level digital capacity function as complements, not substitutes, precisely when protection is most needed. These findings qualify the presumption, implicit in much of the digital finance literature, that digital financial infrastructure offers uniform, unconditional protection against uncertainty, and instead identify a previously undocumented firm-level determinant of whether that protection actually holds.

For policymakers, the results imply that regional digital financial infrastructure and firm-level digital capacity-building are not alternative policy levers but complementary ones: investment in one without the other leaves firms only partially protected against the informational costs of geopolitical stress, an implication that resonates with recent evidence on the broader governance functions of digital finance in transnational settings (Zhang, Wu et al., 2026) and on the role of patient, governance-oriented capital in sustaining supply chain resilience under geopolitical tension (Li, Guo et al., 2026).

For firms themselves, particularly smaller, less financialized firms lacking the internal capital markets and institutional attention available to larger peers, the results suggest that a firm's own digital transformation is not a discretionary investment rendered redundant by regional infrastructure but a determinant of whether that infrastructure's protection actually reaches the firm when geopolitical conditions deteriorate.

This study is subject to limitations that qualify the scope of its conclusions. The single-country design cannot by itself establish whether the mechanisms documented here are features of the Chinese market or of geopolitical risk more generally; a multi-country panel would be needed to distinguish between these possibilities. The reliance on a country-level geopolitical risk index, rather than a firm-specific measure of geopolitical exposure, means that the estimated effects should be interpreted as an average across firms with heterogeneous, unobserved degrees of direct geopolitical exposure.

The identification strategy, while addressing several dimensions of endogeneity concern through fixed effects and sub-dimension analysis, does not rise to the level of a causal research design based on a genuine natural experiment or instrumental variable, a limitation this paper shares with much of the associational literature it engages and one that future work, ideally exploiting a plausibly exogenous shock to either regional digital finance rollout or firm-level digital adoption, should address directly. Finally, the contemporaneous nature of the estimated relationships and their documented sensitivity to the single most extreme year in the sample suggest that the precise numerical magnitudes reported here should be treated as indicative of an economically meaningful and theoretically grounded pattern rather than as tightly estimated structural parameters.

Future research might extend this framework in at least three directions. First, testing whether the complementarity between regional infrastructure and firm-level capacity documented here replicates in other emerging markets with comparable digital finance ecosystems would clarify whether this paper's central finding reflects a general feature of digital finance's informational role or a pattern specific to China's particular market structure. Second, a genuinely causal identification strategy, exploiting staggered regional fintech infrastructure rollouts or firm-level digital adoption shocks, would strengthen confidence that the complementarity documented here is not itself an artifact of unobserved firm quality correlated with both digital investment and informational resilience. Third, examining the specific channels, disclosure practices, investor-relations technology, or data infrastructure, through which firm-level digital capacity translates into informational resilience would sharpen the mechanism this paper identifies but cannot fully decompose.

Declarations

Author Contribution

Huang.WL. wrote the main manuscript text. All authors reviewed the manuscript.

Data Availability

The geopolitical risk index is publicly available from Caldara and Iacoviello's Geopolitical Risk Index webpage (matteoiacoviello.com/gpr.htm). The digital financial inclusion index is published by the Institute of Digital Finance, Peking University (Guo et al., 2020). Firm-level financial and market data are sourced from commercial databases subject to third-party licensing restrictions; processed data and analysis code are available from the corresponding author upon reasonable request, subject to the original data licenses.

References

1. Adra S, Gao Y, Huang J, Yuan J (2023) Geopolitical risk and corporate payout policy. *Int Rev Financial Anal* 87:102613
2. Baker SR, Bloom N, Davis SJ (2016) Measuring economic policy uncertainty. *Quart J Econ* 131:1593–1636
3. Bajra UQ, Aliu F, Prenaj V (2025) Connectivity of green financial assets under geopolitical risks and market-implied volatility. *Finance Res Lett* 76:107037
4. Barber BM, Odean T (2008) All that glitters: The effect of attention and news on the buying behavior of individual and institutional investors. *Rev Financial Stud* 21:785–818
5. Bikhchandani S, Hirshleifer D, Welch I (1992) A theory of fads, fashion, custom, and cultural change as informational cascades. *J Polit Econ* 100:992–1026
6. Bloom N (2009) The impact of uncertainty shocks. *Econometrica* 77:623–685
7. Caldara D, Iacoviello M (2022) Measuring geopolitical risk. *Am Econ Rev* 112:1194–1225
8. Chan K, Hameed A (2006) Stock price synchronicity and analyst coverage in emerging markets. *J Financ Econ* 80:115–147
9. Chen J, Hong H, Stein JC (2001) Forecasting crashes: Trading volume, past returns, and conditional skewness in stock prices. *J Financ Econ* 61:345–381
10. Cohen WM, Levinthal DA (1990) Absorptive capacity: A new perspective on learning and innovation. *Adm Sci Q* 35:128–152
11. Demir F (2009) Financial liberalization, private investment and portfolio choice: Financialization of real sectors in emerging markets. *J Dev Econ* 88:314–324
12. Diamond DW, Verrecchia RE (1991) Disclosure, liquidity, and the cost of capital. *J Finance* 46:1325–1359
13. Ding R, Hou W, Kuo J-M, Lee E (2013) Fund ownership and stock price informativeness of Chinese listed firms. *J Multinatl Financial Manag* 23:166–185
14. Fiorillo P, Meles A, Pellegrino LR, Verdoliva V (2024) Geopolitical risk and stock price crash risk: The mitigating role of ESG performance. *Int Rev Financial Anal* 91:102958
15. Guo F, Wang J, Wang F, Kong T, Zhang X, Cheng Z (2020) Measuring China's digital financial inclusion: Index compilation and spatial characteristics. *China Economic Q* 19:1401–1418
16. Hansen BE (1999) Threshold effects in non-dynamic panels: Estimation, testing, and inference. *J Econ* 93:345–368
17. Hong H, Stein JC (1999) A unified theory of underreaction, momentum trading, and overreaction in asset markets. *J Finance* 54:2143–2184

18. Hong H, Stein JC (2003) Differences of opinion, short-sales constraints, and market crashes. *Rev Financial Stud* 16:487–525
19. Huang J, Chen Y, She Y, Gui Y (2026) Transforming in turbulent times: The geopolitical risk factor in firm digital transformation. *Emerging Markets Finance and Trade*, in press
20. Hutton AP, Marcus AJ, Tehranian H (2009) Opaque financial reports, R2, and crash risk. *J Financ Econ* 94:67–86
21. Jin L, Myers SC (2006) R2 around the world: New theory and new tests. *J Financ Econ* 79:257–292
22. Kyle AS (1985) Continuous auctions and insider trading. *Econometrica* 53:1315–1335
23. Kyriazis NA, Economou EML (2025) Unveiling the impacts of geopolitical risk on the transition to the decentralized financial landscape. *Peace Econ Peace Sci Public Policy* 31:57–89
24. Li J, Bao W, Luo J (2026) Does digital finance flatten supply chain risk for manufacturing firms? *Finance Res Lett* 91:109441
25. Li J, Guo Y, Wei L, Niu X, Li W (2026) Patient capital and supply chain resilience in manufacturing enterprises: An analysis from the perspectives of funding, governance, and innovation. *Int Rev Financial Anal* 110:104905
26. Morck R, Yeung B, Yu W (2000) The information content of stock markets: Why do emerging markets have synchronous stock price movements? *J Financ Econ* 58:215–260
27. Mukherjee BB (2025) Regulating digital fintech: How states navigate power and geopolitics. *Revista UNISCI*, pp 213–241
28. Peng L, Xiong W (2006) Investor attention, overconfidence and category learning. *J Financ Econ* 80:563–602
29. Piotroski JD, Roulstone DT (2004) The influence of analysts, institutional investors, and insiders on the incorporation of market, industry, and firm-specific information into stock prices. *Acc Rev* 79:1119–1151
30. Roll R (1988) R2. *J Finance* 43:541–566
31. Wang C, Jiao H, Cai Y, Zhu X (2026) Economic policy uncertainty and digital finance development: Evidence from 30 regions in China. *Int J Finance Econ* 31:368–389
32. Wang J, Xie X, Chen T (2026) How does digital finance promote energy security? Evidence from China. *Environ Dev Sustain* 28:18101–18127
33. Wang X, Cao Y, Feng Z, Lu M, Shan Y (2023) Local FinTech development and stock price crash risk. *Finance Res Lett* 53:103644
34. Wen Y, Tao Y, Tang H (2024) Geopolitical risk, digital transformation, and corporate outward foreign direct investment. *Finance Res Lett* 69:106171
35. Zeng H, Zhang Z, Ma X (2026) Can digital finance mitigate the inhibitory effect of cultural distance on infrastructure investment? An empirical analysis based on countries along the Belt and Road Initiative. *Int Rev Financial Anal* 110:104893
36. Zhang Q, Wu W, Xiong Y, Hou H (2026) Digital finance and global economic governance: How financial technology reshapes transnational cooperation and competition. *Finance Res Lett* 89:109299
37. Zhang Y, He J, He M, Li S (2023) Geopolitical risk and stock market volatility: A global perspective. *Finance Res Lett* 53:103620

Figures

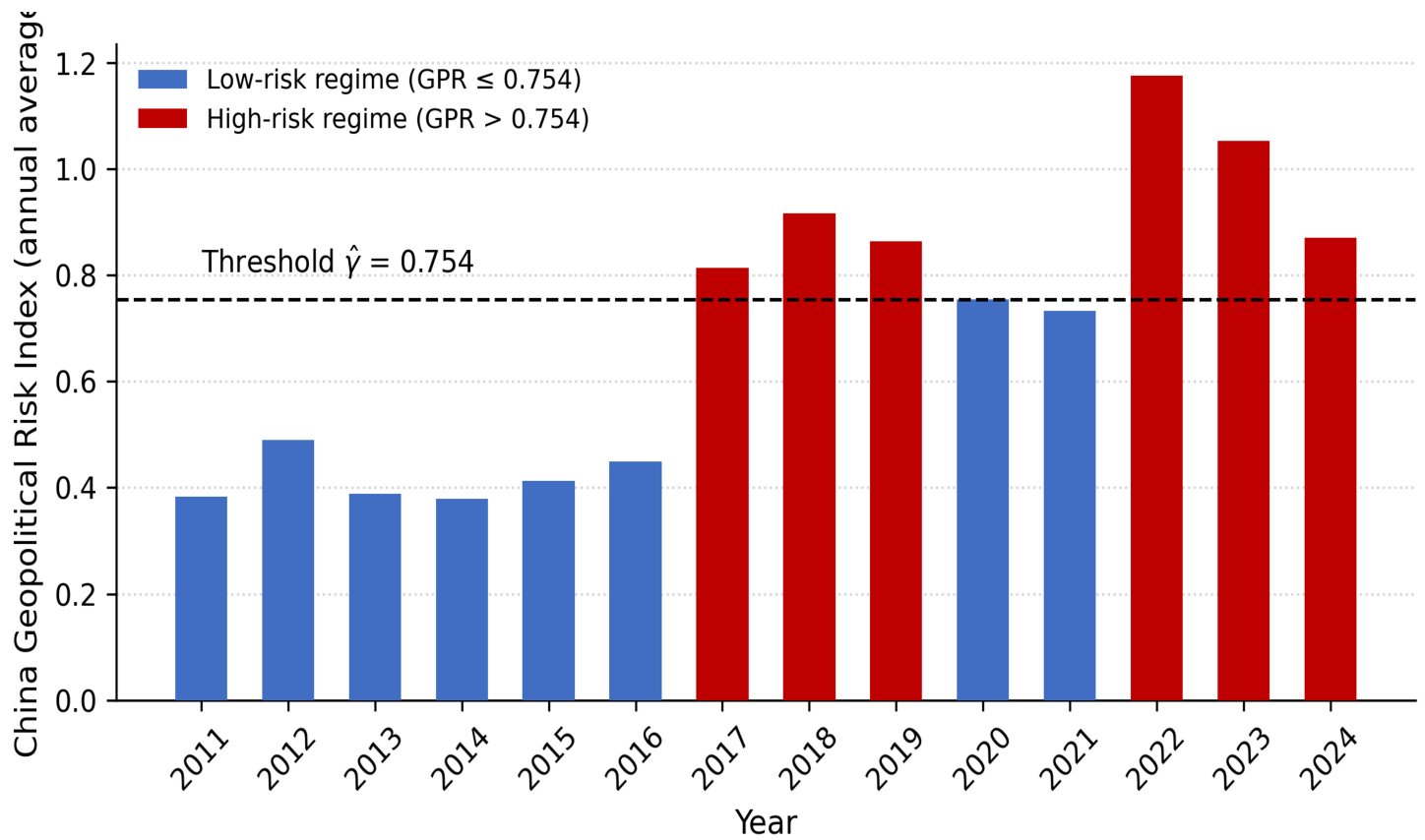


Figure 1

China Geopolitical Risk Index (2011-2024) and the Estimated Threshold

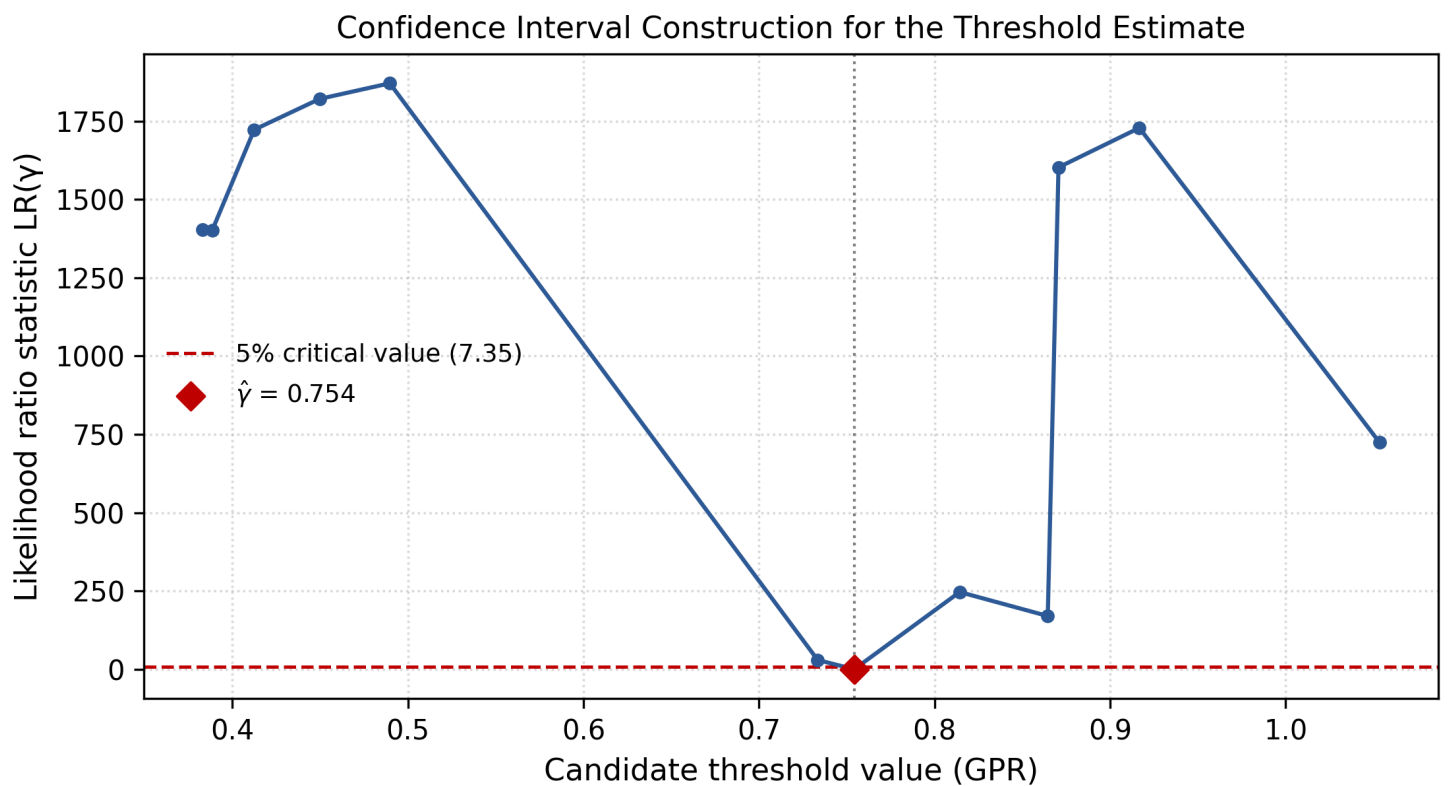


Figure 2

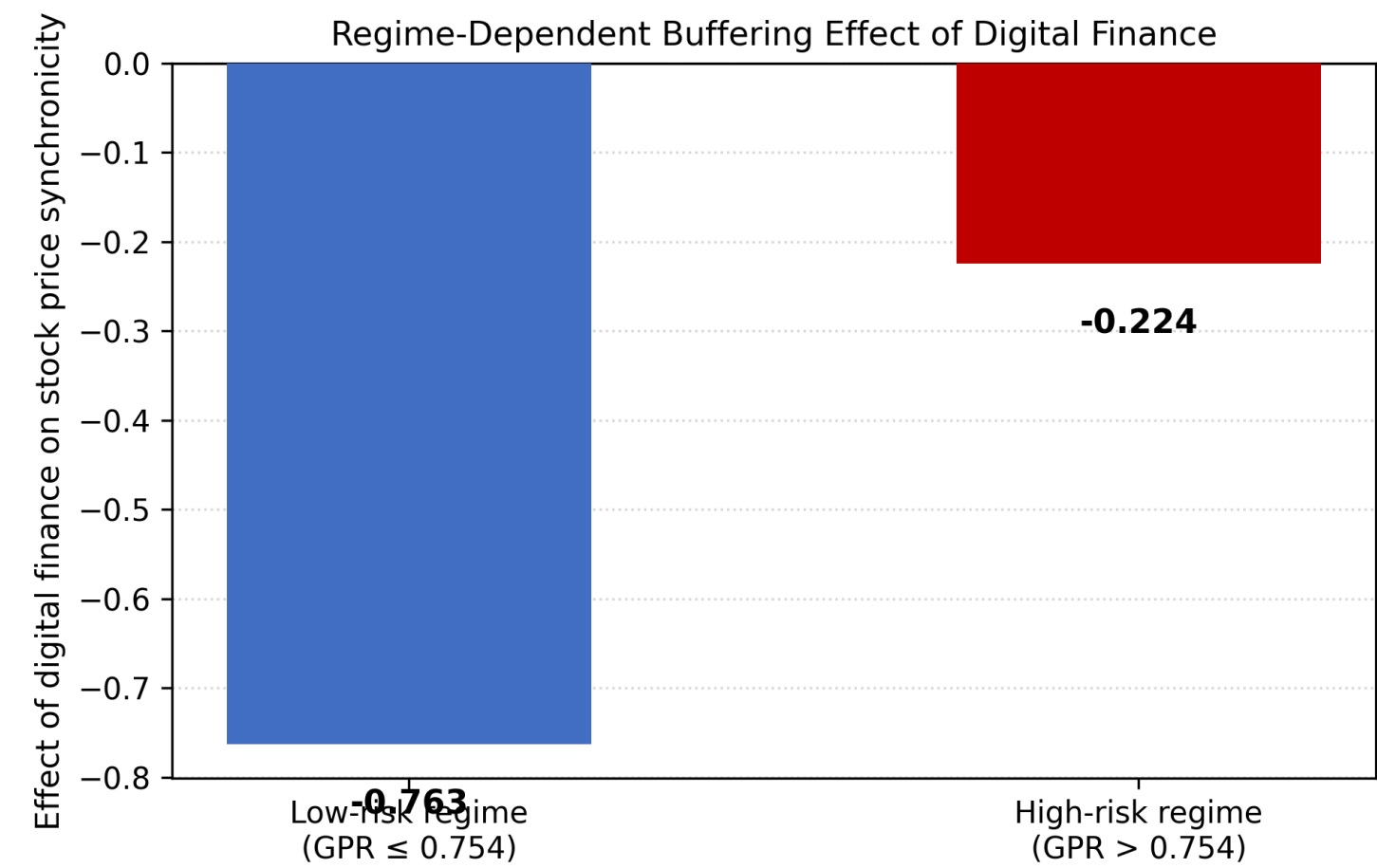


Figure 3

Regime-Dependent Effect of Digital Finance on Stock Price Synchronicity

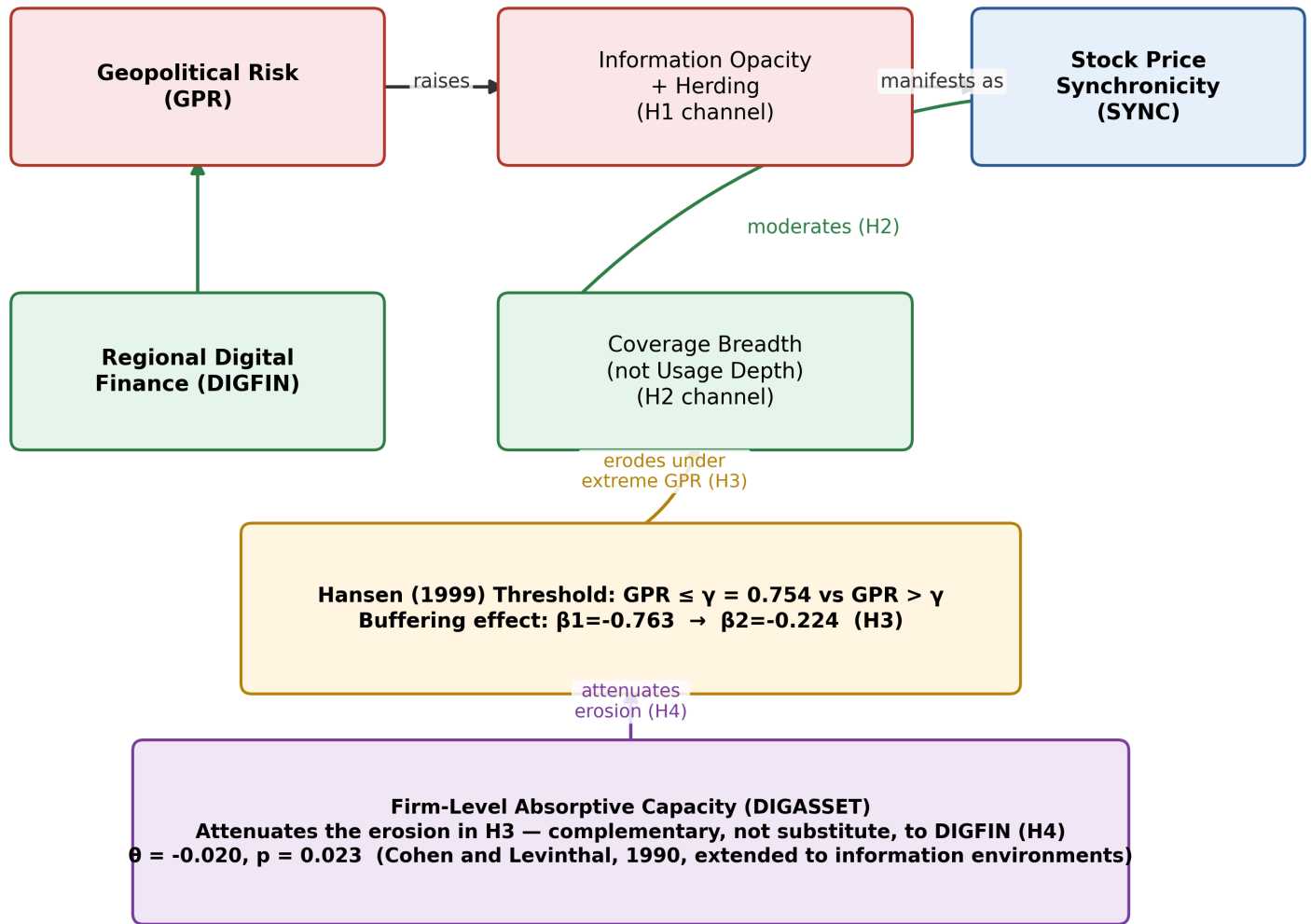


Figure 4

Conceptual Framework: From Geopolitical Risk to Stock Price Synchronicity, Including the Absorptive-Capacity Layer (H4)

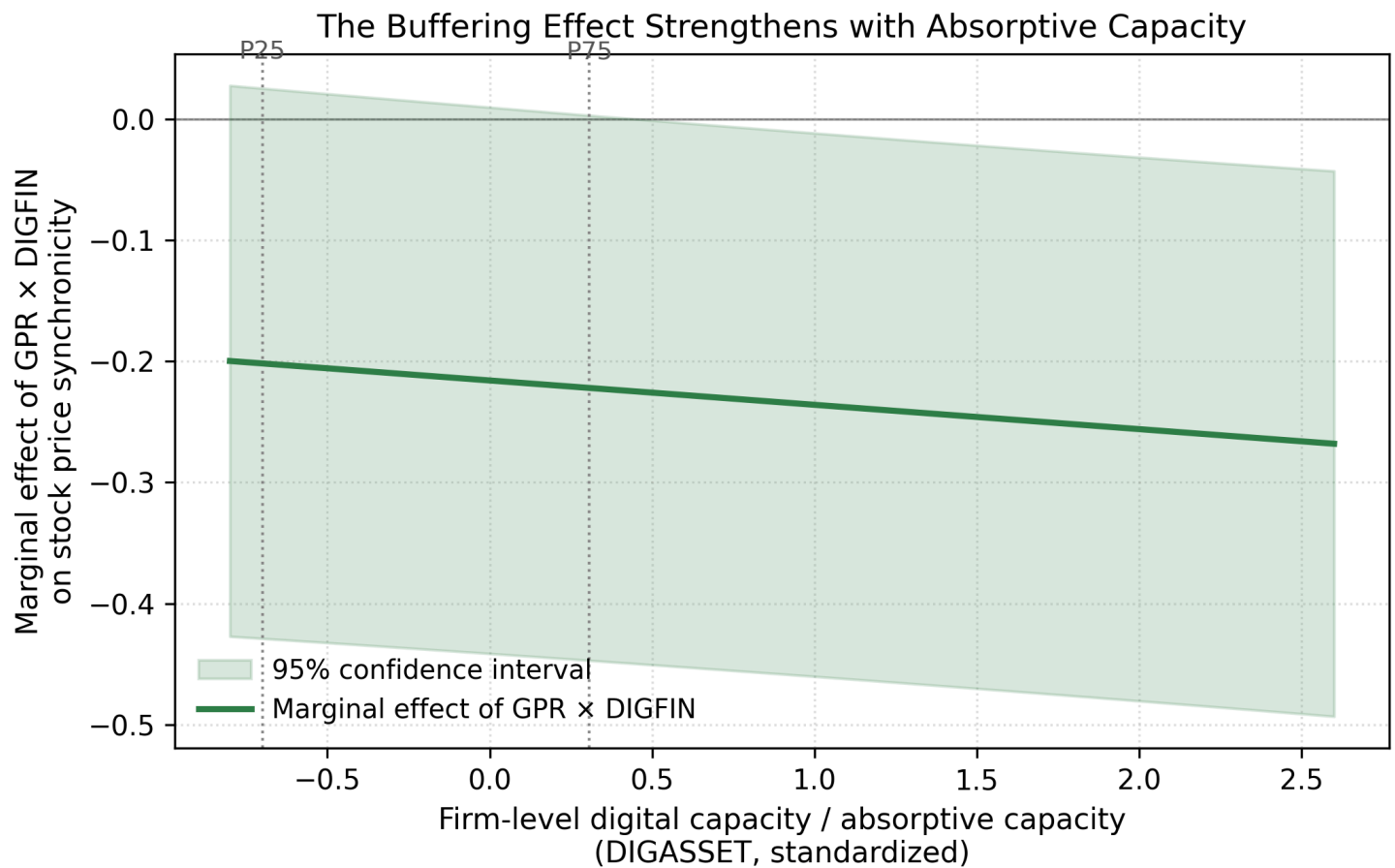


Figure 5

Marginal Effect of GPR x DIGFIN Across Firm-Level Absorptive Capacity, with 95% Confidence Band (Central Result, H4)

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