Stock market liberalization and innovation

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“Peer Monitoring, Syndication, and the Dynamics of Venture Capital Interactions: Theory and Evidence,” (with Onur Bayar and Thomas Chemmanur),2020 ***Journal of Financial and Quantitative Analysis***, Vol. 55 (6), 1875-1914

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“How Does Human Capital Matter? Evidence from Venture Capital,” (with Lifeng Gu, Ruidi Huang, and Yifei Mao), ***Journal of Financial and Quantitative Analysis***, forthcoming

“Does Customer-base Structure Influence Managerial Risk-taking Incentives?” (with Jie Chen, Xunhua Su, and Bin Xu), ***Journal of Financial Economics***, forthcoming

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Role of information intermediaries on capital markets, Chinese and foreign capital markets, Fintech, Sustainable finance

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- Fei Xie, Bohui Zhang, and Wenrui Zhang (2021), "Trust, Incomplete Contracting, and Corporate Innovation," *Management Science*, forthcoming.
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Abstract

We investigate **the effect of stock market liberalization on technological innovation**.

Using a sample of 20 economies that experience stock market liberalization,

(1)we find that these economies exhibit a **higher level of innovation output** after liberalization and that this effect is disproportionately **stronger in more innovative industries**.
(2)The **relaxation of financial constraints**, **enhanced risk sharing** between domestic and foreign investors, and **improved corporate governance** are three plausible channels that allow stock market liberalization to promote innovation.
(3)Finally, we show that technological **innovation is a mechanism** through which stock market liberalization affects productivity growth and therefore economic growth.

Our paper provides new insights into the real effects of stock market liberalization on productivity growth and the economy

Background

- Stock market liberalization is a government decision to remove restrictions on foreign investors and allow them to participate in domestic equity markets.

- Over the last three decades, stock market liberalization has been shown to have a substantial impact on the world economy. stock market liberalization leads to a 1% increase in a country's annual real economic growth.

- Nevertheless, the economic mechanisms underlying the growth effect of stock market liberalization are still not well understood.

Literature Review

- **Previous studies** show that liberalization inducing additional investment
  - facilitates risk sharing
  - lowers the cost of capital
  - Improve productivity
  - Efficient allocations of scarce financial resources
  - Institutional

- Technological innovation has always been considered vital for a country's productivity growth and hence the growth of its economy.
- no empirical research explores innovation as a mechanism underlying the productivity effect of stock market liberalization

Research Framework

The effect of stock market liberalization on innovation → **Economic channels** → **Further analysis**

- ✓Univariate analysis
- ✓Regression analysis
- ✓Across industries analysis
- ✓Robustness check
- ✓Endogenous analysis

- ✓The financing channel
- ✓The risk-sharing channel
- ✓The corporate governance channel

- ✓effect on innovation of private firms
- ✓Patent originality, patent generality, and backward citations to foreign patents
- ✓The effect on economic growth
- ✓Stock market liberalization and capital allocative efficiency

Contributions

- **It adds to the literature on financial openness and economic growth and joins the debate on the growth effects of stock market liberalization**

➢market liberalization and economic growth

- ✓**Prior research:** the effects of stock market liberalization are weak、 mixed、strong.
- ✓**Puzzle:** that the growth effect of liberalization cannot be fully justified by the small risk-sharing benefit of liberalization in reducing the cost of capital .
- ✓**Our findings:** explain this puzzle by showing that technological innovation substantiates a permanent effect of stock market liberalization on economic growth.

➢market liberalization and productivity growth

- ✓**previous literature:** stock market liberalization increases productivity and result from several mechanisms, such as the increase in stock liquidity 、the improvement in information efficiency 、information environments 、corporate governance 、legal institutions .
- ✓**our paper :**identifies technological innovation as an alternative economic mechanism through which stock market liberalization enhances productivity growth.

Contributions

- **Our paper contributes to the literature on finance and innovation in a cross-country setting.**
  - ✓**Existing studies:** explore how country-specific characteristics such as bankruptcy codes, legal institutions, equity market development, foreign institutional ownership, and policy uncertainty affect research and development (R&D) investment and innovation output.
  - ✓ **Our paper:** Unlike these we explore how an important policy change — stock market liberalization — affects a country's innovation output, as well as the underlying economic channels through which this effect occurs.

Research Hypothesis

☐The effect of stock market liberalization on economic growth

The significant growth effect of innovation is justified by its unique features, which distinguish it from conventional investment such as capital expenditures

➢stock market liberalization leads to an increase in capital expenditures (Henry, 2000a) , it is unclear the effect of innovative activities

➢the use of equity is more suitable for financing and motivating innovation than the use of debt contracted over tangible assets (Hsu et al., 2014).

Therefore, innovative activities should be more sensitive to reforms in the equity markets, such as stock market liberalization.

Research Hypothesis

☐Financing channel

➢the most important consequence of stock market liberalization: the relaxation of financial constraints.

➢almost 40% of firms in emerging markets cite insufficient access to finance as the foremost obstacle to their operations and growth.(World Bank Enterprise Surveys)

➢Insufficient access to finance has an even more adverse effect on innovative firms, exhausting their internal capital and thus increasing their reliance on external finance (Brown et al., 2009 , 2013)

Stock market liberalization affects innovation by mitigating local firms' financial constraints.

Research Hypothesis

☐ Risk-sharing channel

➢the innovation process is risky and has unforeseeable consequences involving multiple contingencies

➢a risk-sharing scheme that encourages firms' risk-taking activities could spur innovation

➢Given that foreign portfolio investment induced by stock market liberalization enhances risk sharing between domestic and foreign investors (Henry, 2000b ; Chari and Henry, 2004 ; Bekaert et al., 2005)

expect liberalization to spur innovation through the risk-sharing channel

Research Hypothesis

☐ Corporate governance channel

➢Strong shareholder protection can impede innovation because it can increase the external pressure on managers and lead to managerial short-termism (Belloc, 2013 ; Lin, Liu, and Manso, 2019).

➢liberalization of domestic equity markets attracts more foreign investors who are better monitors and in turn enhance domestic firms' corporate governance (e.g., Aggarwal et al., 2011).

Stock market liberalization could restrain managers' opportunistic behaviors in innovative investment and promote domestic firms' innovation output.

Research Hypothesis

- **The effect of stock market liberalization on economic growth**
  - liberalization can drive investment growth and productivity growth, both of which in turn promote economic growth
  - innovation enhances economic growth mainly through promoting productivity growth.

Technological innovation is the mechanism linking stock market liberalization with productivity growth.

Sample

- **Final sample:**20 industries in 20 countries that were liberalizing their equity markets between 1981 and 2008.
  - remove non-public firms
  - focus solely on manufacturing industries
  - exclude countries where public firms do not produce a single patent during the entire sample period
  - remove US firms from our sample but use them to control for industrial patenting activities or innovation opportunities over time
  - restrict our analysis to a sample of countries that experience stock market liberalization during the sample period

Measures

Innovation

- the number of successful patent applications by public firms in each two-digit SIC industry for each country each year (Pat).
- the number of citations received by all firms' patents in each two-digit SIC industry for each country in each year ((Tcite).
- the number of public firms that have successful patent applications in each two- digit SIC industry for each country and year (Nfirm).

stock market liberalization

- a binary variable that equals one if the observation is in the year after country i 's official liberalization and zero otherwise, measured in year t -3.

Measures

Control variables

- comparative advantages and heterogeneous developments :the share of value added in a two-digit SIC industry to the total value added for each country each year (VA)
- **macroeconomic conditions**: logarithm of real gross domestic product per capita (GDP)and the standard deviation of annual GDP per capita growth in the past 5years (VGDP)as proxies for the level of economic development and macroeconomic risk.
- **human capital** :the logarithm of human capital index (HumCap)
- **trade openness and government size**: the share of imports and exports in a country's GDP (Trade) and the share of government consumption in a country's GDP (Gov)
- **industrial patenting propensity**:logarithm of one plus the average number of patents applied by US firms in each two-digit SIC industry and year(Intensity).

Descriptive statistics

Panel A: Sample distribution by country and economy

Country and economy	Liberalization year (1)	*N* (2)	*Pat* (3)	*Tcite* (4)	*Nfirm* (5)
Argentina	1989	380	7	7	3
Brazil	1991	348	60	158	22
Chile	1992	387	7	12	2
Greece	1987	400	26	87	15
India	1992	560	2,325	4,113	373
Indonesia	1989	360	5	3	4
Israel	1993	546	1,315	2,393	185
Japan	1983	555	521,571	1,060,234	16,286
South Korea	1992	558	132,616	199,936	3,157
Malaysia	1988	560	12	2	11
Mexico	1989	480	29	41	14
New Zealand	1987	396	112	309	39
Philippines	1991	557	11	7	7
Portugal	1986	400	30	90	17
Saudi Arabia	1999	280	214	535	8
South Africa	1996	544	156	331	26
Spain	1985	560	417	1,541	166
Taiwan, China	1991	400	79,571	137,517	3,220
Thailand	1987	400	31	78	13
Turkey	1989	400	966	1,936	98

Research Framework

- ✓Univariate analysis
- ✓Regression analysis
- ✓Across industries analysis
- ✓Robustness check
- ✓Endogenous analysis

(1)Univariate analysis

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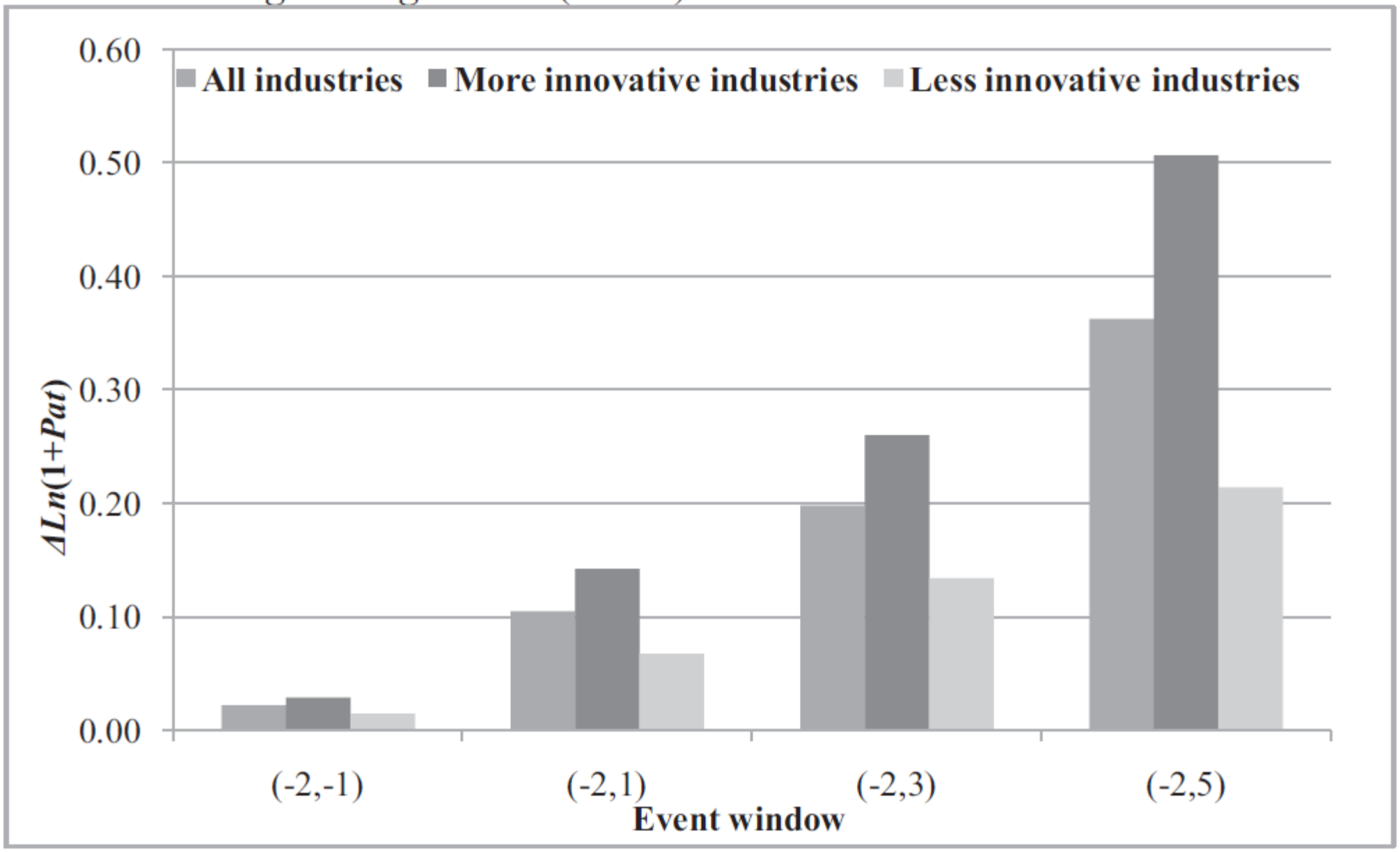
Panel A: Average changes in Ln(1+Pat) around liberalization



(2)regression analysis

$$Innovation_{i,j,t} = \alpha + \beta Lib_{i,t-3} + \gamma' X_{i,j,t-1} + Industry_j \times Country_i + Year_t + \varepsilon_{i,j,t},$$

Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)
Lib	0.125***	0.156***	0.076***
	(0.05)	(0.05)	(0.02)
VA	2.484*	2.847*	1.409*
	(1.33)	(1.47)	(0.72)
GDP	1.421***	1.425***	0.827***
	(0.18)	(0.20)	(0.10)
VGDP	1.261*	0.172	0.802**
	(0.74)	(0.76)	(0.36)
HumCap	0.609	0.923	0.399
	(0.54)	(0.59)	(0.27)
Trade	−1.515***	−1.387***	−0.841***
	(0.22)	(0.25)	(0.13)
Gov	−0.145	−0.774	0.073
	(0.44)	(0.51)	(0.21)
Intensity	−0.011	0.002	−0.009
	(0.02)	(0.02)	(0.01)
Year fixed effects	Yes	Yes	Yes
Country-industry fixed effects	Yes	Yes	Yes
Number of observations	9,071	9,071	9,071
R-squared	0.23	0.15	0.27

(3) Across industries analysis

$$Innovation_{i,j,t} = \alpha + \beta Lib_{i,t-3} \times Intensity_{j,t-1} + \theta Lib_{i,t-3} + \gamma' X_{i,j,t-1} + Industry_j \times Country_i + Year_t + \varepsilon_{i,j,t}, \quad (2)$$

Intensity :logarithm of one plus the average number of patents applied by US firms in each two-digit SIC industry and year

Following Acharya and Subramanian (2009)

(3) Across industries analysis

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Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)
Lib × *Intensity*	0.150***	0.161***	0.087***
	(0.03)	(0.04)	(0.02)
Lib	−0.249***	−0.247***	−0.141***
	(0.08)	(0.09)	(0.04)
VA	2.124*	2.459*	1.199*
	(1.25)	(1.37)	(0.67)
GDP	1.429***	1.433***	0.832***
	(0.18)	(0.20)	(0.10)
VGDP	1.247*	0.157	0.794**
	(0.73)	(0.75)	(0.36)
HumCap	0.634	0.950*	0.413
	(0.52)	(0.57)	(0.26)
Trade	−1.506***	−1.377***	−0.836***
	(0.22)	(0.24)	(0.12)
Gov	−0.113	−0.739	0.092
	(0.43)	(0.50)	(0.21)
Intensity	−0.093***	−0.086***	−0.056***
	(0.03)	(0.03)	(0.01)

stock market liberalization promotes innovation by enhancing it in more innovative industries.

(4) Robustness checks

- using several alternative de jure liberalization dates
- additional sampling criteria
- aggregate all variables at the three-digit International Patent Classification (IPC) class
- employ a two-way clustering of standard errors at both country-industry and year
- replace dependent variables with the number of patents and the number of patent citations of an average (median) firm as proxies for the innovation output of a typical firm in an industry
- construct the liberalization indicator in year t -5 (Lib_lag5) instead of year t- 3
- remove countries with the total number of patents of fewer than one hundred/remove industries with no patent at all during the entire sample period/focus on industries in the US with the number of patents granted above the sample median

(4) Further tests on identification(Endogenous analysis)

- Controlling for potential omitted variables
  - ✓ Financial market development
  - ✓ foreign direct investment
  - ✓ institutional characteristics
- Test on reverse causality
  - ✓ create eight indicators, i.e., Lib_{t-3}, Lib_{t-2}, Lib_{t-1}, Lib_{t}, Lib_{t+1}, Lib_{t+2}, Lib_{t+3}, and $Lib \geq t+4$, which denote relative years around liberalization with t referring to the liberalization years.
- Event study
  - ✓ conduct an analysis by examining the change in average levels of innovation output surrounding liberalization using short event windows. (7-year event window)

Research Framework

The effect of stock market liberalization on innovation → **Economic channels** → **Further analysis**

✓The financing channel

✓The risk-sharing channel

✓The corporate governance channel

(1) The financing channel

- To examine this conjecture, we explore how industry external equity finance dependence and the percentage of non-dividend-paying firms in an industry alter our baseline results.

Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)
Panel A: Equity dependence ($N = 9{,}071$)			
Lib × *Intensity* × *EquityDep*	0.363**	0.467**	0.230***
	(0.17)	(0.20)	(0.09)
Lib × *Intensity*	0.033	0.031	0.021
	(0.03)	(0.04)	(0.02)
Lib × *EquityDep*	−0.555	−0.799	−0.419*
	(0.44)	(0.49)	(0.22)
Intensity × *EquityDep*	−0.335	−0.335	−0.127
	(0.27)	(0.29)	(0.13)
Panel B: One minus the percentage of firms paying dividends ($N = 5{,}849$)			
Lib × *Intensity* × (1-*DivPay*)	0.275***	0.278**	0.115**
	(0.10)	(0.12)	(0.04)
Lib × *Intensity*	−0.006	−0.005	0.020
	(0.05)	(0.06)	(0.03)
Lib × (1-*DivPay*)	−0.454**	−0.497*	−0.214**
	(0.23)	(0.25)	(0.10)
Intensity × (1-*DivPay*)	−0.184**	−0.188*	−0.064*
	(0.09)	(0.10)	(0.04)

(2) The risk-sharing channel

- we consider two proxies related to firms' risk-sharing needs.
  - ✓ difference between local beta and world beta
  - ✓ economies with a creditor-friendly bankruptcy code

Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)
Panel A: The difference of local beta and world beta (N = 5,524)			
Lib × *Intensity* × *DiffBeta*	0.121**	0.107*	0.056**
	(0.06)	(0.06)	(0.03)
Lib × *Intensity*	0.011	0.025	0.028
	(0.05)	(0.05)	(0.02)
Lib × *DiffBeta*	−0.160	−0.181	−0.088
	(0.12)	(0.12)	(0.06)
Intensity × *DiffBeta*	−0.162***	−0.142**	−0.080***
	(0.06)	(0.06)	(0.03)
Panel B: Creditor rights (N = 9,071)			
Lib × *Intensity* × *CR*	0.049**	0.044*	0.027**
	(0.02)	(0.03)	(0.01)
Lib × *Intensity*	0.005	0.029	0.007
	(0.05)	(0.05)	(0.03)
Lib × *CR*	−0.120**	−0.108**	−0.059**
	(0.05)	(0.05)	(0.03)
Intensity × *CR*	−0.044	−0.052*	−0.025*
	(0.03)	(0.03)	(0.01)

(3) The corporate governance channel

- We consider two variables related to firms' governance and institutional environments.
  - ✓ insider blockholders
  - ✓ investment profile of a country

Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)
Panel A: One minus the percentage of firms with closely held blocks ($N = 6{,}089$)			
Lib × *Intensity* × (1-*Block*)	0.281**	0.371**	0.163**
	(0.14)	(0.16)	(0.07)
Lib × *Intensity*	0.048	0.031	0.034
	(0.05)	(0.06)	(0.03)
Lib × (1-*Block*)	−0.501	−0.577*	−0.245
	(0.32)	(0.34)	(0.15)
Intensity × (1-*Block*)	−0.125	−0.190	−0.059
	(0.13)	(0.14)	(0.06)
Panel B: Investment profile ($N = 8{,}435$)			
Lib × *Intensity* × *InvProf*	0.027*	0.028*	0.020**
	(0.01)	(0.02)	(0.01)
Lib × *Intensity*	−0.078	−0.065	−0.078
	(0.09)	(0.11)	(0.05)
Lib × *InvProf*	0.024	−0.005	−0.001
	(0.03)	(0.03)	(0.02)
Intensity × *InvProf*	−0.013	−0.015	−0.011**
	(0.01)	(0.01)	(0.01)

(4) The liberalization effect on existing firms versus new firms

- whether liberalization turn non-innovative firms into innovative firms for a sample of existing firms(intensive margin)
- whether liberalization attract more new firms already engaged in innovative activities to go public.(extensive margin)

Variable	*Ln*(1+*Nfirm_exi*) (1)	*Ln*(1+*Nfirm_IPO*) (2)	*Ln*(1+*Nfirm_exi*) (3)	*Ln*(1+*Nfirm_IPO*) (4)
Lib × *Intensity*			0.038***	0.033***
			(0.01)	(0.01)
Lib	0.038***	0.080***	−0.058**	−0.001
	(0.01)	(0.02)	(0.02)	(0.02)
VA	0.362	0.796***	−0.085	−0.253
	(0.39)	(0.30)	(0.49)	(0.40)
GDP	0.436***	0.227***	0.348***	0.171***
	(0.07)	(0.05)	(0.05)	(0.04)

Research Framework

The effect of stock market liberalization on innovation → **Economic channels** → **Further analysis**

✓effect on innovation of private firms

✓Patent originality, patent generality, and backward citations to foreign patents

✓The effect on economic growth

✓Stock market liberalization and capital allocative efficiency

(1) effect on innovation for a sample of private firms

- the spillover of the innovation effect of liberalization to private firms
  - ✓ competitive environment
  - ✓ institutional environment
  - ✓ pro-FDI policies

Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)
Panel A: The effect of stock market liberalization on innovation of large private firms			
Lib × *Intensity*	0.034	0.080	−0.004
	(0.05)	(0.06)	(0.04)
Lib	−0.062	−0.055	0.010
	(0.09)	(0.10)	(0.06)

(1) effect on innovation for a sample of private firms

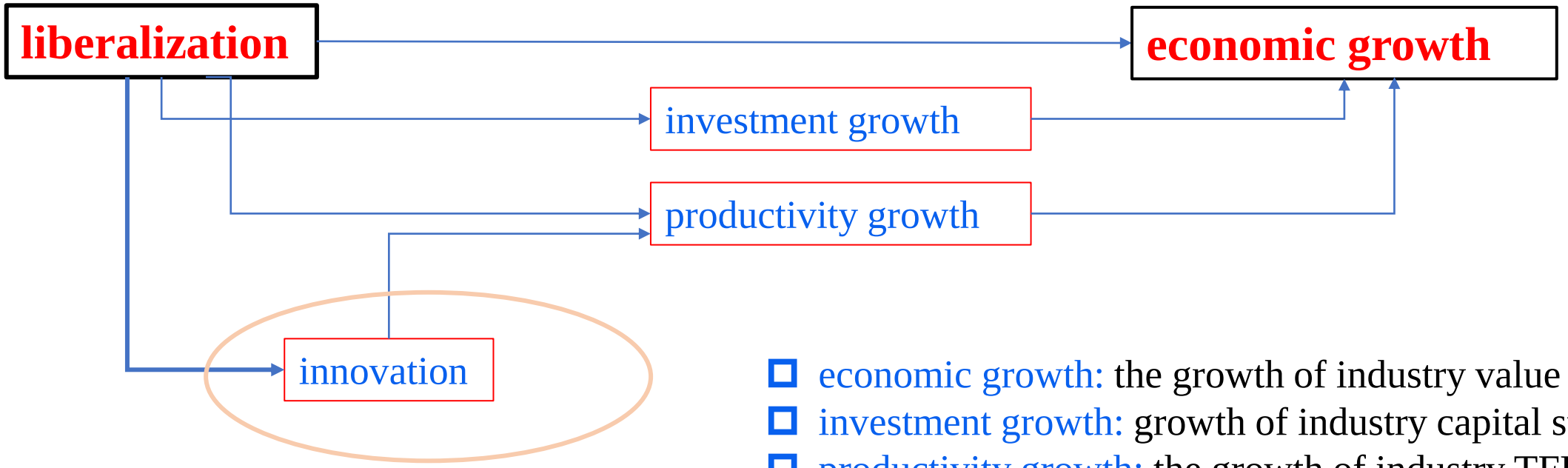
Effect of industry competitive pressure			
Partitioning variable: one minus Herfindahl-Hirschman Index ($N = 10{,}391$)			
Lib × *Intensity* × (1-*HHI*)	1.261**	1.534**	0.921**
	(0.57)	(0.63)	(0.40)
Lib × *Intensity*	−1.112**	−1.307**	−0.846**
	(0.50)	(0.55)	(0.35)
Effect of the institutional environment			
Partitioning variable: quality of institutions ($N = 9{,}115$)			
Lib × *Intensity* × *Institution*	0.038***	0.044***	0.022***
	(0.01)	(0.01)	(0.01)
Lib × *Intensity*	−0.330***	−0.359***	−0.216***
	(0.11)	(0.13)	(0.07)
Effect of the presence of private equity and strategic alliances			
Partitioning variable: the presence of private equity ($N = 10{,}391$)			
Lib × *Intensity* × *PE*	0.704**	0.744**	0.356*
	(0.30)	(0.31)	(0.20)
Lib × *Intensity*	−0.016	0.029	−0.037
	(0.05)	(0.05)	(0.03)

(2) Patent originality, patent generality, and backward citations to foreign patents

- ✓ a patent with a high originality score is inspired by prior inventions from a wide range of technological classes instead of only closely related technological classes
- ✓ a patent with a high generality score has a widespread impact on future patents from various technological classes.
- ✓ The adoption of foreign technology in the innovation process is crucial for domestic firms, particularly in emerging markets, to update their technology base, enhance their innovation performance, and catch up with the technology advances

Variable	*Ln*(1+*Originality*) (1)	*Ln*(1+*Generality*) (2)	*Ln*(1+*FnCite*) (3)	*%FnCite_ave* (4)
Lib × *Intensity*	0.116***	0.092***	0.163***	0.022***
	(0.03)	(0.02)	(0.04)	(0.01)
Lib	−0.284***	−0.197***	−0.357***	−0.013
	(0.06)	(0.05)	(0.09)	(0.02)

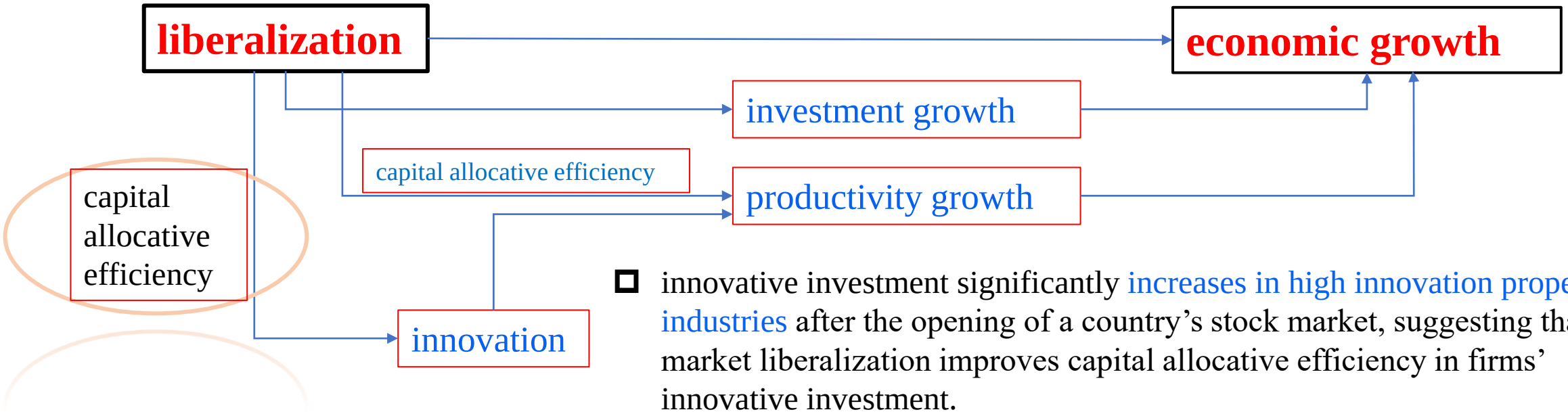
(3) The effect of stock market liberalization on economic growth



- economic growth: the growth of industry value added
- investment growth: growth of industry capital stock
- productivity growth: the growth of industry TFP

Variable	ΔLn($VA)				ΔLn($K)				ΔLn(TFP)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Lib × *Intensity*		0.017***				−0.001				0.010**		
		(0.01)				(0.00)				(0.00)		
Lib	0.070***	0.027			0.033***	0.035***			0.076***	0.050***		
	(0.01)	(0.02)			(0.01)	(0.01)			(0.01)	(0.01)		
Lib_{temp} × *Intensity*				0.009				−0.002				0.009
				(0.01)				(0.00)				(0.01)
Lib_{perm} × *Intensity*				0.019***				−0.001				0.011**
				(0.01)				(0.00)				(0.00)
Lib_{temp}			0.077***	0.054**			0.032***	0.037***			0.087***	0.063***
			(0.01)	(0.02)			(0.01)	(0.01)			(0.01)	(0.02)
Lib_{perm}			0.045***	−0.003			0.035***	0.037***			0.041***	0.014
			(0.02)	(0.02)			(0.01)	(0.01)			(0.01)	(0.02)

(4) Stock market liberalization and capital allocative efficiency



- innovative investment significantly increases in high innovation propensity industries after the opening of a country's stock market, suggesting that stock market liberalization improves capital allocative efficiency in firms' innovative investment.
- liberalization turns existing non-innovative firms into innovative firms and attracts more innovative firms to go public, suggesting that liberalization also promotes within-industry capital allocative efficiency and highlighting the beneficial role of liberalization in the process of creative destruction

Conclusion and discussion

- In this paper, we have investigated the effect of stock market liberalization on technological innovation.
- Using a fixed effects identification strategy and a sample of 20 developed and emerging economies between 1981 and 2008,
- we find that stock market liberalization promotes innovation output and the effect is disproportionately stronger in more innovative industries.
- We find support for three economic channels underlying the positive impact of stock market liberalization on innovation: the financing channel, the risk-sharing channel, and the corporate governance channel.
- We further show that innovation is a plausible mechanism that links stock market liberalization with economic growth through enhancing productivity growth.

Conclusion and discussion

we note two important caveats when interpreting or generalizing our findings.

- First, even though we explore various model specifications and conduct different tests to address the endogeneity issue, unobservable, omitted time-varying country-industry factors still could drive the positive relation between stock market liberalization and innovation in more innovative industries.
- Second, although our economic channels are based on economic theory, our tests are unable to perfectly identify these channels without suffering from potential endogeneity biases. The three channels we discuss are not necessarily mutually exclusive and could jointly contribute to the positive effect of stock market liberalization on innovation.

Thank you!