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mechanisms underlying the growth effect of stock market liberalization are still not well understood.

Previous studies show that liberalization facilitates risk sharing and lowers the cost of capital, thereby inducing additional investment (e.g., Henry, 2000a; Chari and Henry, 2008; Gupta and Yuan, 2009). However, the significant growth effect of liberalization does not fully reconcile with the limited decrease in the cost of capital and the modest increase in the level of investment (e.g., Henry, 2003, 2007). In response, Bekaert et al. (2011) demonstrate that productivity and the efficiency with which the economy allocates scarce financial resources among firms are important components, with attention to the other, possibly institutional, changes liberalization could induce.[2]

Surprisingly, while technological innovation has always been considered vital for a country's productivity growth and hence the growth of its economy (Solow, 1956; Romer, 1986), no empirical research explores innovation as a mechanism underlying the productivity effect of stock market liberalization.[3] In this paper, we attempt to fill the gap between liberalization and growth by examining the impact of stock market liberalization on technological innovation.

The significant growth effect of innovation is justified by its unique features, which distinguish it from conventional investment such as capital expenditures. According to Holmstrom (1989), innovation involves long-term, risky, and idiosyncratic investment in intangible assets, requiring considerable exploration of unknown approaches, while conventional investment is simply the exploitation of well-known methods. Hence, in contrast to conventional investment, innovation entails the heavy use of a variety of intangible assets, such as human capital, knowledge, and organizational support. These distinctions result in two consequences. First, while some studies (e.g., Henry, 2000a) show that stock market liberalization leads to an increase in capital expenditures, it is unclear ex ante how stock market liberalization affects a country's innovative activities.[4] Second, the use of equity is more suitable for financ-

[2] Previous literature has shown the positive effects of stock market liberalization on several institutional factors that could also increase a country's capital allocative efficiency and productivity growth. See Levine and Zervos (1998), Bae, Ozoguz, Tan, and Wirjanto (2012), Bae, Bailey, and Mao (2006), Bae and Goyal, (2010), and Bekaert, Harvey, and Lundblad (2005, 2011), among others.

[3] According to Rosenberg (2004), 85% of economic growth could be attributed to technological innovation. Using an international sample of patents across 59 countries between 1980 and 2010, Chang, McLean, Zhang, and Zhang (2018) show that a one standard deviation increase in patent stock per capita portends a 0.85% increase in gross domestic product growth.

[4] An emerging body of literature shows that several economic factors affect conventional investment and innovation in substantially different ways. For instance, although traditional initial public offering (IPO) literature shows that going public allows firms to raise capital and increase their capital expenditures, Lerner,

tic behaviors in innovative investment and promote domestic firms' innovation output. We call this channel the corporate governance channel.

To measure a country's innovation output, we collect global patent information from the Bureau van Dijk's Orbis patent database.[9] This data set allows us to observe the number of patents a country generates and the number of citations these patents receive post-registration. Accordingly, we are able to explore the effect of stock market liberalization on both the quantity and the quality of a country's innovation output. Moreover, the examination of the technology class distribution of patent citations allows us to better understand the fundamental nature of a country's innovative activities after stock market liberalization.[10] We collect official stock market liberalization date information from Bekaert et al. (2005). Our main sample focuses on public firms from 20 developed and emerging economies that experience stock market liberalizations during the 1981–2008 period.

Consistent with our conjectures, the country-industry-level test shows that stock market liberalization increases a country's innovation output. On average, after a country liberalizes its stock market, its patent counts, citation counts, and the number of innovative firms experience an increase of 13%, 16%, and 11%, respectively. To tackle identification challenges, we follow Acharya and Subramanian (2009) and use the country-industry-year-level panel-based fixed effects identification approach as the main specification. We find that industries with higher innovation intensity exhibit a disproportionately higher level of innovation output after a country opens its equity market. For example, for industries with innovation intensity in the top quartile compared with those with innovation intensity in the bottom quartile, stock market liberalization increases the numbers of patents, citations, and innovative firms from their mean values by 24%, 25%, and 19%, respectively. Our findings continue to hold in an extensive set of robustness checks using alternative subsamples, model specifications, and innovation measures, as well as additional tests to address the endogeneity issue.

To examine the three underlying economic channels, we explore the cross-sectional heterogeneity of our main results from the perspectives of various industry and country characteristics. First, stock market liberalization is more effective in enhancing innovation in more innovative industries of a country when the industries are more reliant on external equity finance and when the industries are less likely to pay dividends. Second, the positive effect of liberalization on innovation output in more innovative industries of a country is more pronounced when the industries have a larger difference of local beta and world beta, i.e., the benefits from diversification are greater (Chari and Henry, 2004; Bae and Goyal, 2010), and when the country has stronger creditor rights, i.e., firms' risk-taking incentives are substantially suppressed (Acharya and Subramanian, 2009). Third, the liberalization effect on innovation is significantly stronger in more innovative industries when the industries have a lower percentage of closely held blocks and when the country has a better investment profile.

Earlier literature argues that new firms, compared with existing firms, are financially more constrained, are less diversified, and have more concentrated ownership. They are thus more likely to benefit from liberalization. However, liberalization perhaps does not ease the constraints on these new firms due to entry barriers.[11] Hence, we look into the intensive versus extensive margin question by investigating whether liberalization changes some existing firms from being non-innovative to being innovative or motivates more firms that have been classified as innovative from their inception to go public. We find that liberalization leads to a significantly larger increase in the number of innovative firms for both a sample of firms listed prior to the liberalization year and a sample of firms undertaking initial public offerings (IPOs) and that the effects are stronger in more innovative industries than in less innovative industries. These results suggest that our findings hold for both the intensive and extensive margins. Overall, the results provide supportive evidence to the three underlying economic channels we propose.

Finally, we test the conjecture that technological innovation is the mechanism linking stock market liberalization with productivity growth by undertaking three sets of analyses. First, consistent with prior literature (e.g., Bekaert et al., 2005, 2011; Gupta and Yuan, 2009), liberalization, on average, promotes the growth of industry value added, the growth of industry capital stock, and the growth of industry total factor productivity (TFP). In addition, the positive effect of liberalization on the growth of industry value added and the growth of industry TFP is more pronounced in more innovative industries, while the effect on the growth of capital stock between more innovative and less innovative industries is insignificant. These findings suggest that stock market liberalization spurs productivity growth in more innovative industries mainly through promoting industry innovation output, which leads to an enhancement of economic growth in these industries.

Second, by breaking down the positive impact of stock market liberalization into temporary and permanent components, we show that liberalization has both a temporary and a permanent positive effect on industry value-added growth, industry capital stock growth, and industry TFP growth. The permanent effect on industry value-

[9] Compared with the National Bureau of Economic Research (NBER) Patent and Citation database compiled based on the United States Patent and Trademark Office (USPTO), the Orbis database has a much broader coverage. In addition to the patents filed in the US and administrated by the USPTO, the Orbis database covers patents filed in 93 non-US patent offices including national patent offices and regional and international organizations, such as the European Patent Office (EPO) and the African Intellectual Property Organization. Therefore, we are able to directly measure a country's innovation level using the Orbis database, instead of inferring it indirectly through the NBER database.

[10] These features of patent data provide a unique advantage of using innovation as the outcome variable because one cannot easily judge the change in the quality and fundamental nature of conventional investment such as capital expenditures.

added growth and industry TFP growth (instead of industry capital stock growth) is mainly attributed to more innovative industries, which suggests that stock market liberalization promotes productivity growth and in turn economic growth in the long run by encouraging innovation.

Third, we discuss the effect of stock market liberalization on capital allocative efficiency in firms' innovative investment. Our baseline findings show that liberalization promotes firms' innovative investment particularly in industries with a higher propensity to innovate after a country opens up its stock market, suggesting that liberalization improves capital allocative efficiency in firms' innovative investment. Moreover, our earlier channel tests indicate that liberalization not only facilitates cross-industry capital allocative efficiency by enhancing the innovation output of firms in industries with a higher innovation propensity while facing financial constraints, lack of risk sharing, and weak governance, but also facilitates within-industry capital allocative efficiency by encouraging existing firms to innovate more in industries with a higher innovation propensity and by attracting more new firms with innovation needs to go public.

Our paper contributes to two streams of literature. First, it adds to the literature on financial openness and economic growth and joins the debate on the growth effects of stock market liberalization. On the one hand, Rodrik (1998) and Edison et al. (2004) find that the effects of stock market liberalization are weak. In a survey paper, Kose et al. (2009) find mixed collective evidence regarding the effect of financial liberalization on economic growth.[12] On the other hand, Bekaert et al. (2005), Gupta and Yuan (2009), and Mitton (2006) find strong growth effects at country, industry, and firm levels. However, it is puzzling that the growth effect of liberalization cannot be fully justified by the small risk-sharing benefit of liberalization in reducing the cost of capital (Henry, 2003, 2007). Our findings help explain this puzzle by showing that technological innovation substantiates a permanent effect of stock market liberalization on economic growth. Moreover, previous literature (e.g., Levine, 2001; Bonfiglioli, 2008; Gupta and Yuan, 2009; Bekaert et al., 2011) finds that stock market liberalization increases productivity growth. The positive effect of liberalization on productivity growth could result from several mechanisms, such as the increase in stock liquidity (Levine and Zervos, 1998), the improvement in information efficiency (Bae et al., 2012) or, more generally, information environments (Bae et al., 2006), and the enhancement of corporate governance (Bae and Goyal, 2010) and legal institutions (Bekaert et al., 2005, 2011). Different from these studies, our paper identifies technological innovation as an alternative economic mechanism through which stock market liberalization enhances productivity growth.

[12] Another large body of literature linking finance and growth goe

Worldwide Patent Statistical Database (PATSTAT), maintained by the European Patent Office (EPO). The Orbis patent database offers a comprehensive coverage of more than 36 million patents granted worldwide from 1850 to 2013. These patents are filed by both publicly traded and privately held firms throughout 94 regional, national, and international patent offices.

The Orbis patent database has a much wider coverage than the National Bureau of Economic Research (NBER) Patent and Citation database, which is based solely on patent filings to the United States Patent and Trademark Office (USPTO). Although the NBER database has been widely used in the innovation literature (e.g., Hall et al., 2005; Aghion et al., 2013), it has limitations in cross-country studies as it covers patents filed only in the US and granted by the USPTO. Hence, the NBER database could result in biases (most likely underestimation) in judging the innovative performance of non-US firms that do not file patent applications to the USPTO.[15] Another important feature of the Orbis database is the ease of identifying patent assignees (owners). The Orbis database lists the majority of patent owners using its unique firm identifiers, with which we are able to determine patent owners' domicile, industry classification, and listing status.[16]

We collect data on the official stock market liberalization date of each country from Bekaert et al. (2005). Furthermore, we extract industry-level data from the United Nations Industrial Development Organization (UNIDO) Industrial Statistics database and country-level data, such

expected to be cited more frequently by other patents subsequent to it, a patent's forward citations reflect the quality of an invention and thus better capture the technological or economic significance of the firm's inventions (Hall et al., 2005). This is particularly true for patents created by emerging economies because the technological development in these countries is relatively slow and their patents are less likely to be cited. An increase in the number of patent citations in emerging markets indicates that their technology level has reached a certain threshold, a trend widely acknowledged by the scientific community. Hence, our second innovation measure is the number of citations received by all firms' patents in each two-digit SIC industry for each country in each year. One potential concern for this variable, as pointed out by Hall et al. (2005), is that patents in certain technology classes and years tend to receive more citations. To address this issue, we adjust raw citations using time–technology class fixed effects as recommended by prior literature, e.g., Atanassov (2013) and Hirshleifer et al. (2012). The citation counts, adjusted for time–technology class fixed effects, are defined as raw citation counts scaled by the average citations in the same year and in the same technology class ($Tcite$).[22]

Our third measure of innovation is the number of innovative firms, as suggested by Acharya and Subramanian (2009), which is defined as the number of public firms that have successful patent applications in each two-digit SIC industry for each country and year ($Nfirm$).

Although the above measures are widely accepted and used in the innovation literature to capture firms' technological advances and innovation output (Acharya and Subramanian, 2009; Acharya et al., 2013; Hsu et al., 2014), we fully acknowledge the limitations of using these measures as the proxy for innovation. For example, firms do not always patent all their innovations either because some innovations do not satisfy patentability criteria or because firms tend to keep the details of their technology secret for strategic reasons.

2.3. Control variables

We control for several industry and country characteristics that could be correlated with stock market liberalization and innovation. First, to account for comparative advantages (Acharya and Subramanian, 2009) and heterogeneous developments of different industries in a country

though we follow previous literature (e.g., Bekaert et al., [illegible]) to control for global industry growth opportunities and comparative advantages, we cannot completely purge the noise in this measure, especially given the complexity of the modern global supply chain.[25] We suggest interpreting these results [illegible]

[illegible]

Table 1, Panel A, presents the sample distribution by country. Our sample covers 20 countries with a mixture of both developed and developing economies.[26] Columns 1 and 2 of Panel A report the official liberalization year and the number of observations for each country. Columns 3–5 report the aggregate innovation measures, i.e., patent counts, citation counts, and the number of innovative firms across industries in each country.

(521,571), the largest number of citations (1,060,234), and the largest number of innovative firm-years (16,286), and Indonesia has the lowest number of patents (five), Malaysia has the lowest number of citations (two), and [illegible] has the lowest number of [illegible] large cross-country variation in innovation performance reflects not only different phases of technological development but also other related factors, such as the capacity of the market (i.e., the number of public firms in each country), the protection of intellectual property, and firms' incentives to keep their innovation secret.[27]

Although the general trends of the three innovation [illegible] are similar, some cross-country differences emerge. For example, although the number of patents in Turkey (986) is twice as many as that in Spain (417), the number of citations in Spain (1,541) is similar in magnitude to that in Turkey (1,936). These results indicate that patents created by Spanish firms have a larger impact [illegible] terms of citations than those by Turkish firms, highlighting [illegible] issues [illegible]

[illegible] the sample distribution of innovation output average values, the share of industry

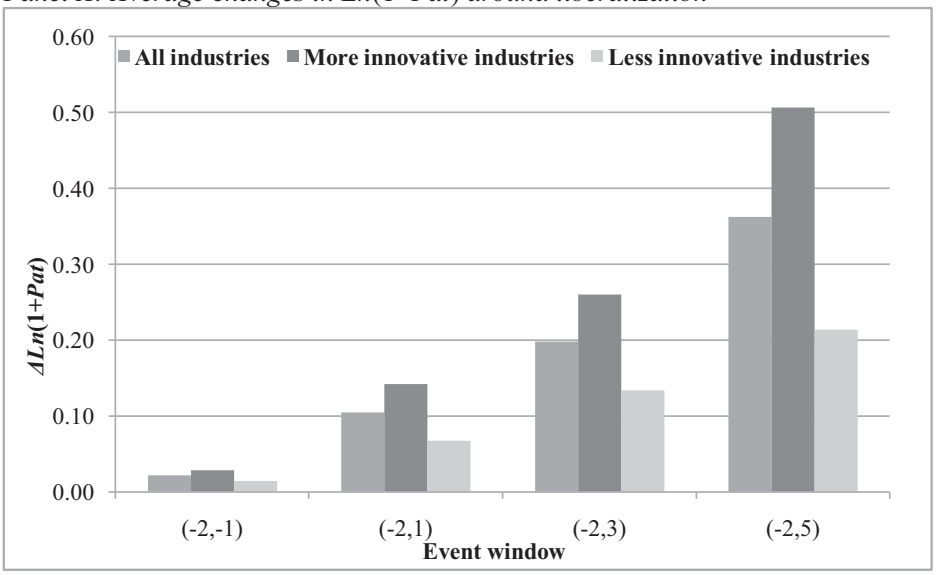
[25] To mitigate the concern that our measure of industry innovation intensity captures global industry growth opportunities, we [illegible] tables in the regression [illegible] Hsu, and Love (2007). Untabulated [illegible] the [illegible] industry over the total value added in a country [illegible] to a large extent, alleviates the concern that our results capture only the effect of industry allocation across countries.

[illegible] Table 1 also shows that stock market liberalization occurred [illegible] countries in our sample over the sample period, which is another noticeable feature of the liberalizing group.

[27] Firms face a trade-off between patenting their innovation and keeping it secret. While patenting innovation can protect innovators' intellectual property, the information disclosure [illegible]

Table 1
Sample distribution.
The sample contains public firms of manufacturing industries in countries and economies experiencing stock market liberalization, which are jointly covered by Bureau van Dijk's Orbis patent database, United Nations Industrial Development Organization (UNIDO) Industrial

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



Panel B: Average changes in Ln(1+Tcite) around liberalization

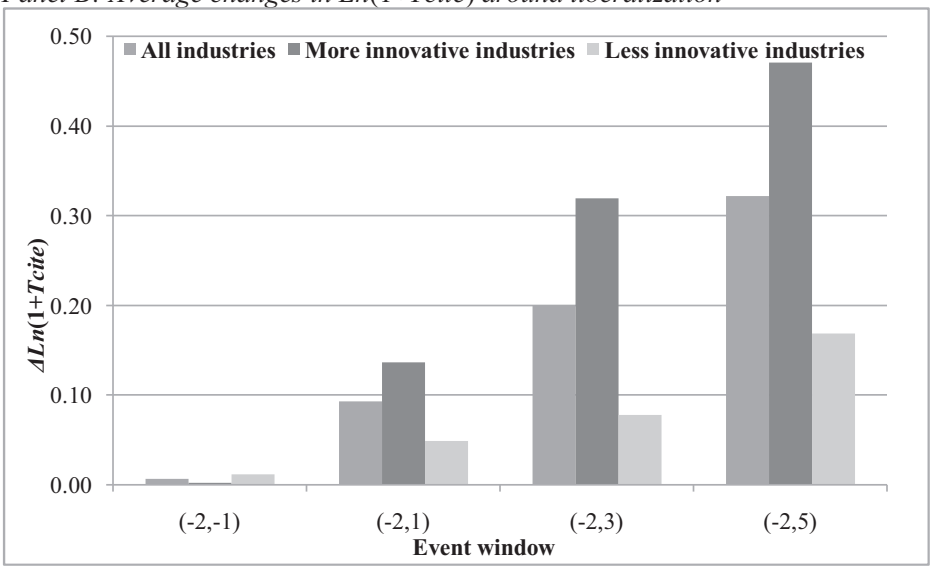


Fig. 1. Average changes in

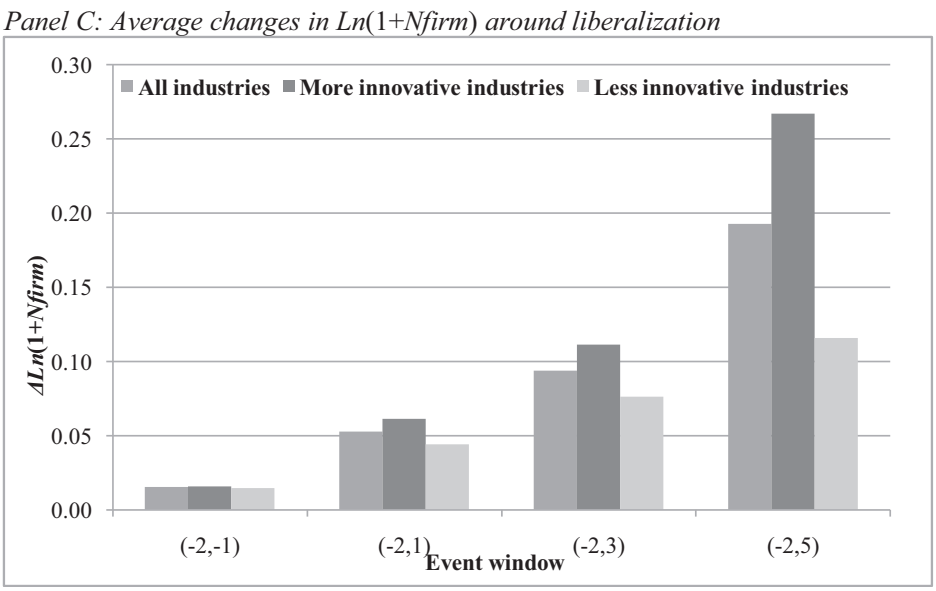


Fig. 1. Continued

Table 2
Summary statistics.

The sample contains public firms of manufacturing industries in countries experiencing stock market liberalization, which are jointly covered by Bureau van Dijk's Orbis patent database, United Nations Industrial Development Organization (UNIDO) Industrial Statistics database, and Penn World Table (PWT) version 8.0 database from 1981 to 2008. *Pat*, *Tcite*, and *Nfirm* are the total number of patents, the total number of citations adjusted for time–technology class fixed effects, and the total number of innovative firms in an industry for each country each year, respectively. *VA* is the percentage of the value added in a two-digit Standard Industrial Classification (SIC) industry over the total value added for each country each year, measured in year *t*-1. *GDP* is the logarithm of gross domestic product (GDP) per capita for each country each year. *VGDP* is the sample standard deviation of the annual GDP per capita growth estimated using a five-year moving window for each country each year, measured in year *t*. *HumCap* is the logarithm of human capital index from PWT 8.0, measured in year *t*-1. *Trade* is a country's exports and imports as a fraction of GDP, measured in year *t*-1. *Gov* is a country's government spending as a fraction of GDP, measured in year *t*-1. *Intensity* is the logarithm of one plus the average number of patents held by a US firm in a two-digit SIC industry each year. Variables in dollars are computed in real terms at constant national prices in 2005 US dollars.

Variable	Mean (1)	Standard deviation (2)	Minimum (3)	Q1 (4)	Median (5)	Q3 (6)	Maximum (7)
Pat	81.52	505.46	0.00	0.00	0.00	0.00	4,428.00
Ln(1+*Pat*)	0.61	1.65	0.00	0.00	0.00	0.00	8.40
Tcite	155.37	952.96	0.00	0.00	0.00	0.00	8,081.36
Ln(1+*Tcite*)	0.62	1.81	0.00	0.00	0.00	0.00	9.00
Nfirm	2.61	13.52	0.00	0.00	0.00	0.00	230.00
Ln(1+*Nfirm*)	0.32	0.86	0.00	0.00	0.00	0.00	4.71
VA	5.02%	4.55%	0.13%	2.10%	3.72%	6.42%	27.19%
GDP	3.18	0.80	1.08	2.73	3.32	3.83	4.37
VGDP	0.03	0.02	0.00	0.01	0.02	0.03	0.10
HumCap	0.90	0.19	0.31	0.77	0.94	1.05	1.25
Trade	0.42	0.26	0.06	0.24	0.37	0.55	1.47
Gov	0.16	0.06	0.06	0.12	0.15	0.18	0.38
Intensity	2.53	1.12	0.00	1.79	2.51	3.36	5.09

tively] and in the number of innovative firms [p-values < 0.01 for event windows $(-2, 1)$, $(-2, 3)$ and $(-2, 5)$, respectively] after liberalization. Moreover, the differences in the changes in the number of patent citations and the number of innovative firms between more innovative and less innovative industries for the event windows $(-2, 3)$ and $(-2, 5)$ are statistically significant (p-values = 0.01 and 0.01 for the number

tion, which is particularly the case in more innovative industries.

3.2. The effect of stock market liberalization on innovation

We first examine the general effect of stock market liberalization on firms' innovation output in a country by estimating the regression model in Eq. (1):

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

where *Innovation* represents the three innovation output measures, i.e., $Ln(1+Pat)$, $Ln(1+Tcite)$, or $Ln(1+Nfirm)$, in industry j for country i in year t. *Lib*, our key explanatory variable, is defined as 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.[30] X represents the share of value added (*VA*) in industry j for country i in year t-1, GDP per capita (*GDP*), the standard deviation of annual GDP growth (*VGDP*), the logarithm of human capital index (*HumCap*), the share of exports and imports in GDP (*Trade*), the share of government consumption in GDP (*Gov*) in country i and year t-1, and the industrial patenting propensity (*Intensity*) in industry j and year t-1. We also control for time-invariant industry characteristics in each country and business cycle by including country-industry fixed effects and year fixed effects. We cluster standard errors by country-industry. Our key variable of interest is *Lib*, and its coefficient estimate, β, captures the general effect of stock market liberalization on innovation.

We present the results estimating Eq. (1) in Table 3. The results show that the coefficient estimates of *Lib* are positive and significant in all three columns, suggesting that firms' innovation output in a country increases after the country liberalizes its stock market. This positive effect is not only statistically significant but also economically sizable. For example, in countries that experience stock market liberalization during our sample period, patent counts, citation counts, and the number of innovative firms, on average, experience an increase of 13%, 16%, and 11%, respectively, after they liberalize their stock markets.

The coefficient estimates of control variables have signs that are generally consistent with previous evidence. For example, *GDP* has a significant and positive effect on innovation at the 1% level in all regressions. *Trade* has a significant and negative effect on innovation, which can be driven by imports because most of our sample countries are less technologically developed. Thus, the results could indicate that a country is more likely to rely on foreign products if its technologies are not sufficiently innovative.

[30] For stock market liberalization to have an impact on innovation output in a country, a series of events need to happen: (1) the country deregulates its stock market, (2) capital flows into the country, (3) firms issue new equity, (4) firms undertake new innovative activities, (5) firms create something new, and (6) firms apply for patents. The time length is undoubtedly long. We hence assume that the stock market liberalization takes effect from three years after the official announcement year. In an untabulated robustness check, we conduct the analysis by assuming that stock market liberalization takes effect from one to five years after the liberalization year and find that the coefficients are still highly significant.

Table

The e[illegible] stock m[illegible]rket liber[illegible]zatio[illegible] innov[illegible]on.

The [illegible]e contai[illegible] public f[illegible]s of [illegible] factu[illegible]g industries [illegible] coun-tries [illegible]ncing st[illegible]k marke[illegible]liberal[illegible]n, w[illegible]h are jointly [illegible]vered by Bu[illegible]n Dijk's [illegible]rbis pate[illegible]datal[illegible] Unite[illegible]Nations Indus[illegible]al De-velop[illegible]rganizat[illegible]n (UNID[illegible] Indus[illegible] Statis[illegible]s database, a[illegible] Penn Worl[illegible] (PWT) [illegible]rsion 8.0[illegible]ataba[illegible]om [illegible]1 to 2008. *F[illegible] Tcite,* and [illegible]e the to[illegible] numbe[illegible]f pat[illegible] the t[illegible] number of [illegible]ations adjusted for time–technology c[illegible]s fixed effects, and the total number of innovative firms in each two-d[illegible] Standard Industrial Classification (SIC) industry for each country each [illegible]ar, respectively, which are measured in year *t*. *Lib* is a binary variable t[illegible]t takes the value of one if the observation is in the year since a cou[illegible]y's official liberalization and zero otherwise, measured in year *t*-3. [illegible] is the ratio of the value added in a two-digit SIC industry over the [illegible]otal value added for each country each year, measured in year *t*-1. *GDP* [illegible] the logarithm of gross domestic product (GDP) per capita for each coun[illegible] each year, measured in year *t*-1. *VGDP* is the sample standard deviati[illegible] of the annual GDP per capita growth estimated using a five-year mo[illegible]g window for each country each year, measured in year *t*. *HumCap* is [illegible] logarithm of human capital index from

c 0 6.3761 433.69312 562.373[illegible]Tm [( )] TJ -0.00 6.3761 479.18483 536F1 .18487 [(

Table 4
The effect of stock market liberalization on innovation across different industries.

The sample contains public firms of manufacturing industries in countries experiencing stock market liberalization, which are jointly covered by Bureau van Dijk's Orbis patent database, United Nations Industrial Development Organization (UNIDO) Industrial Statistics database, and Penn World Table (PWT) version 8.0 database from 1981 to 2008. *Pat*, *Tcite*, and *Nfirm* are the total number of patents, the total number of citations adjusted for time–technology class fixed effects, and the total number of innovative firms in each industry for each country each year, respectively, which are measured in year *t*. *Lib* is a binary variable that takes the value of one if the observation is in the year since a country's official liberalization and zero otherwise, measured in year *t*-3. The definitions of other variables are in Table 3. Robust standard errors in parentheses are clustered by country-industry. ***, **, and * denote significance at

motes innovation by enhancing it in more innovative industries.

3.4. Robustness checks

We conduct an array of additional tests to check the robustness of our baseline results. For brevity, we report the results of the following seven sets of robustness checks in Tables OA1 to OA9 of the Online Appendix. All regressions include interaction terms of control variables and industrial patenting intensity.

First, dating stock market liberalization is challenging because multiple factors can cloud the importance of of-

3.5.1. Controlling for potential omitted variables

We first directly include a few variables omitted from the baseline regressions. Financial market development can be related to both stock market liberalization and innovation. Hsu et al. (2014) show that equity (credit) market development is positively (negatively) associated with innovation in industries that are more dependent on external finance. Given the possibility that stock market liberalization coincides with local financial market development, we include the ratio of total market capitalization of all public firms in a country to its GDP (*Equity*) as a proxy for equity market development and the ratio of domestic credit provided by the banking sector over GDP (*Credit*) as a proxy for credit market development in the regressions.

The second variable relates to foreign direct investment (FDI). Previous literature shows that, through inflows of FDI, foreign acquirers encourage local firms to innovate by facilitating technology transfer to local markets (Guadalupe et al., 2012) and allowing these firms to hire and use high-quality employees (Javorcik, 2015) who are essential to innovative firms. If stock market liberalization, which attracts equity inflows, is correlated with a country's pro-FDI policies, then the positive correlation between stock market liberalization and innovation could be spurious. We hence include the ratio of FDI inflows over GDP (*FDI*) into the regressions.

Last, we add a set of institutional characteristics into the baseline regressions. These characteristics are the quality of institutions (*Institution*) as in Bekaert et al. (2005, 2011), intellectual property protection index (*IPProtect*) created by Park (2008), the Quinn and Toyoda (2008) capital account openness index (*CAOpen*), and an indicator denoting the enforcement of insider trading laws in a country (*InsideTrade*) compiled by Bhattacharya and Daouk (2002) to account for the possibility that a country's stock market liberalization coincides with the change in its legal and regulatory environments.[37]

We control for all these variables and their interactions with *Intensity* in the regression model in Eq. (2) and present the results in Columns 1–3 of Table 5, Panel A. The coefficient estimates of *Lib* × *Intensity* keep positive and significant at the 5% or 1% level in all three columns.

We further include country-year and industry-year fixed effects to account for the potential effects of time-varying country and industry characteristics and present the results in Columns 4–6. The coefficient estimates of *Lib* × *Intensity* are all positive and significant at the 5% level, suggesting that the positive effect of stock market liberalization on the innovation output of more innovative industries continues to hold after controlling for these important variables omitted from the baseline regressions. Also, these additional control variables exhibit signs that are generally consistent with previous findings.

Overall, the evidence in this section suggests that our baseline results are not likely to be driven by these potential omitted variables.

3.5.2. Test on reverse causality

To further address the reverse causality concern, we conduct a test to examine the dynamics of innovation output surrounding stock market liberalization. If the reverse causality drives the results, i.e., a country liberalizes its equity market to facilitate innovative firms' financing needs, an increase in innovation output should be evident even prior to the liberalization year. To rule out this possibility, we follow Bertrand and Mullainathan

[37] The quality of institutions is defined as the sum of the three components of the composite political risk rating in the International Country Risk Guide (ICRG), namely, "law and order," "bureaucratic quality," and "corruption." The intellectual property protection index is on a scale of 1 to 5, with 5 representing the strongest intellectual property protection. The Quinn and Toyoda (2008) capital account openness index is created based on the text from the International Monetary Fund (IMF) *Exchange Arrangements and Exchange Restrictions*. The openness measure has a scale of 0 to 1, with 1 representing a full open economy. Our results are also robust to the Chinn and Ito (2006) capital account openness index. The insider trading enforcement indicator takes the value of one in the year of a country's first insider trading enforcement case and thereafter and zero in years before the enforcement. See Bekaert et al. (2005, 2011), Park (2008), Quinn and Toyoda (2008), Chinn and Ito (2006), and Bhattacharya and Daouk (2002) for more details on variable constructions.

Table 5
Test on endogeneity.

The sample contains public firms of manufacturing industries in countries experiencing stock market liberalization, which are jointly covered by Bureau van Dijk's Orbis patent database, United Nations Industrial Development Organization (UNIDO) Industrial Statistics database, and Penn World Table (PWT) version 8.0 database from 1981 to 2008. *Pat*, *Tcite*, and *Nfirm* are the total number of patents, the total number of citations adjusted for time–technology class fixed effects, and the total number of innovative firms in each industry for each country each year, respectively, which are measured in year *t*. *Lib* is a binary variable that takes the value of one if the observation is in the year since a country's official liberalization and zero otherwise, measured in year *t*-3. In Panel A, *Equity* is the ratio of stock market capitalization over gross domestic product (GDP), measured in year *t*-1. *Credit* is the ratio of domestic credit provided by the banking sector over GDP, measured in year *t*-1. *FDI* is a country's inward foreign direct investment over GDP, measured in year *t*-1. *Institution* is the quality of

Table 5
Continued.

Panel B: Test on reverse causality

Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)
Lib_{t-3} × *Intensity*	0.036	0.042	0.014
	(0.04)	(0.04)	(0.02)
Lib_{t-2} × *Intensity*	0.058	0.075	0.024
	(0.04)	(0.05)	(0.02)
Lib_{t-1} × *Intensity*	0.049	0.055	0.022
	(0.04)	(0.05)	(0.02)
Lib_{t} × *Intensity*	0.070	0.106**	0.031*
	(0.04)	(0.05)	(0.02)
Lib_{t+1} × *Intensity*	0.076*	0.098*	0.030
	(0.05)	(0.05)	(0.02)
Lib_{t+2} × *Intensity*	0.095**	0.130**	0.043**
	(0.05)	(0.05)	(0.02)
Lib_{t+3} × *Intensity*	0.125***	0.178***	0.046**
	(0.05)	(0.06)	(0.02)
$Lib_{\geq t+4}$ × *Intensity*	0.172***	0.202***	0.097***
	(0.05)	(0.05)	(0.02)
Lib_{t-3}	−0.121	−0.058	−0.061
	(0.09)	(0.10)	(0.04)
Lib_{t-2}	−0.218**	−0.173	−0.097**
	(0.10)	(0.11)	(0.05)
Lib_{t-1}	−0.238**	−0.178*	−0.111**
	(0.10)	(0.11)	(0.05)
Lib_{t}	−0.256**	−0.235*	−0.118**
	(0.11)	(0.12)	(0.05)
Lib_{t+1}	−0.195*	−0.155	−0.072
	(0.12)	(0.13)	(0.06)
Lib_{t+2}	−0.213*	−0.206	−0.092
	(0.12)	(0.13)	(0.06)
Lib_{t+3}	−0.257**	−0.275*	−0.080
	(0.13)	(0.15)	(0.06)
$Lib_{\geq t+4}$	−0.320**	−0.261*	−0.167***
	(0.13)	(0.13)	(0.06)
Intensity	−0.322**	−0.318*	−0.250***
	(0.16)	(0.17)	(0.09)
Controls and interactions	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Country-industry fixed effects	Yes	Yes	Yes
Number of observations	9,071	9,071	9,071
R-squared	0.25	0.17	0.30

Panel C: Event study

Event window	Window (−3 yr, +3 yr)			Window (−5 yr, +5 yr)		
Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)	*Ln*(1+*Pat*) (4)	*Ln*(1+*Tcite*) (5)	*Ln*(1+*Nfirm*) (6)
Lib × *Intensity*	0.063***	0.072***	0.031***	0.083***	0.099***	0.041***
	(0.02)	(0.02)	(0.01)	(0.03)	(0.03)	(0.01)
Lib	−0.165***	−0.131**	−0.073***	−0.168**	−0.200***	−0.087***
	(0.05)	(0.06)	(0.02)	(0.07)	(0.07)	(0.03)
VA	−0.026	−0.125	−0.172	−1.053	−1.859	−0.843
	(1.23)	(1.28)	(0.59)	(1.64)	(1.73)	(0.68)
GDP	0.597***	0.567**	0.280***	0.911***	0.927***	0.512***
	(0.19)	(0.22)	(0.08)	(0.21)	(0.24)	(0.10)
VGDP	−0.206	1.210	−0.386	−0.229	1.041	−0.188
	(1.03)	(0.97)	(0.54)	(1.37)	(1.42)	(0.68)
HumCap	3.227**	3.346*	1.896**	2.653***	3.444***	1.583***
	(1.64)	(1.90)	(0.76)	(0.87)	(1.11)	(0.44)
Trade	−1.163**	−1.302**	−0.579**	−1.645***	−1.849***	−0.845***
	(0.53)	(0.62)	(0.25)	(0.36)	(0.47)	(0.17)
Gov	−1.731***	−1.168*	−1.010***	−1.511**	−1.545**	−0.939***
	(0.61)	(0.68)	(0.31)	(0.63)	(0.75)	(0.33)

Table 5
Continued.

Panel C: Event study

Event window	Window (−3 yr, ±3 yr)			Window (−5 yr, ±5 yr)		
Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)	*Ln*(1+*Pat*) (4)	*Ln*(1+*Tcite*) (5)	*Ln*(1+*Nfirm*) (6)
						continued on next page
Intensity	0.123	0.296	0.008	−0.096	−0.005	−0.130*
	(0.18)	(0.27)	(0.06)	(0.16)	(0.25)	(0.07)
VA × *Intensity*	−0.017	−0.147	0.036	0.849	1.290	0.565
	(0.63)	(0.70)	(0.29)	(0.85)	(0.93)	(0.36)
GDP × *Intensity*	−0.042	−0.110*	−0.002	−0.021	−0.074	0.010
	(0.04)	(0.06)	(0.01)	(0.04)	(0.05)	(0.02)
VGDP × *Intensity*	−0.936*	−1.260**	−0.199	−0.855	−1.142	−0.253
	(0.52)	(0.51)	(0.26)	(0.70)	(0.79)	(0.31)
HumCap × *Intensity*	0.058	0.106	−0.007	0.188	0.200	0.094
	(0.17)	(0.21)	(0.06)	(0.17)	(0.22)	(0.07)
Trade × *Intensity*	0.006	0.067	0.003	−0.014	0.064	−0.034
	(0.09)	(0.11)	(0.04)	(0.10)	(0.13)	(0.05)
Gov × *Intensity*	−0.275	−0.333	−0.072	−0.244	−0.079	−0.031
	(0.24)	(0.32)	(0.12)	(0.27)	(0.34)	(0.13)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country-industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2,596	2,596	2,596	3,902	3,902	3,902
R-squared	0.17	0.09	0.18	0.19	0.12	0.22

3.5.3. Event study

While the baseline analysis shows that innovation output in more innovative industries becomes higher after a country opens up its stock market to foreign investors, this analysis does not focus directly on the changes in innovation output around the liberalization events. In this section, we conduct an analysis by examining the change in average levels of innovation output surrounding liberalization using short event windows. This approach also alleviates the concern that our results capture the upward time trend in industrial innovation output.

We perform a regression analysis for a seven-year event window, i.e., three years before and three years after the liberalization events, and an 11-year event window, i.e., five years before and five years after the liberalization events. Table 5, Panel C, presents the event study results. The coefficient estimates of *Lib* × *Intensity* are positive and significant at the 1% level across all columns. The results of the event analysis lend further support to our conjecture that more innovative industries are more

the industry-level equity finance dependence (*EquityDep*) as the industry median equity finance dependence of all US public firms from 1981 to 2008, with firm-level equity finance dependence defined as the ratio of net amount of equity issues to capital expenditures.[40] To smooth temporal fluctuations and reduce the effects of outliers, we aggregate firms' equity issues during the 1981–2008 period and then divide it by the sum of capital expenditures over the same period. In addition, similar to previous literature (e.g., Mitton, 2006; Bae and Goyal, 2010), we define the percentage of firms not paying dividends of an industry as one minus the percentage of firms paying nonzero dividends of an industry in a country (1-*DivPay*). We then employ *EquityDep* and 1-*DivPay*, respectively, as the partitioning variable in the triple interaction approach.

We present the results of the two tests in Panels A and B of Table 6. The coefficient estimates of *Lib* × *Intensity* × *EquityDep* and *Lib* × *Intensity* × (1-*DivPay*) are positive and significant at the 5% level, suggesting that stock market liberalization promotes innovation in more innovative industries by better satisfying the financing needs of the industries. The results support the view that stock market liberalization encourages innovation through the financing channel.

4.2. The risk-sharing channel

Earlier literature (e.g., Henry, 2000b; Chari and Henry, 2004; Bekaert et al., 2005) shows that foreign portfolio holdings induced by stock market liberalization enhance risk sharing between domestic and foreign investors. Moreover, recent studies find that foreign investors can better achieve diversification through their international portfolio investment, which encourages the risk taking of firms they hold (Faccio et al., 2011; Boubakri et al., 2013). To the extent that stock market liberalization lifts the restrictions on foreign investors purchasing shares of domestic listed firms, these firms are better able to tolerate potential failures involved in innovative activities and, hence, should undertake more innovative projects after liberalization.

To test the risk-sharing channel, we consider two proxies related to firms' risk-sharing needs. First, previous studies (e.g., Chari and Henry, 2004; Bae and Goyal, 2010) show that when the market of a country is accessible to foreign investors, risks associated with the investment in the country are largely diversifiable due to these investors' large portfolios. Moreover, the larger the benefits of diversification are, the less the local industry's returns are correlated with the global market portfolio. Second,

[40] As pointed out by Rajan and Zingales (1998), there are different levels of dependence on external finance across industries. Because the US equity market has a long history and is open to global investors, US data are better able to reflect these fundamental industry attributes. More important, using US

vious literature (e.g., Stulz, 1999; Chari and Henry, 2004; Bae and Goyal, 2010) and use the difference between local beta and world beta (*DiffBeta*) to capture the benefits of risk sharing after a

corporate governance is an underlying economic channel that allows stock market liberalization to promote innovation, we expect the positive effect of stock market liberalization on the innovation output of more innovative industries to be stronger in industries with a lower percentage of closely held blocks and in countries with a better investment profile.[41]

Following previous studies, e.g., McConnell and Servaes (1990), Li et al. (2006), and Faccio et al. (2011), we define the percentage of closely held blocks of an industry (*Block*) as the percentage of firms with a block holding of 5% or more in the industry. For easy interpretation of results, we use one minus *Block* in the regression analysis. Moreover, we use the investment profile rating (*InvProf*) from the International Country Risk Guide (ICRG) as a proxy for foreign investor protection, which is a subcategory from the ICRG composite political risk ratings, including the assessment of contract viability, profit repatriation, and payment delays.

We present the results estimated using the triple interaction approach with one minus the percentage of closely held blocks in an industry and the investment profile rating of a country as the partitioning variable in Panels A and B of Table 8, respectively. The coefficient estimates of *Lib* × *Intensity* × (1-*Block*) and *Lib* × *Intensity* × *InvProf* are both positive and significant, suggesting that our baseline result is more pronounced in industries with fewer shares closely held by insiders and in countries with a better investment profile where foreign investors have stronger incentives to participate in the governance of domestic firms.

Overall, these findings support the enhancement of local firms' corporate governance as a channel through which stock market liberalization affects innovation output in more innovative industries. Our results also complement the previous findings (e.g., Bekaert et al., 2005, 2011; Kose et al., 2009; Leuz et al., 2009; Popov, 2011) that the benefits of liberalization in terms of economic growth are greater in countries with better investment and institutional environments.

4.4. The liberalization effect on existing firms versus new firms

Previous studies (e.g., Gopalan and Gormley, 2008; Faccio et al., 2011; Foley and Greenwood, 2010) argue that new firms, compared with existing firms, are financially more constrained, less diversified, and have more concentrated ownership. Therefore, new firms are more likely to achieve greater benefits from the liberalization of a country's stock market. Some literature (e.g., Gupta and Yuan, 2009) shows that these new firms hardly benefit from liberalization due to entry barriers. As such, we investigate whether liberalization enhances the intensive margin of firms' innovation by turning non-innovative firms into innovative firms for a sample of existing firms or promotes the extensive margin of corporate innovation by attracting more new firms already engaged in innovative activities to go public. The answer can help explain the dynamic changes in existing firms' and new entrants' innovative activities after a country liberalizes its stock market as well as the three channels we propose.

Following Foley and Greewood (2010), we use the base date in Datastream to identify a firm's first listing date. We

Table 8
Testing the corporate governance channel.

The sample contains public firms of manufacturing industries in countries experiencing stock market liberalization, which are jointly covered by Bureau van Dijk's Orbis patent database, United Nations Industrial Development Organization (UNIDO) Industrial Statistics database, and Penn World Table (PWT) version 8.0 database from 1981 to 2008. *Pat*, *Tcite*, and *Nfirm* are the total number of patents, the total number of citations adjusted for time–technology class fixed effects, and the total number of innovative firms in each industry for each country each year, respectively, which are measured in year *t*. *Lib* is a binary variable that takes the value of one if the observation is in the year since a country's official liberalization and zero otherwise, measured in year *t*-3. In Panel A, *Block* is the percentage of firms with closely held blocks of 5% or more in each industry for each country each year, measured in year *t*-1. In Panel B, *InvProf* is the investment profile component of the composite political risk rating in the International Country Risk Guide (ICRG), measured in year *t*-1. The definitions of other variables are in Table 3. Control variables and their interactions with industry innovation intensity are included in all regressions but are not tabulated. Robust standard errors in parentheses are clustered by country-industry. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

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)
Lib	0.015	0.046	−0.021
	(0.15)	(0.16)	(0.07)
1-*Block*	0.585*	0.547*	0.278*
	(0.33)	(0.32)	(0.15)
Intensity	−0.180	−0.095	−0.195*
	(0.18)	(0.21)	(0.10)
R-squared	0.23	0.14	0.29
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)
Lib	−0.293	−0.106	−0.063
	(0.19)	(0.20)	(0.10)
InvProf	−0.027	−0.015	−0.009
	(0.02)	(0.03)	(0.01)
Intensity	−0.143	−0.106	−0.148*
	(0.15)	(0.17)	(0.08)
R-squared	0.19	0.12	0.24

[41] In an untabulated test, we employ industry competition as an alternative corporate governance variable and examine the impact of industry competitive pressure on the liberalization-innovation relation. We use one minus the Herfindahl-Hirschman Index (*HHI*), constructed using US public firms in Compustat, as a proxy for the competitive pressure in an industry. The coefficient estimates of *Lib*×*Intensity*×(1-*HHI*) are positive and significant, suggesting that the innovation effect of liberalization is likely driven by firms in industries facing more competitive threat.

Table 9
The effects of liberalization on existing firms and new firms.

The sample contains public firms of manufacturing industries in countries experiencing stock market liberalization, which are jointly covered by Bureau van Dijk's Orbis patent database, United Nations Industrial Development Organization (UNIDO) Industrial Statistics database, and Penn World Table (PWT) version 8.0 database from 1981 to 2008. *Nfirm_exi* and *Nfirm_IPO* are the total number of innovative firms for a sample of existing firms prior to liberalization and the total number of innovative initial public offering (IPO) firms in each industry for each country each year, respectively, which are measured in year *t*. *Lib* is a binary variable that takes the value of one if the observation is in the year since a country's official liberalization and zero otherwise, measured in year *t*-3. The definitions of other variables are in Table 3. Robust standard errors in parentheses are clustered by country-industry. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

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)
VGDP	−0.325	0.394***	0.048	0.126
	(0.26)	(0.15)	(0.45)	(0.30)
HumCap	0.466***	0.094	0.474***	0.117
	(0.15)	(0.10)	(0.14)	(0.11)
Trade	−0.480***	−0.190***	−0.295***	−0.107
	(0.08)	(0.05)	(0.09)	(0.07)
Gov	−0.396***	−0.201**	−0.170	−0.202
	(0.13)	(0.09)	(0.21)	(0.12)
Intensity	−0.009	0.003	−0.105**	−0.090**
	(0.01)	(0.00)	(0.05)	(0.04)
VA × *Intensity*			0.124	0.358*
			(0.16)	(0.20)
GDP × *Intensity*			0.036***	0.021***
			(0.01)	(0.01)
VGDP × *Intensity*			−0.165	0.102
			(0.21)	(0.12)
HumCap × *Intensity*			0.005	0.001
			(0.04)	(0.03)
Trade × *Intensity*			−0.072**	−0.033
			(0.03)	(0.02)
Gov × *Intensity*			−0.092	0.004
			(0.09)	(0.05)
Year fixed effects	Yes	Yes	Yes	Yes
Country-industry fixed effects	Yes	Yes	Yes	Yes
Number of observations	9,071	9,071	9,071	9,071
R-squared	0.16	0.06	0.18	0.07

define a firm as an existing firm if the firm's listing year is prior to the country's liberalization year, and we define a firm as an innovative IPO firm if the firm has patents before its IPO year. We then construct two measures, namely, the number of innovative firms for a sample of existing firms (*Nfirm_exi*) and the number of innovative IPO firms

investible to foreign investors after liberalization. However, it does not preclude the spillover of the innovation effect of liberalization to private firms for a number of reasons. First, the competitive environment within an industry could encourage both public firms and private firms to engage in innovative activities. Second, the changes in the broader institutional environment brought about by liberalization could induce any firms to face an altered incentive to engage in innovation regardless of their listing status. Third, stock market liberalization in a country is often coupled with pro-FDI policies (Henry, 2000a), which generally exhibit friendliness to private equity or venture capital and strategic alliances or joint ventures (Conklin and Lecraw, 1997). The presence of these funds in the industry could also fundamentally transform firms' propensity to engage in innovation irrespective of their listing status.[42]

To examine this spillover effect, we conduct a test by reestimating the baseline model using a sample of large private firms. Given

ularly meaningful for emerging economies because it not only reflects the intricate novelty of inventions but also in-

Table 10 (*continued*)

Variable	*Ln*(1+*Pat*) (1)	*Ln*(1+*Tcite*) (2)	*Ln*(1+*Nfirm*) (3)
Panel			

Table 11
Stock market liberalization, patent originality and generality, and backward citations to foreign patents.

The sample contains public firms of manufacturing industries in countries experiencing stock market liberalization, which are jointly covered by Bureau van Dijk's Orbis patent database, United Nations Industrial Development Organization (UNIDO) Industrial Statistics database, and Penn World Table (PWT) version 8.0 database from 1981 to 2008. *Originality* (*Generality*) is defined as the total originality (generality) score of all patents in an industry for each country in each year, measured in year *t*. The originality (generality) score of a patent is calculated as one minus the Herfindahl-Hirschman Index of the technology class distribution of all the patents that this patent cites (that cite this patent), measured in year *t*. *FnCite* is the number of domestic patents' backward citations to foreign patents in each industry for each country each year. *%FnCite_ave* is the share of foreign backward citations in total backward citations of an average firm in each industry for each country each year. *Lib* is a binary variable that takes the value of one if the observation is in the year since a country's official liberalization and zero otherwise, measured in year *t*-3. The definitions of other variables are in the legend of Table 3. Robust standard errors in parentheses are clustered by country-industry. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	Ln(1+*Originality*)	*Ln*(1+*Generality*)	*Ln*(1+*FnCite*)	*%FnCite_ave*
	(1)	(2)	(3)	(4)
Intensity	0.116***			0.022***
				(0.01)
		−0.197***	−0.357***	−0.013
		(0.05)	(0.09)	(0.02)
	1.249	0.382	2.531	.411
	(1.10)	(0.80)	(1.66)	0.39)
	0.404***	0.315***	0.723***	215***
	(0.10)	(0.08)	(0.15)	(0.03)
	2.137**	0.683	3.	0.743***
	(0.84)	(0.60)	(	(0.29)
HumCap	−1.734***	−0.641**	−1.955***	0.096
	(0.49)	(0.30)	(0.70)	(0.13)
Trade	−0.781***	−0.510***	−0.988***	−0.166***
	(0.21)	(0.14)	(0.26)	(0.06)
Gov		−0.016	1.943**	0.132
		(0.42)	(0.94)	(0.17)
		−0.130*	−0.253	−0.047
	(0.11)	(0.07)	(0.17)	(0.03)
× *Intensity*	0.277	0.340	0.046	−0.004
	(0.47)	.36)	(0.72)	(0.13)
GDP × *Intensity*	0.052**	44***	0.069*	0.010
	(0.02)	.02)	(0.04)	(0.01)
VGDP × *Intensity*	0.257	0.054	−0.047	−0.170
	(0.39)	(0.29)		(0.13)
Intensity	−0.064			0.072

sions. The results are presented in Columns 3 and 4 of Table 11. The coefficient estimates of *Lib* × *Intensity* are positive and significant in both columns, suggesting that the total number and the share of domestic patents' backward citations to foreign patents in more innovative industries significantly increase after a country opens up its stock market to foreign investors.

In sum, these results suggest that stock market liberalization enhances the openness of domestic firms to foreign technology and encourages their adoption of global technology.[45]

5.3. The effect of stock market liberalization on economic growth

Thus far, our findings show that the innovation output of more innovative industries improves after a country liberalizes its equity market. However, it is not clear whether the positive effect of liberalization on economic growth found by previous studies is through the technological innovation mechanism or not. Further, liberalization can drive investment growth and productivity growth, both of which in turn promote economic growth (Bekaert et al., 2011; Henry, 2000a; Chari and Henry, 2008; Gupta and Yuan, 2009). Previous studies (e.g., Kogan et al., 2017; Chang et al., 2018) show that innovation enhances economic growth mainly through promoting productivity growth. Hence, if the positive effect of stock market liberalization on innovation we show captures an improvement in productivity growth after liberalization, we expect that liberalization leads to a significantly higher productivity growth in more innovative industries relative to less innovative industries, but an insignificant difference in investment growth between more innovative industries and less innovative industries.

To test this conjecture, we start by examining the effect of liberalization on the growth of industry value added, the growth of industry capital stock, and the growth of industry TFP. These three variables serve as proxies for industry-level economic growth, investment growth, and productivity growth, respectively. We then compare the effects across industries with different degrees of innovativeness. To perform this test, we define the growth of industry value added [$\Delta Ln(\$VA)$] as the change in the logarithm of industry value added from year t-1 to t. Because industry capital stock ($\$K$) and industry TFP ($TFP$) data are not available from the UNIDO database, we follow previous literature (e.g., Harberger, 1978; Nehru and Dhareshwar, 1993; Caselli, 2005) and construct $\$K$ and TFP based on the perpetual

Table 12
Innovation, stock market liberalization, and econ

The sample contains public firms of manufac tries in countries experiencing st liberalization, which are jointly covered by Dijk's Orbis patent database, United Nations Industrial Development Organization (UNIDO) In stics database, and Penn World T ersion 8.0 database from 1981 to 2008. ΔL K), and $\Delta Ln(TFP)$ are the annual growth rate of industry value added, industry capital stock, total factor productivity in each ndard Industrial Classification (SIC) indust country each year, respectively. *Lib* is a binary variable that takes the value of one after a coun s its equity market and zero other is a binary variable that takes the value e first three years after a country liberalizes its equity market and zero otherwise. Lib_{perm} is a bi that takes the value of one from t r after a country liberalizes its equity m ereafter and zero otherwise. Variables in dollars are computed in real terms at constant national 5 US dollars. The definitions of oth re in Table 3. Robust standard errors i are clustered by country-industry. ***, **, and * denote significance at the 1%, 5%, and 10% level,

	$\Delta Ln(\$VA)$					$\Delta Ln(\$K)$			$\Delta Ln(TFP)$			
Variable	(1)		(3)	(4)	(5)		(7)		(9)	(10)		(12)
Lib × *Intensity*										0.010**		
										(0.00)		
Lib	0.070***				0.033***				0.076***	0.050***		
	(0.01)	(			(0.01)	(0.01)			(0.01)	(0.01)		
Lib_{temp} × *Intensity*				0.009				−0.002				
				(0.01)								(0.01)
Lib_{perm} × *Intensity*				0.019***				−0.001				0.011

References

Acharya, V.V., Baghai, R., Subramanian, K., 2013. Labor laws and innovation. J. Law Econ. 68, 2059–2116.
Acharya, V.V., Subramanian, K., 2009. Bankruptcy codes and innovation. Rev. Financ. Stud. 22, 4949–4988.
Aggarwal, R., Erel, I., Ferreira, M., Matos, P., 2011. Does governance travel around the world? Evidence from institutional investors. J. Financ. Econ. 100, 154–181.
Aghion, P., van Reenen, J., Zingales, L., 2013. Innovation and institutional ownership. Am. Econ. Rev. 103, 277–304.
Atanassov, J., 2013. Do hostile takeovers stifle innovation? Evidence from antitakeover legislation and corporate patenting. J. Finance 68, 1097–1131.
Bae, K.H., Bailey, W., Mao, C.X., 2006. Stock market liberalization and the information environment. J. Int. Money Finance 25, 404–428.
Bae, K.H., Goyal, V.K., 2010. Equity market liberalization and corporate governance. J. Corporate Finance 16, 609–621.
Bae, K.H., Ozoguz, A., Tan, , Ireke ormation

Henry, P.B., 2007. Capital account liberalization: theory, evidence, and speculation. J. Econ. Lit. 45, 887–935.
Hirshleifer, D., Low, A., Teoh, S.H., 2012. Are overconfident CEOs better innovators? J. Finance 67, 1457–1498.
Holmstrom, B., 1989. Agency costs and innovation. J. Econ. Behav. Organ. 12, 305–327.
Hsu, P.H., Tian, X., Xu, Y., 2014. Financial development and innovation: cross-country evidence. J. Financ. Econ. 112, 116–135.
Javorcik, B.S., 2015. In: Does FDI Bring Good Jobs to Host countries?, 30. World Bank Research Observer, pp. 74–94.
Jayaratne, J., Strahan, P.E., 1996. The Finance-growth nexus: evidence from bank branch deregulation. Q. J. Econ. 111, 639–670.
Kim, L., Nelson, R., 2000. Technology, Learning and innovation: Experiences from Newly Industrializing Economies. Cambridge University Press, Cambridge, MA.
King, R.G., Levine, R., 1993. Finance and growth: schumpeter might be right. Q. J. Econ. 108, 717–738.
Kogan, L., Papanikolaou, D., Seru, A., Stoffman, N., 2017. Technological innovation, resource allocation, and growth. Q. J. Econ. 132, 665–712.
Kong, D., Lin, C., Wei, J., Zhang, J., 2019. Information Accessibility and Corporate Innovation. Huazhong University of Science and Technology, China Unpublished working paper.
Kortum, S., Lerner, J., 1999. What is behind the recent surge in patenting? Res. Policy 28, 1–22.
Kortum, S., Lerner., J., 2000. Assessing the contribution of venture capital. RAND J. Econ. 31, 674–692.
Kose, M.A., Prasad, E., Rogoff, K., Wei, S.J., 2009. Financial globalization: a reappraisal. IMF Staff Pap. 56, 8–62.
Lerner, J., Seru, A., 2017. The Use and Misuse of Patent data: Issues For Corporate Finance and Beyond. National Bureau of Economic Research, Cambridge, MA Unpublished working paper.
Lerner, J., Sorensen, M., Stromberg, P., 2011. Private equity and long-run investment: the case of innovation. J. Finance 66, 445–477.
Leuz, C., Lins, K.V., Warnock, F.E., 2009. Do foreigners invest less in poorly governed firms? Rev. Financ. Stud. 22, 3245–3285.
Levine, R., 2001. International financial liberalization and economic growth. Rev. Int. Econ. 9, 688–702.
Levine, R., Lin, C., Wei, L., 2017. Insider trading and innovation. J. Law Econ. 60, 749–800.
Levine, R., Zervos, S., 1998. Stock markets, banks, and economic growth. Am. Econ. Rev. 88, 537–558.
Li, D., Moshirian, F., Pham, P.K., Zein, J., 2006. When financial institutions are large shareholders: the role of macro corporate governance environments. J. Finance 61, 2975–3007.
Li, K., Qiu, J., Wang, J., 2019. Technology conglomeration, strategic alliances, and corporate innovation. Manag. Sci. 65, 5065–5090.
Lin, C., Liu, S., Manso, G., 2019. Shareholder Litigation and Corporate Innovation. University of Hong Kong, Hong Kong Unpublished working paper.
Liu, X., Buck, T., 2007. Innovation performance and channels for international technology spillovers: evidence from Chinese high-tech industries. Res. Policy 36, 355–366.
Luong, L., Moshirian, F., Nguyen, L., Tian, X., Zhang, B., 2017. How do foreign institutional investors enhance firm innovation? J. Financ. Quant. Anal. 52, 1861–1901.
MacGarvie, M., 2006. Do firms learn from international trade? Rev. Econ. Stat. 88, 46–60.
Manso, G., 2011. Motivating innovation. J. Finance 66, 1823–1860.
McConnell, J., Servaes, H., 1990. Additional evidence on equity ownership and corporate value. J. Financ. Econ. 27, 595–612.
Mitton, T., 2006. Stock market liberalization and operating performance at the firm level. J. Financ. Econ. 81, 625–647.
Nehru, V., Dhareshwar, A., 1993. A new database on physical capital stock: sources, methodology and results. Revista de Análisis Económico 8, 37–59.
Park, W., 2008. International patent protection, 1960-2005. Res. Policy 37, 761–766.
Petersen, M.A., 2009. Estimating standard errors in finance panel data sets: comparing approaches. Rev. Financ. Stud. 22, 435–480.
Popov, A., 2011. Financial Liberalization, Growth, and Risk. European Central Bank, Germany Unpublished working paper..
Quinn, D.P., Toyoda, A.M., 2008. Does capital account liberalization lead to growth? Rev. Financ. Stud. 21, 1403–1449.
Rajan, R.G., Zingales, L., 1998. Financial dependence and growth. Am. Econ. Rev. 88, 559–586.
Robinson, D.T., 2008. Strategic alliances and the boundaries of the firm. Rev. Financ. Stud. 21, 649–681.
Rodrik, D., 1998. Symposium on globalization in perspective: an introduction. J. Econ. Perspect. 12, 3–8.
Romer, P.M., 1986. Increasing returns and long-run growth. J. Political Econ. 94, 1002–1037.
Rosenberg, N., 2004. Innovation and Economic Growth. Organization for Economic Cooperation and Development Unpublished working paper..
Saidi, F., Zaldokas, A., 2019. How Does firms' Innovation Disclosure Affect Their Banking Relationships?. Boston University, MA Unpublished working paper.
Seru, A., 2014. Firm boundaries matter: evidence from conglomerates and R&D activity. J. Financ. Econ. 111, 381–405.
Shaw, E., 1973. Financial Deepening in Economic Development. Oxford University Press, New York.
Solow, R., 1956. A contribution to the theory of economic growth. Q. J. Econo. 70, 65–94.
Stulz, R.M., 1999. Globalization, corporate finance, and the cost of capital. J. Appl. Corporate Finance 12, 8–25.
Stulz, R.M., 2005. The limits of financial globalization. J. Finance 60, 1595–1638.
Tian, X., Wang, T., 2014. Tolerance for failure and corporate innovation. Rev. Financ. Stud. 27, 211–255.
Wei, S.J., 2018. Managing Financial Globalization: Insights from the Recent Literature. National Bureau of Economic Research, Cambridge, MA Unpublished working paper.