# Financial globalization and technological innovation: International evidence

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## ABSTRACT

Country's technology progress and innovation development not only depends on internal knowledge stock and human capital, but also external financial resources. This paper explores the effect of financial globalization on technological innovation through empirical investigations by using the system generalized method of moment method and panel data from 110 countries over the period of 1985–2015. Our empirical results suggest that financial globalization exerts a significant enhancing effect on technological innovation and this effect becomes stronger for countries with better institution quality. A one unit change of financial globalization can bring about a 0.6 % increase in patent applications. The comprehensive evidence shows that financial development, not trade integration, is the main channel through which financial globalization promotes national innovation. Subsample analysis shows that financial globalization only promotes innovation development of Non- Organization for Economic Co-operation and Development (OECD) countries. Our findings offer new insights into the influence of financial openness on technology progress.

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## 1. Introduction

Many countries have relaxed the restrictions in foreign investment and cross-border financial transactions after the mid-term of the 1980s, leading to the rise of financial globalization (Broner and Ventura, 2016). This not solely indicates the acceleration of cross-border financial transactions, flows, activities (*de facto*), but also reflects the adjustment in lifting regulation on capital account, reducing restrictions in foreign investment and expanding financial openness (*de jure*). With the acceleration of financial globalization in recent decades, a large number of studies have discussed its economic consequences. From these studies, financial globalization is associated with greater economic growth (Bekaert et al., 2005; Ghosh, 2017), the rise in public debts (Azzimonti et al., 2014), productivity improvement (Bonfiglioli, 2008; Bekaert et al., 2011; Gehringer, 2015), export expansion (Gur, 2013), and improved bank profit

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efficiency (Luo et al., 2016). Financial globalization is also found to bring some negative effects an economy, such as increasing financial volatility (Prasad et al., 2007), raising bank risk (Luo et al., 2016), and enlarging income inequality (Jaumotte et al., 2013).

As innovation is the core driving force for the long-run growth (Aghion and Howitt, 1992), some researchers shift their attention to the influence of financial openness on innovation. Based on panel data from 44 countries, for example, Ang (2011) empirically examines the impact of financial liberalization on knowledge accumulation with the consideration of restrictions on international capital flows in constructing financial liberalization index. He finds that financial liberalization retards the accumulation of new ideas through reallocating talents from the Research and Development (R&D) sector to the financial system. Moshirian et al. (2021) further explore the role of stock market liberalization in technological innovation by using industry-level data from 20 economies. They find that stock market liberalization indeed contributes to greater patent applications and patent citations by alleviating financial constraints and enhancing risk-sharing among investors. However, no studies have examined the impact of financial globalization on innovation by combining de facto and de jure measures simultaneously. Does overall financial globalization have a significant effect on technological innovation at the country level? What are the underlying mechanisms? Given that institution environment is crucial to financial resource allocation and innovation, does institution quality shape the impact of financial globalization on innovation? These questions call for more comprehensive and precise investigation.

This paper attempt to provide empirical evidence about the causal effect of financial globalization on the country's technological innovation. To establish the link between financial globalization and technology innovation, we analyze the pros and cons of financial globalization on technological innovation. Financial globalization brings spillover effect to domestic firms; once foreign capital enters the domestic financial market, financial institutions face intensive competition and hence lower the required interest rate, which in turn decrease the cost of R&D activities and foster innovation. Consistent with the neoclasssical perspective, financial globalization affects real economic activities by providing more available capital. Generally speaking, firms faced with financial constraints have to look for expensive external finance and lower their investment in the long run (Hsu et al., 2014). Especially in the emerging economies, imperfect financial market distorts firm's investment decision and force the firm to decrease the resources allocated to long-term projects, like R&D activities. Insufficient financial resources have been shown the main obstacle for enhancing firm's innovation production. For instance, Brown et al. (2013) find that firms with less access to stock market finance are associated with lower R&D investment. Financial globalization means more foreign capital available to domestic firms, which is capable of reducing the cost of external finance and financial constraints, and hence, domestic firms can increase investment in innovation activities and promote the development of knowledge accumulation and technological innovation. However, financial globalization may reduce the financial resources devoted to innovative firms (Ghosh, 2017). Owing to a lack of local information about firms and market conditions, foreign investors are less willing to build a relationship with local small firms. Additionally, more concentration in the financial market may increase the cost of financing (Owen and Pereira, 2018). This means financial globalization tends to hinder innovation activities. Therefore, financial globalization may affect technological innovation in both positive and negative ways.

To empirically analyze the influence of financial globalization on innovation, we collect panel data from 110 countries during the period 1985–2015. As for innovation, we use patent and trademark applications collected from World Intellectual Property Organization (WIPO) as it allows us to observe actual innovation output. To measure financial globalization precisely, we employ the updated KOF globalization index from Gygli et al. (2019). The updated KOF globalization index utilizes the time-varying weights of variables and introduces more underlying variables, providing a more precise measure for the process of financial globalization (Gygli et al., 2019). In the literature related to globalization's measure, a longstanding concern is that a single indicator cannot describe the whole picture of globalization as globalization has many facets (Chang and Lee, 2010; Chang et al., 2011; Gygli et al., 2019). Gygli et al. (2019) perceive that actual activities and policy adjustments are two aspects of globalization and they should be considered separately in the analysis. As such, we further check how *de facto* and *de jure* financial globalization affects country's innovation performance. In addition, we take the persistence of technological innovation into account in our empirical analysis owing to that innovation has to proceeds on the basis of previous knowledge stock. The results reveal that financial globalization exerts a promoting influence on technological innovation irrespective of innovation measures.

Given institution environment play a crucial role in cultivating technological innovation, we further check whether the impact of financial globalization on innovation distinct from the country's institution quality. We include the interactive term of financial globalization and two institution quality variables, corruption and law and order, in the model. As expected, we see that institution quality is positively moderate the relation between financial globalization and innovation. That is, financial globalization promote innovation more for those countries with better institution quality. We also explore the mechanisms through which financial globalization affects technological innovation. We find that countries with a higher level of financial globalization are associated with greater financial development. This means domestic financial market development are the mechanism that financial globalization foster country's technological innovation. Given economic development reflects available financial resources and decides the marginal return of additional financial input, we further check the relationship between financial globalization and innovation in the Organization for Economic Co-operation and Development (OECD) subsample and the Non-OECD subsample. Results suggest that financial globalization can promote innovation development in Non-OECD countries, but not in OECD countries.

In summary, this paper contributes to the literature in three aspects. First, our research provides systematic evidence about the impact of financial globalization on national innovation. Prior studies mainly concentrate on the stock market dimension of financial globalization (Bekaert et al., 2011) or a de jure measure (Moshirian et al., 2021). Scant studies combine de facto and de jure dimensions, which may lead to bias estimation. We account for both the de facto and de jure dimensions of financial globalization, thereby providing new evidence about its importance in regards to technological innovation. Second, this research checks the role of institution quality in shaping the relationship between financial globalization and technological innovation.

Previous studies find that domestic institution quality affects the outcome of financial globalization (Bekaert et al., 2011; Olaniyi and Oladeji, 2021), but no study explores whether institution quality adjusts the relationship between financial globalization and innovation. This paper presents that the positive effect of financial globalization becomes stronger for countries with better institution quality, which enriches the literature on financial globalization and technological innovation. Third, we identify the potential mechanism by which financial globalization affects technological innovation. Existing literature discusses the mechanism about how financial openness affects productivity (Varela, 2018; Jude and Levieuge, 2017) or how stock market liberalization affects innovation (Moshirian et al., 2021). No study in the literature tests the channel of financial globalization affecting innovation. Therefore, this paper verifies the channels through which financial globalization impacts innovation, deepening the understanding about the relationship between the two.

The remainder of this paper runs in the following manner. In Section 2, we review the related literature and propose our core hypotheses. Section 3 presents data, variables, and the empirical model. Section 4 displays empirical results, including baseline results, and some potential mechanism discussion. Section 5 gives discussions and Section 6 conclusions.

## 2. Literature review and hypotheses' development

It is widely documented that technological innovation shows significant characteristics with great uncertainty in investment scale, program process, technical roadmap, and economic value (Hirsch-Kreinsen, 2011). Technological innovation process takes a great amount of time, meaning that enormous resources are required to be devoted to it for initiating and maintaining the program, and these inputs or investments must not be suspended unless some sort of benefit appears. The huge uncertainty accompanying the innovation process means that internal finance cannot afford the necessary investment for innovation, thus entailing the need for external financing. In fact, the difficulty of financing for the innovation program is also due to information asymmetry compared to a common investment program (Wen et al., 2018). Generally speaking, the innovator knows more about the risk, opportunities, and market competitors of the innovation output than the financial institution, and it is infeasible for a financial institution to reliably evaluate the market change of the innovation program. This means that there is a moral hazard problem in the financing of innovation, and hence the financial institution does not have an incentive to finance technological innovation. In this case, a well-functioning financial market plays a key role in helping innovators gain access to finance and reduce the cost of innovation (Ayyagari et al., 2011; Hsu et al., 2014).

The literature stresses that financial development is able to promote innovation growth as it can overcome the difficulty of getting available finance (Ho et al., 2018; He and Tian, 2018). In other words, the financial market is one of the essential pre-conditions of technological innovation since it decides the allocation of financial resources to innovators. Hsu et al. (2014) focus on the influence of financial market development, including the credit market and capital market, upon industry innovation. They find that capital market development appears to enhance innovation in industries that depend more on external finance and technology knowledge, while credit market development produces an opposite influence. Ho et al. (2018) further show how both credit market and capital market development affect innovation as determined by political institutions. Zhao et al. (2021) state that a stable financial environment helps firms to add research and development (R&D) input and promote innovation (Cheng et al., 2021; Khan et al., 2021). Shahbaz et al. (2021) note that financial development benefits enterprises by triggering technological innovation and employing the latest green technologies.

Many studies in the literature have explored the effect of financial openness on economic growth and productivity. Bekaert et al. (2005) find that equity market liberalization on average results in a 1% increase in economic growth. To understand how financial openness promotes growth, Bekaert et al. (2011) further check the potential mechanism by using country-level data and find that productivity growth is more crucial in the growth effect of financial openness compared with capital growth. Based on micro-level data from 10 Eastern European countries, Larrain and Stumpner (2017) show that capital account liberalization significantly promotes productivity growth with improved capital allocation. Moshirian et al. (2021) explore the role of stock market liberalization in technological innovation and find that stock market liberalization indeed contributes to greater patent applications and patent citations.

Although financial resources are the key to innovation development, the financial market in reality is not always perfect and effective at allocating limited capital to innovative firms, especially in emerging economies (Friedrich et al., 2013). Since domestic financial resources are limited, one natural way to gain access to finance is to look for available resources elsewhere throughout the world. Financial globalization, linking local financial markets and global financial markets, not only gives foreign investors and institutions a chance to enhance economies of scope, but also provides valuable capital and brings forth advanced technology as well as managerial experiences to local markets (Baekert et al., 2005).[1] Foreign banks could provide international funds to these innovative firms, while the entry of institutional investors, national venture capital firm, and private equity are able to support younger firms engaged in radical innovation. In particular, financial globalization increases available foreign capital and improves firms' access to finance (Varela, 2018), thus lowering firms' financial constraints and hence activating their innovation activities. Lin (2011) uses variation in the policy reform of foreign bank entry to show that private firms' access to bank credit improves after the entry of foreign banks. Gu et al. (2020) also find that foreign bank entry is conducive to a corporate innovation proxy through the quantity and quality of patent applications in China, because it improves a firm's access to finance.

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[1] A more specific cross-border capital flow, foreign direct investment, is confirmed to yield innovation output gains in extant literature.

Moreover, financial globalization facilitates the entry of foreign capital and imposes competitive pressure on domestic financial institutions. Generally, foreign financial institutions are more efficient as they can undertake the extra cost of entering an unfamiliar financial market and regulatory policy environment (Mishkin, 2007). Under this circumstance, domestic financial institutions have to compete with high-efficient foreign financial institutions, thereby leading to a reduction in financing cost. Furthermore, the entry of financial institutions increases the diversity of the local financial market, which can meet the distinct financing requirement of firms with different scales. With the enhancement of available financial resources domestically, financial globalization enables firms to get more financial resources or financing at lower costs, stimulating the process of innovation activities.

Financial globalization can positively impact national technological innovation in an indirect way. It not only helps spur the spread of more capital, but also offers some collateral benefits for an economy (Mishkin, 2007; Kose et al., 2006). Given that international financial institutions have better performance in corporate governance and risk management than local institutions, local firms and governments are willing to improve governance level, which can activate innovation production. From the perspective of governments (Hu et al., 2022), financial globalization could be regarded as a commitment to stabilizing macroeconomic policies so as to prevent greater financial vulnerability, which provides a more stable environment for the innovation process (Gupta and Yuan, 2009; Kose et al., 2009).

Furthermore, financial globalization offers external opportunities of financing for local firms to participate in trade activities (Gur, 2013) and hence promotes technological innovation through increased exports. It is well recognized that local firms have to deal with some barriers to participate in trade activities (Manova, 2010), including sunk cost, tariffs, and transportation cost. Except for internal finance, external finance is required to cover these costs, implying that financial frictions will affect firms' decision on trade activities. If firms cannot afford these costs related to trade by themselves, external financial frictions will force firms to quit in export as well as import activities. That means, whether firms are in trade activities depends on external financial resources. Financial globalization increases available external financial resources and reduces the cost of finance, implying that local firms have more opportunities to overcome the difficulty in financing trade activities. Since trade activities lead to knowledge communications and generate a technology spillover on local firms (Zheng et al., 2019), financial globalization hence enhances innovation production through intensive trade activities. We hence propose the following hypothesis.

**H1a.** : financial globalization is positively associated with technological innovation.

It is also should be noted that financial globalization brings a negative influence to the economy as well. Stiglitz (2000) argues that financial globalization tends to result in greater economic instability. Jaumotte et al. (2013) claim that rising income inequality is attributed to financial globalization. As for national technological innovation, financial globalization theoretically has a negative influence. The entry of foreign financial institutions changes the structure of the local financial market, but how the financial market structure affects credit allocation and innovation activities takes place in opposite directions. The entry of foreign financial institutions does not always suggest a more competitive financial market, but rather a more concentrated financial market. In the literature related to financial market structure, the market power view holds that bank competition enhances the availability of financial resources and reduces the cost of financing (Berger and Hannan, 1998; Owen and Pereira, 2018), while the information view argues that competition in the banking system lowers banks' incentive toward building relationships with firms and collecting soft information, leading to less credit availability (Dell'Ariccia and Marquez, 2004). Accordingly, financial globalization may intensify financial constraints and increase the cost of innovation.

Even if financial globalization leads to cheaper capital in the market, these resources do not necessarily flow into innovative firms. On the one hand, because foreign financial institutions lack information and knowledge with regard to local firms as well as market conditions, they have an incentive to pick the most profitable borrowers, which are generally large firms (Ghosh, 2017). In fact, many radical innovations are produced by small- or medium-sized enterprises (SMEs), whereas large firms undertake incremental innovation (Acemoglu and Cao, 2015). However, small and large firms have different financing requirements and must cope with diversified financial sources (Polzin et al., 2017). Since foreign financial institutions are less willing to allocate resources to small firms, the presence of foreign financial institutions increases the difficulty of finance for small innovative firms and is detrimental to innovation development. Furthermore, the growth of banking credit does not flow into firms, but rather household mortgages. Bezemer et al. (2016) find that, since 1990, credit growth has been allocated to real estate markets as well as other asset markets, which leads to a negative association between financial development and growth. This fact means that even though financial globalization offers cheap finance in the financial market, it cannot be allocated to innovative firms. We hence propose the following hypothesis.

**H1b.** : financial globalization is negatively associated with technological innovation.

In the recent innovation literature, institution is thought to be an important determinant of innovation activity across a country (Wang, 2013; Tebaldi and Elmslie, 2013; Alam et al., 2019). Institution refers to rules or policies that adjust the interaction among consumers, firms, government, investors, and innovators, which further shape the motivations and expectations of participants (Jensen, 2008; Nguyen et al., 2013). High institution quality implies that the power of government is limited by imposing significant constraints on authority leaders and providing better protection for the interest of investors and innovators (La Porta et al., 2002). Institution quality is hence associated with higher levels of innovation performance, which is driven by strong incentives on gains of success innovation (Wang et al., 2021a).

Countries with high institution quality tend to limit their government's power to repress and control the financial market and encourage entry of new financial intermediaries (Feng et al., 2021; Wang et al., 2022a). Therefore, high institution quality reduces the possibility of asset expropriation against investors, avoids opportunistic behavior, and secures the interest of investors, which can

help attract foreign investors. International investors choose to make investment decisions based on stable profit expectations, whereas weak institution makes it hard to expect future profit (Ramasamy et al., 2012; Nguyen et al., 2013). Moreover, high institution uncertainty may bring about huge losses for international financial investment, meaning the security of investment profit lies at the heart of investment decisions. Investment gains are more likely to obtain reliable protection from the government under high institution quality, which in turn increases investors' confidence. Foreign investors hence like to invest in locations with better institution quality and help enhance a financial system's ability to finance long-run risky investment, such as technological innovation.

In brief, higher quality institution means that more output of financial globalization would contribute to technological innovation. We thus propose the following hypothesis.

**H2a. The positive impact of financial globalization on technological innovation is larger for countries with better institution quality.**

Stigliz (2000) notes that an inefficient local institution may hinder available foreign capital flow to productivity use, including risky innovation projects. Bad institution quality implies that local governments, especially those in some emerging economies with obvious corruption, are more likely to expropriate the interests of foreign investors, because institution imposes insufficient constraints on leaders and officers (Nguyen et al., 2013). Foreign investors will thus be discouraged to make investments and remove their attention from any risky innovation investment. Without well-developed institutions, financial globalization cannot improve the efficiency of financial resources and benefit a country's economy. Once a certain threshold condition of institution quality is met, financial globalization can result in positive outcomes (Kose et al., 2009).

Foreign investors need to collect necessary information from market prices to make investment decisions (Owen and Pereira, 2018). Generally, foreign investors are not familiar with domestic markets, implying that they tend to prefer large-sized firms and "cherry pick" the well-known profitable firms. Foreign investors, due to high costs at collecting soft information in the market, are less welcome toward small-size and emerging firms that typically have larger incentives to innovate when pursuing market share (Ghosh, 2017). Thus, financial globalization tends to impede the innovation process. Better institution quality means that the government implement policies to improve information transparency and availability for foreign investors (Ho et al., 2018). Accordingly, institution quality can relieve the negative shock of financial globalization on innovation output, since institution quality improves foreign investors' efficiency in collecting information. The better the institution quality is, the less negative effect financial globalization will have on technological innovation. Therefore, we hypothesize the following.

**H2b. The negative impact of financial globalization on technological innovation is weaker for countries with better institution quality.**

## 3. Methodology

### 3.1. Variables and data source

#### 3.1.1. Dependent variable

Following the previous literature in the innovation measurement field, we utilize two indicators to capture a country's innovation activities, including patent applications (*Patent*) and trademark applications (*Trademark*). The *Patent* is measured by the natural logarithms of gross patent applications applied by residents in a given year. Although patent has shortcomings in measuring innovation activities precisely, it is a popular indicator in the recent innovation literature (Lehmann and Seitz, 2017; Kogan et al., 2017; Wang et al., 2019). Granted Patent represents the endorsement of government intellectual property agency for new inventions or new ideas in product, design, process, and other aspects (Francis et al., 2018), which protects the inventors to monopoly the use of discoveries in the time of law permitted. Patent is significantly associated with innovation activity as the huge input in the earlier stage of innovation requires patent system's protection (Zheng et al., 2022; Peng et al., 2022; Yin et al., 2022). As a consequence, despite not all invention is transformed into patent and patent cannot distinguish groundbreaking and incremental innovation improvements (Griliches, 1990; Kang et al., 2018), patent remains a credible and accessed indicator for innovation output. Especially, patent is likely to capture information of innovation input as well as output in the absence of R&D data (Wang et al., 2022b; Yang et al., 2022; Zhao et al., 2022). Given patent may have been taken part in the production and becomes "actual innovation" before the long checking period of granted, the gross numbers of patent applications (not granted numbers) are employed in this study. In short, we believe that patent applications serve as a good indicator for measuring a country's innovation.

Our second measure for innovation is the natural logarithms of gross trademark applications applied by residents in a given year (*Trademark*). Trademark is a special recognized sign in the society that accepts intellectual property protection and can distinguish products or services of an enterprise from other enterprises. As intellectual property, a trademark protects a firm's revenue in specialized goods or services and enhances its market competitiveness faced with other rivals. Contrary to patent as the measure of innovation in the technology field, trademark is more related to innovation activity of service enterprises since trademark reflects efforts and input for intangible assets (Lehmann and Seitz, 2017). Millot (2009) pointed out that trademark incorporates enterprise's non-technological innovation information that R&D as well as patent does not contain. Therefore, we utilize trademark applications to measure a country's innovation performance for ensuring the credibility of the results.[2]

### 3.1.2. Explanatory variable

The explanatory variable of interest is financial globalization. Financial globalization reflects the sustainable link, integration as well as interaction in the global financial market, including the increase in cross-country investment, more international financial enterprises, and less regulation in cross-border financial flows. Dreher (2006) states that globalization refers to the progress of connecting people, goods, capital, and information and integrating economy, society, culture, and governance. Similarly, financial globalization describes the process of integrating cross-border capital flows and lifting restrictions on international financial transactions. That is, financial globalization expresses the extent that a country integrates with the global financial market (Chinn and Ito, 2006; Kose et al., 2009). Therefore, we utilize the latest financial globalization index (*FG*) to serve as the measure of financial globalization, since this measure can systematically exhibit the aggregate level of a country's openness and integration in the finance field (Gygli et al., 2019). According to the definition of the KOF index, greater numbers suggest a higher level of financial globalization.

Vast literatures in the globalization studies have noticed that globalization differs with the focus in different measures and different measure yields distinct results (Quinn et al., 2011). A large distinction in globalization is real activities and government policy adjustment, which correspond to *de facto* and *de jure* dimension. From an empirical perspective, (Quinn et al., 2011) identify the difference between *de facto* and *de jure* measures of financial openness leads to fully distinct results.[3] (Quinn et al., 2011) further perceive that the researcher should select indices following their research objectives. Therefore, in this study, we also check how *de facto* as well as *de jure* measures of financial globalization influence national innovation performance.

Following the approach of Kose et al., (2009), we use both the *de jure* and *de facto* measures of financial globalization in our estimation. The *de jure* measure is capable of representing policy or rules that enabling real flow or activities, while the *de facto* measure could describe these capital flows as well as activities in cross-country financial transactions. To establish *de jure* and *de facto* measures, we employ the financial globalization "*de facto*" (*FGDF*) and financial globalization "*de jure*" (*FGDJ*) from the updated KOF Globalization index. In particular, financial globalization (*de facto*) refers to foreign direct investment, portfolio investment, international debt, international reserves, and international income payments (Lane and Milesi-Ferretti, 2007, 2018). Financial globalization (*de jure*) refers to investment restrictions and capital account openness. As stated by Gygli et al. (2019), the quantity-based measure is used to avoid the problem of volatility compared to flow-based measures.

### 3.1.3. Other control variables

We also include some explanatory variables to control other influencing factors. We account for economic development (*Lngdppc*) that is proxy by the natural logarithm of Gross Domestic Products (GDP) per capita (2010 constant US dollar) (Anokhin and Wincent, 2012; Fu et al., 2020; Wang et al., 2021b; Aghion et al., 2018). The education levels (*Education*) are included in our regression analysis (Chi and Qian, 2010; Wang et al., 2021a; Zheng et al., 2021). we rely on the data from Barro and Lee (2013) and employ the average years of secondary schooling for adults aged 15–64 and above to proxy country's education.[4] Urbanization rate (*Urban*) is incorporated in the estimation. We further utilize the urban share of the gross population to measure urbanization. Furthermore, we include industry structure (*Industry*) in the model (Long et al., 2021). As a result, given manufacture gather most advanced as well as frontier technology, we use the share of the manufacture industry on GDP to capture the impact of industry structure. In addition, we consider the role of political institution factors (*Polity*) in a country's innovation. To address the possible impact of political institutions, following Gao et al. (2017), we employ the Polity2 index from Polity IV database (Acemoglu et al., 2019). Moreover, we account for investment profile (*Invpro*) in the model. Accordingly, we use investment profile indicator from the International Country Risk Guide database in the model. Higher values of investment profile represent lower investment risk in a specific country. Finally, aggregate population (*Lnpop*) is taken into consideration in the estimation. We follow Papageorgiadis and Sharma (2016) and use the natural logarithm of aggregate population to measure country size.

### 3.1.4. Data source

The data of patent and trademark are from WIPO; financial globalization index is from the latest KOF Globalization index 2017; the data of variables *Lnpop* and *Industry* are got from World Development Indicators. Education data are collected from Barro and Lee (2013); *Polity* is from Polity IV projects (Marshall et al., 2014). Based on the above selection, we finally see an unbalanced sample of 100 countries over the 1985–2015 period. The detailed information about variables and data sources are displayed in Appendix Table A1. Table 1 presents descriptive statistics. As can be seen, the mean of *Patent* and *Trademark* are 5.920 and 8.284, revealing that averaged patent application is less than trademark applications. The standard deviation of *Patent* and *Trademark* is larger than 1.8, suggesting that there is a significant difference in the data of patent and trademark.

### 3.2. Empirical model

We mainly rely on the dynamic panel model with a two-step Generalized Method of Moments (GMM) estimator to analyze the impact of financial globalization on domestic innovation (Wen et al., 2021), by controlling the potential endogenous problem and the

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[2] In the robustness checking, we employ more indicators to proxy national innovation. Fortunately, these results are also in line with our expectations.

[3] Similar findings could be seen in Kose et al. (2009) and Gygli et al. (2019).

[4] As the data in Barro and Lee (2013) are shown in five-year intervals, we follow the approach in Gao et al. (2017) to construct continuous data by assuming that education levels fluctuate little in the following four years.

**Table 1**

Descriptive statistics.

| Variables | N | Mean | Standard derivation | Min | Median | Max |
|---|---|---|---|---|---|---|
| *Patent* | 3952 | 5.920 | 2.624 | 0.693 | 5.731 | 13.913 |
| *Trademark* | 4241 | 8.284 | 1.863 | 0.693 | 8.442 | 14.560 |
| *FG* | 5689 | 53.809 | 17.415 | 4.892 | 53.513 | 98.195 |
| *FGDF* | 5782 | 56.216 | 20.396 | 3.062 | 56.034 | 100.000 |
| *FGDJ* | 5605 | 51.514 | 20.200 | 1.000 | 50.122 | 98.310 |
| *Lngdppc* | 5722 | 8.408 | 1.548 | 4.880 | 8.299 | 12.136 |
| *Education* | 4402 | 2.450 | 1.433 | 0.069 | 2.280 | 6.868 |
| *Urban* | 6620 | 55.660 | 24.741 | 5.057 | 55.040 | 100.000 |
| *Industry* | 4867 | 12.946 | 7.483 | 0.000 | 12.347 | 56.651 |
| *Polity* | 4735 | 2.598 | 6.896 | -10.000 | 5.000 | 10.000 |
| *Lnpop* | 6635 | 14.984 | 2.417 | 9.009 | 15.443 | 21.039 |
| *Invpro* | 4103 | 7.377 | 2.504 | 0.000 | 7.333 | 12.000 |

Note: N denotes observations.

dynamic effect (Arellano and Bond, 1991; Blundell and Bond, 1998 ). The dynamic panel data model is set as follows:

$$Innovation_{it} = \alpha Innovation_{it-1} + \beta FG_{it} + \delta X_{it} + \varepsilon_{it} \qquad (1)$$

where $Innovation_{it}$ represents the dependent variable (*Patent* or *Trademark*) for countries $i$ in year $t$ that denotes the innovation performance; $Innovation_{it-1}$ represents the lagged innovation in year (t-1) and captures the persistence of innovation performance; *FG* denotes financial globalization; X represent the control variables, include Economic development (*Lngdppc*), industry structure (*Industry*), aggregate population (*Lnpop*), Urbanization process (*Urban*), Education (*Education*), and Democratic institution (*Polity*); $\varepsilon_{it}$ is the idiosyncratic disturbance.

## 4. Empirical results

### 4.1. Baseline results

The results of the impact of financial globalization on innovation are listed in Table 2. In particular, columns 1–3 and columns 4–6 correspond to the dependent variable *Patent* and *Trademark*, respectively. From column 1 of Table 2, we observe that the variable *FG* is positive and significant at the 1 % level, implying that financial globalization is positively related to patent applications. The level of financial globalization increases 1, patent applications increase 0.6%. We also see in column 4 of Table 2 that the variable *FG* shows positive sign and passes the significance test, suggesting that financial globalization is associated with more trademark applications. We further check how different measures of financial globalization influence national innovation performance. The results using *de facto* and *de jure* measures are presented in column 2–3 as well as column 5–6 of Table 2. As can be seen, the coefficients of *FGDJ* and *FGDF* are positive and significant no matter what innovation indices are used, implying that real financial globalization activities and financial openness policies lead to an incline in the country's innovation production. Combing the results of financial globalization variables, we can see that financial globalization exerts a deepening influence on a country's innovation performance, irrespective of the measures of financial globalization and technological innovation.[5]

Our finding concerning the positive impact of financial globalization on innovation performance lends support to the argument that financial openness exhibits considerable value to economic development and productivity improvements (Bekaert et al., 2011). According to the neoclassical economic theory, financial integration with other countries helps local financial market developments and makes foreign capital available, which decreases a firm's financial constraints and stimulates long-run investment, including high-risk technological innovation (Bekaert et al., 2005). Furthermore, financial globalization introduces more foreign investors into the local financial market (Moshirian et al. 2021), which accelerates cross-border trade activities. Trade activities expansion bringing from financial globalization also tends to promote innovation activities since trade activities create a technology spillover effect in innovation activities.

*De jure* financial globalization is generally regarded as the precondition of *de facto* financial globalization. That is, international financial investment proceeds followed with the abolition or relaxation of capital account controls; equity market restrictions need to be lifted or reduced to attract foreign enterprises. With the lifting of cross-border financial transaction restrictions, a firm's innovation production will benefit from available foreign financial resources, domestic institution improvements, and public governance spillovers. In addition, a firm could reduce or eliminate the distortionary cost of evading these financial controls (Forbes, 2005; Kose et al., 2009). Hence, *de jure* financial globalization imposes significant gains for national innovation performance. On the other hand, available foreign financial resources increase actual financial input in innovation program. Innovators

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[5] The results in the baseline analysis show that financial globalization does promote domestic innovation output. The credibility of this significant positive impact may be suspected by possible measurement errors and other omitted variable which may affect country's innovation. We address these concerns and check whether our finding is robust to alternative measures and control variable composition. The results of robustness test are provided in appendix B (online supplementary material) and consistent with baseline one.

**Table 2**
The impact of financial globalization on innovation.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dependent variable | *Patent* | *Patent* | *Patent* | *Trademark* | *Trademark* | *Trademark* |
| L. *Patent* | 0.872*** | 0.862*** | 0.932*** | | | |
| | (0.021) | (0.024) | (0.010) | | | |
| L.*Trademark* | | | | 0.889*** | 0.883*** | 0.924*** |
| | | | | (0.004) | (0.005) | (0.002) |
| FG | 0.006*** | | | 0.001*** | | |
| | (0.002) | | | (0.000) | | |
| FGDJ | | 0.005*** | | | 0.004*** | |
| | | (0.001) | | | (0.000) | |
| DGDF | | | 0.002*** | | | 0.002*** |
| | | | (0.001) | | | (0.000) |
| Lngdppc | 0.063* | 0.088** | 0.035** | -0.015** | -0.030*** | -0.028*** |
| | (0.036) | (0.035) | (0.016) | (0.007) | (0.006) | (0.005) |
| Education | 0.045* | 0.080*** | -0.038*** | 0.048*** | 0.065*** | 0.030*** |
| | (0.025) | (0.027) | (0.011) | (0.004) | (0.005) | (0.002) |
| Urban | -0.001 | -0.002 | 0.008*** | 0.003*** | 0.003*** | 0.002*** |
| | (0.002) | (0.002) | (0.002) | (0.000) | (0.001) | (0.000) |
| Manu | 0.023*** | 0.025*** | 0.009*** | 0.003*** | 0.004*** | 0.010*** |
| | (0.004) | (0.004) | (0.002) | (0.001) | (0.001) | (0.000) |
| Polity | 0.003 | -0.005 | -0.003 | 0.003*** | -0.003*** | -0.004*** |
| | (0.005) | (0.005) | (0.003) | (0.001) | (0.001) | (0.000) |
| Lnpop | 0.186*** | 0.172*** | 0.053*** | 0.108*** | 0.112*** | 0.098*** |
| | (0.041) | (0.048) | (0.011) | (0.003) | (0.005) | (0.004) |
| Invpro | -0.020*** | -0.017*** | -0.012*** | -0.021*** | -0.026*** | -0.016*** |
| | (0.006) | (0.005) | (0.003) | (0.001) | (0.001) | (0.001) |
| constant | -3.413*** | -3.340*** | -1.294*** | -0.895*** | -0.945*** | -0.957*** |
| | (0.684) | (0.808) | (0.217) | (0.050) | (0.063) | (0.059) |
| N | 2455 | 2455 | 2455 | 2466 | 2466 | 2466 |
| AR1 | 0.000 | 0.000 | 0.000 | 0.023 | 0.022 | 0.023 |
| AR2 | 0.324 | 0.292 | 0.322 | 0.208 | 0.200 | 0.210 |
| Hansen | 0.347 | 0.352 | 0.150 | 0.143 | 0.139 | 0.485 |

Notes: The system GMM method is employed to obtain the results. N refers to observations. AR1 and AR2 denote the p value of Arellano and Bond test of first-order and second-order autocorrelation. Hansen denotes the p value of Hansen over-identification test for instruments. *, ** and *** indicate the statistical significance at the 10%, 5% and 1% level. Standard errors are presented below the corresponding coefficient. *FGDF* and *FGDJ* represent financial globalization (*de facto*) and financial globalization (*de jure*).

can devote more efforts on innovation without the fear of insufficient finance. Thus, our results indicate that foreign capital entry (*de jure* and *de facto* dimension) bring to domestic innovation development.

Numerous studies find that financial openness exerts a significantly beneficial influence on economic growth and total factor productivity (Bekaert et al., 2005; Bonfiglioli, 2008; Kose et al., 2009; Bekaert et al., 2011; Gehringer, 2015; Rodriguez, 2017; Larrain and Stumpner, 2017; Varela, 2018). Our results corroborate Moshirian et al. (2021) who show that stock market liberalization leads to increased domestic innovation through relaxing financial constraints and enhancing risk-sharing between domestic and foreign investors. However, this finding is inconsistent with Ang (2011) who finds that financial liberalization leads to lower knowledge accumulation. The cause for this difference could be sourced from two points. On the one hand, Ang (2011) only uses data of 44 countries, while this paper uses data from 110 countries to ensure its reliability. On the other hand, Ang (2011) only employs the cointegration test and panel ordinary least squares method, which cannot deal with the endogeneity, while this paper takes the persistence of innovation activities into account and uses the system GMM method to deal with endogeneity, thus providing more robust results regarding the impact of financial globalization on innovation.

As for the control variables, we observe some interesting results in Table 2. As we can see, the variable *Lngdppc* is positive when the dependent variable is *Patent*, but negative when turning to *Trademark*, implying that economic development is associated with more patent applications but fewer trademark applications.[6] The variable *Education* does indicate a positive effect on patent applications as well as trademark applications except for column 3,[7] meaning that education levels are conducive to greater innovation output (Hanushek and Woessmann, 2010). It is also worth noting that the variable *Urban* is positive and significant in column 3–6,

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[6] This finding is straightforward as trademark cannot reflect advanced technology progress in the developed era. Compared to trademark, patent exhibits advanced technology progress and requires more inputs. In era of economic underdevelopment, firms will choose to mainly apply for trademarks since this lowers difficulty in the innovation process. With the development of an economy, firms can then devote more resources to innovation activities and hence mainly apply for patents.

[7] The negative effect shown in column 3 of Table 2 may arise, because education may not be beneficial to patent applications when considering de facto financial globalization as more real foreign capital will attract talents to the financial sector from innovation positions.

**Table 3**

The impact of financial globalization on innovation: the role of corruption.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | *Patent* | *Patent* | *Patent* | *Trademark* | *Trademark* | *Trademark* |
| L.*Patent* | 0.991*** | 0.979*** | 0.973*** | | | |
| | (0.004) | (0.003) | (0.004) | | | |
| L.*Trademark* | | | | 0.879*** | 0.957*** | 0.975*** |
| | | | | (0.004) | (0.018) | (0.004) |
| *FG\*CR* | 0.002*** | | | 0.001*** | | |
| | (0.000) | | | (0.000) | | |
| *FGDF\*CR* | | 0.001** | | | 0.001** | |
| | | (0.000) | | | (0.000) | |
| *FGDJ\*CR* | | | 0.002*** | | | 0.001*** |
| | | | (0.000) | | | (0.000) |
| *FG* | -0.002** | | | -0.004*** | | |
| | (0.001) | | | (0.000) | | |
| *FGDF* | | 0.001 | | | 0.001 | |
| | | (0.001) | | | (0.002) | |
| *FGDJ* | | | -0.006*** | | | -0.003*** |
| | | | (0.001) | | | (0.001) |
| *CR* | -0.085*** | -0.039 | -0.063*** | -0.040*** | -0.012 | -0.041*** |
| | (0.024) | (0.027) | (0.015) | (0.010) | (0.025) | (0.012) |
| *Controls* | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 2455 | 2455 | 2455 | 2466 | 2466 | 2466 |
| AR1 | 0.000 | 0.000 | 0.000 | 0.023 | 0.024 | 0.023 |
| AR2 | 0.297 | 0.289 | 0.290 | 0.214 | 0.203 | 0.214 |
| Hansen | 0.397 | 0.393 | 0.464 | 0.708 | 0.002 | 0.237 |

Notes: The system GMM method is employed to obtain the results. N refers to observations. AR1 and AR2 denote the p value of Arellano and Bond test of first-order and second-order autocorrelation. Hansen denotes the p value of Hansen over-identification test for instruments. *, ** and *** indicate the statistical significance at the 10 %, 5 % and 1 % level. Standard errors are presented below the corresponding coefficient. *FGDF* and *FGDJ* represent financial globalization (*de facto*) and financial globalization (*de jure*). The results of control variables are not offered but available upon request.

showing that the process of urbanization brings greater technological innovation output. This finding coordinates the argument in Andersson et al. (2009) that urbanization enhances innovation activities through aggregation effect and social network. Another interesting finding is that the variable *Polity* is insignificant for the *Patent* case and mixed for the *Trademark* case, implying that democracy country cannot bring about more patent applications and more trademark applications. This result is partly in line with Gao et al. (2017) who find that democracy is irrelevant to a country's innovation performance.

*4.2. The role of institution quality*

We examine whether institution quality moderate the relationship between financial globalization and innovation. It is clear that research as well innovative activities proceed with the surrounding of various institutions. Institutions decide how much resources are distributed into an innovation program, and people have incentives to take part in invention and creativity (Boudreaux, 2017; Barasa et al., 2017). Acemoglu et al. (2001) state that an institution is the core determinant of long-run economic growth, and that well-designed institutions are associated with productivity improvements. Alonso and Garcimartín (2013) point out that institutions are set up to reduce transaction cost and enhance cooperation among peoples. Institutional quality reflects the ability to formulate and enact policies. Hence, a firm's decision to innovate depends on the external institutional environment. For example, weak intellectual property rights protection will lower a firm's incentive to innovate and hinder innovation development. Some empirical investigations explore the impact of institutional quality on technological innovation and show that innovation output positively correlates with institutional quality (Tebaldi and Elmslie, 2013; Lee and Law, 2017). To examine the role of institution quality on the relationship between financial globalization and innovation, we use two measures to proxy institution quality. The two measures are corruption (*CR*) and law and order (*LO*), which are from the International Country Risk Guide database. Higher value of *CR* and *LO* means less corruption within the political system and better strength and observance of the legal system. We further interact *CR* as well as *LO* with three financial globalization variables in the model.

Table 3 presents the results testing the role of corruption. Column 1–3 and 4–6 correspond to the dependent variable Patent and Trademark, respectively. From column 1 and 4 of Table 3, it can be seen that the interaction term *FG\*CR* is positive and significant, implying that the positive effect of financial globalization on innovation performance is more pronounced in countries with less corruption within the political system. When turning to the interaction term *FGDF\*CR* and *FGDJ\*CR*, we also find that these two terms remain positive and significant irrespective of the dependent variable, suggesting that financial globalization no matter which dimension does bring about more patent applications and trademark applications in countries with less corruption. As a result, we can conclude that corruption is positively moderate the relation between financial globalization and innovation, and reducing corruption in the political system intensifies the positive effect of financial globalization on innovation. As the literature states, corruption may lead to high transaction costs (Tian et al., 2021), barriers in foreign investment, which discourages firms to process the innovation activities. That is, even the entry of foreign

**Table 4**
The impact of financial globalization on innovation: the role of law and order.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Patent | Patent | Patent | Trademark | Trademark | Trademark |
| L.Patent | 0.952*** | 0.967*** | 0.934*** | | | |
| | (0.010) | (0.004) | (0.010) | | | |
| L.Trademark | | | | 0.887*** | 0.872*** | 0.892*** |
| | | | | (0.007) | (0.006) | (0.025) |
| FG*LO | 0.002*** | | | 0.001*** | | |
| | (0.001) | | | (0.000) | | |
| FGDF*LO | | 0.002*** | | | 0.001*** | |
| | | (0.000) | | | (0.000) | |
| FGDJ*LO | | | 0.001* | | | 0.003** |
| | | | (0.001) | | | (0.001) |
| FG | -0.009*** | | | -0.009*** | | |
| | (0.003) | | | (0.002) | | |
| FGDF | | -0.006*** | | | -0.006*** | |
| | | (0.001) | | | (0.001) | |
| FGDJ | | | -0.007*** | | | -0.007* |
| | | | (0.002) | | | (0.004) |
| LO | -0.056 | -0.051*** | -0.013 | -0.124*** | -0.128*** | -0.194*** |
| | (0.042) | (0.014) | (0.035) | (0.024) | (0.012) | (0.068) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 2455 | 2455 | 2455 | 2466 | 2466 | 2466 |
| AR1 | 0.000 | 0.000 | 0.000 | 0.027 | 0.026 | 0.027 |
| AR2 | 0.320 | 0.324 | 0.298 | 0.194 | 0.191 | 0.209 |
| Hansen | 0.136 | 0.203 | 0.194 | 0.515 | 0.976 | 0.209 |

Notes: The system GMM method is employed to obtain the results. N refers to observations. AR1 and AR2 denote the p value of Arellano and Bond test of first-order and second-order autocorrelation. Hansen denotes the p value of Hansen over-identification test for instruments. *, ** and *** indicate the statistical significance at the 10%, 5% and 1% level. Standard errors are presented below the corresponding coefficient. *FGDF* and *FGDJ* represent financial globalization (*de facto*) and financial globalization (*de jure*). The results of control variables are not offered but available upon request.

investors increases the availability of capitals, firms may choose to not engaging in innovation activities due to harmful effects of corruption. The reduction of corruption is hence able to enhance the positive effect of financial globalization on innovation.

We next check how law and order moderate the relationship between financial globalization and innovation. We add the interactive terms of *LO* and three financial globalization variables into the model and Table 4 presents the corresponding results. From column 1of Table 4, it appears that the coefficient of *FG*LO* is 0.002 and show statistical significance at the 1 % level, suggesting that law and order strengthen the promoting effect of financial globalization on innovation. The other five column provide similar results, implying that financial globalization spurs technology improvement in countries with better quality of law system. Given that law system plays a role in maintaining economic order and allowing knowledge to flourish, financial resources from financial globalization will be allocated to more efficient firms in a better economic order, leading that financial globalization promotes national innovation more in countries with greater law and order level. From Tables 3–4, we can conclude that institution quality can intensify the promoting influence of financial globalization on innovation.

### 4.3. Potential mechanisms

We now test potential mechanisms through which financial globalization influences a country's innovation production. Understanding potential mechanism is crucial to help policymakers in reforming financial institutions effectively for pursuing excellent innovation consequence. Following Baron and Kenny (1986), we set the following equations:

$$M_{it} = \gamma_1 FG_{it} + \theta X_{it} + \varepsilon_{it} \tag{2}$$

$$Innovation_{it} = \alpha Innovation_{it-1} + \sigma M_{it} + \beta FG_{it} + \delta X_{it} + \varepsilon_{it} \tag{3}$$

Where $M_{it}$ denotes the mediator variable. In Eq. 2, we test whether financial globalization is related to mediator variable, namely financial development and trade in this paper. If so, we next test whether the mediator variable play the mediating role in Eq. 3. That is, when we find the coefficient of the mediator variable is positive and significant, we can argue that financial globalization affect a country's innovation performance through the mediator variable.

#### 4.3.1. Financial development

First, we test whether domestic financial development changes along with financial globalization and hence promotes national innovation. Financial development is recently regarded as a key driver of innovation outcome (Hsu et al., 2014), as it does not simply induces more resource into R&D activities, but also improve the efficiency of mobilizing resources and help diversify potential risk (Hsu et al., 2014; Ho et al., 2018). According to the financial openness theory, capital market integration to the international market

has a positive influence on domestic financial development (Rajan and Zingales, 2003). Baltagi et al. (2009) and Ashraf (2018) further provide empirical evidence that openness is related to greater financial development, especially bank development. We conjecture that financial globalization leads to domestic financial sector expansion and hence promote innovation activities.

Svirydzenka (2016) contents that existing indicators for financial development are incapable of indicating "the complex multi-dimensional nature of financial development".[8] Hence, Svirydzenka (2016) constructed a new financial development index to reflect its comprehensive facet. In particular, this index account for financial institutions and financial markets in the aspect of depth access, and efficiency. As Svirydzenka's index provides multidimensional information about financial development, we hence utilize it to identify our conjunction. Column 1–2 of Table 5 presents the results using the new financial development index obtained from International Monetary Fund (IMF) database. As expected, we observe that the variable *FG* is still positive and shows significance in column 1, implying that financial globalization indeed exerts a promoting effect on domestic financial development. We next include *FD* in the baseline specification. We find that now the variable *FD* is positive and significant (column 2 and 6), but FG loses its significance, suggesting that financial globalization exerts a positive influence on a country's financial development and hence enhance national technological innovation. Overall, the results in column 1–2 as well as 6 of Table 5 support the argument that financial globalization has a positive effect on a country's innovation through financial development. This result corroborates with Moshirian et al. (2021) who find that stock market liberalization promotes innovation through alleviating firms' financing difficulties.

### 4.3.2. Trade expansion

We check whether financial globalization leads to trade expansion. Kiriyama (2012) document that trade openness is a pivotal determinant of national innovation. Trade activities not only create larger market demand to help firms obtaining profit from innovative products but also lead to market competition to push firms taking part in R&D and innovation (Aghion et al., 2018). In addition, trade facilitates technology knowledge diffusion and hence improves the probability of innovation success (Chen et al., 2017). The presence of financial constraints in real-world implies that trade activities will be restricted since trade happens at the expense of related cost, like transport fees (Hur et al., 2006; Kim et al., 2011; Manova, 2010). Financial globalization makes more external capital available and reduces the cost of capital, which is like to enhance trade activities (Gur, 2013). We hence expect that countries with a greater level of financial globalization exhibit better trade outcomes and hence innovation performance.

For a gesture of measuring trade activities systematically, we employ aggregate trade flow with defining *Trade* as the ratio of export plus import to GDP. Column 3–4 of Table 5 provides the results testing the mediating role of trade. In column 3, we find that the variable *FG* show positive sign and significance, reflecting that financial globalization generates a positive effect on trade activities. This finding corroborates the results of Anwar and Nguyen (2011) who discover a complementary relationship between foreign capital entry and export. However, when adding the variable *Trade* into the baseline model, we observe that *Trade* is not significant, meaning that trade activities does not promote innovation development directly. This also implies that financial globalization is not capable of promoting a country's innovation through intensive trade activities. To observe the effect of these two mediator variables, we simultaneously include *FD* and *Trade* in the model, and the results are offered in column 5 as well as column 8 of Table 5. We see that the variable *FD* is positive and significant, while the variable *Trade* is insignificant, implying that financial globalization enhance a country's innovation through financial development, not trade expansion.

### 4.4. Subsample analysis

We examine the conditions under which the association between financial globalization and innovation development varies. Specifically, we investigate whether the positive impact of financial globalization on innovation changes by economic development level. Many studies noted that countries with different development levels exhibit the distinct capacity to utilize financial resources and create new invent (Giannetti and Yu, 2008). It is conceivable that high-income countries, like members of OECD, generally enjoy high human capital and technology knowledge stock, efficient financial market, and good institution quality (Bekaert et al., 2005). Given innovation production requires a large amount of financial input, strong knowledge stock, and effective institutional environment, OECD countries may witness more innovation improvements from financial globalization compared to Non-OECD countries.[9] On the other hand, weak financial market and insufficient financial sources mean the importance of foreign capital to domestic innovation. Due to the lag in financial institution marketization and economic development, middle-income countries as well as low-income countries have a difficulty in providing enough funding for innovation projects. In fact, weak innovation capacity in developing countries roots in inadequate financial resources (Ullah, 2019). The entry of foreign capital help domestic firms of developing countries in solving the difficulty of finance,[10] and hence encourage firms to pursue and produce new invents, thereby generating a larger positive effect on innovation in developing countries. Accordingly, the effect of financial globalization on innovation is conditional on a country's economic development level.

We next restrict our sample to the OECD group as well as the Non-OECD group, and redo our baseline estimation. Table 6 offers the results of subsample analysis. Panel A and B of Table 6 correspond to the OECD group and the Non-OECD group, respectively. From panel A, we find that three financial globalization variables is not significant irrespective of the measure of innovation, implying that financial

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[8] For example, except for commercial banks, investment banks, mutual funds, and other financial institutions play a more crucial role in the financial market. In addition, Svirydzenka (2016) points out that the ways to invest for households and firms are more diversified.

[9] Some studies also note that whether capital flows bring about economic growth depends on initial conditions (Arya, 2019). For example, Kose et al. (2011) state that financial development and institution quality are required to be fulfilled for capital flows to produce growth effect.

[10] With weak innovation capacity and inadequate financial resources, foreign capital chooses to enter for market share and resources.

**Table 5**
Potential mechanism.

| Dependent variable | (1)<br>FD | (2)<br>Patent | (3)<br>Trade | (4)<br>Patent | (5)<br>Patent | (6)<br>Trademark | (7)<br>Trademark | (8)<br>Trademark |
|---|---|---|---|---|---|---|---|---|
| L.Patent | | 0.882*** | | 0.862*** | 0.862*** | | | |
| | | (0.021) | | (0.022) | (0.022) | | | |
| L.Trademark | | | | | | 0.843*** | 0.912*** | 0.776*** |
| | | | | | | (0.007) | (0.003) | (0.012) |
| FD | | 0.875*** | | | 0.895*** | 0.113* | | 0.489*** |
| | | (0.208) | | | (0.209) | (0.064) | | (0.055) |
| Trade | | | | 0.000 | -0.000 | | -0.000 | 0.000 |
| | | | | (0.001) | (0.001) | | (0.000) | (0.000) |
| FG | 0.001*** | 0.002 | 0.373*** | 0.005*** | 0.001 | 0.007*** | 0.005*** | 0.005*** |
| | (0.000) | (0.002) | (0.051) | (0.002) | (0.002) | (0.001) | (0.000) | (0.000) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 2846 | 2402 | 2850 | 2419 | 2366 | 2435 | 2418 | 2387 |
| AR1 | | 0.000 | | 0.000 | 0.000 | 0.000 | 0.025 | 0.000 |
| AR2 | | 0.330 | | 0.276 | 0.271 | 0.163 | 0.219 | 0.253 |
| Hansen | | 0.297 | | 0.312 | 0.200 | 0.148 | 0.119 | 1.000 |

Notes: *FD* is defined by the overall financial development indicator in Svirydzenka et al. (2016). *Trade* is measured by the ratio of trade to GDP. The system GMM method is employed to obtain the results. N refers to observations. AR1 and AR2 denote the p value of Arellano and Bond test of first-order and second-order autocorrelation. Hansen denotes the p value of Hansen over-identification test for instruments. *, ** and *** indicate the statistical significance at the 10 %, 5 % and 1 % level. Standard errors are presented below the corresponding coefficient. *FGDF* and *FGDJ* represent financial globalization (*de facto*) and financial globalization (*de jure*). The results of control variables are not offered but available upon request.

**Table 6**
Subsample analysis.

| | (1)<br>Patent | (2)<br>Patent | (3)<br>Patent | (4)<br>Trademark | (5)<br>Trademark | (6)<br>Trademark |
|---|---|---|---|---|---|---|
| **Panel A OECD countries** | | | | | | |
| L.Patent | 0.851*** | 0.867*** | 0.871*** | | | |
| | (0.029) | (0.035) | (0.024) | | | |
| L.Trademark | | | | 0.990*** | 0.994*** | 0.960*** |
| | | | | (0.049) | (0.052) | (0.048) |
| FG | -0.003 | | | 0.000 | | |
| | (0.002) | | | (0.001) | | |
| FGDJ | | -0.000 | | | 0.000 | |
| | | (0.001) | | | (0.001) | |
| FGDF | | | 0.001 | | | 0.000 |
| | | | (0.002) | | | (0.002) |
| N | 817 | 817 | 817 | 745 | 745 | 745 |
| AR1 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 |
| AR2 | 0.038 | 0.040 | 0.040 | 0.221 | 0.224 | 0.202 |
| Hansen | 0.991 | 0.993 | 1.000 | 1.000 | 1.000 | 1.000 |
| **Panel B Non-OECD countries** | | | | | | |
| L.Patent | 0.796*** | 0.776*** | 0.877*** | | | |
| | (0.018) | (0.017) | (0.013) | | | |
| L.Trademark | | | | 0.865*** | 0.843*** | 0.625*** |
| | | | | (0.004) | (0.004) | (0.110) |
| FG | 0.008*** | | | 0.004*** | | |
| | (0.002) | | | (0.001) | | |
| FGDJ | | 0.005*** | | | 0.009*** | |
| | | (0.001) | | | (0.000) | |
| FGDF | | | 0.004*** | | | 0.009* |
| | | | (0.001) | | | (0.005) |
| N | 1638 | 1638 | 1638 | 1721 | 1721 | 1721 |
| AR1 | 0.000 | 0.000 | 0.000 | 0.035 | 0.034 | 0.067 |
| AR2 | 0.669 | 0.629 | 0.707 | 0.187 | 0.182 | 0.177 |
| Hansen | 0.536 | 0.554 | 0.927 | 0.825 | 0.884 | 0.113 |

Notes: The system GMM method is employed to obtain the results. N refers to observations. AR1 and AR2 denote the p value of Arellano and Bond test of first-order and second-order autocorrelation. Hansen denotes the p value of Hansen over-identification test for instruments. *, ** and *** indicate the statistical significance at the 10 %, 5 % and 1 % level. Standard errors are presented below the corresponding coefficient. *FGDF* and *FGDJ* represent financial globalization (*de facto*) and financial globalization (*de jure*). The results of control variables are not offered but available upon request.

globalization has no significant effect on innovation in OECD countries. When turning to panel B, it appears that all financial globalization variables is positive and significant regardless of innovation indicators, showing that financial globalization still exerts a stimulating effect on a country's innovation output in the Non-OECD group. The results in panel B corroborate our baseline finding. As we know, Non-OECD countries have less financial resources compared with OECD countries, meaning that financial globalization can make up for insufficient financial resources in the innovation programs of Non-OECD countries by providing available foreign capital. However, innovation activities face less financial constraint, and financial globalization mainly leads to competition in the financial markets of OECD countries and increases financial cost. As such, financial globalization can promote innovation in Non-OECD countries, but not in OECD countries. Our findings related to the difference between the OECD group and the Non-OECD group are consistent with Gaies et al. (2020) who find financial globalization directly leads to economic growth in developing countries, but not for developed countries.

## 5. Discussion

The empirical results of this research illustrate that financial globalization is able to promote national innovation by increasing financial development, especially for Non-OECD countries. Empirical analyses also suggest that institution quality can enhance the positive effect of financial globalization on technological innovation.

### 5.1. Theoretical implications

Our study mainly advances the literature on financial globalization and innovation in three ways. First, our research provides systematic evidence about the impact of financial globalization on national innovation. Prior studies have discussed the impact of financial openness on productivity and innovation (Bekaert et al., 2011; Ang, 2011; Arif-Ur-Rahman and Inaba, 2020; Moshirian et al., 2021), but mainly consider a single dimension, such as stock market liberalization (Moshirian et al., 2021). Systematic analysis linked to financial globalization and technological innovation at the country level is indeed limited. At the same time, scant attention is paid to combining both the de facto and de jure dimensions of financial globalization. In this paper we account for both the de facto and de jure dimensions of financial globalization and advance the discussion to financial globalization and national technological innovation. As such, this paper provides new evidence about the importance of financial globalization on technological innovation.

Second, this paper checks the role of institution quality in shaping the relationship between financial globalization and technological innovation. Previous studies find that the domestic institution environment significantly influences the effectiveness of allocating resources and innovation performance (Tebaldi and Elmslie, 2013; Lee and Law, 2017), and institution quality plays a role in the nexus of financial development (openness) and productivity growth (Bekaert et al., 2011; Olaniyi and Oladeji, 2021). However, previous studies do not examine whether institution quality shapes the relationship between financial globalization and technological innovation. Hence, we examine the role of institution quality in the relationship between financial globalization and innovation, which extends the research about financial globalization and technological innovation.

Third, we explore the potential mechanism by which financial globalization affects technological innovation. Existing literature has found that financial openness can improve productivity through financial development and investment efficiency (Bekaert et al., 2011; Larrain and Stumpner, 2017; Varela, 2018; Jude and Levieuge, 2017). Moshirian et al. (2021) also find that stock market liberalization can promote innovation through the financing channel and risk-sharing channel. Nevertheless, there is no literature identifying the channels of financial globalization affecting innovation. This paper verifies the channels through which financial globalization affect innovation and presents that financial development is the main channel and that trade expansion has a little influence. Therefore, this paper helps to understand the mechanism through which financial globalization promotes technological innovation.

### 5.2. Practical implications

Our study has implications for policy makers striving to effectively stimulate innovation development as follows. First, governments in economies with insufficient financial resources should relax restrictions on international capital flow to accelerate the process of financial globalization and promote national technological innovation. There is a great debate on whether financial globalization improves productivity growth for local firms. Our results show that financial globalization indeed activates technological innovation activities in the Non-OECD group and highlight the role of financial globalization in promoting technological innovation. One policy implication from these findings suggests that those less innovative economies that still strictly regulate cross-border capital flows, especially Non-OECD countries, should implement policies that facilitate the process of financial globalization in order to attract more foreign investments and inflow of resources. Reform in cross-border financial transactions does not simply relate to a financial system, but is also the driving force of long-run growth via technological innovation. In particular, more policies should be formulated to attract foreign institutional investors, venture capital, and private equity, because these financial institutions can provide diversified funding for innovation projects at different stages (Migendt et al., 2017). Governments in Non-OECD economies should synthesize their innovation policy and financial openness policy under a framework that strengthens policy effectiveness.

Second, governments in OECD economies should overcome the negative influence of financial globalization on the domestic financial market. Our results prove that financial development is the main mechanism through which financial globalization can impact innovation output. However, OECD economies generally face a small problem of insufficient financial resources and have a high level of financial development. In this case, financial globalization mainly brings about competition pressure on the financial market, as it does not allocate more financial resources to efficient firms. Accordingly, policy makers in OECD economies should propose specific financial globalization initiatives from the perspective of reducing the negative shock of financial globalization.

Third, governments should take care of institution quality when formulating and implementing financial openness policies. This paper shows that institution quality plays a crucial role in the relationship between financial globalization and innovation development. The promoting effect of financial globalization may be intensified under stronger institution quality. The extant literature claims that the growth effect of financial globalization requires certain initial institution conditions (Arya et al., 2019). Policymakers should fully classify this fact so that they can create a favorable institution environment for innovation development by implementing institution reform. Therefore, governments should attach institution quality conditions when enacting financial openness policies.

### 5.3. Limitations and future opportunities

Our empirical analyses about the influence of financial globalization on innovation face at least two challenges. On the one hand, the variables are sensitive to measurement errors. It is straightforward that single or two measures cannot describe the comprehensive facets of financial globalization as well as innovation activities. More measures could be used in future analysis. On the other hand, our causal identification faces potential endogenous problems arising from reverse causality and omitted variables. Although financial globalization leads to deeper knowledge and innovation production, technological innovation is also likely to promote financial globalization. Bekaert et al. (2011) argue that international financial investment will be attracted into countries with large growth opportunities and strong innovation capacity - that is, financial globalization is the outcome of innovation performance. Moreover, unobserved country-specific characteristics and other factors omitted in the empirical model could result in bias in the estimation and inferences. We look to address this concern by employing the system Generalized Method of Moment. Other techniques related to solving the endogeneity could be utilized in future research. Moreover, other mechanisms through which financial globalization affects innovation should be checked. In this paper we further consider the financial development and trade expansion channel. Other possible mechanisms exist through which financial globalization influences innovation, making it worth it to explore these possible mechanisms.

## 6. Conclusions

Over the past decades, the interaction between finance and innovation has received significant attention from numerous scholars. In this paper, we explore the influence of financial globalization on technological innovation empirically. By using the panel data from 110 countries over the period of 1985–2015, We find that financial globalization exerts a significant enhancing effect on technological innovation. Interestingly, both *de jure* financial globalization and *de facto* financial globalization promote innovation development. We further find that institution quality, including less corruption and better law and order, can intensify the enhancing influence of financial globalization on innovation. Moreover, we observe that financial development, not trade integration, plays the role of the underlying mechanism, suggesting that financial globalization promotes innovation through promoting domestic financial market development. Subsample analysis shows that this positive influence of financial globalization on innovation also occurs in Non-OECD countries, and is insignificant in OECD countries. Our baseline finding is robust to alternative measures of innovation, alternative measures of financial globalization, and the inclusion of R&D input.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ecosys.2022.101048.

## References

Acemoglu, D., Cao, D., 2015. Innovation by entrants and incumbents. J. Econ. Theory 157, 255–294.
Acemoglu, D., Johnson, S., Robinson, J.A., 2001. The colonial origins of comparative development: an empirical investigation. Am. Econ. Rev. 91 (5), 1369–1401.
Acemoglu, D., Naidu, S., Restrepo, P., Robinson, J.A., 2019. Democracy does cause growth. J. Political Econ. 127 (1), 47–100.
Aghion, P., Howitt, P., 1992. A model of growth through creative destruction. Econometrica 60 (2), 323–351.
Zheng, M., Feng, G.-F., Jiang, R.-A., Chang, C.-P., 2022. Does environmental, social, and governance performance move together with corporate green innovation in China? Business Strategy and the Environment 1–10.
Aghion, P., Bergeaud, A., Lequien, M., Melitz, M.J., 2018. The impact of exports on innovation: theory and evidence. NBER Working Paper, No.24600.
Alam, A., Uddin, M., Yazdifar, H., 2019. Institutional determinants of R&D investment: evidence from emerging markets. Technol. Forecast. Soc. Change 34–44.
Alonso, J.A., Garcimartín, C., 2013. The determinants of institutional quality. More on the debate. J. Int. Dev. 25 (2), 206–226.
Andersson, R., Quigley, J.M., Wilhelmsson, M., 2009. Urbanization, productivity, and innovation: Evidence from investment in higher education. J. Urban Econ. 66 (1), 2–15.
Ang, J.B., 2011. Financial development, liberalization and technological deepening. Eur. Econ. Rev. 55 (5), 688–701.
Anokhin, S., Wincent, J., 2012. Start-up rates and innovation: a cross-country examination. J. Int. Bus. Stud. 43 (1), 41–60.
Anwar, S., Nguyen, L.P., 2011. Foreign direct investment and trade: the case of Vietnam. Res. Int. Bus. Financ. 25 (1), 39–52.
Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Rev. Econ. Stud. 58 (2), 277–297.

Arif-Ur-Rahman, M., Inaba, K., 2020. Financial integration and total factor productivity: in consideration of different capital controls and foreign direct investment. J. Econ. Struct. 9 (1), 1–20.

Arya, V., Banerjee, R., Cavoli, T., 2019. Capital flows to Asia and Latin America: does institutional quality matter? World Econ. 42 (7), 2039–2069.

Ashraf, B.N., 2018. Do trade and financial openness matter for financial development? Bank-level evidence from emerging market economies. Res. Int. Bus. Financ. 44, 434–458.

Ayyagari, M., Demirgüç-Kunt, A., Maksimovic, V., 2011. Firm innovation in emerging markets: the role of finance, governance, and competition. J. Financ. Quant. Anal. 46 (6), 1545–1580.

Azzimonti, M., De Francisco, E., Quadrini, V., 2014. Financial globalization, inequality, and the rising public debt. Am. Econ. Rev. 104 (8), 2267–2302.

Baltagi, B.H., Demetriades, P.O., Law, S.H., 2009. Financial development and openness: evidence from panel data. J. Dev. Econ. 89 (2), 285–296.

Barasa, L., Knoben, J., Vermeulen, P., Kimuyu, P., Kinyanjui, B., 2017. Institutions, resources and innovation in East Africa: a firm level approach. Res. Policy 46 (1), 280–291.

Baron, R.M., Kenny, D.A., 1986. The moderator–mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J. Personal. Soc. Psychol. 51 (6), 1173.

Barro, R.J., Lee, J.W., 2013. A new data set of educational attainment in the world, 1950–2010. J. Dev. Econ. 104, 184–198.

Bekaert, G., Harvey, C.R., Lundblad, C., 2005. Does financial liberalization spur growth? J. Financ. Econ. 77 (1), 3–55.

Bekaert, G., Harvey, C.R., Lundblad, C., 2011. Financial openness and productivity. World Dev. 39 (1), 1–19.

Berger, A.N., Hannan, T.H., 1998. The efficiency cost of market power in the banking industry: a test of the "quiet life" and related hypotheses. Rev. Econ. Stat. 80 (3), 454–465.

Bezemer, D., Grydaki, M., Zhang, L., 2016. More mortgages, lower growth? Econ. Inq. 54 (1), 652–674.

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. J. Econ. 87 (1), 115–143.

Bonfiglioli, A., 2008. Financial integration, productivity and capital accumulation. J. Int. Econ. 76 (2), 337–355.

Boudreaux, C.J., 2017. Institutional quality and innovation: some cross-country evidence. J. Entrep. Public Policy 6 (1), 26–40.

Broner, F., Ventura, J., 2016. Rethinking the effects of financial globalization. Q. J. Econ. 131 (3), 1497–1542.

Brown, J.R., Martinsson, G., Petersen, B.C., 2013. Law, stock markets, and innovation. J. Financ. 68 (4), 1517–1549.

Chang, C.P., Lee, C.C., 2010. Globalization and economic growth: a political economy analysis for OECD countries. Glob. Econ. Rev. 39 (2), 151–173.

Chang, C.P., Lee, C.C., Hsieh, M.C., 2011. Globalization, real output and multiple structural breaks. Glob. Econ. Rev. 40 (4), 421–444.

Chen, Z., Zhang, J., Zheng, W., 2017. Import and innovation: evidence from Chinese firms. Eur. Econ. Rev. 205–220.

Cheng, C., Ren, X., Dong, K., Dong, X., Wang, Z., 2021. How does technological innovation mitigate $CO_2$ emissions in OECD countries? Heterogeneous analysis using panel quantile regression. J. Environ. Manag. 280, 111818.

Chi, W., Qian, X., 2010. The role of education in regional innovation activities: spatial evidence from China. J. Asia Pac. Econ. 15 (4), 396–419.

Chinn, M.D., Ito, H., 2006. What matters for financial development? Capital controls, institutions, and interactions. J. Dev. Econ. 81 (1), 163–192.

Dell'Ariccia, G., Marquez, R., 2004. Information and bank credit allocation. J. Financ. Econ. 72 (1), 185–214.

Forbes, K.J. (2005). The microeconomic evidence on capital controls: No free lunch. NBER Working Paper, No. 11372.

Feng, G.F., Yang, H.C., Gong, Q., Chang, C.P., 2021. What is the exchange rate volatility response to COVID-19 and government interventions? Economic Analysis and Policy 69, 705–719.

Francis, B.B., Kim, I., Wang, B., Zhang, Z., 2018. Labor law and innovation revisited. J. Bank. Financ. 94, 1–15.

Friedrich, C., Schnabel, I., Zettelmeyer, J., 2013. Financial integration and growth – why is emerging Europe different? J. Int. Econ. 89 (2), 522–538.

Fu, Q., Chen, Y.E., Jang, C.L., Chang, C.P., 2020. The impact of international sanctions on environmental performance. Sci. Total Environ. 745, 141007.

Gaies, B., Goutte, S., Guesmi, K., 2020. Does financial globalization still spur growth in emerging and developing countries? Considering exchange rates. Res. Int. Bus. Financ. 52, 101113.

Gao, Y., Zang, L., Roth, A., Wang, P., 2017. Does democracy cause innovation? An empirical test of the popper hypothesis. Res. Policy 46 (7), 1272–1283.

Gehringer, A., 2015. Uneven effects of financial liberalization on productivity growth in the EU: evidence from a dynamic panel investigation. Int. J. Prod. Econ. 159, 334–346.

Ghosh, A., 2017. How does banking sector globalization affect economic growth? Int. Rev. Econ. Financ. 48, 83–97.

Giannetti, M., Yu, X., 2008. Favoritism or markets in capital allocation?. Working paper.

Griliches, Z., 1990. Patent statistics as economic indicators: a survey. J. Econ. Lit. 28 (4), 287–343.

Gu, L., Ni, X., Peng, Y., Zhang, H., 2020. Entry of foreign banks, state ownership, and corporate innovation. Pac.-Basin Financ. J. 61, 101340.

Gupta, N., Yuan, K., 2009. On the growth effect of stock market liberalizations. Rev. Financ. Stud. 22 (11), 4715–4752.

Gur, N., 2013. Does financial integration increase exports? Evidence from international industry-level data. Emerg. Mark. Financ. Trade 49 (sup5), 112–129.

Gygli, S., Haelg, F., Potrafke, N., Sturm, J.E., 2019. The KOF globalisation index–revisited. Rev. Int. Organ. 14 (3), 543–574.

Hanushek, E.A., Woessmann, L., 2010. Education and economic growth. Econ. Educ. 60–67.

He, J., Tian, X., 2018. Finance and corporate innovation: a survey. Asia-Pac. J. Financ. Stud. 47 (2), 165–212.

Hirsch-Kreinsen, H., 2011. Financial market and technological innovation. Ind. Innov. 18 (4), 351–368.

Ho, C.-Y., Huang, S., Shi, H., Wu, J., 2018. Financial deepening and innovation: the role of political institutions. World Dev. 109, 1–13.

Hsu, P.H., Tian, X., Xu, Y., 2014. Financial development and innovation: cross-country evidence. J. Financ. Econ. 112 (1), 116–135.

Hu, R., Chen, D., Fu, Q., 2022. Does a government response to COVID-19 hurt the stock price of an energy enterprise? Emerging Markets Finance and Trade 58 (1), 1–10.

Hur, J., Raj, M., Riyanto, Y.E., 2006. Finance and trade: a cross-country empirical analysis on the impact of financial development and asset tangibility on international trade. World Dev. 34 (10), 1728–1741.

Jaumotte, F., Lall, S., Papageorgiou, C., 2013. Rising income inequality: technology, or trade and financial globalization? IMF Econ. Rev. 61 (2), 271–309.

Jensen, N., 2008. Political risk, democratic institutions, and foreign direct investment. J. Polit. 70 (4), 1040–1052.

Jude, C., Levieuge, G., 2017. Growth effect of foreign direct investment in developing economies: the role of institutional quality. World Econ. 40 (4), 715–742.

Kang, J.K., Liu, W.L., Low, A., Zhang, L., 2018. Friendly boards and innovation. J. Empir. Financ. 45, 1–25.

Khan, Z., Ali, S., Dong, K., Li, R.Y.M., 2021. How does fiscal decentralization affect $CO_2$ emissions? The roles of institutions and human capital. Energy Econ. 94, 105060.

Kim, D.H., Lin, S.C., Suen, Y.B., 2011. Interactions between financial development and trade openness. Scott. J. Political Econ. 58 (4), 567–588.

Kiriyama, N., 2012. Trade and Innovation. OECD Trade Policy Papers, No. 135.

Kogan, L., Papanikolaou, D., Seru, A., Stoffman, N., 2017. Technological innovation, resource allocation, and growth. Q. J. Econ. 132 (2), 665–712.

Kose, M.A., Prasad, E., Terrones, M.E., 2009. Does openness to international financial flows raise productivity growth? J. Int. Money Financ. 28 (4), 554–580.

Kose, M.A., Prasad, E., Rogoff, K.S., Wei, S.J., 2006. Financial globalization: a reappraisal. NEER Working Paper, No. 12484.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., 2002. Government ownership of banks. J. Financ. 57 (1), 265–301.

Lane, P.R., Milesi-Ferretti, G.M., 2007. The external wealth of nations mark II: revised and extended estimates of foreign assets and liabilities, 1970–2004. J. Int. Econ. 73 (2), 223–250.

Lane, P.R., Milesi-Ferretti, G.M., 2018. The external wealth of nations revisited: international financial integration in the aftermath of the global financial crisis. IMF Econ. Rev. 66 (1), 189–222.

Larrain, M., Stumpner, S., 2017. Capital account liberalization and aggregate productivity: the role of firm capital allocation. J. Financ. 72 (4), 1825–1858.

Lee, W.C., Law, S.H., 2017. Roles of formal institutions and social capital in innovation activities: a cross-country analysis. Glob. Econ. Rev. 46 (3), 203–231.

Lehmann, E.E., Seitz, N., 2017. Freedom and innovation: a country and state level analysis. J. Technol. Transf. 42 (5), 1009–1029.

Lin, H., 2011. Foreign bank entry and firms' access to bank credit: evidence from China. J. Bank. Financ. 35 (4), 1000–1010.

Long, H., Chang, C.P., Jegajeevan, S., Tang, K., 2021. Can central bank mitigate the effects of the COVID-19 pandemic on the macroeconomy? Emerg. Mark. Financ. Trade 1–18.

Luo, Y., Tanna, S., De Vita, G., 2016. Financial openness, risk and bank efficiency: Cross-country evidence. J. Financ. Stab. 24, 132–148.

Manova, K., 2010. Credit constraints and the adjustment to trade reform. Trade adjustment costs in developing countries: impacts, determinants, and policy responses, 315–329.

Migendt, M., Polzin, F., Schock, F., Täube, F.A., von Flotow, P., 2017. Beyond venture capital: an exploratory study of the finance-innovation-policy nexus in cleantech. Ind. Corp. Change 26 (6), 973–996.

Millot, V., 2009. Trademarks as an indicator of product and marketing innovations. IN: OECD Science. Technol. Ind. Work. Pap. 2009/0 6.

Mishkin, F.S., 2007. Is financial globalization beneficial? J. Money, Credit Bank. 39 (2–3), 259–294.

Moshirian, F., Tian, X., Zhang, B., Zhang, W., 2021. Stock market liberalization and innovation. J. Financ. Econ. 139 (3), 985–1014.

Nguyen, T.V., Le, N.T., Bryant, S.E., 2013. Sub-national institutions, firm strategies, and firm performance: a multilevel study of private manufacturing firms in Vietnam. J. World Bus. 48 (1), 68–76.

Olaniyi, C.O., Oladeji, S.I., 2021. Moderating the effect of institutional quality on the finance–growth nexus: insights from West African countries. Econ. Change Restruct. 54 (1), 43–74.

Owen, A.L., Pereira, J.M., 2018. Bank concentration, competition, and financial inclusion. Rev. Dev. Financ. 8 (1), 1–17.

Papageorgiadis, N., Sharma, A., 2016. Intellectual property rights and innovation: a panel analysis. Econ. Lett. 141, 70–72.

Polzin, F., Sanders, M., Täube, F., 2017. A diverse and resilient financial system for investments in the energy transition. Curr. Opin. Environ. Sustain. 28, 24–32.

Prasad, E.S., Rogoff, K., Wei, S.J., Kose, M.A., 2007. Financial globalization, growth and volatility in developing countries. Globalization and poverty. University of Chicago Press,, pp. 457–516.

Quinn, D., Schindler, M., Toyoda, A.M., 2011. Assessing measures of financial openness and integration. IMF Economic Review 59 (3), 488–522.

Rajan, R.G., Zingales, L., 2003. The great reversals: the politics of financial development in the twentieth century. J. Financ. Econ. 69 (1), 5–50.

Ramasamy, B., Yeung, M., Laforet, S., 2012. China's outward foreign direct investment: location choice and firm ownership. J. World Bus. 47 (1), 17–25.

Rodriguez, C.M., 2017. The growth effects of financial openness and exchange rates. Int. Rev. Econ. Financ. 48, 492–512.

Shahbaz, M., Destek, M.A., Dong, K., & Jiao, Z., 2021. Time-varying impact of financial development on carbon emissions in G-7 countries: evidence from the long history technological forecasting and social change, 171, 120966.

Stiglitz, J.E., 2000. Capital market liberalization, economic growth, and instability. World Dev. 28 (6), 1075–1086.

Svirydzenka, K., 2016. Introducing a new broad-based index of financial development. IMF Working Papers, 16(05).

Tebaldi, E., Elmslie, B., 2013. Does institutional quality impact innovation? Evidence from cross-country patent grant data. Appl. Econ. 45 (7), 887–900.

Tian, L., Yang, J.Y., Li, J., 2021. Does legal registration help or hurt? The effect of government corruption on resource acquisition by nascent ventures in an emerging economy. Asia Pac. J. Manag. 38 (2), 547–572.

Ullah, B., 2019. Firm innovation in transition economies: the role of formal versus informal finance. J. Multinatl. Financ. Manag. 50, 58–75.

Varela, L., 2018. Reallocation, competition, and productivity: evidence from a financial liberalization episode. Rev. Econ. Stud. 85 (2), 1279–1313.

Wang, C., 2013. Can institutions explain cross country differences in innovative activity? J. Macroecon. 128–145.

Wang, H.J., An, K., Zheng, M., 2021b. Who has done a better job in fighting the COVID-19 epidemic? Left or Right? Emerg. Mark. Financ. Trade 1–11.

Wang, Q.J., Feng, G.F., Chen, Y.E., Wen, J., Chang, C.P., 2019. The impacts of government ideology on innovation: what are the main implications? Res. Policy 48 (5), 1232–1247.

Wang, Q.J., Feng, G.F., Wang, H.J., Chang, C.P., 2021a. The impacts of democracy on innovation: revisited evidence. Technovation 108, 102333.

Wang, Q.J., Feng, G.F., Wang, H.J., Chang, C.P., 2022a. The influence of political ideology on greenhouse gas emissions. Global Environmental Change 74, 102496.

Wang, Q.J., Wang, H.J., Chang, C.P., 2022b. Environmental performance, green finance and green innovation: What's the long-run relationships among variables? Energy Economics 110, 106004.

Wen, J., Feng, G.F., Chang, C.P., Feng, Z.Z., 2018. Stock liquidity and enterprise innovation: new evidence from China. Eur. J. Financ. 24 (9), 683–713.

Wen, J., Zhao, X.X., Chang, C.P., 2021. The impact of extreme events on energy price risk. Energy Econ. 99, 105308.

Yang, H.C., Feng, G.F., Zhao, X.X., Chang, C.P., 2022. The impacts of energy insecurity on green innovation: A multi-country study. Economic Analysis and Policy 74, 139–154.

Zhao, J., Shahbaz, M., Dong, X., Dong, K., 2021. How does financial risk affect global $CO_2$ emissions? The role of technological innovation. Technol. Forecast. Soc. Change 168, 120751.

Zhao, X.X., Zheng, M., Fu, Q., 2022. How natural disasters affect energy innovation? The perspective of environmental sustainability. Energy Economics 109, 105992.

Zheng, M., Feng, G.F., Feng, S., Yuan, X., 2019. The road to innovation vs. the role of globalization: a dynamic quantile investigation. Econ. Model. 83, 65–83.

Zheng, M., Feng, G.F., Jang, C.L., Chang, C.P., 2021. Terrorism and green innovation in renewable energy. Energy Econ. 104, 105695.

Peng, X. Y., Zou, X. Y., Zhao, X. X., & Chang, C. P. (2022). How does economic policy uncertainty affect green innovation?. Technological and Economic Development of Economy, forthcoming.

Yin, H.T., Chang, C.P., & Wang, H. J. (2022) The impact of monetary policy on green innovation: Global evidence. Technological and Economic Development of Economy, forthcoming.