Financing constraints, intellectual property rights protection and incremental innovation

Abdin, Joynal; Sharma, Abhijit; Trivedi , Rohit ; Wang, Chengang

DOI:
10.1016/j.techfore.2023.122982

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (Harvard):
Abdin, J, Sharma, A, Trivedi , R & Wang, C 2024, 'Financing constraints, intellectual property rights protection and incremental innovation: Evidence from transition economy firms', *Technological Forecasting and Social Change*, vol. 198, 122982. https://doi.org/10.1016/j.techfore.2023.122982

Technological Forecasting & Social Change 198 (2024) 122982

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

journal homepage: www.elsevier.com/locate/techfore

Financing constraints, intellectual property rights protection and incremental innovation: Evidence from transition economy firms

Joynal Abdin [a], Abhijit Sharma [b,*], Rohit Trivedi [c], Chengang Wang [d]

[a] Ministry of Public Administration, Bangladesh
[b] University of Huddersfield Business School, UK
[c] School of Management, University of Bradford, UK
[d] University of Birmingham Business School, UK

ARTICLE INFO

Keywords:
Incremental innovation
Transition economies
Financing constraints
IPR protection
Probit model

ABSTRACT

Despite a growing literature, the relationship between financing constraints (FC), intellectual property rights (IPR) protection and firm innovation remains unclear within the transitional country context. Drawing on endogenous growth theory and extending the Gorodnichenko and Schnitzer (2013) framework, we hypothesize that in addition to firm-specific factors, country-level variables manifested within FC hamper incremental innovation, albeit in varying degrees due to industry heterogeneity. Secondly, as opposed to previous studies that solely focus on FC affecting firm innovation, we propose that due to resource constraints, firms in transition economies tend to follow an imitational innovation strategy, and therefore, from this perspective, IPR protection can be crucial for firm-level innovation within those economies. Using data from the World Bank Enterprise Survey (WBES) consisting of information for about 21,960 firms from 27 Eastern European and Central Asian transition countries and employing a two-step probit model with endogenous regressors, we find that adverse effects of FC and IPR on firms' innovation activities are driven from within as well as between industries. Focusing on the differential impacts of FC and IPR protection across industries, we direct potential causal pathways from easing FC and optimal IPR protection to encourage firms' innovation. Based on the findings, while very strict IPR protection is detrimental to firms' product and process innovation in industries with limited resource and skill capabilities, it is nevertheless helpful for research and development (R&D) activities in industries characterised by strong R&D and IP capacities. Our results offer useful insights for policymakers to support incremental innovation as well as boost invention. IPR protection policies require to be customised to the industries and firms, since invariably tight or lax IPR enforcement can be discouraging to both incremental and radical innovation, causing all industries suffering from the same treatment.

1. Introduction

Among the multitude of factors affecting long-term survival and growth of firms, it is well established by endogenous growth theory that institutions play a key role in influencing productivity, growth and economic development (Lucas, 1988; Romer, 1986, 1990). Institutional arrangements such as those involving financial and IPR protection affect innovation and technological adoption, especially among firms operating in developing and transition economies that often lag in use of latest technologies. Because of the structural difference between transition and industrialised developed countries, innovation activities vary between these two types of countries (Altenburg, 2009). More importantly, institutional arrangements for innovation in the transition economies differ significantly from the standard setup in developed countries (Biggart and Guillén, 1999). Endogenous growth theory argues that in order to catch up with the technology frontier, firms need to invest significantly in knowledge creation and technology adoption. However, decisions about technology investment are often restrained by financing constraints (Aghion et al., 2018; Aghion et al., 2005; King and Levine, 1993). Hall and Lerner (2010) report that due to lack of internal financial resources and underdeveloped financial markets, firms in developing and transition economies face a funding gap for investing in R&D activities. Moreover, innovation requires a substantial investment, and entrepreneurs are not willing to invest unless the resulting profit can

* Corresponding author.
E-mail address: A.Sharma2@hud.ac.uk (A. Sharma).

https://doi.org/10.1016/j.techfore.2023.122982
Received 14 November 2022; Received in revised form 16 October 2023; Accepted 5 November 2023
Available online 16 November 2023

be captured. For financing innovation, the investor needs some monopoly power, since this generates a positive externality for consumers and intellectual property rights protection can provide investors with that monopoly power (Aghion and Howitt, 1992; Barro and Sala-i-Martin, 1997). However, since firms in developing and transition countries lag behind the world technological frontier due to financing constraints, imitation activities are more important for them to catch up with the advanced technologies (Acemoglu and Akcigit, 2012; Benhabib et al., 2014; Chu et al., 2014). Therefore, institutional arrangements for financing innovation and intellectual property rights (IPR) protection can be predominant institutional factors that shape innovation activities in those economies.

This study focuses on countries that can be classified as small to medium-sized transition economies and emerging economies, which distinguishes this study from many other studies that focus on investigating the effects of financing constraints on innovation, providing evidence from developed economies (Aghion et al., 2012; Canepa and Stoneman, 2007; Hottenrott and Peters, 2012) and large players in transition and emerging economies, particularly China (Guariglia and Liu, 2014; Yu et al., 2021). Economic structure and social organisation of economic activities differ substantially between transition and industrialised developed countries, which is critical to understand the firms' innovation activities in the transition country context (Altenburg, 2009; Biggart and Guillén, 1999; Hamilton and Biggart, 1988). Moreover, innovation is widely recognised as a key component of industrialisation and catch-up in transition countries (Lall, 1992; Ramadani et al., 2019). However, technological innovation in low-income transition countries is costly and relies substantially on different factors, including enough resources, appropriate institutional setup, optimal policies, appropriate transfer mechanism, absorption capacity as well as overall economic and social conditions (Cohen and Levinthal, 1989; Keller, 1996, 2004; Stojčić et al., 2020). So, to understand the social changes through technological development, it is necessary to understand the drivers of innovation in transition economies. While policy prescription through innovation studies is essential for the transition economies as their firms' performances and economic development largely depend on innovation activities and financing facilities as well as IPR, which may play a vital role in firms' innovation, only a handful study focuses on transition economies using firm-level data (Ayyagari et al., 2011; Gorodnichenko and Schnitzer, 2013). Although findings from past studies provide important insights into the effects of financial constraints, country-level factors affecting firms have not been investigated adequately. In addition, the effect of financial constraints on firm-level innovation varies due to industry heterogeneity, which is mostly ignored within extant studies. Our paper seeks to address such gaps by assessing the impact of financing constraints and IPR protection on firm innovation within the context of medium-sized transition economies and emerging economies in the Eastern European region, considering especially country-level factors and industry heterogeneity.

Second, this is a joint analysis of the impact of financial constraints and intellectual property rights protection on firm-level innovation in a single framework. Technological innovation is costly and as it is costly it requires protection of the rents of inventors against imitations (i.e., Barro and Sala-i-Martin, 1997; Iwaisako and Futagami, 2013; Saito, 2017). Therefore, institutional arrangements for financing innovation and intellectual property rights (IPR) protection are connected to shaping innovation performance. These two factors are more relevant for firms in small to medium-sized transition economies and emerging economies as they face funding gaps due to lack of internal financial resources and they engage mainly in imitational and incremental types of innovation activities (see, for example, Bhatti and Ventresca, 2012; Chataway et al., 2014). For this reason, international IPR agreements and internal institutional arrangements for IPR protection are crucial for firms' innovation (Rodríguez et al., 2022; Wu et al., 2022; Zhang and Groen, 2021). Firms in these countries rely substantially on different financial factors including enough resources, credit facilities, subsidies, tax exemption, etc. (see Aghion et al., 2018; Aghion et al., 2005), and IP related factors, including secrecy, appropriate transfer mechanism, absorption capacity (see Acemoglu and Akcigit, 2012; Chu et al., 2014). Resources availability, credit facilities, subsidies and tax exemption are reflected in the financing constraints which are determined by the institutional settings that govern the financial system. Secrecy, appropriate transfer mechanism and absorption capacity are controlled by the IPR enforcement that is governed by the institutional settings for intellectual property protection. Along with understanding the effects of financial constraints, IPR protection is crucial for firms to engage in innovation activities. So, this study investigates the impact of financing constraints and IPR protection on firms' innovation activities in small to medium-sized transition economies and emerging countries. The incorporation of both variables into a single study helps to avoid the bias resulting from missing important variables, and findings reveal new insight into the combined effects of financing constraints and IPR protection on firms' incremental innovation outcomes in transition countries.

Third, this analysis extends the existing study (i.e., Gorodnichenko and Schnitzer, 2013) and contributes to the growing literature by addressing potential endogeneity in financing constraints adequately. Empirically, this study is related to Gorodnichenko and Schnitzer (2013), who have used firm-specific instruments to address endogeneity in the financing constraint, whereas it is well established in the literature (e.g., Beck et al., 2006; De la Torre et al., 2017; Levine, 2005) that firms' financial constraints are determined endogenously by both firm-specific and country-level factors. So, unobserved heterogeneity may arise due to uncaptured variation in the country-related factors. To adequately address the potential endogeneity, this study uses a two-step probit model employing suitable instrumental variables to treat potential endogeneity as well as include both firm-specific and country-level variables as our instruments. This study finds supporting evidence for the significant role of country-level factors in determining firms' financial constraints. These results confirm that this study employs better treatment to address endogeneity. Moreover, to address industry heterogeneity, we incorporate industry dummies within our model estimations and introduce suitable interaction terms for key variables along with relevant industry dummies. Furthermore, while Gorodnichenko and Schnitzer (2013) capture industry heterogeneity only at the aggregate level by performing sub-sample analysis for the services and manufacturing sector, we extend and build upon their approach by including a set of industry dummies based on more detailed industry classification, and we incorporate relevant interactions with financing constraints and IPR protection on incremental innovation. The findings on the interaction terms of this study confirm that the magnitude of the impacts of financial constraints and IPR on innovation varies significantly across industries. We thus make a further contribution by building upon prior research work and addressing the limitations of previous research.

Fourth, the final contribution arises from measuring the efficiencies of intellectual property protection, whereby this study uses an intellectual property rights (IPR) index, which measures the effectiveness of both the book laws and the enforcement components of intellectual property laws and administrative procedures. Previous studies mainly used the patent rights index developed by Ginarte and Park (1997) and Park (2008), which measures only the effectiveness of the *de jure* book laws, whereas the de facto enforcement components of intellectual property laws and the effectiveness of related administrative procedures are very much crucial for the efficiency of IPR (Kukharskyy, 2020). Keeping this in mind, we employ a composite IPR index developed by the Property Rights Alliance, which is the unweighted average of the patent rights index of Ginarte and Park (1997) and Park (2008), the index of intellectual property protection (IPP) of the World Economic Forum (WEF), and a piracy index of the Business Software Alliance (BSA). The original Ginarte and Park's index comprises five categories of patent protection: (i) extent of patent coverage, (ii) affiliation to

international patent agreements, (iii) provision for losses of protection, (iv) enforcement procedure, and (v) length of patent protection (see Park, 2008). This composite IPR index of Property Rights Alliance includes the level of piracy within the above five categories of patent protection, drawing data from the Global Software Survey of the BSA. The score of this index, thus, reflects the inclination of the citizens of a country towards infringing on intellectual property as well as the judicial efficiency of the country in prosecuting against intellectual property piracy (Kukharskyy, 2020). The level of piracy in the IP sector is an important indicator of the effectiveness of IPR protection (Depken and Simmons, 2004; Marron and Steel, 2000). Thus, this composite IPR index assesses the protection level of IPR of the country from de jure perspectives since it is based on Ginarte and Park's (1997) and Park's (2008) index of patent rights and de facto enforcement strength of IPR institutions of a country through including the piracy level. This study adds more to the literature since it opts for this index to investigate the strength of IPR protection on firms' innovation activities.

2. Literature review and hypotheses development

2.1. Institutions and incremental innovation in transition economies

Institutions play a key role in shaping economic, political and social interactions between firms by reducing exchange uncertainties (North, 1991). The New Institutional Economics (NIE) propounds institutions as the key determinants of firm performance as well as a country's productivity, growth and economic development (North, 1990; Sokoloff and Engerman, 2000). Past studies have empirically proven that a country with strong institutional arrangements provides incentives to a firm for innovation by protecting intellectual property rights (IPR), reducing exchange risks, ensuring regulatory support and availability of finance (Aghion et al., 2005; Barro and Sala-i-Martin, 1997; Grossman and Helpman, 1991; King and Levine, 1993; Saito, 2017).

In the past, scholars have focused on the role of myriad institutions in innovation, primarily by focusing on R&D and patenting activities of a firm (Abramovitz, 1986; Acemoglu and Akcigit, 2012; Benhabib et al., 2014; Chu et al., 2014; König et al., 2016; Abramovitz, 1986; Acemoglu and Akcigit, 2012; Benhabib et al., 2014; Chu et al., 2014; König et al., 2016). Existing work on national innovation systems (NSI), particularly Freeman (1995), Arocena and Sutz (2000), and Acs et al. (2017), arguing that a country's innovation capacity is embedded with national institutional settings, such as education systems, technological and scientific institutions, governance, industrial relations, culture and tradition, and innovation performance of economies shapes by these national institutional regimes.

In such situations, optimal institutional arrangements are paramount for firms from transition economies to actively engage in incremental innovation (Acemoglu and Akcigit, 2012; Arora, 2009; Dosi et al., 2007; Hagedoorn and Hesen, 2007).

Endogenous growth theory argues that to catch up with the ever-expanding technology frontiers, firms from transition economies need to invest in knowledge creation or adopt technology developed elsewhere (Aghion et al., 2018; Aghion et al., 2005; King and Levine, 1993). Here, several scholars have argued that by incorporating the roles played by institutions, we can understand incentives and inhibitors for firm innovation (Altman, 2009; Hall and Lerner, 2010; Sredojević et al., 2016; Stough, 2001). Here, Bronwyn H Hall and Lerner (2010) opined that due to the lack of internal financial resources and underdeveloped financial markets, firms in developing and transition economies often face a funding gap to invest in innovation activities. At the same time, existing literature within endogenous growth theory argues that for firms from transition economies, optimal intellectual property rights protection is equally crucial for innovation (Abramovitz, 1986; Acemoglu and Akcigit, 2012; Benhabib et al., 2014; Chu et al., 2014). Since firms in developing and transition countries often lag behind the world technology race, incremental innovation is often practised to catch up with the advanced technologies (Abramovitz, 1986; Acemoglu and Akcigit, 2012; Benhabib et al., 2014; Chu et al., 2014). Therefore, among other key institutions, we argue that optimal IPR protection arrangements and financing mechanisms play a crucial role in firms' incremental innovation in developing and transition countries.

2.2. Financing constraints and incremental innovation in transition economies

According to endogenous growth theory, financial institutions play a crucial role in firm innovation by mobilising capital, optimally allocating growth funds, and diversifying risk (Aghion et al., 2018; Huang and Xu, 1999; King and Levine, 1993; Laeven et al., 2015). Past studies focusing on the role of financial institutes as one of the key determinants of innovation indicate that investments in R&D activities often face financial constraints due to the inherent riskiness in R&D projects coupled with uncertainty of outcomes that may adversely affect interest of equity as well as debt financiers (Hall et al., 2016). It is further exacerbated due to intangible nature of assets created by R&D projects (Griliches, 1981; Haskel and Westlake, 2017), significant part of the budget spent towards salary and training expenses of high skilled workers that are often sunk cost in nature (Arora et al., 2013; Grabowski, 1968; Rong and Wu, 2020), and resultant profits from innovation projects being extremely skewed and often very difficult to estimate in advance (Hall and Lerner, 2010; Kerr and Nanda, 2015).

In developing and transition economies, the credit market also entails information asymmetry and weaker contract enforcement, thereby adversely affecting lender behaviour and price discovery mechanisms. Moreover, due to information asymmetry, it may also be challenging to write comprehensive contracts (Aghion and Tirole, 1994; Grossman and Hart, 1986; Hart, 2017) resulting in a higher cost for innovation projects (Agénor and Canuto, 2017). Besides, shortage of capital and lower than expected development of financial institutions also hampers credit availability for firms in transition countries (Buera et al., 2015; Law et al., 2018; Ranasinghe and Restuccia, 2018). With this, moral hazard problems owing to conflicts of interest between managers and investors may also negatively affect availability of debt financing (Crawford et al., 2018).

Past studies have empirically proven that firms engaged in R&D activities from developed countries often face financing constraints resulting into negative effects on innovation (Aghion et al., 2012; Brown et al., 2012; Cincera et al., 2016; Czarnitzki and Hottenrott, 2011; Hall et al., 2016; Lööf and Nabavi, 2016). The results of these studies indicate that firms' R&D investments are highly sensitive to cash flows, indicating an issue of access to finance for R&D activities. However, Kaplan and Zingales (1997) have argued that higher sensitivity of investments to cash flows cannot always be interpreted as an indication of financing constraints. Therefore, instead of using cash flows as a measure of financial constraints, a handful of studies (e.g., Fang et al., 2014; Hottenrott et al., 2016; Li, 2011) use stock liquidity or working capital of firms as measures of financing constraints negatively affecting R&D activities. In a similar vein, self-reported qualitative measures of innovation and financial constraints obtained from firm-level surveys also indicate that financing constraints hamper investment of firms in R&D projects (Ayyagari et al., 2011; Coad et al., 2016a; Gorodnichenko and Schnitzer, 2013; Hottenrott et al., 2016).

Existing literature also highlights various firm-specific factors such as size, age, and ownership affecting availability of capital for innovative projects (Akcigit and Kerr, 2018; Caggese, 2019; Hall and Lerner, 2010). The literature also suggests that firms' financing obstacles can be influenced largely by cross-country differences in financial market development, stock market capitalization, GDP levels and legal environment (Bruno et al., 2015; De la Torre et al., 2017; Hsu et al., 2014; Levine, 2005; Love, 2003).

In the face of overwhelming evidence that financing constraints negatively affect innovation activities at large, however, limited

evidence especially in context of incremental innovation for firms in transition economies, we posit that:

Hypothesis 1. Financial constraints negatively affect firms' investment in incremental innovation activities in transition economies.

2.3. IPR protection and innovation

There are varied theoretical views and conflicting empirical evidence about the impact of IPR protection on firm innovation. Some of the scholars have strongly argued that firms need incentives such as strong IPR protection to stimulate innovation (Acemoglu and Akcigit, 2012; Aghion and Howitt, 1992; Barro and Sala-i-Martin, 1997; Grossman and Helpman, 1991; O'donoghue and Zweimüller, 2004; Poyago-Theotoky, 1998; Saito, 2017). By including property rights protection into a formal growth framework, endogenous growth literature espouses that strong IPR protection encourages firms to engage in innovation. According to the literature, the intellectual property institution is a crucial aspect of intellectual property protection, which can be utilised as a tool to influence the degree of excludability of the stock of knowledge (O'donoghue and Zweimüller, 2004). Generally, idea creation requires a substantial initial one-off investment for the initial layout of the invention, and entrepreneurs are not willing to invest unless the resulting profit can be captured. The high degree of IP protection provided through the legal system allows the investors to enjoy some monopoly power and thereby spurs idea generation and technological development. In their quality ladder model, Grossman and Helpman (1991) show that the growth rate of a country responds to profit incentives in the R&D sector. Barro and Sala-i-Martin (1997) argue that, with weak intellectual property protection, the leader (technologically advanced firms) has insufficient incentive to innovate, and the follower has excessive incentive to copy. Acemoglu and Akcigit (2012) assert that an optimal intellectual property rights policy is crucial for technological innovation, and such policy involves state-dependent IPR protection providing greater protection to the leaders (technologically advanced firms) that are further ahead of the followers (technologically less advanced firms). Focusing on firms from developed countries, Kanwar and Evenson (2003) show that IPR protection works as an incentive to spur innovation.

However, other studies reported either non-significant (e.g., Moser, 2005; Qian, 2007), or negative relationship between IPR protection and firm innovation (e.g., Lerner, 2009; Woo et al., 2015). To explain such a large deviation in results, scholars have propounded a U-shaped relationship between IPR protection, level of economic development and technological innovation (e.g., Chen and Puttitanun, 2005; Hudson and Minea, 2013; Papageorgiadis and Sharma, 2016). Here, studies have shown that the impact of IPR protection depends on a country's development level, and mainly developed countries with an initial above-average level of development and a higher level of technological capabilities could enjoy the positive effects due to stringent IPR protection (Allred and Park, 2007; Kim et al., 2012; Sweet and Maggio, 2015).

The debate on the impact of IPR protection on innovation is also placed in the North-South framework, whereby the dominant argument is that developing countries (i.e., South) are likely to be losers due to the strengthening of IPR protection. Here, the central view is that developing countries cannot gain significantly from tighter IPR protection, since strong IPR protection can shift the terms of trade and cause reallocation of resources towards higher-priced products of developed countries, which eventually reduces innovation in developing countries (i.e., Chen, 2018; Chin and Grossman, 1988; Segerstrom, 1991). Helpman (1993) argues that tighter IPR protection may have a negative effect on technological innovations in developing economies as these countries often imitate developed countries. It is argued that due to the complexity and huge investment involved in technological innovation, only developed countries can afford to focus on innovative products and processes – i.e., radical innovation – and firms in developing countries mainly engage in imitation of already existing technologies (Acemoglu and Akcigit, 2012; König et al., 2016).

Contributing to this ongoing debate, Acemoglu et al. (2006), König et al. (2016) and Hwang et al. (2016) have also argued that at the initial stage of economic development, when countries are far behind the advanced technologies, firms pursue an adoption-based strategy and try imitating technological advancements. At a later stage, they come closer to the technology frontier and switch from an imitation to an innovation strategy. Only at such a later stage firm innovation in transition economies shall be positively influenced by stringent IPR protection. Strong IPR protection at earlier stages of economic development may prevent firms from imitating and realizing firm-level incremental innovations in developing and transition countries. Krammer (2009), using panel data for 16 Eastern European transition economies, finds that IPR protection increases the propensity to patent significantly. Similarly, Papageorgiadis and Sharma (2016) investigate the impact of the enforcement-related component of IPR on innovation by using panel data from 48 developed and developing countries and found a relationship. However, examining firm-level data from 23 transition economies, Balsmeier and Delanote (2015) found that strong IPR has positive impacts only on small and young innovative firms but old innovative firms grow up faster in countries with weaker IPR. Overall, evidence on the impact of the strengthening of IPR on firms' innovation in transition economies is limited fraught with mixed results, wherein few have demonstrated positive (e.g., Balsmeier and Delanote, 2015) while others showing negative (i.e., Krammer, 2015) or no significant relationship between IPR protection and firm innovation (such as, Balsmeier and Delanote, 2015).

In the context of incremental innovation, there is clear dearth of studies that investigated the effect of strengthening IPR protection on firm innovation in transition economies. Hence, amidst ongoing theoretical debate with little empirical evidence, we argue that firms in transition economies lag in radical innovation; instead, they often pursue path of imitation and stringent IPR protection can be detrimental to incremental innovation.

Hypothesis 2. Strong IPR protection has a negative effect on firms' investment in incremental innovation activities in transition economies.

3. Data and method

3.1. Dataset

We use data from four different sources. We mainly use the Enterprise Surveys data from the World Bank database, which contains information about firm-level innovation activities of 27 Eastern European and Central Asian transition countries (Appendix Table A1). This pooled cross-sectional data contains information on firms' innovation activities spanning 2002–2009. Due to missing values, our study has data on 21,960 firms for the years 2002, 2005 and 2009. The significant advantage of the WBES database is that it covers a wider range of innovative activities of firms in transition countries. Currently, many of the firms in such countries are adopting the already-created and tested innovations instead of investing in knowledge capital-building for ground-breaking or cutting-edge innovations (Acemoglu et al., 2012; Aghion et al., 2001; König et al., 2016). So, for a sound study on firm-level innovation activities of transition economies, one needs data on incremental innovation activities such as the introduction of the new and improved product, new production process, upgrading of the production line, or acquisition of technology (Cirera, 2015; Moser, 2013; Smith, 2005). Considering the innovation context of transition countries, the World Bank's Enterprise Surveys have focused on collecting data both on the knowledge inputs and on incremental innovation activities of firms during the survey. Therefore, by using this survey dataset, this study avails itself of the advantage to capture the full range of innovation activities that have been undertaken by the firms in

transition countries.

We utilize an index developed by the Property Rights Alliance for measuring the strength of IPR protection for a country. This measure ranges from '0' to '10', where 0 is the lowest rating and 10 is the highest rating for the strength of property rights protection within a country. A recent study by Kukharskyy (2020) uses this index to measure the intellectual property protection level within a country. For country-level data on financial sectors, we use the Financial Development and Structure dataset of the World Bank. We also use the World Development Indicators data provided by the World Bank for GDP per capita.

3.2. Measures

3.2.1. Dependent variable

We employ four different measures to capture the innovation activities of firms in transition countries. Generally, firm-level innovation can be measured by focusing either on knowledge capital inputs such as training, equipment, R&D activities and intellectual property acquisition or on innovation outcomes such as introducing technologically new products, services, production processes or upgrading of existing production methods (Fagerberg et al., 2016; Moser, 2013; Stoneman, 1995). In-house R&D activities or patenting activities are less seen in developing and transition economies. Due to the complexity and vast investment requirement for the original innovation, firms of developing or transition economies engage more in the incremental innovation process than become involved in in-house original innovation activities for radical or pioneering inventions. They make an effort to innovate by introducing technologically new products/services or upgrading their existing product line through copying others' products or adopting already-innovated more productive technologies from others (Gorodnichenko et al., 2010; Grossman and Helpman, 1994; König et al., 2016; Mukoyama, 2003; Segerstrom, 1991). Considering the imitational and adoption phenomenon of firms' innovation in transition countries, in line with previous studies, we mainly focus on innovation outcomes for capturing incremental innovation activities (Ayyagari et al., 2011; Gorodnichenko and Schnitzer, 2013). Here, we use two self-reported qualitative measures of innovation, viz. product and process innovation. Naturally, the self-reported qualitative measure has some limitations for econometric analysis due to the subjective nature of the questions used in the survey (Mairesse and Mohnen, 2010). Nonetheless, in the transition country context above, self-reported qualitative measures of firms' innovation activities have some advantages over more frequently used measures of innovation such as R&D or patenting activities. The Data (2005) refers to product innovation as creation of new or significantly improved products or services, and process innovation as the new or upgrading of the production process, marketing or delivery methods. The World Bank Enterprise Survey follows the Oslo Manual. Surveys ask firms to report whether they have initiated any of the following during the last three years: introduced a new product or service (henceforth 'product innovation') or introduced a new or significantly improved process (henceforth 'process innovation). Firms can report any initiative as an innovation if they have adopted it from others or improved the existing technologies[1]. To get a more comprehensive picture of the innovation activities of the firms in transition economies, we include R&D activities and R&D expenditure as additional measures of innovation since financial constraints and IPR protection may have different effects on innovation inputs (i.e., R&D) and outputs (i.e., product and process innovation).

3.2.2. Independent variables

For measuring financing constraints, we use the degree of a given obstacle faced by firms in accessing finance. This self-reported measure of financing constraints captures obstacles directly faced by firms when they attempt to finance projects. Firms are requested to report on a '0' to '4' scale how difficult they found gaining access to finance; here, difficulties include availability, costs, interest rates, fees, and collateral requirements. However, this often-used self-reported qualitative measure of financing constraints (e.g., Ayyagari et al., 2011) may entail endogeneity problems due to the subjectivity of the questions or inherent cultural biases. Therefore, it is essential to check potential endogeneity problems by introducing alternative macroeconomic variables. For this purpose, along with firm-level instrumental variables, we introduce country-level instrumental variables to capture unobserved-heterogeneity due to cross-country differences.

For measuring the strength of IPR protection of a country, we use Property Right Alliance's IPR Index. This index is an unweighted average of the patent rights index of Ginarte and Park (1997) and Park (2008), Intellectual Property Protection (IPP) of the World Economic Forum (WEF), and piracy index of the Business Software Alliance (BSA). The index developed by Ginarte and Park (1997) and Park (2008) comprises five categories of patent protection: (i) level of patent coverage, (ii) affiliation to international patent agreements, (iii) provision for losses of protection, (iv) enforcement system, and (v) length of patent protection (see Park, 2008). The original Ginarte and Park's index does not measure the enforcement of IPR as it is 'designed to provide an indicator of the strength of patent protection and not the quality of patent systems' (see Park, 2008, p. 761). The benefit of using the composite IPR index developed by the Property Rights Alliance is that it includes IPR protection as well as the level of piracy within the above five categories of patent protection. The patent right index and IPP index capture the strength of book laws of protection (*de jure*), while piracy level in the IP sector reflects the inclination of the citizens of a country towards infringement of IP as well as judicial efficiency of the country in prosecuting against intellectual property piracy, reflecting IPR enforcement (de facto) (Depken and Simmons, 2004; Kukharskyy, 2020; Marron and Steel, 2000). By using this composite IPR index, this study thereby takes both the *de jure* book laws and a de facto enforcement perspective of intellectual property protection of a country into account.

3.2.3. Control variables

In our estimations, we also include a set of firm-, industry- and country-level factors that may affect firms' innovation activities (following Becheikh et al., 2006; Furman et al., 2002; Gorodnichenko and Schnitzer, 2013; Hsu et al., 2014; Protogerou et al., 2017; Sinani and Meyer, 2004). We include firm-specific factors such as age, size, competitiveness, international orientation, workforce human capital and knowledge acquisition as control variables in our regression model.

Firm size is measured by the number of workers employed by the firm. Age is the number of years from the beginning of the operation of the firm to the year the survey is carried out. Our study uses two measures of competitiveness of the firm. First, a dummy variable is used, which indicates whether the firm competes in the national market or not. Second, following Gorodnichenko and Schnitzer (2013), capacity utilization is measured by the ratio of temporary employees to the total employees of the firm expressed as a percentage.

To measure the international orientation of the firm, we utilize the share of imported material inputs for firms. Generally, using material inputs and supplies from foreign markets stimulates a firm's innovation since international firms and markets usually have better technology, processes and products. We use the number of skilled workers to indicate workforce human capital and knowledge acquisition by a firm.

Finally, although sample countries within our study are from the same region, they are not homogeneous in terms of levels of economic development. There are substantial differences in the structure and development of financial institutions and markets across countries within our sample (see, Beck and Demirguc-Kunt, 2009). To capture the effect of the overall level of development of a country, we include GDP per capita in our model. Table 1 provides a detailed description of our selected variables.

Summary statistics are reported in Table 2, while Table 3 reports the correlation matrix for our variables. According to our descriptive statistics, about 46 % and 64 % of the firms are engaged in product and

Table 1
Variables and definitions.

Variable	Full variable name	Definition	Source
Measures of innovation			
Prod_In	Product innovation	Coded 0 or 1: *Prod_In* = 1 if firms introduced new product/service in the last three years prior to the date of the survey; *Prod_In* = 0 if otherwise	Enterprise Surveys, World Bank
Proc_In	Process innovation	Coded 0 or 1: *Proc_In* = 1 if firms introduced new/significantly improved process in the last three years prior to the date of the survey; *Proc_In* = 0 if otherwise	Enterprise Surveys, World Bank
RD	R&D activity	*RD* takes the value 1 if firms involved in R&D activities in the last year (in-house or outsourced) and 0 otherwise	Enterprise Surveys, World Bank
RDExpn	R&D expenditure	The logarithm of firms' expenditures on R&D	Enterprise Surveys, World Bank
Independent			
FC	Financial constraint	A five-category scale of obstacles of access to finance assessed by the firms: 0 = No Obstacle, 1 = Minor Obstacle, 2 = Moderate Obstacle, 3 = Major Obstacle, and 4 = Very Severe Obstacle	Enterprise Surveys, World Bank
IPR	Intellectual property protection	An index that captures six categories of the strength of *de jure* book laws and de facto enforcement of IPR in a country [ranges from 1 to 10, with a higher score indicating the stronger level of protection]	Property Right Alliance database
Control			
LnAge	Firms' age	Age is the logarithm of the number of years from the beginning of the operation of the firm to the year of survey	Enterprise Surveys, World Bank
LnEmp	Firms' size	The logarithm of the total employees of the firms	Enterprise Surveys, World Bank
Comp	Market competition	*Comp* = 1 if the firms compete against the other firms at a national level	Enterprise Surveys, World Bank
TEmp	Capacity utilization	The share of the temporary employee as % of the total employees	Enterprise Surveys, World Bank
ImInputs	Imported inputs	% of material inputs and supplies of the firms from foreign origin at the end of last year	Enterprise Surveys, World Bank
Skill	Skills of employees	Skilled employees of the firms at the end of last year (%)	Enterprise Surveys, World Bank
LnGDP	GDP per capita	GDP per capita (constant 2010 US$)	World Development Indicators (WDI), World Bank
Instrument			
Due	Overdue payment	*Due* takes value 1 if firm pay for any material inputs/services after delivery in the last fiscal year and 0 otherwise	Enterprise Surveys, World Bank
Loss	Unexpected losses	Losses due to power outages, lost exports, and theft (% of sales)	Enterprise Surveys, World Bank
AF	Access to finance	Firms with a bank loan or line of credit (%)	Financial Development and Structure dataset, WB
CP	Depth of the financial sector	Domestic credit to the private sector (% of GDP)	Financial Development and Structure dataset, WB
STOCK	Stock market capitalization	The ratio of stock market capitalization to GDP	Financial Development and Structure dataset, WB

Note: Ln denotes the natural logarithm of the variables.

Table 2
Descriptive statistics.

Variable	Obs	Mean	Std.Dev.	Min	Max
Prod_In	21,960	0.469	0.499	0	1
Proc_In	21,960	0.642	0.48	0	1
RD	14,341	0.311	0.463	0	1
RDExpn	7180	0.343	0.703	0	9.844
FC	21,960	1.498	1.232	0	4
IPR	21,960	3.861	1.632	1.242	8.164
LnAge	21,960	2.78	0.606	0.693	5.347
LnEmp	21,960	3.418	1.603	0.689	11.29
Comp	21,960	0.152	0.359	0	1
TEmp	21,960	8.182	16.589	0	100
ImInputs	21,960	5.023	1.107	0	5.756
Skill	21,960	3.043	1.721	0	5.769
LnGDP	21,960	8.553	0.894	6.188	10.054
Due	21,960	0.467	0.499	0	1
Loss	21,960	1.102	4.471	0	100
AF	21,960	38.867	15.412	2.044	85.44
CP	21,960	37.117	23.543	4.178	125.468
STOCK	21,960	15.491	16.663	0.05	101.232

Note: Ln denotes the natural logarithm of the variables.

process innovation activities, respectively, whereas only 31 % of the firms have in-house R&D activities. Looking at these summary statistics, it is clear that firms in transition countries are more involved in incremental innovation activities instead of engaging in in-house R&D activities for radical innovation. When looking at the main covariates of interest, it is observed that 24 % of firms face severe financial obstacles, while 20 % of firms face minor FC. We do not observe any significant collinearity issues (Table 3).

3.3. Model specification

To empirically investigate the relationship between financial constraints, IPR and firms' innovation activities, in line with Gorodnichenko and Schnitzer (2013), we specify our baseline model in Eq. (1). In this specification, we model innovation (I_{fict}) as a function of instrumented financial constrained (FC) and all other independent variables.

$$I_{fict} = \phi\left[\alpha_0 + \beta_0 FC_{fict} + \beta_1 IPR_c + \gamma.Z_{fict} + \eta_i + \kappa_c + \rho_t + \varepsilon_{fict}\right] \quad (1)$$

where *I* denotes innovation, *'FC'* denotes financial constraints, *IPR* indicates intellectual property rights protection level, Z is a vector of other controls and ε is the error term. ϕ refers to c.d.f. of the standard normal random variable. F, I, c and t denote firms, industry, country and year, respectively. H_I, κ_c and ρ_t are the industry, country and year fixed effects, respectively.

Table 3
Pairwise correlations.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Prod_ln	1.000																	
Proc_ln	0.418*	1.000																
RD	0.201*	0.125*	1.000															
RDExpn	0.150*	0.072*	0.212*	1.000														
FC	−0.016*	−0.047*	−0.074*	−0.278*	1.000													
IPR	−0.122*	−0.298*	0.431*	0.057*	−0.058*	1.000												
LnAge	−0.015*	−0.019*	0.162*	0.010	−0.025*	0.138*	1.000											
LnEmp	0.169*	0.182*	0.294*	0.064*	−0.053*	−0.035*	0.323*	1.000										
Comp	0.125*	0.151*	−0.056*	−0.008	0.123*	−0.203*	−0.108*	0.027*	1.000									
TEmp	0.004	0.022*	0.051*	0.002	0.020*	−0.008	−0.045*	−0.006	−0.001	1.000								
ImInputs	0.160*	0.430*	−0.036*	0.016	0.006	−0.184*	−0.043*	−0.097*	0.101*	0.030*	1.000							
Skill	0.164*	0.230*	0.119*	0.033*	−0.029*	−0.212*	−0.022*	0.121*	−0.009	0.048*	0.129*	1.000						
LnGDP	0.021*	0.044*	0.031*	0.045*	−0.035*	0.585*	0.039*	−0.004	−0.004	−0.025*	−0.010	−0.205*	1.000					
Due	−0.308*	−0.221*	0.044*	−0.103*	0.116*	0.066*	0.040*	−0.147*	−0.153*	0.017*	−0.070*	−0.013	−0.196*	1.000				
Loss	−0.025*	−0.021*	−0.026*	−0.015	0.067*	−0.067*	−0.016*	−0.034*	0.017*	0.046*	−0.009	−0.013	−0.106*	0.022*	1.000			
AF	0.103*	0.150*	0.142*	0.116*	−0.223*	0.162*	0.065*	0.051*	−0.007	−0.027*	0.045*	0.010	0.171*	−0.010	−0.056*	1.000		
CP	0.092*	0.132*	−0.113*	0.016	−0.042*	−0.190*	−0.156*	0.060*	0.236*	−0.008	0.075*	0.037*	−0.035*	−0.188*	0.013*	0.086*	1.000	
STOCK	0.115*	0.115*	0.022*	0.056*	−0.037*	0.233*	0.008	0.065*	0.041*	−0.028*	0.094*	−0.004	0.523*	−0.203*	−0.057*	0.084*	0.112*	1.000

* Shows significance at the 0.05 level.

3.4. Estimation technique: dealing with endogeneity and selection of instrumental variables

The most straightforward strategy for estimating the basic specification of our study is either OLS or a probit model. However, one of our key concerns is that pre-estimation statistics and prior studies (Gorodnichenko and Schnitzer, 2013; Hajivassiliou and Savignac, 2008) suggest that our main explanatory variable, financing constraint (FC), can be endogenous. First, we begin by estimating the baseline model using a standard probit model to assess the relationship between firms' innovation activities, FC and IPR protection levels. But, we find a weak negative relationship between measures of firms' innovation activities and FC. This downward bias is very likely due to omitted variables or measurement errors (Wooldridge, 2010). Therefore, FC is tested for endogeneity with the help of the Durbin test and the Wu-Hausman procedure suggested by Greene (2012), Hausman (1978) and Wu (1973). Both the Durbin score statistics as well as the Wu-Hausman statistics suggest that we should reject the null hypothesis that the variable FC is exogenous.

Without treating the endogeneity within our main explanatory variable, estimation may lead to biased estimates. An instrumental variables (IV) approach is very widely used for dealing with endogeneity. Wooldridge (2010) suggests that a successful IV strategy can correct not only the omitted variable biases but also the classical form of measurement error in the endogenous variable. Therefore, we adopt an instrumental variable strategy and estimate our model using a two-stage estimation strategy. We introduce two firm-level and three country-level instrumental variables, which could potentially affect FC but do not affect firms' innovation activities directly.

Instrument variables have been selected using prior empirical research and common institutions and applying the assumption of relevant economic theory (Ullah et al., 2020). Following Gorodnichenko and Schnitzer (2013), overdue payments and unexpected losses of firms are included as firm-level instrumental variables. When firms are confronted with financial constraints, they may delay payments to suppliers. In our sample, around 70 % of firms use internal resources to fund new investments. Therefore, it is very unlikely that the firm deliberately depends on the use of non-payment, except when they confront a substantial lack of liquidity (see Gorodnichenko and Schnitzer, 2013). The argument for using unexpected losses as an instrument is that it is an exogenous shock to firm cash flows. This shock affects not only firms' internal funds but also reduces the firms' external creditworthiness.

However, FC is not determined solely by firm-related factors but is also influenced by institutional factors of the country or origin. Access to finance for innovation spending by firms can be influenced significantly by financial market development, stock market development and overall development level of a country (De la Torre et al., 2017; Levine, 2005). Beck et al. (2006) present evidence that cross-country differences in firm-level financing obstacles are explained significantly by the level of financial institutional development (see also Korosteleva and Mickiewicz, 2011). Therefore, to adequately treat endogeneity in FC, we consider three country-level instrumental variables which influence financing obstacles faced by firms. Following the seminal works of Rajan and Zingales (1996) and King and Levine (1993), we include domestic credit to the private sector (% of GDP) and the ratio of stock market capitalization to GDP as country-level factors influencing FC. These two variables measure the depth of the financial market of a country (Hsu et al., 2014; Love, 2003). A country's ability to provide access to finance is another factor in determining cross-country variability in financial obstacles faced by firms. So, we use another country-level variable, the percentage of firms with bank loans or lines of credit, to measure the ability of a country to provide firms access to finance. Our first-stage instrumental variables strategy is, therefore, as follows:

$$FC_{fict} = \alpha_0 + \beta_0 Due_{fic,t-1} + \beta_1 Loss_{fict} + \beta_2 AF_{ct} + \beta_3 CP_{ct} + \beta_4 STOCK_{ct} + \gamma.Z_{fict} + \eta_i + \kappa_c + \rho_t + e_{fict} \quad (2)$$

where *Due* is overdue payments of firms which is a binary variable; *Loss* denotes unexpected losses of firms; *AF* indicates access to finance; *CP* indicates credit to the private sector; *STOCK* is the ratio of stock market capitalization; *e* is the error term, and – same as the baseline specification – *Z* is a vector of other controls and η_i, κ_c and ρ_t are the industry, country and year fixed effects, respectively.

Two-stage estimation with endogenous regressors estimation approach is most widely used to implement the IV estimation technique (Lu et al., 2018). Therefore, our model is estimated by using a two-stage probit with endogenous regressors estimation strategy. Finally, in the second stage, the baseline equation (Eq. (1)) is estimated by using the IV probit regression technique. The reasons for choosing a probit model are that the dependent variable of this study is binary, and to ensure unbiased and consistent estimation, probit or logit regression techniques are more appropriate than other methods (Baltagi, 2008; Greene, 2012; Long et al., 2006). Moreover, for treating endogeneity bias, our study uses an IV technique, and for this purpose, the IV probit technique is widely considered the best possible approach. In addition, to address industry heterogeneity adequately, the interactions between financial constraints and industry dummies along with IPR and industry dummies are included in our model estimation. These interaction terms allow us to verify how the impact of FC and IPR on firms' innovation varies across industries.

We carried out a series of pre- and post-estimation tests to check the sensitivity of our selected instruments and test statistics confirm that using of IV approach and our selected instruments are relevant and exogenous. Results of these tests, shown in the results section (at the bottom of Table 5), justify the appropriateness of the instrument. Theoretically, perceived endogenous variables must be truly endogenous and instrument variables must be highly correlated with endogenous variables but should be uncorrelated with the error term (Bascle, 2008; Kennedy, 2008; Papies et al., 2017). To test whether our perceived endogenous variable FC is truly endogenous, we performed the Wald test of exogeneity. The results of the test show that we can reject the null hypothesis of no endogeneity because the *p*-value is <0.05. Hence, we can conclude that instrumental variables are endogenous and the estimates of the ivprobit model are appropriate. First-stage F-statistics is considered to be a "*more robust and conservative*" indicator of correlation between instrument variable and endogenous variable (Bascle, 2008, p. 295). Our first-stage F-statistics is 164.90, which is greater than the threshold value of 10.83. Moreover, our first-stage results indicate that instrument variables are strongly correlated with endogenous variable FC and subsequent changes in the first-stage regression are significantly higher (see Papies et al., 2017). So, our selected instrumental variables are highly correlated with our endogenous variable FC. Moreover, to check further the instrument relevance assumption, we performed the *weakiv* test. Test results indicate that we can reject the null hypothesis that the instruments are weak. So, our instruments are likely to be strong. We also ran the overidentification test to check whether our selected instrument variables are uncorrelated with the disturbance term. Test statistic indicates that our instruments are correctly specified. Lastly, another potential problem related to this study could be a serial correlation. We follow Wooldridge (2010), who states that using clustered robust standard errors can mitigate the biases resulting from serial correlation and heteroskedasticity.

4. Empirical results and discussion

4.1. First-stage results

Before proceeding to the main results of our study, we present first-stage results. The purpose of this initial presentation is twofold. First, it verifies whether instrumental variables used in this study are significant determinants of our endogenous variable (FC). Second, it shows how the financial institutions of a country can influence the financing constraints faced by firms. The first-stage relationships between FC and instrumental variables are presented in Table 4.

Our first-stage results suggest that all instrumental variables are significant predictors of the endogenous variable FC. Results in Table 4 show that FC is strongly related to the firms' financial status reflected through overdue payments (*Due*) and unexpected losses (*Loss*), as well as country-level factors such as access to finance (*AF*), credit to the private sector (*CP*), and stock market capitalization (*STOCK*). This result indicates that FC is determined not only by firm-related factors but also by a country's level of development of financial intermediaries and stock market capitalization. In column 1 of Table 4, the first-stage regression coefficients of access to finance (*AF*), credit to the private sector (*CP*) and stock market capitalization (*STOCK*) are −0.025, −0.005 and −0.033, respectively, which implies that in countries with greater access to finance, a higher level of financial intermediary development and more liquid stock markets, firms face lower levels of financial constraints.

Overall, our first-stage results suggest that a more developed financial system can reduce financial constraints faced by firms within transition economies. The finding of our study is consistent with the previous studies, including Levine (2005), Beck et al. (2006), De la Torre et al. (2017) and Ullah (2020), who provide evidence that financial obstacles faced by firms are determined both by firm-level factors as well as country characteristics.

4.2. Main findings

4.2.1. Impact of FC on firms' incremental innovation

Table 5 reports our baseline results. Columns 1 and 3 provide probit estimates and columns 2 and 4 report IV probit estimations for the baseline equation (Eq. (1)). Results illustrate that financing constraints can significantly explain whether or not firms innovate in transition economies.

In column 2 of this table, the IV probit regression coefficient of *FC* on product innovation is significantly negative (−0.573), implying that

Table 4
Results of first-stage regression.

Variable		Financial constraint
Due	Overdue payment	0.355***
		(0.018)
Loss	Unexpected losses	0.013***
		(0.002)
AF	Access to finance	−0.025***
		(0.001)
CP	Depth of the financial sector	−0.005***
		(0.000)
STOCK	Stock market capitalisation	−0.033***
		(0.001)
LnAge	Firms' age	0.026*
		(0.015)
LnEmp	Firms' size	−0.033***
		(0.006)
Comp	Market competition	0.220***
		(0.028)
TEmp	Capacity utilization	0.001**
		(0.000)
ImInputs	Imported inputs	0.020***
		(0.007)
Skill	Skills of employees	0.013***
		(0.005)
LnGDP	GDP per capita	0.165
		(0.108)
Constant		0.873***
		(0.854)
N		21,960
R^2		0.2035
First-stage *F*-statistics		164.90

Note: (1) Cluster robust standard errors are in brackets. (2) Significance shows * at p < 0.10, ** at p < 0.05, and *** at p < 0.01.

Table 5
Results of baseline estimation for incremental innovation.

Variable	Product innovation			Process innovation		
	(1)	(2)		(3)	(4)	
	probit	ivprobit		probit	ivprobit	
		Coefficient	Marginal effects		Coefficient	Marginal effects
FC	−0.044*	−0.573***	−0.666***	−0.192**	−0.578***	−0.647***
	(0.009)	(0.012)	(0.010)	(0.016)	(0.016)	(0.013)
IPR	−0.228***	−0.168***	−0.072***	−1.746***	−1.242***	−0.276***
	(0.016)	(0.012)	(0.006)	(0.086)	(0.025)	(0.009)
LnAge	−0.113***	−0.042***	−0.040***	−0.200***	−0.109***	−0.039**
	(0.020)	(0.016)	(0.013)	(0.029)	(0.021)	(0.016)
LnEmp	0.160***	0.065***	0.059***	0.305***	0.181***	0.121***
	(0.008)	(0.007)	(0.006)	(0.019)	(0.010)	(0.007)
Comp	0.190***	0.236***	0.454***	0.247***	0.262***	0.415***
	(0.035)	(0.028)	(0.022)	(0.053)	(0.039)	(0.026)
Temp	0.001	0.001***	0.001*	0.001	0.002***	0.001**
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
ImInputs	0.188***	0.106***	0.084***	0.661***	0.445***	0.331***
	(0.012)	(0.009)	(0.008)	(0.042)	(0.017)	(0.011)
Skill	0.124***	0.074***	0.045***	0.240***	0.161***	0.089***
	(0.007)	(0.006)	(0.005)	(0.015)	(0.007)	(0.006)
LnGDP	0.215	0.062	0.084***	1.450***	1.139***	0.378***
	(0.143)	(0.112)	(0.011)	(0.187)	(0.133)	(0.016)
Constant	−0.769***	−0.259***	−0.215*	−10.702***	−7.782***	−3.157***
	(1.127)	(0.881)	(0.111)	(1.471)	(1.048)	(0.166)
Observation	21,960	21,960		21,960	21,960	
Wald chi^2(26)	1392.67	443.47		7996.00	10,023.58	
Log pseudolikelihood	−13,263.11	−7067.389		−45,969.517	−40,159.434	
Wald test of exogeneity (*p*-value)		chi^2 = 988.06 (P-value = 0.000)			chi^2 = 720.04 (*P*-value = 0.000)	
Weak instrument robust tests		chi^2 = 577.08 (P-value = 0.000)			chi^2 = 540.06 (P-value = 0.000)	
Test of overidentifying restrictions:						
Amemiya-Lee-Newey minimum chi-sq statistic		2.587 (P-value = 0.274)			31.097 (P-value = 0.74)	

Note: Table 2.5 shows the estimated results of the baseline specification. Firm-level instrumental variables are overdue payment and unexpected losses, and country-level instrumental variables are access to finance, credit to the private sector and stock market capitalization. Wald test statistics suggest that we should reject the null hypothesis of no endogeneity. Therefore, using an instrumental variable is justified. Moreover, first-stage regression results show that instrumental variables are not only statistically significant but also have an expected relationship with financial constraints that justify the choice of instruments. Cluster robust standard errors are in brackets. *Significant at $p < 0.10$, **significant at $p < 0.05$, and ***significant at $p < 0.01$.

firms facing FC have less likelihood of introducing a new product or service in the market.

We also estimate the marginal effects of our explanatory variables on dependent variables. In the same column, the average marginal effect of FC on firms' product innovation is −0.666 at the 1 % significance level. This result indicates that a one unit increase in FC causes a 6.66 % decrease in the probability of engaging in product innovation by firms in transition economies.

Similarly, the IV probit coefficient in column 4 of the same table shows that FC negatively affect firms' process innovation. In this column, the IV probit coefficient and marginal effects of FC on firms' process innovation are −0.578 and −0.647, respectively. Furthermore, coefficients from standard probit (in columns 1 and 3 of Table 5) reaffirm the negative relationship between the FC and incremental innovation activities. The probit coefficients of FC on firms' product and process innovations are −0.044 and −0.192, respectively. However, the magnitude and statistical significance levels are lower for both of these probit coefficients. After treating endogeneity bias by introducing firm-specific and country-related instruments, we find a significant negative impact of FC on firms' product and process innovation activities.

Table 6 shows similar results for the effects of financing constraints on firms' R&D activities and expenditures. Results from this table indicate that FC has a negative impact on firms' innovation activities irrespective of the measure of innovation used in this study. Our results demonstrate evidence of a significant negative impact of FC on firms' R&D efforts. In column 2 of Table 6, the IV probit regression coefficient and marginal effects of the impact of FC on firms' R&D activities are −0.101 and −0.147, respectively.

In column 4 of the same table, the IV regression coefficient of the effect of FC on R&D expenditure is −0.259 at the 1 % significance level, which implies that a one-unit increase in the firms' financing constraints causes an approximately 25 % reduction in R&D expenditure.

The overall findings of our study are in line with the theoretical argument that resource constraints hold back firms' efforts to invest in innovation activities (see Kerr and Nanda, 2015). These results align with findings from previous empirical work, such as Hewitt-Dundas (2006), Ayyagari et al. (2011), Gorodnichenko and Schnitzer (2013), Howell (2016) and Mateut (2018), that firms' resource constraints are key barriers to engagement in innovation activities.

4.2.2. *Impact of IPR on firms' incremental innovation*

Looking at the coefficients of IPR in Table 5, it can be clearly observed that the presence of stronger IPR protection has a negative influence on firms' products as well as process innovation activities. Columns 2 and 4 of Table 5 show that IV probit regression coefficients of IPR on product and process innovation activities are −0.168 and −1.242 (marginal effects are −0.072 and −0.276), respectively. However, the magnitude of the adverse effect of IPR is much higher for process innovation than product innovation. This result implies that strong IPR is more detrimental to firms' incremental innovation activities in transition economies.

In contrast, our results indicate that strengthening IPR protection increases transition economy firms' likelihood of engaging in R&D activities as well as incurring R&D expenditure. Note the results in column

Table 6
Results of baseline estimation for R&D.

	R&D activity			R&D expenditure	
	(1)	(2)		(3)	(4)
	probit	ivprobit		reg	ivreg
		Coefficient	Marginal effects		
FC	−0.115***	−0.101**	−0.147***	−0.160***	−0.259***
	(0.024)	(0.044)	(0.039)	(0.007)	(0.023)
IPR	1.529***	0.850***	0.867***	0.023***	0.022***
	(0.179)	(0.017)	(0.016)	(0.007)	(0.007)
LnAge	0.057	0.036	0.070***	−0.004	0.004
	(0.042)	(0.024)	(0.022)	(0.014)	(0.014)
LnEmp	0.476***	0.271***	0.277***	0.017***	0.008
	(0.057)	(0.011)	(0.010)	(0.006)	(0.006)
Comp	0.457***	0.267***	0.249***	0.000	0.019
	(0.083)	(0.039)	(0.001)	(0.025)	(0.026)
TEmp	0.009***	0.005***	0.004***	0.001	0.001
	(0.002)	(0.001)	(0.034)	(0.001)	(0.001)
ImInputs	0.285***	0.156***	0.122***	0.018**	0.018**
	(0.045)	(0.016)	(0.013)	(0.008)	(0.008)
Skill	0.198***	0.113***	0.147***	0.010**	0.009*
	(0.028)	(0.010)	(0.009)	(0.005)	(0.005)
LnGDP	1.190*	0.656**	0.738***	0.010	0.006
	(0.144)	(0.021)	(0.020)	(0.001)	(0.001)
Constant	2.699***	1.523***	0.554***	0.305***	0.484***
	(0.453)	(0.208)	(0.186)	(0.098)	(0.109)
Observation	14,341	14,341		7180	7180
Wald chi^2(26)	83.95	4259.24		608.84	233.68
Log pseudolikelihood	−4976.085	−27,664.769			
R^2				0.024	0.023
Tests of endogeneity					$p = 0.000$
Durbin (score)					
Wu-Hausman F (1,21,949)					p = 0.000
Wald test of exogeneity (p-value)		0.000			
Test of overidentifying restrictions:					
Amemiya-Lee-Newey minimum chi-sq statistic		23.489 ($P = 0.054$)			
Weak identification test (Cragg-Donald F statistic)					117.043 (> critical values)
Overidentification test (Sargan statistic)					32.495 ($p = 0.0521$)
First-stage F-statistics		120.76			58.57

Note: The above table shows the results of the baseline specification for R&D. Fixed effects for year, industry and location are included but not reported here. The result of the Wald test of exogeneity suggests that we should reject the null hypothesis of no endogeneity. Therefore, using the instrumental variable is justified. Cluster robust standard errors are in brackets. *Significant at p < 0.10, **significant at p < 0.05, and ***significant at p < 0.01.

4 of Table 6, where IV regression coefficients of IPR on R&D expenditure show that if a country's IPR protection level increases by 1 %, R&D expenditure of firms is expected to increase by 2.2 %. The likelihood of firms engaging in R&D activities also increases with strengthening of IPR protection levels as seen in column 2 of the same table whereby the regression coefficient for the effect of IPR on R&D activities is significantly positive. Results of probit estimates (in columns 1 and 3 of Table 6) also show similar positive impacts arising from strengthening of IPR protection on firms' R&D efforts.

4.2.3. Results of other determinants of incremental innovation

In terms of control variables, our study has many interesting findings. First, younger firms are more likely to report incremental innovation than older firms. Columns 2 and 4 of Table 5 show the marginal effects of firm age on product and process innovation (−0.040 and −0.039, respectively). These results imply that younger firms are approximately 0.40 % more likely to engage in innovation activities than older firms. Previous studies have also shown that young firms tend to show a higher inclination towards engaging in innovation activities (Coad et al., 2016b; Huergo and Jaumandreu, 2004; Zhang et al., 2020). Second, using imported material inputs and supplies is positively associated with increased innovation activities, which is similar to results found by Gorodnichenko et al. (2010).

Third, number of employees is positively related to the propensity for innovation, which indicates that larger firms are more likely to be innovative than smaller firms. Based on a threshold regression model, Zhou et al. (2020) also show that size difference is a significant factor in explaining Chinese manufacturing firms' innovation (further example: Vaona and Pianta, 2008).

Fourth, we find that firm-level capabilities are positively associated with innovativeness. For example, results in columns 2 and 4 of Table 5 indicate that compared with non-competitive firms, a competitive firm has approximately 23 % greater likelihood of engaging in product innovation and 26 % higher possibility of engaging in process innovation. Moreover, firms that have higher capacity utilization ability are more innovative.

Fifth, the stock of human capital of firms, as measured by the percentage of skilled workers, has a positive impact on firms' innovative activities irrespective of the measures of innovation used (Acemoglu et al., 2018). Finally, the overall development level of the country is also crucial for firms to take part in innovation activities as country-level GDP per capita is positively related to the firm innovation activities.

4.2.4. Effect of FC and IPR across industry

Table 7 reports the results of the impact of FC and IPR on firms' innovation activities for each industry. Our results indicate that adverse effects of FC and IPR on firms' innovation activities are driven from within as well as between industries. Financial constraints impact firm-level innovation differently across industries. In particular, columns 1 and 2 of this table show that the coefficients on the interaction terms of FC and industry dummies are significantly negative for product and process innovation in every industry. This finding implies that in every

Table 7
Results of the impact of FC and IPR on firms' innovation for each industry.

	(1)	(2)	(3)	(4)
Industry	Impact of FC on product innovation	Impact of FC on process innovation	Impact of IPR on product innovation	Impact of IPR on process innovation
Manufacturing sector				
Food	−0.292***	−0.430***	−0.008	−0.467***
	(0.027)	(0.048)	(0.011)	(0.034)
Textile	−0.354***	−0.458***	−0.010	−0.481***
	(0.063)	(0.111)	(0.028)	(0.055)
Garments	−0.311***	−0.053	−0.018	−0.340***
	(0.034)	(0.063)	(0.015)	(0.034)
Chemical	−0.235***	−0.461***	0.044	−0.437***
	(0.062)	(0.105)	(0.028)	(0.058)
Plastic and	−0.258***	−0.537***	0.015	−0.501***
Rubber	(0.070)	(0.104)	(0.027)	(0.048)
Non-metallic	−0.474***	−0.717***	−0.055**	−0.552***
mineral	(0.065)	(0.099)	(0.026)	(0.052)
product				
Basic metal	−0.403***	−0.716***	−0.062*	−0.572***
	(0.096)	(0.152)	(0.036)	(0.065)
Fabricate	−0.310***	−0.385***	−0.027*	−0.471***
metal product	(0.035)	(0.059)	(0.014)	(0.037)
Machinery	−0.307***	−0.475***	−0.027*	−0.484***
and equipment	(0.036)	(0.063)	(0.015)	(0.038)
Electronics	−0.196**	−0.510***	0.093**	−0.385***
	(0.086)	(0.137)	(0.046)	(0.076)
Construction	−0.766***	−0.936***	−0.196***	−0.686***
section F	(0.034)	(0.070)	(0.012)	(0.047)
Others	−0.346***	−0.511***	−0.034**	−0.505***
manufacturing	(0.033)	(0.060)	(0.014)	(0.040)
Service sector				
Wholesale	−0.508***	−0.882***	−0.105***	−0.668***
	(0.031)	(0.067)	(0.010)	(0.045)
Retail	−0.488***	−0.891***	−0.093***	−0.704***
	(0.029)	(0.068)	(0.012)	(0.049)
Hotel and	−0.676***	−0.837***	−0.159***	−0.638***
Restaurant	(0.044)	(0.077)	(0.015)	(0.046)
Transport	−0.704***	−0.762***	−0.171***	−0.604***
section I	(0.039)	(0.072)	(0.014)	(0.044)
IT	−0.196**	−0.382**	−0.002	−0.490***
	(0.083)	(0.150)	(0.029)	(0.058)
Other services	−0.723***	−0.871***	−0.173***	−0.661***
	(0.037)	(0.069)	(0.011)	(0.045)

Note: The above table shows the second-stage regression results of the interaction model. To account for industry heterogeneity fully, these estimation results are obtained from the interaction between the predicted value of instrumented FC and industry dummies and IPR and industry dummies. Cluster robust standard errors are in brackets. *Significant at $p < 0.10$, **significant at $p < 0.05$, and ***significant at $p < 0.01$.

industry, FC holds back firms' innovative efforts. However, the magnitude of the negative impact of FC on firms' innovation varies across industries.

Overall, firms operating in the service sector, except IT, face more severe constraints than firms in the manufacturing sector for financing their innovation activities. On the other hand, results in columns 3 and 4 of Table 7 indicate that IPR protection level impacts firms' product and process innovation activities differently across industries. Our findings show that, in general, due to stronger IPR, firms face greater obstacles to process innovation than the introduction of a new product.

4.3. Results discussion and policy implications

The findings of this study provide some novel narratives to the literature surrounding endogenous growth theory on how institutional settings influence innovation performances. Previous studies, specifically work on national systems of innovation (NSIs) such as Freeman (1995), Arocena and Sutz (2000), and Acs et al. (2017), argue that the innovation capacity of a country is shaped by national institutional regimes, such as education system, technical and scientific institutions, governance, industrial relations, culture and traditions. This study, however, provides more specific information on the influence of institutional settings on innovation performance in developing and transition countries by establishing causal relationships between financial and IPR institutional settings and innovation outcomes. Findings also provide fresh looks at how could the policy instruments possibly affect future innovation outcomes in these economies.

The first-stage results demonstrate that cross-country differences in access to finance, financial intermediary development, and stock market capitalisation are crucial factors in determining firms' financing constraints. These country characteristics that explain the cross-country variations in financing obstacles facing firms, however, seem to be related to the overall financial institutional development level of a country (Beck et al., 2006). The better developed financial institutions can ease firms' external financing constraints (i.e., De la Torre et al., 2017; Korosteleva and Mickiewicz, 2011; Levine, 2005; Love, 2003). Developed financial institutions and markets can mitigate frictions, such as informational asymmetries and transaction costs, from financial transactions (Rajan and Zingales, 2004). The access dimension of financial institutional development is most relevant in this perspective — firms' financing constraints can be reduced by broadening the access to finance for innovative firms (De la Torre et al., 2017). Despite this wide recognition of the importance of broadening access to finance among scholars, firms (more specifically SMEs) in developing and transition countries have minimal access to formal credit and financial services. For example, the Global Findex database shows that about 56 % of adults in high-income countries borrowed from formal financial institutions, whereas that share was only around 10 % in developing economies. These figures can help to give us the actual picture of the differences between developed and developing economies in the use of formal loans and financial services. Therefore, policymakers in developing and transition countries should realise the actual conditions during policymaking and give priority to broadening access to finance and financial services for innovative firms. Moreover, public subsidies and reduction in the tax burden for financially constrained firms can influence them to invest in innovation activities. Mateut (2018) finds a positive influence of public subsidies on the innovation activities of 11,998 firms in 30 Eastern Europe and Central Asian countries (can see also Cecere et al., 2020). Tax remission can also work in easing firms' financing constraints for innovative activities. Howell (2016), for example, shows that remission in corporate tax burden for financially constrained firms stimulates new product and process innovation. Overall, the policy strategy that this result suggests for developing and transition countries is that in addition to easing financing constraints for firms in financial distress, these countries need to invest substantial resources in R&D, education, and infrastructure development since innovation-based development in these countries is more limited or facilitated by investment in these sectors than strong or weak IPR systems (e.g., Archibugi and Filippetti, 2015).

Regarding the impact of intellectual property rights (IPR) protection in transition countries, the results of this study reveal an interesting pattern. Results show that strengthening of IPR protection has a negative impact on firms' product and process innovation activities, which is novel in the empirical literature relating to endogenous growth theory. In contrast, it has a positive impact on firms' R&D efforts. At first glance, the results of this study appear to contradict our typical understanding and other studies surrounding endogenous growth theory demonstrating a positive relationship between IPR protection level and innovation (c.f. Aghion et al., 2015; Fang et al., 2017; Kanwar and Evenson, 2003). In the context of developing and transition countries, however, these findings are supported by the existing theories. Such as, Lerner (2009) asserts that the influence of the strengthening of intellectual property protection in developing countries may be far less in promoting innovation than much of the policy as well as economics literature assumes. Generally, resource-constrained firms tend to engage in the

incremental innovation process and try to follow the technologies of the leading firms that engage in radical innovation (see König et al., 2016). The IPR policy of a country regulates whether follower firms in an industry can imitate the technologies of the leader firms (Acemoglu and Akcigit, 2012). Here lies the explanation of the findings of this study – tight IPR protection prevents firms from imitating the leaders' technologies, and thus strong IPR protection has a negative impact on the firms' product and process innovation. Certainly, the finding of this study has a policy implication for developing and transition economies. Single full protection is not an optimal IPR policy in those economies (Acemoglu and Akcigit, 2012; Dosi et al., 2007). Instead, to avail firms of the full benefit of the trickle-down effect, IPR policies should be customised, providing stronger protections to the leaders and certain special arrangements for the follower industry and firms. When the government provides full IPR protection for all industries and firms, it may negatively affect the imitative or adaptive innovation of the firms in the less R&D-intensive industries (Ginarte and Park, 1997). The results of this study, for example, clearly demonstrate that strong IPR protection has a negative impact on firms' incremental innovative activities. To reduce this negative consequence and gaps between the firms and industries, policymakers in developing and transition economies should combine the tight IPR policy with some complementary arrangements such as governmental support for open innovation initiatives or collaborative R&D activities among resource-constrained firms. Since it is impractical to lax the strength of the protection, particularly for these firms and industries, the policymaker can adjust the strength of the protection by instigating other complementary regulations and policies providing special arrangements. Even the economic effectiveness of the global regime of IPRs, e.g., the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), predominantly depends on the government's proper policy instrument as the enforcement and policing of IPR violations are largely controlled by the national authorities (Filippetti and Archibugi, 2015).

Results across industries demonstrate that the magnitude of the negative impact of FC on firms' innovation varies across industries. This finding is aligned with the theoretical arguments as theory argues that differences in the industries are also significant in determining financing constraints for firms' innovation. In the traditional industry with good track records, it is relatively easy to finance innovation, either from internal or external sources. Hall and Lerner (2010) argue that profitable industries are less dependent on external funds because, in profitable industries, firms can raise funds from their retained profits. In the riskier industries, particularly the high-tech industry, it is more difficult to get finance for innovation due to risk factors involved with investment (Kerr and Nanda, 2015). In high-tech industries, innovation project is more likely to be the type that has not been undertaken anywhere before. So, it is much more difficult to evaluate such kinds of projects to determine the appropriate discount rate to invest (Griliches and Stoneman, 1995). Moreover, in the high-tech industry, the presence of asymmetric information is higher, and the financing constraints high-tech firms face are obvious (Himmelberg and Petersen, 1994).

Industry results also demonstrate that effects of IPR on firms' innovation activities are driven from within as well as between industries, and due to stronger IPR, firms face greater obstacles to process innovation than the introduction of a new product. Focusing on this differential impact of IPR across industries, we suggest effective causal pathways from lax IPR to incremental innovation through product and process innovation and stronger IPR to radical innovation through R&D activities. Based on our findings, we can say that potential causal pathways diverge not only by industry heterogeneity but also by firms' size and capability. Subject to the resource and skill capability, firms in an economy can engage in either in-house research and development (R&D) for radical innovation or they can follow incremental innovation strategy and try to imitate other firms' technologies as demonstrated by König et al. (2016). Tight IPR protection is detrimental to industries where firms have limited resources and skill capabilities since stronger IPR protection prevents them from imitating and upgrading. On the other hand, tight IPR protection is beneficial to R&D-intensive industries characterised by intensive R&D activities and IP capacities as strong IPR protection provides the inventor with some degree of 'monopolistic power' and the ability to conceal successful invention. So, to support incremental innovation as well as boost invention, IPR protection policies require to be customised to the industries and firms. Invariably tight or lax IPR enforcement can be discouraging to both incremental and radical innovation, causing all industries to suffer from the same treatment.

4.4. Robustness checks

We estimate our baseline specification using a series of sub-samples and alternative measures to check the robustness of our results. Overall, estimated results from these sub-samples and alternative sets of measures are very similar to baseline model estimations. To justify attention to incremental innovation among firms in transition economies, robustness checks by controlling for R&D expenditure and R&D activity are performed. First, we create a dummy variable that records observations on R&D expenditure, and this dummy is inserted as a control in a bigger sample focusing on estimating the probability of firms engaging in product and process innovation. Second, R&D activity is also inserted as a control in a bigger sample focusing on estimating firms' probability to engage in product and process innovation. Estimated results, highlighted in Appendix Tables A2 and A3, show that the negative sign of IPR protection remains the same after controlling for in-house R&D (both R&D expenditure and R&D activity). These results confirm that the dependent variable captures product and process innovation accurately.

We also conduct sub-sample analysis to check the robustness of our results. Appendix Table A4 presents results from our baseline model estimation by firm size, and Appendix Table A5 presents results of baseline estimation based on firm ownership. The results presented in these tables largely support the conclusion that the main results of our study are robust.

5. Conclusions

It has been long argued that, in developing and transition economies, financing constraints hold back firms from investing in innovation activities. There is also a debate on the role of IPR protection in the complex process of innovation in those economies. Despite the importance of rigorous empirical evidence to understand the role of financial institutions and IPR institutions on innovation activities, there has been relatively little work examining the impact of these two institutions on innovation in transition countries. This study takes a step in that direction.

This study explores the impact of financing constraints and IPR protection on firms' innovation to provide rigorous empirical evidence on the effect of financing constraints and IPR protection on innovation activities. This study defines firms' innovation as the introduction of the new product, process or service and the upgrading of the existing one, which is particularly relevant for firms in transition countries. Using a dataset of 21,960 firms from 27 Eastern European and Central Asian transition countries, this study exploits the exogenous variation in financing constraints driven by both firm-specific and country-level factors. The first-stage results demonstrate that the financial constraints of the firms are determined by firm-specific as well as country-level factors. The most prominent country-level factor explaining the variation in financing obstacles for firms, however, seems to be overall financial institutional development. Then this study employs the instrumental variables (IV) approach by introducing some firm-specific and country-level variables to address the potential endogeneity of financing constraints and unobserved heterogeneity due to the variations in the country's characteristics. The second-stage results document that financing constraints have negative impacts on firms' product and

process innovation activities as well as on firms' research and development (R&D) activities. The results on the effect of IPR protection show an interesting pattern that tight IPR protection appears to prevent firms from product and process innovation activities but is also helpful for firms' research and development (R&D) activities.

This study conjectures that in developing and transition economies, stronger IPR protection prevents firms from innovating through imitation. There is a strong argument that many of the firms in developing and transition countries try to innovate by introducing technologically new products/services or upgrading their existing product line through copying others' products or adopting already innovated more productive technologies from others, and tight IPR protection prevents them from imitating. To address industry heterogeneity adequately, this study introduces interaction terms of some of the focal variables with the industry dummies in the model, and results imply that both the financing constraint and IPR have a significant effect on firms' innovation activities for every industry. However, the magnitude of the impact varies across industries. Thus, this research makes a significant contribution to developing better insight into the interactional relationship between firms' innovation, financing constraints and IPR protection in developing and transition economies.

Based on the findings, this study points to some effective causal pathways from financing and IPR protection to encourage firms' innovation in transition economies. First, broadening access to finance, public subsidising, and tax remission can be useful policy tools for easing financing constraints, thereby promoting firms' innovation in developing and transition countries. Second, a single IPR policy providing full protection for all industries and firms is sub-optimal in a transition economy, IPR policies need to be customised, and it is better to use mixed IPR policies protecting according to the innovation and resource capability of the industries and firms. The best way can be to encourage firms' innovation through various special arrangements such as open innovation, R&D collaboration and international technology transfer programmes for the industries and firms that are lagging.

Despite the important policy implications of the findings of this study, it has some limitations like other studies. First, this study only considers the measurable components of institutions – i.e., IPR protection and financing constraints. Other informal components of institutions such as culture, tradition, sanctions, norms, taboo and code of conduct may have impacts on firms' innovation (North, 1991). However, this study is conducted by using the quantitative approach, and these aforementioned informal components of institutions are difficult to measure for empirical investigation (see Hodgson, 1988). Future work following the alternative methodologies to a purely quantitative approach can efforts to explore the effects of informal institutional components on innovation outcomes. The second limitation of the findings arises from the difficulty of measuring incremental as opposed to radical innovation. We acknowledge that product innovation and process innovation variables here possibly mix different types of innovation and may not capture incremental and radical innovation differently. Moreover, for measuring financing constraints, we use a self-reported qualitative measure of financing obstacles faced by the firms. Naturally, the self-reported qualitative measure has some limitations for econometric analysis owing to the subjective nature of the questions used in the survey or to cultural biases (Mairesse and Mohnen, 2010). Therefore, it would be helpful if this study could include a more subjective measure like firm financial slack as a proxy for financial constraints. However, due to the data constraint, it is not possible through this study. Third, this study does not cover all possible components of intellectual property protection that can explain the firms' innovative efforts. Therefore, further research using more refined measures that capture the formal and informal institutional constraints in IP systems (for a review of IPR measures, please see Papageorgiadis and McDonald, 2019) can further our understanding of the role of IPR in firm innovation.

Declaration of competing interest

The authors declare they have no competing interests.

Data availability

The authors do not have permission to share data.

Appendix A

Table A1
Sample countries.

Country	Number of firms
Albania	366
Armenia	807
Azerbaijan	819
Belarus	796
Bosnia	661
Bulgaria	700
Croatia	463
Czech Republic	766
Estonia	575
FYROM	652
Georgia	620
Hungary	1009
Kazakhstan	1194
Kyrgyz	564
Latvia	562
Lithuania	546
Moldova	788
Montenegro	119
Poland	1730
Romania	1218
Russia	1864
Serbia	841
Slovakia	571
Slovenia	625
Tajikistan	638

(*continued on next page*)

Table A1 (*continued*)

Country	Number of firms
Ukraine	1707
Uzbekistan	759
Total	21,960

Table A2
Results of baseline estimation for incremental innovation after controlling for R&D expenditure (by generating a dummy that records the observations on R&D expenditure).

Variable	Product innovation		Process innovation	
	(1)	(2)	(3)	(4)
	probit	ivprobit	probit	ivprobit
FC	−0.056***	−0.571***	−0.184***	−0.610***
	(0.016)	(0.021)	(0.034)	(0.025)
IPR	−0.259***	−0.192***	−1.687***	−1.163***
	(0.032)	(0.022)	(0.249)	(0.042)
LnAge	−0.114***	−0.024	−0.239***	−0.113***
	(0.036)	(0.027)	(0.057)	(0.034)
LnEmp	0.159***	0.055***	0.338***	0.184***
	(0.017)	(0.012)	(0.055)	(0.017)
Comp	0.277***	0.278***	0.225**	0.234***
	(0.062)	(0.046)	(0.088)	(0.061)
Temp	0.000	0.002*	0.002	0.002**
	(0.001)	(0.001)	(0.002)	(0.001)
ImInputs	0.206***	0.118***	0.669***	0.439***
	(0.025)	(0.016)	(0.109)	(0.028)
Skill	0.134***	0.078***	0.229***	0.147***
	(0.015)	(0.010)	(0.036)	(0.012)
LnGDP	−0.258	0.164	1.088***	0.699***
	(0.280)	(0.206)	(0.358)	(0.236)
RD_dummy	0.027	0.024	0.009	0.028
	(0.041)	(0.031)	(0.053)	(0.039)
Constant	1.119	1.473	−7.953***	−4.416**
	(2.208)	(1.620)	(2.791)	(1.866)
Observation	7193	7193	7193	7193

Table A3
Results of baseline estimation for incremental innovation after controlling for R&D activities.

Variable	Product innovation		Process innovation	
	(1)	(2)	(3)	(4)
	probit	ivprobit	probit	ivprobit
FC	−0.034***	−0.471***	−0.244***	−1.024***
	(0.011)	(0.019)	(0.029)	(0.050)
IPR	−0.897***	−0.553***	−1.186***	−0.649***
	(0.044)	(0.033)	(0.110)	(0.020)
LnAge	−0.078***	−0.034*	−0.241***	−0.121***
	(0.023)	(0.019)	(0.046)	(0.029)
LnEmp	0.094***	0.046***	0.312***	0.162***
	(0.010)	(0.009)	(0.032)	(0.013)
Comp	0.158***	0.212***	0.386***	0.521***
	(0.035)	(0.029)	(0.066)	(0.046)
Temp	−0.001	0.001	−0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
ImInputs	0.080***	0.053***	0.837***	0.454***
	(0.013)	(0.011)	(0.074)	(0.014)
Skill	0.078***	0.056***	0.249***	0.141***
	(0.009)	(0.007)	(0.026)	(0.010)
LnGDP	0.546**	0.582***	1.373***	0.717***
	(0.234)	(0.189)	(0.127)	(0.026)
RD_activity	1.756***	1.126***	2.161***	1.086***
	(0.075)	(0.055)	(0.200)	(0.050)
Constant	−4.089**	−3.916***	−12.009***	−4.828***
	(1.841)	(1.489)	(1.090)	(0.244)
Observation	14,341	14,341	14,341	14,341

Table A4
Results of baseline estimation by firms' size.

Variable	Product innovation			Process innovation		
	(1)			(2)		
	ivprobit coefficient			ivprobit coefficient		
	Small firms	Medium firms	Large firms	Small firms	Medium firms	Large firms
FC	−0.441***	−0.419***	−0.417***	−0.442***	−0.637***	−0.637***
	(0.053)	(0.061)	(0.064)	(0.033)	(0.025)	(0.025)
IPR	−0.080***	−0.083***	−0.129***	−1.265***	−1.190***	−1.190***
	(0.012)	(0.014)	(0.017)	(0.039)	(0.050)	(0.050)
LnAge	−0.077**	−0.093***	−0.055**	−0.145***	−0.062*	−0.062*
	(0.033)	(0.030)	(0.027)	(0.040)	(0.035)	(0.035)
LnEmp	0.199***	0.018	0.082***	0.208***	0.120***	0.120***
	(0.022)	(0.034)	(0.025)	(0.030)	(0.042)	(0.042)
Comp	0.526***	0.448***	0.396***	0.182***	0.278***	0.278***
	(0.048)	(0.053)	(0.063)	(0.067)	(0.064)	(0.064)
Temp	−0.000	0.001	0.001	0.002**	0.003*	0.003*
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
ImInputs	0.340***	0.123***	0.063***	0.852***	0.381***	0.381***
	(0.019)	(0.015)	(0.014)	(0.061)	(0.026)	(0.026)
Skill	0.067***	0.100***	0.152***	0.125***	0.225***	0.225***
	(0.008)	(0.012)	(0.015)	(0.011)	(0.016)	(0.016)
LnGDP	0.145***	0.126***	0.216***	1.327***	1.002***	1.002***
	(0.021)	(0.023)	(0.028)	(0.200)	(0.221)	(0.221)
Constant	−2.773***	−0.932***	−1.742***	−11.704***	−6.235***	−6.235***
	(0.232)	(0.263)	(0.298)	(1.581)	(1.750)	(1.750)
Observation	10,008	6868	5084	10,008	6868	5084

Table A5
Results of baseline estimation by firms' ownership.

Variable	Product innovation			Process innovation		
	(1)			(2)		
	ivprobit coefficient			ivprobit coefficient		
	Domestic firm	Foreign firm	Government firm	Domestic firm	Foreign firm	Government firm
FC	−0.538***	−0.722***	−0.680***	−0.571***	−0.560***	−0.514***
	(0.015)	(0.027)	(0.034)	(0.019)	(0.070)	(0.095)
IPR	−0.135***	−0.196***	−0.427***	−1.126***	−1.758***	−2.174***
	(0.014)	(0.035)	(0.051)	(0.027)	(0.112)	(0.140)
LnAge	−0.049***	0.040	0.068	−0.067***	0.054	−0.116
	(0.019)	(0.050)	(0.044)	(0.025)	(0.077)	(0.077)
LnEmp	0.087***	0.046**	0.048**	0.188***	0.231***	0.299***
	(0.008)	(0.019)	(0.021)	(0.012)	(0.031)	(0.048)
Comp	0.248***	0.025	0.264	0.235***	0.351*	0.836**
	(0.030)	(0.105)	(0.232)	(0.042)	(0.188)	(0.346)
Temp	0.002***	−0.001	0.001	0.002**	0.000	0.000
	(0.001)	(0.002)	(0.002)	(0.001)	(0.003)	(0.004)
ImInputs	0.139***	0.016	0.045	0.538***	0.228***	0.602***
	(0.012)	(0.018)	(0.036)	(0.024)	(0.029)	(0.085)
Skill	0.079***	0.051***	0.073***	0.156***	0.184***	0.285***
	(0.006)	(0.019)	(0.026)	(0.008)	(0.030)	(0.046)
LnGDP	0.056	0.257	0.172	1.077***	0.641	1.780**
	(0.126)	(0.339)	(0.501)	(0.146)	(0.481)	(0.696)
Constant	−0.542	−1.368	−0.973	−8.142***	−2.041	−12.662**
	(0.993)	(2.673)	(3.956)	(1.155)	(3.838)	(5.537)
Observation	17,237	2176	1593	17,237	2176	1593

Table A6
Results of the impact of FC and IPR on each industry (without interaction).

	(1)	(2)	(3)	(4)
Industry	Impact of FC on product innovation	Impact of FC on process innovation	Impact of IPR on product innovation	Impact of IPR on process innovation
Manufacturing sector				
Food	0.026	−0.100**	0.059	−0.045
	(0.047)	(0.048)	(0.048)	(0.056)

(*continued on next page*)

Table A6 (*continued*)

	(1)	(2)	(3)	(4)
Industry	Impact of FC on product innovation	Impact of FC on process innovation	Impact of IPR on product innovation	Impact of IPR on process innovation
Textile	−0.091	−0.228**	−0.120	−0.343***
	(0.099)	(0.099)	(0.101)	(0.115)
Garments	−0.092	0.042	−0.182***	0.026
	(0.063)	(0.064)	(0.064)	(0.072)
Chemical	0.467***	0.445***	0.436***	0.502***
	(0.105)	(0.109)	(0.108)	(0.128)
Plastic and Rubber	0.228**	0.141	0.246**	0.243*
	(0.111)	(0.117)	(0.114)	(0.138)
Non-metallic mineral product	−0.138	−0.012	−0.137	−0.061
	(0.096)	(0.097)	(0.099)	(0.114)
Basic metal	−0.024	−0.260**	0.041	−0.256
	(0.140)	(0.132)	(0.142)	(0.160)
Fabricate metal product	−0.051	−0.041	−0.060	0.109
	(0.064)	(0.064)	(0.065)	(0.074)
Machinery and equipment	0.069	−0.011	0.068	0.121
	(0.067)	(0.068)	(0.068)	(0.078)
Electronics	0.507***	0.352**	0.396**	0.291
	(0.158)	(0.162)	(0.164)	(0.199)
Construction section F	−0.634***	−0.410***	−0.623***	−0.374***
	(0.053)	(0.051)	(0.053)	(0.059)
Others manufacturing	−0.055	−0.259***	−0.014	−0.017
	(0.051)	(0.072)	(0.029)	(0.035)
Service sector				
Wholesale	−0.465***	−0.710***	−0.368***	−0.617***
	(0.049)	(0.050)	(0.049)	(0.057)
Retail	−0.179***	−0.211***	−0.208***	−0.322***
	(0.048)	(0.048)	(0.048)	(0.055)
Hotel and Restaurant	−0.633***	−0.504***	−0.511***	−0.391***
	(0.063)	(0.061)	(0.063)	(0.070)
Transport section I	−0.611***	−0.506***	−0.538***	−0.427***
	(0.058)	(0.057)	(0.059)	(0.065)
IT	0.366***	0.240*	0.503***	0.540***
	(0.123)	(0.128)	(0.125)	(0.150)
Other services	−0.718***	−0.629***	−0.564***	−0.434***
	(0.052)	(0.051)	(0.053)	(0.058)

Note: (1) Cluster robust standard errors are in brackets. (2) Significance shows * at $p < 0.10$, ** at $p < 0.05$, and *** at $p < 0.01$.

References

Abramovitz, M., 1986. Catching up, forging ahead, and falling behind. J. Econ. Hist. 46 (2), 385–406.

Acemoglu, D., Akcigit, U., 2012. Intellectual property rights policy, competition and innovation. J. Eur. Econ. Assoc. 10 (1), 1–42.

Acemoglu, D., Aghion, P., Zilibotti, F., 2006. Distance to frontier, selection, and economic growth. J. Eur. Econ. Assoc. 4 (1), 37–74. https://doi.org/10.1162/jeea.2006.4.1.37.

Acemoglu, D., Gancia, G., Zilibotti, F., 2012. Competing engines of growth: innovation and standardization. J. Econ. Theory 2 (147), 570–601 (e573).

Acemoglu, D., Akcigit, U., Alp, H., Bloom, N., Kerr, W., 2018. Innovation, reallocation, and growth. Am. Econ. Rev. 108 (11), 3450–3491.

Acs, Z.J., Audretsch, D.B., Lehmann, E.E., Licht, G., 2017. National systems of innovation. J. Technol. Transf. 42, 997–1008.

Agénor, P.-R., Canuto, O., 2017. Access to finance, product innovation and middle-income traps. Res. Econ. 71 (2), 337–355.

Aghion, P., Howitt, P., 1992. A model of growth through creative destruction. Econometrica 60 (2), 323–351.

Aghion, P., Tirole, J., 1994. The management of innovation. Q. J. Econ. 109 (4), 1185–1209.

Aghion, P., Harris, C., Howitt, P., Vickers, J., 2001. Competition, imitation and growth with step-by-step innovation. Rev. Econ. Stud. 68 (3), 467–492.

Aghion, P., Howitt, P., Mayer-Foulkes, D., 2005. The effect of financial development on convergence: theory and evidence. Q. J. Econ. 120 (1), 173–222.

Aghion, P., Askenazy, P., Berman, N., Cette, G., Eymard, L., 2012. Credit constraints and the cyclicality of R&D investment: evidence from France. J. Eur. Econ. Assoc. 10 (5), 1001–1024.

Aghion, P., Howitt, P., Prantl, S., 2015. Patent rights, product market reforms, and innovation. J. Econ. Growth 20 (3), 223–262.

Aghion, L., Howitt, P., Levine, R., 2018. Financial development and innovation-led growth. In: Handbook of Finance and Development. Edward Elgar Publishing.

Akcigit, U., Kerr, W.R., 2018. Growth through heterogeneous innovations. J. Polit. Econ. 126 (4), 1374–1443.

Allred, B.B., Park, W.G., 2007. Patent rights and innovative activity: evidence from national and firm-level data. J. Int. Bus. Stud. 38 (6), 878–900.

Altenburg, T., 2009. Building inclusive innovation systems in developing countries: challenges for IS research. In: Handbook of Innovation Systems and Developing Countries. Edward Elgar Publishing.

Altman, M., 2009. A behavioral-institutional model of endogenous growth and induced technical change. J. Econ. Issues 43 (3), 685–714.

Archibugi, D., Filippetti, A., 2015. Knowledge as global public good (2015). In: Archibugi, D., Filippetti, A. (Eds.), Handbook of Global Science, Technology and Innovation. Wiley, Oxford.

Arocena, R., Sutz, J., 2000. Looking at national systems of innovation from the south. Ind. Innov. 7 (1), 55–75.

Arora, A., 2009. The economics of intellectual property: suggestions for further research in developing countries and countries with economies in transition. In: Chapter Intellectual Property Rights and the International Transfer of Technology: Setting out an Agenda for Empirical Research in Developing Countries. WIPO, pp. 41–58.

Arora, A., Branstetter, L.G., Drev, M., 2013. Going soft: how the rise of software-based innovation led to the decline of Japan's IT industry and the resurgence of Silicon Valley. Rev. Econ. Stat. 95 (3), 757–775.

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.

Balsmeier, B., Delanote, J., 2015. Employment growth heterogeneity under varying intellectual property rights regimes in European transition economies: young vs. mature innovators. J. Comp. Econ. 43 (4), 1069–1084.

Baltagi, B., 2008. Econometric Analysis of Panel Data. John Wiley & Sons.

Barro, R.J., Sala-i-Martin, X., 1997. Technological diffusion, convergence, and growth. J. Econ. Growth 1 (2), 1–26.

Bascle, G., 2008. Controlling for endogeneity with instrumental variables in strategic management research. Strateg. Organ. 6 (3), 285–327.

Becheikh, N., Landry, R., Amara, N., 2006. Lessons from innovation empirical studies in the manufacturing sector: a systematic review of the literature from 1993–2003. Technovation 26 (5–6), 644–664.

Beck, T., Demirguc-Kunt, A., 2009. Financial Institutions and Markets across Countries and over Time-data and Analysis: The World Bank.

Beck, T., Demirgüç-Kunt, A., Laeven, L., Maksimovic, V., 2006. The determinants of financing obstacles. J. Int. Money Financ. 25 (6), 932–952.

Benhabib, J., Perla, J., Tonetti, C., 2014. Catch-up and fall-back through innovation and imitation. J. Econ. Growth 19 (1), 1–35.

Bhatti, Y.A., Ventresca, M., 2012. The Emerging Market for Frugal Innovation: Fad, Fashion, or Fit? Fashion, or Fit.
Biggart, N.W., Guillén, M.F., 1999. Developing difference: social organization and the rise of the auto industries of South Korea, Taiwan, Spain, and Argentina. Am. Sociol. Rev. 722–747.
Brown, J.R., Martinsson, G., Petersen, B.C., 2012. Do financing constraints matter for R&D? Eur. Econ. Rev. 56 (8), 1512–1529.
Bruno, R.L., Douarin, E., Korosteleva, J., Radosevic, S., 2015. Technology choices and growth: testing new structural economics in transition economies. J. Econ. Policy Reform 18 (2), 131–152. https://doi.org/10.1080/17487870.2015.1013541.
Buera, F.J., Kaboski, J.P., Shin, Y., 2015. Entrepreneurship and financial frictions: a macrodevelopment perspective. Annu. Rev. Econ. 7, 409–436.
Caggese, A., 2019. Financing constraints, radical versus incremental innovation, and aggregate productivity. Am. Econ. J. Macroecon. 11 (2), 275–309.
Canepa, A., Stoneman, P., 2007. Financial constraints to innovation in the UK: evidence from CIS2 and CIS3. Oxf. Econ. Pap. 60 (4), 711–730.
Cecere, G., Corrocher, N., Mancusi, M.L., 2020. Financial constraints and public funding of eco-innovation: empirical evidence from European SMEs. Small Bus. Econ. 54 (1), 285–302.
Chataway, J., Hanlin, R., Kaplinsky, R., 2014. Inclusive innovation: an architecture for policy development. Innov. Dev. 4 (1), 33–54.
Chen, H.-J., 2018. Innovation and imitation: effects of intellectual property rights in a product-cycle model of skill accumulation. Macroecon. Dyn. 22 (6), 1475–1509.
Chen, Y., Puttitanun, T., 2005. Intellectual property rights and innovation in developing countries. J. Dev. Econ. 78 (2), 474–493.
Chin, J.C., Grossman, G.M., 1988. Intellectual property rights and North-South trade. In: National Bureau of Economic Research Cambridge, Mass., USA.
Chu, A.C., Cozzi, G., Galli, S., 2014. Stage-dependent intellectual property rights. J. Dev. Econ. 106, 239–249.
Cincera, M., Ravet, J., Veugelers, R., 2016. The sensitivity of R&D investments to cash flows: comparing young and old EU and US leading innovators. Econ. Innov. New Technol. 25 (3), 304–320.
Cirera, X., 2015. Catching up to the technological frontier?: understanding firm-level innovation and productivity in Kenya. In: Working Paper 94671. The World Bank.
Coad, A., Pellegrino, G., Savona, M., 2016a. Barriers to innovation and firm productivity. Econ. Innov. New Technol. 25 (3), 321–334.
Coad, A., Segarra, A., Teruel, M., 2016b. Innovation and firm growth: does firm age play a role? Res. Policy 45 (2), 387–400.
Cohen, W.M., Levinthal, D.A., 1989. Innovation and learning: the two faces of R & D. Econ. J. 99 (397), 569–596.
Crawford, G.S., Pavanini, N., Schivardi, F., 2018. Asymmetric information and imperfect competition in lending markets. Am. Econ. Rev. 108 (7), 1659–1701.
Czarnitzki, D., Hottenrott, H., 2011. R&D investment and financing constraints of small and medium-sized firms. Small Bus. Econ. 36 (1), 65–83.
Data, I.I., 2005. Oslo manual. OECD/Euro-stat, Paris and Luxembourg.
De la Torre, A., Gozzi, J.C., Schmukler, S.L., 2017. Innovative Experiences in Access to Finance: Market-friendly Roles for the Visible Hand? World Bank Publications.
Depken, C.A., Simmons, L.C., 2004. Social construct and the propensity for software piracy. Appl. Econ. Lett. 11 (2), 97–100.
Dosi, G., Marengo, L., Pasquali, C., 2007. Knowledge, competition and the innovation: is stronger IPR protection really needed for more and better innovations. Mich. Telecommun. Technol. Law Rev. 13 (2), 471–485.
Fagerberg, J., Mowery, D.C., Nelson, R.R., 2016. The Oxford Handbook of Innovation. Oxford University Press.
Fang, V.W., Tian, X., Tice, S., 2014. Does stock liquidity enhance or impede firm innovation? J. Financ. 69 (5), 2085–2125.
Fang, L.H., Lerner, J., Wu, C., 2017. Intellectual property rights protection, ownership, and innovation: evidence from China. Rev. Financ. Stud. 30 (7), 2446–2477.
Filippetti, A., Archibugi, D., 2015. The globalization of intellectual property rights. Handb. Glob. Sci. Technol. Innov. 419–442.
Freeman, C., 1995. The 'National System of Innovation' in historical perspective. Camb. J. Econ. 19 (1), 5–24.
Furman, J.L., Porter, M.E., Stern, S., 2002. The determinants of national innovative capacity. Res. Policy 31 (6), 899–933.
Ginarte, J.C., Park, W.G., 1997. Determinants of patent rights: a cross-national study. Res. Policy 26 (3), 283–301.
Gorodnichenko, Y., Schnitzer, M., 2013. Financial constraints and innovation: why poor countries don't catch up. J. Eur. Econ. Assoc. 11 (5), 1115–1152.
Gorodnichenko, Y., Svejnar, J., Terrell, K., 2010. Globalization and innovation in emerging markets. Am. Econ. J. Macroecon. 2 (2), 194–226.
Grabowski, H.G., 1968. The determinants of industrial research and development: a study of the chemical, drug, and petroleum industries. J. Polit. Econ. 76 (2), 292–306.
Greene, W.H., 2012. Econometric Analysis, 71e. New York University, Stern School of Business.
Griliches, Z., 1981. Market value, R&D, and patents. Econ. Lett. 7 (2), 183–187.
Griliches, Z., Stoneman, P., 1995. Handbook of the economics of innovation and technological change. In: R&D and Productivity: Econometric Results and Measurement Issues, pp. 52–89.
Grossman, S.J., Hart, O.D., 1986. The costs and benefits of ownership: a theory of vertical and lateral integration. J. Polit. Econ. 94 (4), 691–719.
Grossman, G.M., Helpman, E., 1991. Quality ladders in the theory of growth. Rev. Econ. Stud. 58 (1), 43–61.
Grossman, G.M., Helpman, E., 1994. Endogenous innovation in the theory of growth. J. Econ. Perspect. 8 (1), 23–44.
Guariglia, A., Liu, P., 2014. To what extent do financing constraints affect Chinese firms' innovation activities? Int. Rev. Financ. Anal. 36, 223–240.
Hagedoorn, J., Hesen, G., 2007. Contract law and the governance of inter-firm technology partnerships–an analysis of different modes of partnering and their contractual implications. J. Manag. Stud. 44 (3), 342–366.
Hajivassiliou, V., Savignac, F., 2008. Financing Constraints and Firm's Decision and Ability to Innovate. Retrieved From.
Hall, B.H., Lerner, J., 2010. The financing of R&D and innovation. In: Handbook of the Economics of Innovation, vol. 1. Elsevier, pp. 609–639.
Hall, B.H., Moncada-Paternò-Castello, P., Montresor, S., Vezzani, A., 2016. Financing constraints, R&D investments and innovative performances: new empirical evidence at the firm level for Europe. Econ. Innov. New Technol. 25 (3), 183–196.
Hamilton, G.G., Biggart, N.W., 1988. Market, culture, and authority: a comparative analysis of management and organization in the Far East. Am. J. Sociol. 94, S52–S94.
Hart, O., 2017. Incomplete contracts and control. Am. Econ. Rev. 107 (7), 1731–1752.
Haskel, J., Westlake, S., 2017. Capitalism without Capital: The Rise of the Intangible Economy. Princeton University Press.
Hausman, J.A., 1978. Specification tests in econometrics. Econometrica 1251–1271.
Helpman, E., 1993. Innovation, Imitation, and Intellectual Property Rights. Econometrica J. Econ. Soc. 1247–1280.
Hewitt-Dundas, N., 2006. Resource and capability constraints to innovation in small and large plants. Small Bus. Econ. 26 (3), 257–277.
Himmelberg, C.P., Petersen, B.C., 1994. R & D and internal finance: a panel study of small firms in high-tech industries. Rev. Econ. Stat. 38–51.
Hodgson, G.M., 1988. Economics and institutions. Paper presented at the Journal of Economic Issues.
Hottenrott, H., Peters, B., 2012. Innovative capability and financing constraints for innovation: more money, more innovation? Rev. Econ. Stat. 94 (4), 1126–1142. https://doi.org/10.1162/REST_a_00227.
Hottenrott, H., Hall, B.H., Czarnitzki, D., 2016. Patents as quality signals? The implications for financing constraints on R&D. Econ. Innov. New Technol. 25 (3), 197–217.
Howell, A., 2016. Firm R&D, innovation and easing financial constraints in China: does corporate tax reform matter? Res. Policy 45 (10), 1996–2007.
Hsu, P.-H., Tian, X., Xu, Y., 2014. Financial development and innovation: cross-country evidence. J. Financ. Econ. 112 (1), 116–135.
Huang, H., Xu, C., 1999. Institutions, innovations, and growth. Am. Econ. Rev. 89 (2), 438–443.
Hudson, J., Minea, A., 2013. Innovation, intellectual property rights, and economic development: a unified empirical investigation. World Dev. 46, 66–78.
Huergo, E., Jaumandreu, J., 2004. How does probability of innovation change with firm age? Small Bus. Econ. 22 (3–4), 193–207.
Hwang, H., Wu, J.Z., Yu, E.S., 2016. Innovation, imitation and intellectual property rights in developing countries. Rev. Dev. Econ. 20 (1), 138–151.
Iwaisako, T., Futagami, K., 2013. Patent protection, capital accumulation, and economic growth. Econ. Theory 52 (2), 631–668. March.
Kanwar, S., Evenson, R., 2003. Does intellectual property protection spur technological change? Oxf. Econ. Papers 55 (2), 235–264.
Kaplan, S.N., Zingales, L., 1997. Do investment-cash flow sensitivities provide useful measures of financing constraints? Q. J. Econ. 112 (1), 169–215.
Keller, W., 1996. Absorptive capacity: on the creation and acquisition of technology in development. J. Dev. Econ. 49 (1), 199–227.
Keller, W., 2004. International technology diffusion. J. Econ. Lit. 42 (3), 752–782.
Kennedy, P., 2008. A Guide to Econometrics. John Wiley & Sons.
Kerr, W.R., Nanda, R., 2015. Financing innovation. Annu. Rev. Financ. Econ. 7, 445–462.
Kim, Y.K., Lee, K., Park, W.G., Choo, K., 2012. Appropriate intellectual property protection and economic growth in countries at different levels of development. Res. Policy 41 (2), 358–375.
King, R.G., Levine, R., 1993. Finance, entrepreneurship and growth. J. Monet. Econ. 32 (3), 513–542.
König, M.D., Lorenz, J., Zilibotti, F., 2016. Innovation vs. imitation and the evolution of productivity distributions. Theor. Econ. 11 (3), 1053–1102.
Korosteleva, J., Mickiewicz, T., 2011. Start-up financing in the age of globalization. Emerg. Mark. Financ. Trade 47 (3), 23–49.
Krammer, S.M., 2009. Drivers of national innovation in transition: evidence from a panel of Eastern European countries. Res. Policy 38 (5), 845–860.
Krammer, S.M., 2015. Do good institutions enhance the effect of technological spillovers on productivity? Comparative evidence from developed and transition economies. Technol. Forecast. Soc. Chang. 94, 133–154.
Kukharskyy, B., 2020. A tale of two property rights: knowledge, physical assets, and multinational firm boundaries. J. Int. Econ. 122, 103262.
Laeven, L., Levine, R., Michalopoulos, S., 2015. Financial innovation and endogenous growth. J. Financ. Intermed. 24 (1), 1–24.
Lall, S., 1992. Technological capabilities and industrialization. World Dev. 20 (2), 165–186.
Law, S.H., Kutan, A.M., Naseem, N., 2018. The role of institutions in finance curse: evidence from international data. J. Comp. Econ. 46 (1), 174–191.
Lerner, J., 2009. The empirical impact of intellectual property rights on innovation: puzzles and clues. Am. Econ. Rev. 99 (2), 343–348.
Levine, R., 2005. Finance and growth: theory and evidence. Handb. Econ. Growth 1, 865–934.
Li, D., 2011. Financial constraints, R&D investment, and stock returns. Rev. Financ. Stud. 24 (9), 2974–3007.
Long, S.J., Long, J.S., Freese, J., 2006. Regression Models for Categorical Dependent Variables Using Stata. Stata Press.

Lööf, H., Nabavi, P., 2016. Innovation and credit constraints: evidence from Swedish exporting firms. Econ. Innov. New Technol. 25 (3), 269–282.
Love, I., 2003. Financial development and financing constraints: international evidence from the structural investment model. Rev. Financ. Stud. 16 (3), 765–791.
Lu, G., Ding, X.D., Peng, D.X., Chuang, H.H.-C., 2018. Addressing endogeneity in operations management research: recent developments, common problems, and directions for future research. J. Oper. Manag. 64, 53–64.
Lucas, R.E., 1988. On the mechanics of economic development. J. Monet. Econ. 22 (1), 3–42.
Mairesse, J., Mohnen, P., 2010. Using innovation surveys for econometric analysis. In: Handbook of the Economics of Innovation, vol. 2. Elsevier, pp. 1129–1155.
Marron, D.B., Steel, D.G., 2000. Which countries protect intellectual property? The case of software piracy. Econ. Inq. 38 (2), 159–174.
Mateut, S., 2018. Subsidies, financial constraints and firm innovative activities in emerging economies. Small Bus. Econ. 50 (1), 131–162.
Moser, P., 2005. How do patent laws influence innovation? Evidence from nineteenth-century world's fairs. Am. Econ. Rev. 95 (4), 1214–1236.
Moser, P., 2013. Patents and innovation: evidence from economic history. J. Econ. Perspect. 27 (1), 23–44.
Mukoyama, T., 2003. Innovation, imitation, and growth with cumulative technology. J. Monet. Econ. 50 (2), 361–380.
North, D.C., 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press, Cambridge.
North, D.C., 1991. Institutions. J. Econ. Perspect. 5 (1), 97–112.
O'donoghue, T., Zweimüller, J., 2004. Patents in a model of endogenous growth. J. Econ. Growth 9 (1), 81–123.
Papageorgiadis, N., McDonald, F., 2019. Defining and measuring the institutional context of national intellectual property systems in a post-TRIPS world. J. Int. Manag. 25 (1), 3–18.
Papageorgiadis, N., Sharma, A., 2016. Intellectual property rights and innovation: a panel analysis. Econ. Lett. 141, 70–72.
Papies, D., Ebbes, P., Van Heerde, H.J., 2017. Addressing endogeneity in marketing models. Adv. Methods Model. Markets 581–627.
Park, W.G., 2008. International patent protection: 1960–2005. Res. Policy 37 (4), 761–766.
Poyago-Theotoky, J., 1998. R&D competition in a mixed duopoly under uncertainty and easy imitation. J. Comp. Econ. 26 (3), 415–428.
Protogerou, A., Caloghirou, Y., Vonortas, N.S., 2017. Determinants of young firms' innovative performance: empirical evidence from Europe. Res. Policy 46 (7), 1312–1326.
Qian, Y., 2007. Do national patent laws stimulate domestic innovation in a global patenting environment? A cross-country analysis of pharmaceutical patent protection, 1978–2002. Rev. Econ. Stat. 89 (3), 436–453.
Rajan, R.G., Zingales, L., 1996. Financial Dependence and Growth (0898-2937). Retrieved From.
Rajan, R.G., Zingales, L., 2004. Saving Capitalism from the Capitalists: Unleashing the Power of Financial Markets to Create Wealth and Spread Opportunity. Princeton University Press.
Ramadani, V., Hisrich, R.D., Abazi-Alili, H., Dana, L.-P., Panthi, L., Abazi-Bexheti, L., 2019. Product innovation and firm performance in transition economies: a multi-stage estimation approach. Technol. Forecast. Soc. Chang. 140, 271–280.
Ranasinghe, A., Restuccia, D., 2018. Financial frictions and the rule of law. J. Dev. Econ. 134, 248–271.
Rodríguez, A., Hernández, V., Nieto, M.J., 2022. International and domestic external knowledge in the innovation performance of firms from transition economies: the role of institutions. Technol. Forecast. Soc. Chang. 176, 121442.
Romer, P.M., 1986. Increasing returns and long-run growth. J. Polit. Econ. 94 (5), 1002–1037.
Romer, P.M., 1990. Endogenous technological change. J. Polit. Econ. 98 (5, Part 2), S71–S102. https://doi.org/10.1086/261725.
Rong, Z., Wu, B., 2020. Scientific personnel reallocation and firm innovation: evidence from China's college expansion. J. Comp. Econ. 48 (3), 709–728. Elsevier.
Saito, Y., 2017. Effects of patent protection on economic growth and welfare in a two-R&D-sector economy. Econ. Model. 62, 124–129.
Segerstrom, P.S., 1991. Innovation, imitation, and economic growth. J. Polit. Econ. 99 (4), 807–827.
Sinani, E., Meyer, K.E., 2004. Spillovers of technology transfer from FDI: the case of Estonia. J. Comp. Econ. 32 (3), 445–466.
Smith, K., 2005. Measuring innovation. In: The Oxford Handbook of Innovation.
Sokoloff, K.L., Engerman, S.L., 2000. Institutions, factor endowments, and paths of development in the new world. J. Econ. Perspect. 14 (3), 217–232.
Sredojević, D., Cvetanović, S., Bošković, G., 2016. Technological changes in economic growth theory: neoclassical, endogenous, and evolutionary-institutional approach. Econ. Themes 54 (2), 177–194.
Stojčić, N., Srhoj, S., Coad, A., 2020. Innovation procurement as capability-building: evaluating innovation policies in eight Central and Eastern European countries. Eur. Econ. Rev. 121, 103330.
Stoneman, P., 1995. Handbook of the Economics of Innovation and Technological Change. Blackwell.
Stough, R.R., 2001. Endogenous Growth Theory and the Role of Institutions in Regional Economic Development. Theories of Endogenous Regional Growth: Lessons for Regional Policies, pp. 17–48.
Sweet, C.M., Maggio, D.S.E., 2015. Do stronger intellectual property rights increase innovation? World Dev. 66, 665–677.
Ullah, B., 2020. Financial constraints, corruption, and SME growth in transition economies. Q. Rev. Econ. Finance 75, 120–132.
Ullah, S., Zaefarian, G., Ullah, F., 2020. How to use instrumental variables in addressing endogeneity? A step-by-step procedure for non-specialists. Ind. Mark. Manag. 96.
Vaona, A., Pianta, M., 2008. Firm size and innovation in European manufacturing. Small Bus. Econ. 30 (3), 283–299.
Woo, S., Jang, P., Kim, Y., 2015. Effects of intellectual property rights and patented knowledge in innovation and industry value added: a multinational empirical analysis of different industries. Technovation 43, 49–63.
Wooldridge, J.M., 2010. Econometric Analysis of Cross Section and Panel Data. MIT Press.
Wu, D.-M., 1973. Alternative tests of independence between stochastic regressors and disturbances. Econometrica 733–750.
Wu, L., Wei, Y., Wang, C., McDonald, F., Han, X., 2022. The importance of institutional and financial resources for export performance associated with technological innovation. Technol. Forecast. Soc. Chang. 185, 122040.
Yu, C.-H., Wu, X., Zhang, D., Chen, S., Zhao, J., 2021. Demand for green finance: resolving financing constraints on green innovation in China. Energy Policy 153, 112255.
Zhang, J., Groen, A., 2021. Informal and formal open activities: innovation protection methods as antecedents and innovation outputs as consequences. Technol. Forecast. Soc. Chang. 167, 120696.
Zhang, D., Zhuge, L., Freeman, R.B., 2020. Firm dynamics of hi-tech start-ups: does innovation matter? China Econ. Rev. 59, 101370.
Zhou, X., Li, Y., Zhang, Y., 2020. The threshold effect of firm size on technological innovation: examination of panel data from China. J. Econ. Stud. 48 (3), 571–586. Emerald Group Publishing Limited, July.

Joynal Abdin is a senior civil servant with the Government of Bangladesh

Abhijit Sharma is a Professor of Economics and Finance at the University of Huddersfield Business School.

Chengang Wang is a Professor of International Business at the University of Birmingham Business School.

Rohit Trivedi is an Associate Professor in Strategic Marketing at the Bradford School of Management.