

Firm innovation and access to finance: firm-level evidence from India

Firm
innovation

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Received 16 July 2020
Revised 20 October 2020
7 January 2021
Accepted 4 February 2021

Abstract

Purpose – Based on 9,281 firm-level survey data on micro, small and medium enterprises (MSMEs) in India, this study aims to investigate how access to different finance sources and collateral requirement facilitates the firm's innovation activity across industries.

Design/methodology/approach – This paper used ordered logit regression models using Stata software for explanatory variables to measure the impact of explanatory variables on firm innovation performance. Firms' innovation performance is measured through the aggregate innovation index obtained by adding up the no. of "new-to-firm" activities.

Findings – The empirical results reveal that external sources of funding impact innovation activity than other financing sources. Also, the requirement of collateral for financing impacts innovation performance significantly. This paper finds that firms funded by state-owned banks or government agency are more actively engaged in innovation activities. The firm's size, ownership structure and location of the firm also show the varying innovation performance. This paper found variation in innovation performance across industries as well.

Practical implications – First, the present study underlines the significance of funding sources. Second, minimizing the need for collateral to obtain external finance boosts small firms' innovation activity and will also trigger overall economic growth. Finally, while making policies for ownership transformation of state-owned institutions, policymakers should discuss these policies' impact on innovative firms.

Originality/value – What facilitates innovation performance in an emerging market is missing in the literature for MSMEs, largely due to lack of data. It is reasonable not to generalize innovation knowledge in large firms to small firms because of the constraints, particularly MSMEs face.

Keywords Innovation performance, Financial constraints, Innovation index, Logistic regression, Firm-level analysis, India, Financial markets, Banks, Financial economics

Paper type Research paper

1. Introduction

Micro small and medium enterprises (MSMEs) are particularly considered important for innovation because of their flexibility to respond to new opportunities, ability to diversify their activities and entrepreneurial spirits to create new products, processes and organization forms (Organisation for Economic Co-operation and Development [OECD], 2013). Talking



about drivers of innovation for small and medium enterprises, factors such as resource allocation, having a competitive market and access to overdraft facility is considered as positive significant factors for firm Innovation in India (Kaur and Kaur, 2020). Empirically, it has been found that SMEs and startups are financially constrained, which hinders their investment, productivity and growth. Compared to larger firms, SMEs' innovation expenditures are less, leading to a wide and persistent innovation gap (Goujard and Guérin, 2018).

In emerging countries, access to finance is often seen as a proxy of significant economic growth (Gorodnichenko and Schnitzer, 2013). Innovation acts as a vital part of the growth in developing and developed countries, ultimately resulting in innovation investment obstacles. This obstacle is dominant for MSMEs in India, where a lack of collateral and information asymmetry exists, which is the root cause. Surprisingly, in India, where a significant share of total industrial enterprises and manufacturing output and exports covers by MSMEs, information and data about this industry are scarce. Veitayaki (2008) deduces that finance is a real problem in the Indian scenario. World Bank Enterprise Survey (2014) found a higher probability that micro and small firms and firms operating in traditional sectors will be more financially constrained. A report by the Commission on the Private Sector and Development, 2004 states that even after having an extensive formal financial institution system, finance availability is finite in many countries. It may be due to the inability of the firm to provide adequate collateral to acquire credit. Kumar and Rao (2015) listed reasons for inadequate finance for SMEs in India are like the accessibility of limited financial sources (demand gap), limited availability of finance for SMEs (supply gap), lack of awareness about potential sources of finance (knowledge gap) and the reluctance of financial institution in providing funds to SMEs (benevolence gap). According to Schwab (2019), India slips down to 68th rank on Global Competitiveness Index 4.0 in 2019 but performs better in the innovation capability pillar than many emerging economies. The Global Competitiveness Report also advocates that emerging economies such as India, China and Brazil with growing innovation capacity must also focus on technological integration and human capital investments.

This paper's focal point is the connection of firms' innovation performance with access to finance and collateral sources. SMEs across countries belongs to different sectors, sizes, age and profitability and are exposed to different macroeconomic factors, institution system, financial market and banking sectors (Blach *et al.*, 2020; Pelka, 2018). There is little evidence on how finance sources affect firm Innovation in developing countries (Ayyagari *et al.*, 2011). Empirical studies, which set up a link between firm innovation and finance, especially bank finance, is scant and skewed toward developed countries (Fomtang and Adjasi, 2018; Giudici and Paleari, 2000). Besides, studies are focused more on difficulties SMEs face in finding market-based finance, Venture capital funding and crowdfunding for knowledge-based (Intangible) assets (Lee *et al.*, 2015; Vasilescu, 2014; Baldock and Mason, 2015; Schenk, 2015) rather than Internal finance. Our paper by focusing on an important emerging economy India will provide new evidences of the role of internal finance in innovation performance for MSMEs.

What facilitates innovation in emerging markets are missing in the literature. India has become especially important because of its massive spending in R and D in the past few years and SMEs' potential to fuel economic growth (Kaur and Kaur, 2020). An extensive database at this massive scale was not possible except by international agencies such as the World Bank. Data used to be the biggest bottleneck to draw any inferences about SMEs. To investigate these issues empirically, we used a firm-level data set collected by World Bank

across India under World Bank Enterprises Survey conducted in 2013–2014. The objectives of this study are three i.e.

- Whether access to finance impact firm innovation performance?
- Whether the requirement of collateral impact firm innovation performance?
- How do the finance sources and the collateral impact innovation performance industry-wise?

Contrary to most literature on financial access and firm Innovation, we adopt output measures of broad innovation, i.e. aggregate innovation index, to measure firms' innovative performance. This index includes product innovation, process innovation, improved organizational structures or management practices and enhanced marketing methods (Ayyagari *et al.*, 2011). We add firm characteristics as a control variable, which can be important for emerging countries and can correlate with access to different sources of finance and collateral required. Based on the ordered logit model, our empirical analysis suggests that the external source of finance has the highest positive impact on innovative activities carried out by the firms. The requirement of collateral is positively and significantly associated with innovative activities. Further, industry-wise results show that manufacturing firms are the most innovative firms across all industries.

The article is structured as follows: Section 2 highlights the relevant literature and sets out the hypotheses, Section 3 discusses the methodology and empirical approach. In Section 4, we present empirical findings, Section 5 suggests the policy implication of the study. Section 6 highlights conclude and discuss directions for future research.

2. Theoretical background and hypotheses

This study examines the relationship between finance sources and collateral requirements with a firm's innovation performance. While breaking up the finance sources into proxies, we intend to fetch more insights into the innovation and funding sources. The following part summarizes the literature on Innovation and finance in Indian industries and exhibits the hypotheses' section.

2.1 Finance and firm innovation performance

Large firms are engines of economic growth, as evident from Schumpeter (1976). Schumpeter (1976) also emphasizes that finance is a vital part of innovative processes. Financial sources support firms to invest in innovative methods with the help of which they expand their markets. Thus, financial resources are directly linked with various innovation activities carried out by firms, and it is of utmost importance to study the linkage between sources of finance and innovation activities in developing countries where sources of finance are scarce. However, there are mixed views on the ties of financial sources and innovation.

"Demand-pull" theory of innovative activities given by Schmookler (Kleinknecht and Verspagen, 1990) proposes that firms first use their internal sources of finance for innovative activity and then, if necessary, move to an external source for financing due to the limited availability of internal funds. This view is supported by the pecking order theory, which poses that firms use their finance sources in hierarchical order, i.e. internal sources first and if required then external resources (Donaldson, 1962; Giudici and Paleari, 2000; Myers, 1984). Rao *et al.* (2019) confirm that for Indian SMEs capital structure is driven by the pecking order theory. Baker *et al.* (2020) found that firms in India prefer internal funds followed by bank financing and funds from government and financial institutions. The next preferred sources for SMEs are trade credit followed by funds from family friends,

relatives and money lenders. Considering the fact, the innovation activities are risky and generate intangible assets or knowledge-based assets, it becomes challenging for firms to fund these activities through external market-based funding (Lee *et al.*, 2015; Vasilescu, 2014; Baldock and Mason, 2015). The majority of SMEs depend on their internal funds (Minola *et al.*, 2013; Revest and Sapio, 2012). This view can also be justified because the requirement of collateral and the high cost of external funds induce firms to use their internal funds first. So, the first hypothesis of the study is:

H1a. Access to internal finance is positively associated with firm innovation performance.

Trade credit and asset finance are positively associated with aggregate innovation (Fombang and Adjasi, 2018; Kaur and Kaur, 2020). Firms rely heavily on an overdraft facility to finance innovation activity (Freel, 2007). Firms having an overdraft facility are highly engaged in innovation activity, especially those who are product innovators and innovation strategies such as make or buy and technology buy, assist in newer innovation activities (Goedhuys and Veugelers, 2012). Angilella and Mazzù (2015) found that SMEs face many obstacles to the credit market especially if SMEs are Innovative. Moro and Fink (2013) claim that obstacles to finance particularly increase if credit is taken from banks because of lending approaches adopted by banks. Banks generally follow four approaches i.e. financial statement lending, asset-based lending, credit score models and relationship lending. The first three approaches are also labeled as transaction lending where SMEs lag behind big firms. Fombang and Adjasi (2018) found that financing through an overdraft strengthens the innovation process. Ayyagari *et al.* (2011) concluded that bank funding is linked with the highly innovative firm compared to the financing from other sources such as internal funds. So, the second hypothesis of the study is:

H1b. Access to external finance is positively associated with firm innovation performance.

Further, Demirel and Parris (2015) concluded that innovation activities do not stimulate bank funding but act as a signal to venture capitalists and government grants for investments. Even patenting helps in reducing uncertainties about financing the firms. Venture capitalism provides finance to a small number of sectors and firms that are too large (Hall, 2002). Colombo and Grilli (2007) find that credit is imperfect and there exists a financial hierarchy. This study found that for innovative SME startups, financial leverage increases with an increase in total initial capital and decreases based on the number of owners and work experience of founders. So, the third hypothesis of the study is:

H1c. Access to total finance is positively associated with firm innovation performance.

Investors consider the firm size as a significant factor while financing innovation projects. Consequently, medium and large firms find it easier to acquire external finance (Canepa and Stoneman, 2008; Czarnitzki, 2006; Ughetto, 2008), which exhibits that small innovators appear to be more financially constrained. It is because of excellent credit ratings and better financial records of medium and large firms. "Pecking order theory" suggests that due to a substantial amount of information and higher ability to provide collateral, more significant and older firms are less financially constrained than the smaller and younger firms (Berger and Udell, 2006; Freel, 2007; Lee *et al.*, 2015; Mahendra *et al.*, 2015; Myers, 1984). So, the fourth hypothesis of the study is

H1d. Requirement of collateral is positively associated with firm innovation performance.

2.2 Variations in firm innovation performance across various firm characteristics

Literature shows that various firm features are associated with firm innovation activities and impact differently. Standalone firms look for finance more often than subsidiaries or affiliated firms (Mina *et al.*, 2013). Being a part of a larger firm positively impacts firm innovation activity. Choi *et al.* (2011) concentrated on ownership structure and innovation activity and concluded that insider ownership deteriorates the firm's innovation while concentrated ownership does not significantly impact firm innovation.

Firms with government ownership do not find themselves in a shortage of funds because they are preferred by domestic investors while collectively owned, private firms face higher hindrances in obtaining finance. Still, innovation is positively associated with foreign ownership (Girma *et al.*, 2008). This finding is in line with Choi *et al.* (2011).

Firms owned by women face more financial constraints (Lee *et al.*, 2015). Older firms are more engaged in product innovation (Mahendra *et al.*, 2015), which contradicts the findings (Ayyagari *et al.*, 2011). Ayyagari *et al.* (2011) found that private ownership and highly educated managers are characteristics of more innovative firms. However, Paunov (2012) finds that newly-established firms and firms that have public funding abandon innovation projects more often. Investors consider firm size while financing but ignore age (Mina *et al.*, 2013). Firms who export are successful innovators (Crisuolo *et al.*, 2010; Efthyvoulou and Vahter, 2016; Fombang and Adjasi, 2018).

2.3 Variations in firm innovation performance across industries

Studies by Efthyvoulou and Vahter (2016) and Giudici and Paele (2000) showed that the fast-growing service industry helps the firm obtain more ease. These findings contradict the results of Silva and Carreira (2016), which found that the service industry faces more severe financial constraints than the manufacturing industry. Manufacturing firms go for obtaining finance more often than other firms (Mina *et al.*, 2013).

Gorodnichenko and Schnitzer (2013) and Savignac (2008) find that financial constraint and innovation activities are negatively associated with each other in manufacturing and service firms. However, they find no significant negative associations between innovative activities and access to external finance. A possible explanation for this is that innovative firms may need more external finance; thus, they are financially constrained. They also found that the probability of developing an innovative product or technology decreases with age. Czarnitzki and Hottenrott (2011) found that smaller firms are financially constrained for R and D investment than larger firms in manufacturing firms. Disparities in innovative activities across industries also confirm by Savignac (2008). He founds that the probability of having innovative activities increases with firm size, but Silva and Carreira (2016) confirms this finding in manufacturing firms, not in services firms.

3. Research methodology

The present study is based on the firm-level data of 9,281 Indian firms collected by the World Bank. The data were collected using stratified random sampling with replacement, based on face-to-face interviews and questionnaires from business owners and senior managers. Three-level of stratification based on industry, size and region were used in this survey. The universe of the study is stratified into 11 manufacturing industries and 7 services industries. Standardized definition for size is used considering small (5 to 19

employees), medium (20 to 99 employees) and large (more than 99 employees). The survey was conducted between June 2013 and December 2014 and captures the information on innovation activities, financial performance, obstacles in growth and the business environment indicators in general from the manufacturing, retail and service industry. This data set [1] includes firms from 23 states and represents 26 different sectors across India. We delete outliers from the data by excluding those firms that refuse to respond for some items or do not know or have missing data because it restricts us from using our empirical specification to achieve objectives.

3.1 *Dependent variable*

This study undertakes firms' innovation performance as the dependent variable. Firms' innovation performance is measured through the aggregate innovation index obtained by adding up the no. of "new-to-firm" activities. Organisation for Economic Co-operation and Development [OECD], (2013) has defined new-to-firm innovation as "the implementation of a new or significantly improved product (good or service) or process, a new marketing method or a new organizational method in business practices, workplace organization or external relations" for its innovation Microdata project. The firm's innovation performance score is calculated by summing 1 when the establishment introduced new or significantly improved products or services establishment introduced new or substantially improved manufacturing products or offering services; establishment introduced new or improved organizational structures or management practices; establishment introduced new or significantly enhanced marketing methods.

We describe the firm as "not innovative" if it scores "0" in innovation performance, "low innovative" if it scores "1 or 2" in innovation performance and "highly innovative" if it scores "3 or 4." Then, the innovation index is constructed based on the firm's innovation performance score. The index fluctuates from 0 to 2. A firm takes an innovation index score 0 if they do not undertake any innovative activity, innovation index score 1 if it undertakes any 1 or 2 innovative activity, innovation index score 2 if it takes 3 or 4 innovative activity.

Approach parallels (Ayyagari *et al.*, 2011; Porta *et al.*, 1998), we use an ordered dependent variable ($I_{\text{innovation}}$) for our analysis.

3.2 *Explanatory variable*

We used internal finance access, access to external finance, access to total funding and collateral required as our explanatory variables. Access to internal finance is measured from "does this establishment have a checking or savings account?" Access to external funding is measured from two questions, which are, "does this establishment have an overdraft facility?" and "does this establishment a line of credit or a loan from a financial institution?" Access to total finance is measured by all three questions used in internal and access to external funding. At last, collateral required is measured from "did the financing required collateral?"

3.3 *Control variables*

We control for the main business city of the firm (CITY), the age of the firm (AGE), the size of the firm (SIZE), dummy variable PART if the firm is part of a larger firm. The firm's age is measured from the year of the foundation. In addition, the size of the firm is measured in the number of employees. We also considered the dummy variable GOWN and FOWN, representing government ownership and female ownership, respectively. Finally, to control the firm located in an export processing zone or other industrial parks, we use the dummy

variable EPZ/IP. For every empirical model, we control for these variables. These control variables are described in [Appendix](#).

3.4 Model specifications

We use different specifications of ordered logit regression models for explanatory variables to measure the impact of explanatory variables on firm innovation performance.

We used an ordered logit model rather than a logit model as our dependent variable can be categorized into meaningful structures, i.e. a range of 0–2. The logit model is used when the dependent variable is binomial. The order logit function is the inverse cumulative distribution function associated with the standard logistic distribution ([Greene, 2011](#)). The analysis is performed using STATA software. These specifications take four forms, namely, Model (1), where the explanatory variable is access to internal finance, Model (2), where the explanatory variable is access to external finance, Model (3), where the explanatory variable is access to total finance, Model (4), where the explanatory variable is collateral required. Besides, we include a set of control variables for the various firm characteristics, which may be associated with firm innovation performance. We use the following five model for our principal empirical analysis and used Stata software to run the analysis:

$$I_{innovation} = \alpha + \beta_1 INTATF + \beta_2 X + \mu_i \quad (1)$$

$$I_{innovation} = \alpha + \beta_1 EXATF + \beta_2 X + \mu_i \quad (2)$$

$$I_{innovation} = \alpha + \beta_1 TATF + \beta_2 X + \mu_i \quad (3)$$

$$I_{innovation} = \alpha + \beta_1 COLLREQ + \beta_2 X + \mu_i \quad (4)$$

Here:

- $I_{innovation}$ = firm's innovation performance measured through aggregate innovation index.
- $INTATF$ = Access to internal finance.
- $EXATF$ = Access to external finance.
- $TATF$ = access to total finance.
- $COLLREQ$ = Requirement of collateral.
- X = is a vector of control variables.

To evaluate the explanatory variable's impact on firms' innovation performance from the industry's perspective, we segregate the data according to industries. We split the data into the manufacturing industry, retail industry and service industry. Industry-wise model specifications are given below:

$$I_{innovation, manufacturing} = \alpha + \beta_1 INTATF_{manufacturing} + \beta_2 X + \mu_i \quad (5)$$

$$I_{innovation, retail} = \alpha + \beta_1 INTATF_{retail} + \beta_2 X + \mu_i \quad (6)$$

$$I_{innovation, services} = \alpha + \beta_1 INTATF_{services} + \beta_2 X + \mu_i \quad (7)$$

$$I_{innovation,manufacturing} = \alpha + \beta_1 EXATF_{manufacturing} + \beta_2 X + \mu_i \quad (8)$$

$$I_{innovation,retail} = \alpha + \beta_1 EXATF_{retail} + \beta_2 X + \mu_i \quad (9)$$

$$I_{innovation,services} = \alpha + \beta_1 EXATF_{services} + \beta_2 X + \mu_i \quad (10)$$

$$I_{innovation,manufacturing} = \alpha + \beta_1 TATF_{manufacturing} + \beta_2 X + \mu_i \quad (11)$$

$$I_{innovation,retail} = \alpha + \beta_1 TATF_{retail} + \beta_2 X + \mu_i \quad (12)$$

$$I_{innovation,services} = \alpha + \beta_1 TATF_{services} + \beta_2 X + \mu_i \quad (13)$$

$$I_{innovation,manufacturing} = \alpha + \beta_1 COLLREQ_{manufacturing} + \beta_2 X + \mu_i \quad (14)$$

$$I_{innovation,retail} = \alpha + \beta_1 COLLREQ_{retail} + \beta_2 X + \mu_i \quad (15)$$

$$I_{innovation,services} = \alpha + \beta_1 COLLREQ_{services} + \beta_2 X + \mu_i \quad (16)$$

Here:

$I_{innovation,manufacturing}$	= firm's innovation performance in the manufacturing industry, which is our dependent variable.
$I_{innovation,retail}$	= firm's innovation performance in the retail industry, which is our dependent variable.
$I_{innovation,services}$	= firm's innovation performance in the service industry, which is our dependent variable.
$INATF_{manufacturing}$	= access to internal finance in the case of the manufacturing industry.
$INATF_{retail}$	= access to internal finance in the case of the retail industry.
$INATF_{services}$	= Access to internal finance in the case of the service industry.
$EXATF_{manufacturing}$	= access to external finance in the case of the manufacturing industry.
$EXATF_{retail}$	= access to external finance in the case of the retail industry.
$EXATF_{services}$	= Access to external finance in the case of the service industry.
$TATF_{manufacturing}$	= access to total finance in the case of the manufacturing industry.
$TATF_{retail}$	= access to total finance in the case of the retail industry.
$TATF_{services}$	= Access to total finance in the case of the service industry.
$COLLREQ_{manufacturing}$	= Collateral required in the case of the manufacturing industry.
$COLLREQ_{retail}$	= Collateral required in the case of the retail industry.
$COLLREQ_{services}$	= Collateral required in the case of the service industry.
X	= is a vector of control variables.

4. Empirical analysis

Before we present results for our key variable of interest from our main findings, we first show descriptive statistics for the firms engaged in innovation activity by segregating them

Notes: Table 2 shows the innovation performance of all firms and their share in observation and percentage. According to an innovation index score, the firms are segregated, which indicates that firms are highly innovative if they score 2, lower innovative if they score 1 and not innovative if they score 0

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Table 3.
 Descriptive statistics
 of independent and
 control variables

Variables	Observation	Mean	S.D.	Min.	Max.
<i>Explanatory variable</i>					
<i>INATF</i>	9,264	0.9573	0.2020	0	1
<i>EXATF</i>	8,979	0.6339	0.4817	0	1
<i>TATF</i>	8,824	0.2075	0.4055	0	1
<i>COLLREQ</i>	2,511	0.8741	0.3317	0	1
<i>Control variable</i>					
<i>CITY</i>	9,281	0.8134	0.3895	0	1
<i>SIZE</i>	9,281	0.2263	0.4185	0	1
<i>PART</i>	9,281	0.2151	0.4109	0	1
<i>GOWN</i>	9,281	0.0042	0.0646	0	1
<i>FOWN</i>	9,281	0.1478	0.3549	0	1
<i>AGE</i>	9,281	19.5995	14.2851	1	151
<i>EPZ/IP</i>	9,281	0.5707	0.4949	0	1

Notes: Table 3 provides descriptive statistics for explanatory variables and control variables. The variables are defined and coded in Appendix

collateral required, we expect a 0.61, 0.69, 0.67, 0.42 change in the log odds of being an innovative firm, respectively. These results confirm our hypotheses *H1a–H1d*, which postulates that these explanatory variables positively and significantly associated with firm innovation performance. The magnitude of the coefficient is different for the first three models, which indicated that various finance sources show different possibilities of being an innovative firm. Firms' having only access to external funding has a higher probability of being an innovative firm than firms' having internal sources or both sources of finance. This finding is in line with [Fombang and Adjasi \(2018\)](#), [Blach et al., 2020](#) and [Goedhuys and Veugelers \(2012\)](#), which found that access to external funding is more helpful to firms in becoming innovators. These findings are in contrast to earlier findings that assume that innovative firms are more likely to be financed by equity than debt ([Hall, 2010](#)). [Ayyagari et al. \(2011\)](#) highlight the importance of bank lending in innovative activities. Also, firms heavily rely on short-term bank funding, especially bank overdraft, to finance innovation ([Freel, 2007](#)). Innovation activities are high-risk activities because of uncertainty in terms of output. The transaction cost theory of debt financing claims that firms prefer to use debt financing or external for these high-risk activities. [Galende and de la Fuente \(2003\)](#) found that credit and personal finance lines facilitate process innovation, new organization structure and new marketing methods. Firms using personal finance are less likely to do product innovation.

Model (4) indicates that for a one-unit change in collateral required, we can expect a 0.42 change in the log odds of being an innovative firm, which specifies that firms who mortgaged assets to receive external finance are likely to be more creative than their counterparts. The possible explanation for this can be that the innovative firms require and apply for more funds, and thus, they need collateral to access external sources of finance.

4.2.2 Results for control variables. We also add control variables in these models. Control variable PART is positive and statistically significant for all the specifications, which indicate that the firms, who are part of larger firms, are more innovative than other firms. It reveals that lager firms positively influence the firms to be an innovator and foster innovation activities. This finding is consistent with the study of [Choi et al. \(2011\)](#) and [Kaur et al. \(2021\)](#). Firms with female ownership are more likely to be an innovator than other firms

Variables	Dependent variable $I_{\text{innovation}}$			
	Model (1)	Model (2)	Model (3)	Model (4)
<i>Explanatory variable</i>				
INATF	0.6118*** (0.1004)			
EXATF		0.6985*** (0.0426)		
TATF			0.6713*** (0.0511)	
COLLREQ				0.4289*** (0.1146)
<i>Control Variable</i>				
CITY	−0.0754 (0.0502)	−0.0513 (0.0513)	−0.0709 (0.0512)	−0.0346 (0.0988)
SIZE	0.0026 (0.0467)	−0.0212 (0.0478)	−0.0071 (0.0476)	−0.0851 (0.0918)
PART	0.8059*** (0.0496)	0.7760*** (0.0510)	0.7551*** (0.0512)	0.6282*** (0.0896)
GOWN	−0.0539 (0.3083)	−0.2220 (0.3136)	−0.2707 (0.3155)	−0.1443 (0.4371)
FOWN	0.2813*** (0.0551)	0.2310*** (0.0564)	0.2168*** (0.0568)	−0.0559 (0.0898)
AGE	−0.0024* (0.0013)	−0.0027** (0.0013)	−0.0031** (0.0013)	−0.0039* (0.0024)
EPZ/IP	0.2035*** (0.0396)	0.1488*** (0.0405)	0.2254*** (0.0402)	0.5058*** (0.0768)
Observations	9,083	8,835	8,824	2,484
Log-likelihood	−9,726.2873	−9,352.5604	−9,389.0973	−2,550.4527
LR χ^2	389.70	615.47	519.48	114.79
Pseudo R^2	0.0196	0.0319	0.0269	0.0220

Notes: Table 4 shows the coefficients of the following regression models.

$$I_{\text{innovation}} = \alpha + \beta_1 \text{INATF} + \beta_2 X + \mu_i \quad (1)$$

$$I_{\text{innovation}} = \alpha + \beta_1 \text{EXATF} + \beta_2 X + \mu_i \quad (2)$$

$$I_{\text{innovation}} = \alpha + \beta_1 \text{TATF} + \beta_2 X + \mu_i \quad (3)$$

$$I_{\text{innovation}} = \alpha + \beta_1 \text{COLLREQ} + \beta_2 X + \mu_i \quad (4)$$

All these regression model has the same dependent variable, $I_{\text{innovation}}$, which describe the innovation index. Model (1) include explanatory variable INATF, that takes the value of 1 if the firm has a checking or saving account; otherwise, 0, Model (2) include explanatory variable EXATF, that makes the value of 1 if the firm has access to anyone source of finance out of overdraft and loan account; otherwise 0, Model (3) include explanatory variable TATF, that takes the value of 1 if the firm has access to internal and both external sources; otherwise, 0, Model (4) include explanatory variable COLLREQ, that takes the value of 1 if the firm requires collateral for financing; otherwise 0. All the above model consists of the vector (X) for firm-specific control variable, which includes CITY that takes the value of 1 if the firm is located in the main business city; otherwise 0, variable SIZE take the value of 1 if the size of the firm is large; otherwise 0, variable PART takes the value of 1 if the firm is part of a large establishment; otherwise, 0, variable GOWN take the value of 1 if the firm has state ownership; otherwise 0, variable FOWN take the value of 1 if a female owns the firm; otherwise 0, variable AGE shows the age of the firm and variable EPZ/IP take the value of 1 if the firm is located in an export processing zone or an industrial park; otherwise 0. Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 4.
Determinants of
firms' innovation
performance

(Fombang and Adjasi, 2018), which are in support of our Models (1)–(3) indicating firm with female ownership are more likely to be an innovative firm. However, Model (4) does not have a statistically significant value and specifies that female ownership does not relate to the higher probability of being an innovator in this model.

Similarly, the variable AGE is significant for all the models. It shows a negative sign indicating that older firms are less likely to engage in innovation activity than younger firms, confirming the findings (Ayyagari *et al.*, 2011; Giudici and Paleari, 2000;

Gorodnichenko and Schnitzer, 2013). However, this finding is contradicted (Girma *et al.*, 2008; Mahendra *et al.*, 2015), indicating that older firms, who have a higher firm experience, are more likely to engage in innovation activity. Finally, variable EPZ/IP is positive and significant. All the models confirm that the firms located in the export processing zone or industrial park are more likely to be engaged in innovation activity. This finding supports the result of (Criscuolo *et al.*, 2005; Efthyvoulou and Vahter, 2016; Fombang and Adjasi, 2018), which provide evidence that firms active in the export market are more innovative than others. To survive in the competitive market both nationally and internationally, firms continuously need to develop and improve new products and processes.

Our findings support the hypotheses developed based on literature, which confirms that our findings are consistent with most past studies. Table 4 shows that results are in line with the *H1a–H1d*.

4.2.3 Results for explanatory variables industry-wise. We also analyze the impact of the explanatory variables on innovation performance according to industry. Following are the table showing results:

The above Tables 5 and 6 shows that access to internal finance and external finance is significantly and positively associated only in a manufacturing firm, indicating that manufacturing firms who have internal sources of funding are more likely to be innovative firms. Results from Table 7, Models (11)–(13) show that only manufacturing and services firms with access to total finance are more likely to indulge in innovation activity. Gorodnichenko and Schnitzer (2013) found that financial constraints and innovation activities are negatively associated with the manufacturing and service industries, which partially confirms our findings. It has been found that, as the manufacturing industry and service industry are knowledge-intensive firms, they have more tendency to innovate. MSMEs that are spending money on formal research and giving employees time to innovate are more likely to introduce a new product, new

Variables	Dependent variable		
	Model (5) Manufacturing	I _{Innovation} Model (6) Retail	Model (7) Services
<i>Explanatory variable</i>			
INATF	0.7853 ^{***} (0.1155)	−0.0779 (0.4483)	0.0728 (0.2283)
<i>Control variable</i>			
CITY	−0.0281 (0.0534)	−0.5943 (0.5287)	−0.1279 (0.1702)
SIZE	0.0012 (0.0522)	0.0730 (0.3772)	0.0576 (0.1131)
PART	0.7746 ^{***} (0.0529)	1.0077 ^{***} (0.3396)	0.7047 ^{***} (0.1739)
GOWN	−0.2372 (0.3151)	0	14.3322 (655.99)
FOWN	0.2986 ^{***} (0.0605)	−0.3373 (0.2952)	0.2907 [*] (0.1535)
AGE	−0.0016 (0.0015)	−0.0097 (0.0070)	−0.0031 (0.0034)
EPZ/IP	0.2251 ^{***} (0.0443)	0.0748 (0.1996)	0.0498 (0.1013)
Observations	7,378	356	1,349
Log-likelihood	−7,856.2552	−383.4605	−1,455.8718
LR chi ²	335.65	14.05	27.98
Pseudo R ²	0.0209	0.0180	0.0095

Table 5. Industry-wise result

Notes: Table 5 shows the industry-wise result from the Models (5)–(7). It includes explanatory variable internal access to finance (INATF). Robust standard errors in parentheses; ^{***}*p* < 0.01, ^{*}*p* < 0.10

Variables	Dependent variable		
	Model (8) Manufacturing	I _{innovation} Model (9) Retail	Model (10) Services
<i>Explanatory variable</i>			
EXATF	0.6960*** (0.0486)	0.5333** (0.2059)	0.6600*** (0.1038)
<i>Control variable</i>			
CITY	−0.0166 (0.0545)	−0.6091 (0.5304)	−0.1312 (0.1728)
SIZE	−0.0197 (0.0534)	−0.1443 (0.3885)	0.0316 (0.1151)
PART	0.7690*** (0.0544)	0.9407*** (0.3443)	0.5909*** (0.1768)
GOWN	−0.3926 (0.3201)	0	0
FOWN	0.2578*** (0.0621)	−0.4295 (0.2979)	0.2266 (0.1550)
AGE	−0.0020 (0.0015)	−0.0098 (0.0071)	−0.0029 (0.0035)
EPZ/IP	0.1800*** (0.0453)	−0.0033 (0.2056)	−0.0062 (0.1031)
Observations	7,157	350	1,326
Log-likelihood	−7,547.8173	−374.2631	−1,413.015
LR chi ²	495.36	19.75	60.48
Pseudo R ²	0.0318	0.0257	0.0210

Notes: Table 6 shows industry-wise results from the Models (8)–(10). It includes explanatory variable external access to finance (EXATF). Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$

Table 6.
Industry-wise result

Variables	Dependent variable		
	Model (11) Manufacturing	I _{innovation} Model (12) Retail	Model (13) Services
<i>Explanatory variable</i>			
TATF	0.7046*** (0.0558)	0.3666 (0.2915)	0.4381*** (0.1462)
<i>Control variable</i>			
CITY	−0.0214 (0.0554)	−0.5607* (0.3053)	−0.1466 (0.1558)
SIZE	0.0081 (0.0531)	0.1239 (0.2636)	−0.1015 (0.1211)
PART	0.7292*** (0.0558)	0.4850* (0.2910)	0.8882*** (0.1470)
GOWN	−0.3749 (0.3501)	0.6687 (1.0117)	−0.2746 (1.0907)
FOWN	0.2116*** (0.0619)	0.2349 (0.3195)	0.1362 (0.1627)
AGE	−0.0028* (0.0015)	−0.0093 (0.0067)	−0.0014 (0.0035)
EPZ/IP	0.2535*** (0.0452)	0.1281 (0.2026)	0.0193 (0.1029)
Observations	7,147	350	1,327
Log-likelihood	−7,567.8441	−377.6244	−1,416.2323
LR chi ²	434.82	13.23	56.42
Pseudo R ²	0.0279	0.0172	0.0195

Notes: Table 7 shows the industry-wise result from the Models (11)–(13). It includes explanatory variable access to total finance (TATF). Robust standard errors in parentheses; *** $p < 0.01$, * $p < 0.10$

Table 7.
Industry-wise result

process and organization structures and introduce new marketing methods in India (Kaur and Kaur, 2020).

This disparity in innovative activities across industries is also confirmed by (Savignac, 2008). It is also shown by Mina *et al.* (2013) that the manufacturing industry applies to

finance more often. Efthyvoulou and Vahter (2016) found that the service industry, a fast-growing sector in India, acquires finance easily, which correlates with our finding, which shows that firms with access to external finance are more innovative than other firms. Retail industries are the least innovative, as demonstrated by coefficients. One possible explanation of it would be that the retail sector includes static activities and lesser scope to innovate than other industries. Retail firms are believed to be supplier-dominated firms focusing on the adoption of other discoveries and not very active on innovative on their own (De Jong and Vermeulen, 2006).

The Table 8 shows that the firm, which required collateral while financing their activities, is more likely to be an innovative firm only in the manufacturing industry. The requirement of more finance from external sources because of high investment needs can be the possible reason for collateral required. Moro and Fink (2013) proposed the emphasis on relationship lending and the importance of trust to evaluate creditworthiness especially in the case of SMEs to extend credit to innovative SMEs. Table 6 also shows that firms, which required access to external finance, are more innovative.

For the control variable, it is found that older manufacturing firms are less likely to be innovative in the manufacturing firm's case, which is in line with the results of Gorodnichenko and Schnitzer (2013), who confirm that the probability of developing innovative products and technology decreases with age.

Results also show that firms that are part of larger establishments are more innovative in all sectors. At the same time, firms with female ownership are more innovative in the manufacturing and services industry. Other studies also confirm that firms with female ownership are conscious and proactive in investing in innovation (Popović-Pantić, 2014).

Manufacturing firms established in the export processing zone or industrial park are more innovative than other firms.

Variables	Dependent variable		
	Model (14) Manufacturing	Innovation Model (15) Retail	Model (16) Service
<i>Explanatory variable</i>			
<i>COLLREQ</i>	0.4687*** (0.1285)	−1.1051 (0.7065)	0.4182 (0.2833)
<i>Control variable</i>			
<i>CITY</i>	0.0097 (0.1049)	−0.8679 (1.0480)	−0.0909 (0.3374)
<i>SIZE</i>	−0.0244 (0.1019)	−0.9196 (0.6660)	−0.2279 (0.2389)
<i>PART</i>	0.5760*** (0.0953)	0.2466 (0.5735)	0.7771*** (0.3565)
<i>GOWN</i>	−0.1699 (0.4383)	0	0
<i>FOWN</i>	−0.1511 (0.0976)	0.0288 (0.5094)	0.6472*** (0.2697)
<i>AGE</i>	−0.0031 (0.0026)	−0.0004 (0.0152)	−0.0078 (0.0075)
<i>EPZIP</i>	0.6028*** (0.0849)	0.1725 (0.4251)	−0.0375 (0.2133)
Observations	2,086	80	318
Log-likelihood	−2,105.6259	−84.3585	−338.6840
LR chi ²	108.87	5.03	15.41
Pseudo R ²	0.0252	0.0289	0.0222

Table 8.
Industry-wise result

Notes: Table 8 shows the industry-wise result from the Models (14)–(16). It includes explanatory variable collateral required (COLLREQ). Robust standard errors in parentheses; ****p* < 0.01, ***p* < 0.05

5. Discussion and policy implication

This paper aims at highlighting the innovation performance of Indian firms from the finance perspective. Our descriptive statistics confirm that more than 1/3rd of the firms is highly innovative based on the aggregate innovation index. According to our main findings, access to both finance sources positively impacts innovation performance, individually and jointly. However, the external source of finance has more impact than internal sources of finance. Empirical evidence also shows that innovative firms require more collateral to acquire funds, which approve earlier findings because collateral is required for external capital only. Our results in Table 4 verify our hypotheses *H1a–H1d*.

We also found variations in the innovation performance of firms across the industry. The manufacturing industry is more innovative than the service and retail industries. The retail sector is innovative only if they have access to external finance. In contrast, the service industry is innovative if they have access to external finance or both finance sources.

The results for the explanatory variable are listed in Table 9.

Our control variable also shows that if a firm is a part of the larger firm or established in an export processing zone/other industrial parks, it is more indulge in innovative activities. Similarly, female ownership enhances innovation performance. However, as the age of the firm increases, innovation activities reduces significantly.

Exploring the innovation performance of firms from a financial constraints perspective is highly relevant for transition countries such as India. Emerging countries have an excellent opportunity for growth through innovation processes. Still, various barriers, especially ineffective financial systems and policies, make it difficult for firms to accelerate their growth through innovation activity. Emerging markets have weaker investment climates that depress overall profitability. Middle-income countries such as India can reap the benefit by increasing their spending on R and D with complementary efforts to improve the quality of human capital, strengthen research institutions, order the national innovation system and raise the sophistication of the private sector (Kaur and Kaur, 2020). Stimulus policies sometimes do wonder for the industry, for instance, Horizon 2020 program introduced by European Commission is the biggest European Union Research and Innovation Program ever with nearly EUR80bn funding available over seven years (2014 to 2020). The main goal is to ensure that Europe produces world-class science, remove barriers to innovation and make it easier for the public and private sectors to work together in delivering innovation (Pelka, 2018).

Our study lighted up these issues and concluded that, in general, financial constraints cutback innovation activities and hinder firm growth. Nevertheless, firms in transition countries can make their way to innovate if the policy environment provides favorable conditions. Rao *et al.* (2017) found that SMEs consider the high cost of credit, complex procedures of lending institutions, information asymmetry, creditworthiness and self-abstaining from external financial resources as common financing challenges in India. Our results have a few direct policy implications for fast-emerging countries.

Variables	Dependent variable	
	Expected sign	Actual sign
<i>Explanatory variable</i>		
INATF	+	+
EXATF	+	+
TATF	+	+
COLLREQ	+	+

Table 9.
Result summary

First, the present study underlines the significance of funding sources. The external source of funding promotes innovation activity; thus, policymakers should ensure smooth financing to the industries, primarily small-sized firms. They are less innovative than large firms, which indicates higher constraints to smaller firms in acquiring funds.

Second, the requirement of collateral is another major constraint to innovation. Minimizing the need for collateral to obtain external finance boosts small firms' innovation activity and will also trigger overall economic growth.

Third, Policymakers can note that competition rather than policy restricting markets is good for innovation, and further, exposing firms to global competition even encourage more innovation.

Finally, the present study highlights that the ownership structure of funding agency also regulates the innovation performance. While making policies for ownership transformation of state-owned institutions, policymakers should discuss these policies' impact on innovative firms.

6. Conclusion and directions for future research

Based on the ordered logit model, our empirical analysis suggests that the external source of finance has the highest positive impact on innovative activities carried out by the firms. The requirement of collateral is positively and significantly associated with innovative activities. Further, industry-wise results show that manufacturing firms are the most innovative firms across all industries. The study has some limitations, which can be used to explore more insights in future research studies. First, we built and used an aggregate innovation index as a proxy for innovation, which includes new or significantly improved:

- Products or services.
- Methods of manufacturing products or offering services.
- Organizational structures or management practices.
- Marketing methods.

However, not all firms innovate only through these practices. Thus, future research can use other proxies such as patents and R&D expenditure to gain more insights. Similarly, the researchers can explore various other firm-specific characteristics such as share of ownership, management, quality certification and country-specific factors, for instance, technological environment, innovation policies, etc. These additions would further broaden our knowledge base about firm innovation in emerging countries.

Note

1. World Bank. India Enterprise Survey (ES) 2014, Ref. IND_2014_ES_v01_M. Data set downloaded from [<https://www.enterprisesurveys.org/en/data/exploreeconomies/2014/india>] on [August 8th 2019].

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Further reading

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Table A1.
Variables summary

Appendix	
Variables	Definition/coding
<i>Dependent variable</i>	
I _{innovation}	Firm innovation performance measured through aggregate innovation index coded 0 if innovation performance score 0, coded one if the innovation performance score is 1 or 2 and coded two if the innovation performance score is 3 or 4
<i>Explanatory variables</i>	
INATF	If a firm has access to a checking or saving account, then 1 otherwise 0
EXATF	If a firm has access to anyone source of finance out of overdraft facility and line of credit from a financial institution, then 1 otherwise 0
TATF	If the firm has access to internal and external sources of finance, then 1 otherwise 0
COLREQ	If the financing require collateral, then 1 otherwise 0
<i>Control variables</i>	
CITY	Is the current city is the main business city? if yes, then 1, otherwise 0
SIZE	If the firm's size (no. of employees) is >100, then 1, otherwise 0
PART	If the firm is part of the larger establishment? if yes, then 1, otherwise 0
GOWN	If the firm owned by the state or govt.? if yes, then 1, otherwise 0
FOWN	If the firm has a female owner? if yes, then 1, otherwise 0
AGE	What is the age (from foundation year) of the firm?
EPZ/IP	If the firm is located in an export processing zone or an industrial park? if yes, then 1, otherwise 0

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