



Epitome : International Journal of Multidisciplinary Research

ISSN : 2395-6968

FINANCING FIRM-INNOVATION : A COMPARISON BETWEEN INDIA AND CHINA



Anu Satyal (Ph.D., Cantab.),
College of Vocational Studies,
University of Delhi

ABSTRACT

This paper examines the impact of financial constraints on firm innovation. We use World Bank's Enterprise survey data for India and China and compare the role of alternative forms of financing innovation. Core and composite innovation indices are used and Ologit estimations are presented for the two indices. Findings suggest that for India as firms undertake more paired innovations role of bank finance with retained profits is elevated and dependence on equity finance falls. Complementarities in various forms of finance suggest that a combined policy of provision of institutional credit and tax concessions to firms can play

a positive role in easing the financial constraints faced by firms. With bank finance and retained profits, equity finance is also significant for Chinese firms. R&D is complementary to finance for both India and China. Further, an explanation for China being more innovative lies in the synchronized access to finance and improvement in the absorptive capacity of firms in the form of training and skill development of workers and adoption and assimilation of foreign technology.

KEYWORDS

Firm innovation, Financial constraints, India, China.

JEL classification: G32, O32

RESEARCH PAPERS

INTRODUCTION

Knowledge, both tacit and explicit, learning and innovation together affect growth, productivity and competitiveness. Innovation is affected by firm-specific or internal factors and occurs in the context of national, sectoral and regional innovation ecosystems. Innovation comprises product and process innovation, up-gradation, changes in organizational structure, product design and marketing methods (Oslo Manual, 2005). Various forms of technological and non-technological innovations are complementary and reinforce each other. Further, innovation can be disruptive/radical or incremental and can be either new to the market or new to the firm and firms can cater to local, national and international markets. Access to new ideas and their assimilation requires funds to innovate and up-grade firm's absorptive capacity and capabilities in tandem with availability and exploitation of new knowledge. In developing countries, a large number of firms are medium and small enterprises, operate below the technology frontiers which is constantly moving and, *inter alia*, face financial constraints. Shortage of funds for working capital, for fixed investments and for R&D is one of the most important obstacles to R&D and innovation listed by many developing country firms in the Innovation Surveys.

This paper compares financing innovation in India and China. In a set of 129 countries China ranks 17th in the Global Innovation Index (GII) (2018) and 14th in the GII (2019) report though it is not part of the high-income category among the top 20 countries. India has the 57th rank in GII (2018) which improved to 52nd position in GII (2019). Comparison between India and China is instructive as both are emerging markets¹ and financial systems have deepened in both the economies (Didier and Schumkler, 2013). Stock market has gained more importance and market capitalization has increased². Equity and bond markets have also expanded with large inflows of foreign capital. It is primarily the large firms which rely more on capital markets to finance their growth³.

Financial institutions are an integral part of the innovation ecosystem and an efficient capital market is imperative for financing firm-innovation. In this context the present paper looks at the relative importance of varied sources of funds used for financing innovation in India and China, comprising both internal to external sources. Our research explores the impact of

¹ China has grown at average rate of 10 percent per annum between 1978 and 2014, increased its per capita income to \$8260 and its share in global manufacturing has gone up from 7 percent to 25 percent between 2000 and 2016. Its forex reserves stood at \$3 trillion and a trade surplus of \$38 billion. India's per capita income in 2016 was \$1718 with forex reserves equal to \$372 billion and a trade deficit of \$10 billion. India has a more developed securities market compared to China and the latter's financial markets are politically sensitive with a large proportion of funds going to state-owned enterprises (ICS, 2017). Political intervention creates inefficiency in the allocation of resources as well as a rise in non-performing assets (Farrel, D. and Lund, S., 2006). Both countries initiated financial sector reforms in the early 1990s. At the end of the 1990s China had a more effective informal financial system even though the formal legal and financial systems were in their formative stages (Allen et. al. , 2002). It has a large but not an efficient banking system. Jadhav and Raj (2005) compare the financial systems in the two countries and bring out their strengths and weaknesses¹.

² Stock market capitalization in China and India increased from 4 percent and 22 percent respectively in 1992 to 80 percent and 95 percent in 2010. Over 1990-94 and 2005-10 the share of equity and bond market in China increased from an average of 11 percent to 53 percent. In India this share increased from 57 percent to 65 percent (Didier and Schumkler, 2013).

³ An earlier study by Singh and Hamid, (1994) and Singh (1995) concluded that firms in developing countries do not follow the pecking order of finance. Rather they rely largely on external finance.

financial constraints on innovation in case of emerging economies with relevant policy implications. The core index of innovation comprises product and process innovation and the composite index includes core index and soft innovation⁴. Most of the extant literature on innovation looks at the effect of finance on growth, productivity and innovation for developed economies. This paper looks at the performance of two large emerging economies. This inquiry has implications for funding of innovation, design of S&T policy and has lessons for other developing countries. It concludes that, availability of internal and external finance is complementary to paired innovations. If these countries rely more on borrowed technology then it must suit their local contexts and requires an upgradation of firms' absorptive capacity. The paper is organized as follows. Following the Introduction, section II presents the analytical framework. A discussion of data, methodology and results are presented in section III. The last section concludes.

ANALYTICAL FRAMEWORK

Innovation is often treated synonymous with R&D or patents generated. The inability to appropriate gains arising from R&D dissuades firms to undertake R&D or innovate. Sources of finance available to firms are both internal in the form of retained profits or bank loans and equity finance. Optimal allocation of financial resources requires efficient financial markets and strong institutions and the ability of firms to raise external sources of finance. Firm-heterogeneity influences differential access to external sources of finance which has varied impact on firm innovation. Firms are part of the ecosystem made up of organizations, institutions in the context of state policy. Interface and feed-back between firms and the various entities of the ecosystem renders innovation non-linear or path-dependent.

Financial markets are reluctant to provide funds for innovation due to uncertainty and risk in innovation, appropriability issues, skewed return on investment, asymmetric information and moral hazard between the financial institution and the innovator, less than optimal contracts and agency costs and loss of tacit knowledge when researchers leave the firm (Hall (2014), Hall and Lerner, (2010), Khan et. al., (2018), Cong et.al. (2018), Levine, (2005), Acemoglu, Aghion and Zilibotti, (2006), Akerlof, (1970), Kerr and Nanda, 2014)). Bank loans have to be backed by collateral. Firms withhold information from the financial institutions (Anton and Yao, 2002). Small or young firms in less developed financial markets in developing countries also find it difficult to raise funds from external sources which directly impedes their ability to innovate. (Brown and Petersen 2011). Raising funds via public issue creates a wedge between the objectives of shareholders and the managers or the principal-agent problem. Managers avoid punishment for failure by not undertaking risks and play safe. The nature and design of contracts and compensation promised in it with allowance for experimentation ought to be optimal else it adversely influences the rate of innovation. Thus, a policy of entrenchment, tolerance of failure, soft bankruptcy laws and incentivization of undertaking R&D encourages new innovation. The empirical evidence is at best mixed (Kerr and Nanda, 2014).

Most innovation and innovation systems' theories have been formulated in the context of developed economies. Innovation systems in developing countries are weak with little interface among agents. Often firms indulge in 'technology cobbling' (Sharma and Iyer, 2012). Firms in developing countries undertake less disruptive and more incremental innovation and try to adopt, adapt and assimilate borrowed technology. Hence an improvement in their absorptive capacity in

⁴ This is in line with Khan et.al (2018).

the form of worker training and learning is more useful than 'new to market' innovation. More than innovation, it is the learning systems in developing countries that should be geared to assimilate and diffuse borrowed technology. Chasing a moving technology frontier is challenging for developing country firms (OECD, (2009), Sharma and Jha, (2016), Khan, et. Al., (2018), Ayyagari et. al. (2011), Mahendra, et.al. (2015)).

The present paper estimates the role of alternative forms of funding R&D comprising bank loans, overdraft facility, retained or own profits and equity on innovation. It studies the complementarity or substitutability between external funds and retained profits. Surveys of empirical studies on industrial economies are provided by (Hall, 2009) but for developing countries such analyses have started to emerge more recently (Khan, et.al. 2018).

DATA, METHODOLOGY AND EMPIRICAL ANALYSIS

Data and Methodology

The data set used in the present paper is the World Bank's Enterprise Survey data which comprises information on innovation and business environment in countries. The data used for the analysis is the cross-section data for 2014 for India and 2012 for China. For India, *Full Data* and the *Innovation Data* sets are merged with 3492 firms. The methodology used in the paper is suited for the limited dependent variable which has more than two options. An ordered logit or an Ologit model is used to estimate the sign of coefficients and marginal effects give the change in the response variable for a unit change in the independent variables. When the qualitative dependent variable is a binary variable then simple logit or probit models can be used but when the dependent variable has three or more options, then ordered models can be used if the numbers given to the categorical dependent variable are in the increasing order of importance or significance. In our study the dependent variable is made up of core and composite indices. The former uses both product and process innovations and hence takes the value 0, 1 or 2 where a higher order signifies a larger number of innovations undertaken by the firm. For composite index marketing and organizational innovations are used so that the ordering goes from 0 to 4 for India and 0 to 8 for China. In the Ologit model the observed ordinal response variable is Y which is a function of the latent variable Y^* . The Ologit model predicts the probability P_i of the outcome being in different categories with different intercepts for different partitions given by categories. The Ologit coefficients are not to be read as normal OLS coefficients. Negative coefficients of X imply that the independent variable is more likely to be in the lower categories of dependent variable Y . A positive coefficient means that it is more likely to be in the higher categories of the dependent variable. Marginal effects give the actual effect of a change in the X on Y and these are for as many categories as the ordinal values of Y . A negative marginal effect implies that if X increases by one unit then it is $x\%$ less likely in that category and a positive value means it is $x\%$ more likely to be in that category. Our empirical model estimates: Index of Innovation (core or composite) = f (size, ownership, legal status, age of firms, educational status of managers organizational arrangements, worker performance, inclusive management, training and skill formation, access to finance, in-house R&D expenditure, patents, external source of knowledge, corruption levels).

Empirical Analysis

Empirical analysis covers summary statistics and econometric estimations. The estimations use a core or a composite index of innovation as the dependent variable⁵. Core index is made up of product and process innovation and composite index comprises technological and soft innovation. Different sources of finance are the independent variables. Other firm-specific variables are used as control variables.

Summary Statistics for India

The summary statistics are first presented for full data. By size, the distribution of the various sources of funding working capital show a clear dominance of internal funds (Table 1).

Table 1 Sources of finance of working capital by firm-size (means in percent, N= 9281)

Source of finance of working capital	All firms	Small	Medium	Large
Internal funds or retained earnings	69.2	71.2	66.9	69.3
Borrowings from private or state-owned banks	17.3	12.5	21.0	22.6
Borrowings from NBFIs, credit coops, credit unions or finance companies	1.1	1.8	0.5	0.5
Purchases on credit from suppliers and advances from customers	6.8	7.2	7.5	3.5
Others – moneylenders, friends, relatives, etc	2.6	4.6	0.2	0.3

New fixed assets comprising machinery, vehicles, equipment, land or buildings are used as a proxy for capital equipment needed for R&D. By firm size 14.3 percent of small firms, 28.4 percent of medium and 49.7 percent of large firms purchase these assets. Funding of these assets is once again dominated by internal resources (Table 2).

Table 2 Sources of funding of purchase of fixed assets (mean, percent), by size

Source of finance of purchase of fixed assets	All firms	Small	Medium	Large
Internal funds or retained earnings	69.3	72.7	68.8	66.8
Owner's contribution or issue of new equity shares	5.2	3.8	6.5	4.5
Borrowings from private or state-owned banks	16.2	16.5	18.6	11.8
Other sources	Neg.	Neg.	Neg.	Neg.

Note: 'Neg.' – Negligible

Eighty six percent of firms have a savings or a checking account. Forty six percent of all firms have an overdraft facility which is lower for small firms at 31.2 percent compared to 55.3 percent for medium and 66.7 percent for large firms. Twenty one percent of all firms have a line of credit or a loan from a financial institution currently. In order to obtain this particular line of credit 84.2 percent of firms had to furnish collateral. Of the various reasons as to why the given firms did not apply for credit 53 percent of firms do not have a need for a loan. Thirteen percent firms find interest rates too high. Six percent of firms find application procedures too complex and another 6.5 find collateral requirements to be too high. Around 5 percent of firms feel that the size of loan and maturity are insufficient to meet their needs. Regarding the most recent application for loan 29 percent firms report that their application was approved while 52.4 percent report that application was rejected. Regarding the extent to which lack of finance or access to finance poses an impediment 34 percent of all sample firms do not find it to be an

⁵ We also estimate Probit models for product, process, organizational and marketing innovations taken as the dependent variables. In this case the dependent variable is a binary limited dependent variable and hence probit model is used to derive the marginal effects. However, for reasons of space these results are not reported in the paper.

obstacle. Around 50.6 percent of all firms find it to be a minor or a moderate obstacle. While 15 percent firms find it to be a major or a severe problem. It is a major or a severe problem for 17.1 percent of all small firms, 13.5 percent of all medium firms and 12.2 percent of all large firms. Hence small firms are more severely financially constrained.

The follow-up innovation survey conducted for 3492 firms captures in detail the various aspects of the four forms of innovation – product, process, organisational and marketing innovation. Product Innovation. Of the 3492 firms, 63.7 percent firms report that they have introduced a new product or service in the last three years. Table 3 compares the attributes of the existing and the new products which shows that quality and newness are more vital and price or cost considerations are less central to introducing new product or service.

Table 3 Comparison between the main innovative product/service with the existing products/services for innovative firms, India (percent)

All responses to a 'Yes' to the following questions	By size (N = 2275)			By sector		All firms
	small	medium	large	mfg	services	
Does it have completely new functions?	66.2	60.7	67.9	63	71.4	64
Is it cheaper to produce or offer?	23.5	24.6	18.7	22.3	26	22.8
Is it a better-quality product or service?	66.7	72.7	75.2	69.8	84.8	71.7
Does it use different inputs?	55.2	54.1	54.1	53.2	62.3	54.4
Is it based on a technology or industrial design not already used by the establishment?	31.8	40.6	44.6	37.9	47.9	39.2

The three main forms of process innovations undertaken by firms include innovative methods of production, innovative logistics, delivery or distribution methods for inputs, products or services and innovative supportive activity for processes such as maintenance systems or operations for purchasing, accounting or computing. Sixty two percent of all firms have introduced innovative methods of manufacturing products or offering services, 47.6 percent have undertaken innovative logistics, delivery or distribution methods and 49 percent of all firms have introduced innovative supportive activity for processes such as maintenance systems or operations for purchasing, accounting or computing. For 68.5 percent of the 2403 firms report that the most important innovative process introduced by the firm is also associated with an innovative product or service introduced by the establishment. There are 34.7 percent firms in the sample which have undertaken both forms of innovation.

Organisational innovation refers to changes in organisation or management which may or may not be related to product or process innovation. Table 4 below provides a list of possible innovative marketing methods the firms have either introduced or changed significantly over the reference period.

Table 4 List of innovative marketing methods introduced or changed significantly, India (percent)

Innovative marketing methods introduced or changed significantly	All firms	By size		
		Small	Medium	Large
Packaging	34.3	33	28.9	45.6
Branding, logo, name, trademark	24.3	23.2	21.3	31
Products' appearance excluding packaging or branding	46.4	47.3	43.8	49.9
Advertising methods	42.6	44.5	38.4	47.8
Promotion of producer service	50.1	49.5	49.6	51.7
Sales channels or sales points	50.7	42.2	48.3	64.9
Discount schemes	35.9	31.2	35	42.9
Pricing strategies excluding discount schemes	37.9	32.4	39.8	41.1
Payment schemes	35.7	36.6	36.5	33.3
Customer loyalty awards	16.8	16.6	13.9	22.4

Of all firms, 58.2 percent firms conduct internal R&D and 48.5 percent firms provide formal training to their employees. A large proportion of firms which introduce new products do not train their workers. Sixty eight percent have bought new equipment, machinery or software to develop or produce an innovative product, service or process. For the development of innovative products 4.4 percent firms have obtained a license of a patented or a non-patented invention/knowledge. The alternate sources of financing innovative activities are listed in Table 5 below.

Table 5 Alternate sources of funding innovative activities, India, (percent)

Alternative sources of funding	All firms	By size		
		Small	Medium	Large
N = 3492				
Own funds	96.9	97.1	96.8	96.8
Private or state banks	56.6	49.7	51.4	73.8
Government agencies or departments	6.3	4.9	7.6	5.6
NGOs or international organizations	2.2	2.6	1.9	2.3
Other money lenders, friends, relatives, etc	8.4	6.8	9	9

Summary Statistics for China

There are 2700 firms in the sample. Small, medium and large firms comprise 65.3 percent, 26 percent and 8.6 percent respectively. For the entire sample 43.5 percent firms undertake innovation to produce new products or services. Thirty seven percent of 1692 responding firms have spent on R&D activities within the establishment. Of 1693 firms, 11.4 percent firms have spent on R&D activities contracted with other firms. On an average, 48 percent of the establishments' workforce use computers. Almost a quarter of total sales by Chinese firms are conducted online.

The survey lists eight options under the sub-head of 'various types of innovation activities' undertaken firms given Table 6. Cost reduction and improving the absorptive capacity of firms by training their workers has the largest shares in the types of innovation in China. The latter is a direct consequence of the use of imported technology in various firms to optimize the gains from adoption and technology assimilation via training the workers.

Table 6 Types of innovation activities undertaken by the firm, China (percent), N= 1693

Type of Innovation	Share of all firms
New technology or equipment to improve product or process	55.2
Introduction of new quality control procedure in production or operations	40.3
Introduced new managerial/administrative processes	39
Provide training to their staff to acquaint them with the use of new technology	64
Have introduced a new product or a service	46
have added new features to existing products or services	43.8
adopted measures to reduce costs	67
Improved production flexibility	54.1

With regards to financing working capital, eighty five percent of working capital is financed by internal funds or retained earnings, 5.9 percent from borrowings from private and state-owned banks, 0.25 percent borrowing from NBFIs (microfinance institutions, credit cooperatives, credit unions and finance companies) and 4 percent as suppliers' credit and customer advances. Small firms are more financially constrained. Of all firms, 39.3 percent firms have purchased new fixed assets made up of machinery, vehicles, equipment, land or buildings. Internal funds or retained earnings are used to fund 86.5 percent of fixed assets with 3 percent funds from are owners or new equity shares, 4.1 percent from bank funds with an significant

share of borrowings from NBFIs and funds from other informal sources. Supplier-credit and customer advances comprise 1.5 percent.

Ninety six percent firms have a savings account but only 23.4 percent firms have an overdraft facility. Twenty five percent firms have a loan from a financial institution in the current period. Both the overdraft facility and the incidence of loans are higher for large firms. State-owned banks provide the largest share of loans which is 75.6 percent. Private commercial banks provide 16.2 percent of the loans and NBFIs have a share of 4.8 percent. Others provide only 2.1 percent funds. Seventy one percent firms out of 810 firms have had to furnish collateral to obtain the loan or credit. Only 3.3 percent of 2700 firms have personal loans to finance the establishment's business operations. Around 21.2 percent firms applied for any form of loan or credit. For the remaining firms with no loan, 57.2 percent have no need for a loan, 10 percent firms cite very high value of collateral, others find application procedures very complex (9.7 percent), size of the loan and maturity insufficient (7.7 percent), unfavourable interest rates (6.4 percent) and some firms did not think it will be approved (5.3 percent). Of 2700 firms access to finance is not an obstacle or a minor obstacle for 77.6 percent firms. It is a major or a very severe obstacle for 2.8 percent of sample firms. However, it is a moderate obstacle for 17.5 percent firms. Access to finance is a major or a severe problem more for medium followed by large and small firms.

Econometric Analysis for India

The Ologit estimates for the composite index are given Table 7 below. The Ologit estimations have been done for all four forms of financing and for core and composite definitions of innovation. Estimations are also conducted for only external and only internal sources. For reasons of space, we report the marginal effects for the composite index only. The control variables are firm-specific variables⁶. *BANK_FINANCE* is a binary categorical variable made up of finance from banks and non-banking financial institutions (NBFIs). *BORROW_FIX* is made up of a loan or an overdraft facility and takes a value one if firms have a loan and/or an overdraft facility and zero otherwise. Own funds and retained profits are *RET_PROF* and equity finance is *EQUITY_FIX*. The signs of the three of the four alternative sources of financing for core innovation are positive which implies that they are more likely to be used in higher categories of dependent variable. Only equity finance has a negative sign which implies that when firms do not innovate or lack depth in innovation, they use equity finance. Higher levels of innovation index are relatively uncertain and risky and the principal-agent conflict is stronger whereby firms using equity finance are less keen to take on this risk or do not find investors forthcoming. The signs of coefficients for all four innovations in the composite index also give a negative sign of equity finance compared to other three sources. Marginal effects in table 8 show that medium and large firms, younger firms and firms which undertake R&D are more likely to undertake larger number of innovations. When a larger number of innovations are undertaken reliance on equity finance falls. Firms which train their workers or rely on foreign technology undertake more innovations although the relation is not significant. Capacity utilization is an important determinant of the ability of firms to introduce a larger number of innovations.

When loan/overdraft facility and bank finance to purchase fixed assets are introduced without retained profit and equity finance they emerge complementary and positive especially when more than two innovations are undertaken. Significant complementarity is obtained with fuller

⁶ Another set of estimates for India include business environment variables but not reported as results remain robust.

capacity utilization and firm-R&D. Between retained profits and equity finance to fund fixed assets, there is a trade-off and for larger number of innovations, firms prefer using their own funds than equity finance. This is also partly because of the principal-agent issue. Managers are less prone to take risks and hence limit themselves to minor or few innovations to safeguard the interests of shareholders. Thus, for core innovation external sources of funding with in-house R&D are significant whereas for composite innovation which reflects the rise in the depth of innovation and paired innovation, retained profits, bank finance and loans are significant whereas equity finance remains less reliable source of finance.

Table 7 Ologit estimates for India for composite innovation index using internal and external sources of finance

Variables	Coeff.	Marginal effects for outcome 1	Marginal effects for outcome 2	Marginal effects for outcome 3	Marginal effects for outcome 4
(1)	(2)	(3)	(4)	(5)	(6)
SIZE					
<i>Medium</i>	0.056 (0.30)	-0.009 (-0.30)	-0.002 (-0.31)	0.007 (0.29)	0.005 (0.30)
<i>Large</i>	0.149 (0.59)	-0.023 (-0.59)	-0.005 (-0.56)	0.018 (0.58)	0.012 (0.60)
LEGAL_STATUS					
<i>Shareholding</i>	0.554 (1.69)	-0.085 (-1.64)	-0.014 (-1.48)	0.068 (1.65)	0.046 (1.81)
<i>Sole proprietorship</i>	0.388 (1.30)	-0.061 (-1.28)	-0.007 (-1.47)	0.049 (1.29)	0.030 (1.44)
<i>Partnership</i>	0.238 (0.74)	-0.038 (-0.73)	-0.003 (-0.60)	0.030 (0.74)	0.018 (0.77)
<i>Limited partnership</i>	0.112 (0.34)	-0.018 (-0.34)	-0.0004 (-0.28)	0.014 (0.34)	0.008 (0.35)
LNAGE	-0.084 (-1.20)	0.013 (1.18)	0.003 (1.14)	-0.011 (-1.20)	-0.007 (-1.20)
BORROW_FIX	0.329 (2.14)	-0.051 (-2.11)	-0.010 (-2.00)	0.041 (2.10)	0.028 (2.18)
BANK_FINANCE	0.733 (4.36)	-0.113 (-4.49)	-0.023 (-2.95)	0.092 (4.47)	0.062 (4.03)
RET_PROF	0.388 (2.70)	-0.059 (-2.69)	-0.012 (-2.52)	0.048 (2.65)	0.033 (2.77)
EQUITY_FIX	-0.549 (-1.56)	0.084 (1.56)	0.017 (1.49)	-0.069 (-1.55)	-0.047 (-1.56)
RND	0.923 (5.18)	-0.142 (-5.13)	-0.029 (-2.80)	0.116 (5.07)	0.078 (4.84)
TRAIN	0.134 (0.85)	-0.026 (-0.86)	-0.004 (-0.85)	0.017 (0.86)	0.011 (0.83)
MARKET_ORIENT					
<i>National</i>	-1.26 (-2.87)	0.158 (3.74)	0.076 (2.49)	-0.113 (-5.87)	-0.14 (-2.22)
<i>International</i>	-0.767 (-1.55)	0.087 (1.65)	0.059 (1.65)	-0.057 (-1.95)	-0.101 (-1.43)
FOREIGN_TECH	0.191 (0.62)	-0.029 (-0.62)	-0.006 (-0.61)	0.024 (0.62)	0.016 (0.62)
IMP_INPT	-0.366 (-1.06)	0.056 (1.07)	0.011 (1.02)	-0.045 (-1.05)	-0.031 (-1.08)
INTL_CERTI	0.086	-0.013	-0.002	0.010	0.007

Variables	Coeff.	Marginal effects for outcome 1	Marginal effects for outcome 2	Marginal effects for outcome 3	Marginal effects for outcome 4
	(0.50)	(-0.50)	(-0.48)	(0.50)	(0.50)
CAPACITY_USE	0.016 (3.18)	-0.002 (-3.17)	-0.0005 (-2.84)	0.002 (3.23)	0.001 (3.18)

Note: Figures in the brackets for coefficients are t values and for marginal effects are z values. For marginal effects critical values of z are: 10 percent level of significance is ± 1.64 , 5 percent level of significance is ± 1.96 and at 1 percent level of significance is ± 2.58 .

Econometric Analysis for China

Results for the composite index for China are reported in Table 8 below. There are eight innovations listed in the survey. The signs of coefficients for the three configurations of sources of finance show that the likelihood of loan or credit line being used is higher for lower categories of the dependent variable and as the number of innovations undertaken increase reliance on other sources of finance increases. For all models estimated, complementarity exists between these finance options and R&D expenditures with greater reliance on foreign technology, workers' training in the use of this technology and dependence on skilled labour. Hence, firms in China have work on improving their absorptive capacity by upgrading human skills, exploit foreign technology and impart training to workers to exploit and assimilate this technology with innovation. Firms which are less innovative rely more on imported inputs than foreign technology as the latter involves greater learning and assimilation effort. However, marginal effects for imported inputs are not significant. Firms are also more innovative when their managers fully comply with government regulations. The most important source of finance is retained profits followed by equity issues and then bank finance whereas dependence on loan or credit reduces as firms become more innovative.

Table 8 Marginal effects for China (all sources of finance with eight forms of innovation)

Variables	Marginal effects for outcome 1	Marginal effects for outcome 2	Marginal effects for outcome 3	Marginal effects for outcome 4	Marginal effects for outcome 5	Marginal effects for outcome 6	Marginal effects for outcome 7	Marginal effects for outcome 8
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
BORROW_FIX	0.005 (1.53)	0.011 (1.62)	0.006 (1.66)	0.003 (1.38)	-0.002 (-1.12)	-0.007 (-1.58)	-0.008 (-1.62)	-0.055 (-1.69)***
BANK_FIN	-0.007 (-1.80)	-0.013 (-1.95)	-0.007 (-1.92)	-0.003 (-1.76)	0.002 (1.14)	0.008 (1.92)	0.009 (2.01)	0.062 (2.36)**
RET_PROF	-0.009 (-2.89)	-0.016 (-2.01)	-0.009 (-3.85)	-0.004 (-2.13)	0.003 (1.20)	0.011 (2.82)	0.013 (3.07)	0.083 (3.97)*
EQUITY_FIX	-0.008 (-1.77)	-0.016 (-2.01)	-0.009 (-1.90)	-0.004 (-1.54)	0.003 (1.20)	0.011 (1.80)	0.012 (1.88)	0.079 (2.06)**
RND	-0.015 (-3.51)	-0.03 (-4.28)	-0.017 (-4.88)	-0.008 (-2.39)	0.005 (1.43)	0.019 (3.69)	0.023 (4.71)	0.147 (7.06)*
TRAIN	-0.033 (-4.16)	-0.063 (-6.44)	-0.036 (-5.40)	-0.017 (-2.09)	0.1 (1.56)	0.041 (4.43)	0.048 (5.03)	0.309 (11.13)*
FOREIGN_TECH	-0.013 (-2.79)	-0.025 (-3.49)	-0.014 (-4.18)	-0.007 (-2.27)	0.004 (1.37)	0.016 (3.07)	0.019 (3.53)	0.122 (5.21)*
IMP_INPT	0.004 (1.05)	0.008 (1.05)	0.004 (1.09)	0.002 (0.98)	-0.001 (-0.90)	-0.005 (-1.05)	-0.006 (-1.06)	-0.037 (-1.08)
CAPACITY_USE	-0.00003 (-0.59)	-0.0001 (-0.60)	-0.00003 (-0.61)	-0.00002 (-0.61)	0.00 (0.55)	0.00003 (0.61)	0.00004 (0.60)	0.0003 (0.61)
MANAGER_TIME	-0.001 (-2.04)	-0.002 (-2.08)	-0.001 (-2.23)	-0.0004 (-1.72)	0.0003 (1.23)	0.001 (2.04)	0.001 (2.19)	0.009 (2.37)*
SKILLED_LAB	-0.008	-0.016	-0.009	-0.004	0.003	0.010	0.012	0.078

Variables	Marginal effects for outcome 1	Marginal effects for outcome 2	Marginal effects for outcome 3	Marginal effects for outcome 4	Marginal effects for outcome 5	Marginal effects for outcome 6	Marginal effects for outcome 7	Marginal effects for outcome 8
	(-1.43)	(-1.71)	(-1.65)	(-1.57)	(1.08)	(1.58)	(1.69)	(1.83)*

Note: Figures in the brackets for coefficients are t values and for marginal effects are z values. For marginal effects critical values of z are: 10 percent level of significance is ± 1.64 , 5 percent level of significance is ± 1.96 and at 1 percent level of significance is ± 2.58 .

The results show that depth of innovation depends on various sources of finance in the presence of firm-heterogeneity. Firms in India and China rely on their internal funds and undertake R&D to be innovative. The incidence of innovation is higher for Indian firms when they utilize their created capacity more fully. Firms in China innovate with a fuller use of imported technology by training their workers and recruit skilled workers capable of exploiting the borrowed technology complementary to their internal R&D efforts. In India, 15.08 percent firms consider access to finance as a major or a very severe constraint. For China only 2.79 percent of all firms are majorly or severely finance constrained. Smaller firms are more severely constrained compared to medium and large firms. Chinese firms spend on imported technology and optimize its use by investing in human capital by providing formal training in the use of technology. Improvement in absorptive capacity by upgrading worker skills plays a significant role in determining the depth of innovation in China.

CONCLUSION

This paper brings out the significance of the alternate sources of finance in firm-innovation in India and China. The main conclusions are two-fold. One, firms use both internal and external sources of finance to innovate. In India, reliance on equity finance declines and in China rises, as depth of innovation increases. Two, there are many firm-specific factors, the control variables, which affect the choice of the kind of finance especially internal R&D and capacity utilization. Use of foreign technology with worker-training is crucial to innovation especially as depth of innovation rises in China. Complementarity between various forms of innovation and R&D in both India and China draw attention to the fact that availability of funds with R&D together result in innovation. Comparisons between India and China show that access to finance, is not a 'major' or a 'very severe obstacle' for Chinese firms as much as it is for Indian firms. Bank credit, retained profits and equity finance are all important for firms in China especially for higher orders of the composite index. Borrowings are used more for funding four or less than four forms of innovations undertaken by firms. Own funds are used more as innovation deepens. Chinese firms focus more on cost reduction and worker training than India. In contrast Indian firms rely on equity markets to purchase fixed assets in the earlier stages of innovation. As innovation deepens and cuts across technological and soft innovations firms rely most on bank finance followed by internal funds and loans and overdraft facility to build fixed assets. Complementary to finance is the role of R&D. Foreign technology and training to workers is not significant. Large firms innovate more than small and medium firms. Depth of innovation is the least for limited partnership firms. Increased capacity utilization allows firms to experiment and undertake all kinds of innovation.

Policy implications of the above analysis is that small and medium firms are more financially constrained and hence financial inclusion especially formal institutional credit must be made available to SMEs. Large, mature firms manage to command a greater share in external funds due to their ability to furnish collateral. Provision of finance followed by monitoring of loans and their utilization is critical to the health of the financial system and overcome the

problem of bad loans. Firms in both the countries also rely on internal funds and hence tax policy can be made more pro-R&D and innovation than simply provide blanket tax concessions on profits to all firms across the board irrespective whether they innovate at all or not. Policy should ensure that the business environment and access to foreign technology or imported inputs should be eased. An important lesson from China is the use of foreign technology must be accompanied with worker training which allows better assimilation of imported technology, improves absorptive capacity and motivates firms to innovate. This explains China's superior performance compared to India as given in Global Innovation Index Reports. The depth of innovation in the composite index for both India and China also underscore the complementarity of technological and non-technological innovation. Further research on sub-sample analyses with respect to size, incidence of innovation, location, sector and ownership will shed more light on the finance-innovation linkages in developing economies.

REFERENCES

- Acemoglu, D., Aghion, P. and Zilibotti, F. (2006). Distance to Frontier, Selection and Economic Growth, *Journal of European Economic Association*, Vol. 4, No. 1, pp. 37-74.
- Akerlof, G. (1970). The Market for Lemons: Qualitative Uncertainty and the Market Mechanism. *Quarterly Journal of Economics* Vol. 84, No. 3, pp.448-500.
- Anton, J.J., and Yao, D. (1995). Start-ups, Spin-offs and Internal Projects. *Journal of Law, Economics and Organisation*, Vol. 11, No. 2, pp. 362-378.
- Ayyagari, M., Demircuc-Kunt, A. and Maksimovic, V. (2011). Firm Innovation in Emerging Markets: The Role of Finance, Governance and Competition, *Journal of Financial and Quantitative Analysis*, Vol. 46, No. 6, pp. 1545-1580.
- Brown, J. R. and Petersen, B. C. (2011). Cash Holdings and R&D Smoothing. *Journal of Corporate Finance* Vol. 17, No. 3, pp. 694-709.
- Cong, L. W., Lee, C. M. C., Qu, Y. and Shen T. (2018). Financing Entrepreneurship and Innovation in China: A Public Policy Perspective.
- Didier, T. and Schmukler, S. L. (2013). The Financing and Growth of Firms in China and India – Evidence from Capital Markets. Policy research Working Paper 6401, World Bank.
- Elliot, D. J. and Yan, K. (2013). The Chinese Financial System – An Introduction and Overview. John L. Thornton Center at Brookings. Washington DC.
- Farrel, D. and Lund, S., (2006). 'A Tale of Two Financial Systems: A comparison of China and India', Mckinsey Global Institute. <https://www.mckinsey.com/featured-insights/winning-in-emerging-markets/a-tale-of-two-financial-systems>
- GII (2018). *The Global Innovation Index 2018: Energizing the World with Innovation*. Cornell University, INSEAD and WIPO. Geneva. ISBN 979-10-95870-09-8. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2018.pdf
- GII (2019). *The Global Innovation Index 2019: Creating Healthy Lives – The Future of Medical Innovation*. Cornell University, INSEAD and WIPO. Geneva. ISBN 979-10-95870-14-2. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019.pdf
- Hall, B. H. (2009). The Financing of Innovative Firms, EIB Papers, Vol.14, No.2, pp.8-29.
- Hall, B. and Lerner, J. (2010). The Financing of R&D and Innovation. In B. Hall and N. Rosenberg, (Eds.). *Handbook of Economics of Innovation* (pp.609-639). Netherlands: Elsevier.
- ICS (2017). Comparing Financial Markets of India and China, Institute of Chinese Studies, 4th October, Delhi.
- Jadhav, N. and Raj, J. (2005). Financial System in India and China – A Comparative Study, Conference Paper, Economic Reforms in India and China – Emerging Issues and Challenges, January 29-30.
- Khan, S. U., Shah, A. U. and Rizwan, M. F. (2018). Innovation and Access to Finance: International Evidence from Developing Markets. <https://www.pide.org.pk/psde/pdf/AGM34/papers/Dr.Safi-Ullah-Khan.pdf>
- Kerr, W. R. and Nanda, R. (2014). Financing Innovation, Working Paper No. 15-034, *Harvard Business School*, November 5.

- Levine, R. (2005). Finance and Growth: Theory and Evidence. In P. Aghion and S. N. Durlauf (Eds.) *Handbook of Economic Growth*. Amsterdam: North-Holland Elsevier Publishers.
- OECD (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, Third Edition, OECD, Paris.
- OECD (2009). *Innovation and Growth: Chasing a Moving Frontier*, OECD, Paris.
- Sharma, A. and Jha, S. (2016). Innovation from Emerging Market Firms: What Happens when Market Ambitions meet Technology Challenges, *Journal of Business and Industrial Marketing*, Vol. 31, No. 4, pp. 507-518
- Sharma, A. and Iyer, G. R. (2012). Resource-Constrained Product Development: Implications for Green Marketing and Green Supply Chains, in *Industrial Marketing Management*, Vol. 41, pp. 599-608.
- Singh, A. and Hamid, J. (1992). Corporate Financial Structures in Developing Countries. Technical Paper 1, IFC, Washington DC.

