DOI: https://doi.org/10.17323/j.jcfr.2073-0438.18.3.2024.97-109
JEL classification: G28, G30, G32, G38, O32

Financing and Management of Innovation in India: New Paths for Green Innovation

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Abstract

India is a fascinating example of an emerging economy which adapts the concept of innovation-based growth to its own specific economic and cultural context. Innovation in India has attracted growing interest among researchers, with a steady increase in the number of published works on the subject and in the number of their citations. The present paper provides a meta-review of the literature on the financing and management of innovation and green innovation in India. The novelty of the analysis is severalfold. Firstly, we highlight the coexistence of universal and India-specific features in the types of innovation and the practices of financing and management of innovation in the country. Secondly, the paper not only summarizes a range of bibliometric surveys and a large number of methodological and empirical papers on innovation in India, but also reviews a unique series of papers associated with the World Management Survey, which compare and contrast managerial practices in India with those in a large number of developed and emerging economies. Our analysis shows that India follows a number of universal approaches to the financing and management of innovation, and that parallels can be established between innovative IT companies in India and Japan. However, India uses many practices that are deemed inefficient in developed countries: the government, not the private sector, is the major supplier of R&D expenditure and green investment; family ownership is a driver of (not an obstacle to) innovation; there is a focus on low-income consumers; and cost-cutting rather than quality competition is the primary innovation technique. In conclusion, we link the India-specific innovation path to various opportunities for fostering green growth in the country.

Keywords: R&D, green innovation, green financing, ESG, BRICS

For citation: Besstremyannaya G., Dasher R. (2024) Financing and Management of Innovation in India: New Paths for Green Innovation. *Journal of Corporate Finance Research.* 18(3): 97-109. https://doi.org/10.17323/j. jcfr.2073-0438.18.3.2024.97-109

Introduction

India is a fast-growing middle-income country with strong regulation by government. Growth of real GDP in India has been the fastest in emerging and developing Asia since 2021, achieving rates of 7–8% per year [1, p. 7]. India is also the world's third largest emitter of greenhouse gases (GHG) [2].

India obtained its political independence in 1947 and has been implementing market reforms since 1991. Despite commitment to shifting from a planned to a liberalized economy, progress over the last 30 years has been very gradual. The National Party, which has led the reform process, only gained a majority in government in 1999 and it has taken one or two decades to put in place essential legislation for the functioning of a new economic system[1].

India has followed the modern paradigm of fostering economic growth through innovation [4], a paradigm that is particularly emphasized in the BRICS countries [5]. According to the OECD and Eurostat [6]: "an innovation is 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, work place organization or external relations" [6, paragraph 146]; and "a new or improved product is implemented when it is introduced on the market. New processes, marketing methods or organisational methods are implemented when they are brought into actual use in the firm's operations" [6, paragraph 150].

Green innovation stands apart from other innovation and may be broadly considered as "the adoption and development of technologies for the mitigation of environmental degradation" [7]. According to the OECD, green innovation (eco-innovation) is "the development of products (goods and services), processes, marketing methods, organizational structure, and new or improved institutional arrangements which, intentionally or not, contribute to a reduction of environmental impact in comparison with alternative practices" [8, p. 67–68]. Green investment (or green financing) implies "investment…venture or commitment made for the alleviation or avoidance of ecological debasement" [7].

The government of India stated its commitment to innovation in 1999 and several policy reforms have attempted to create stimuli for innovation through better protection of intellectual property rights (IPRs)[2]. Types of innovation and the drivers of successful innovation in middle-income countries in transition commonly differ from what is usual in developed countries [9]. Accordingly, a large body of literature focuses on the specific features of innovation in emerging countries and on national systems of innovation[3]. It has been noted that the model of large projects with substantial budgets financed by government or corporations, which is prevalent in the US, EU, and Japan, is not observed in India [10]. In the absence of such generous sources of financing, innovation in India tends to be "resource-constrained" [11; 12]. Moreover, lack of competition and inadequate market mechanisms in the Indian economy explain an emphasis by companies on incremental (non-radical, often imitative) innovation and the existence of domestic industries with very modest innovation potential [4].

Innovation undoubtedly requires R&D expenditure [13], and this highlights the importance of the financial context of national systems of innovation [5]. R&D expenditure must be properly managed in order to produce innovation outcomes [14–16]. It is generally agreed that a combination of appropriate economic and financial institutional environment at macro level and effective managerial practices at company level are prerequisites for successful innovation [17–19]. On the one hand, forms of entrepreneurship in general and management of innovation in particular display a number of unique features in India [11; 12; 20]. On the other hand, a large amount of research on India highlights the country's use of universal building blocks of successful innovation, which have proved effective in developed countries. It is plausible to claim that financing and management of innovation in India is most accurately described as a synthesis of universal and India-specific approaches.

The purpose of this paper is to provide an up-to-date meta-review of literature on the financing and management of innovation in India. The meta-review is novel because it highlights the co-existence of two types of practices in the country: universal practices that are well-established worldwide; and approaches that are India-specific. We studied a range of bibliometric surveys on the subject and selected a large number of papers that offer qualitative and quantitative analysis of innovation and the financing and management of innovation in India (Table 1). Additionally, we used a unique series of papers associated with the World Management Survey that contrast various managerial practices in India with those used in developed and other developing countries [21–23]. Finally, the analysis in this paper reviews policy evaluation papers [24; 25] which assess a field experiment that introduced several internationally well-established managerial techniques to Indian firms.

[1] According to [3], the Competition Act, Right to Information Act, and Land Acquisition Act required, respectively, 11, 15 and 17 years for their pre-legislative stages alone (see Tables 2.3 and 2.4 in [3, p. 46, 64].

[2] Examples include signing of the Trade Related Property Rights Agreement in 2005 when joining the WTO and adoption of the Intellectual Property Rights Policy in 2016.

[3] According to [5, p. XXX]: "Systems of innovation, defined as a set of different institutions that contribute to the development of the innovation and learning capacity of a country, region, economic sector, or locality, comprise a series of elements and relations that relate production, assimilation, use, and diffusion of knowledge".

Table 1. Studies analyzed in this paper on innovation and the financing and management of innovation in India

Type of study	Details
Bibliometric reviews	A. Nair et al. (2015): a review of innovation in India [4]. D. Chatterjee and S. Sahasranamam (2018): a comparative review of technological innovation in China and India in 1991–2015 [32]. G. Sharma (2019): a review of innovation and entrepreneurship in India in 2000–2018 [31]. S. Khan et al. (2021): a systematic review of green process innovations worldwide, including India [69]. S. Tomer and G. Rana (2020): green human resource management worldwide, including India [70]. Y. Gaajar (2021): green investment in the coal sector worldwide, including India [7]. S. Bhatnagar and D. Sharma (2021): potential for financial innovation through green financing in India [45]. U. Chaturvedi et al. (2017): green innovation in the pharmaceutical industry in India [71]. H. Diwan and B. Sreeraman (2024): ESG reporting worldwide, including India [44].
Case studies	N. Sharma (2016): management of innovation at 3 IT and 3 pharmaceutical firms [29]. P. Ray and S. Ray (2010): case study of resource-constrained innovation at telecom company C-DoT [11]. P. Ray and S. Ray (2011): resource-constrained innovation by Tata Motors (the Nano car) [12]. J. Prabhu and S. Jain (2015): frugal innovation ("jugaad") in India [10]. S. Jain (2022): frugal innovation and its evolution in India [9]. A. Motwani and R. Gupta (2023): content analysis of ESG reports by 9 large Indian companies in the energy sector [43]
Statistical analyses: surveys of managers and employees, company-level surveys, data analysis in the World Management Survey	P. Malaviya and S. Wadhwa (2005): innovation management in a software firm as viewed by its 45 employees [27]. J. Bhatnagar (2012): innovation management and people management, survey of 291 managers from five innovative firms [26]. R. Singh et al. (2005): innovation as a strategy at Indian electronics firms, 44 SMEs, mailed questionnaire [63]. V. Gupta and B. Gupta (2014): management of innovation at 88 SMEs, face-to-face interviews [65]. A. Chakraborty (2024): quality management at 52 manufacturing SMEs in Southern India, mailed questionnaire [3]. S. Sahoo (2019): quality management and innovation at 34 manufacturing SMEs, face-to-face interviews [28]. N. Bloom et al. (2010), N. Bloom and Van Reenen (2010): management scores of 620 manufacturing firms in India contrasted with scores of 100–700 firms in other countries [21; 22]. M. Singh et al. (2021): ESG disclosure by 203 SMEs listed on the Bombay Stock Exchange [42]

Type of study	Details
Econometric analysis	S. Ray and P. Ray (2021): 961 pharmaceutical firms in 1994–2012, policy evaluation of tightening IPR protection and its impact on exploratory innovation [20]. N. Bloom et al. (2013): 28 plants in 17 firms in 2008–2011, weekly data, policy evaluation of the effect on firm production of introduction of 38 modern management practices [24]. N. Bloom et al. (2020): 28 plants in 17 firms in 2008–2017, a study of whether newly introduced management practices were maintained by firms; analysis of impact of the new practices on the firms in the long run [25]. M. Nazir et al. (2021): macro-level analysis for China, India and Pakistan; interrelation between financial innovation and economic growth [72]. P. Mishra and M. Yadaw (2021): determinants of green innovation at 221 large firms in the manufacturing and service sectors in India [2]. G. Rana and V. Arya (2024): green human resource management as a predictor of green innovation according to a survey of 579 employees in India's manufacturing sector [55]. P. Sharma et al. (2020): ESG reporting and financial performance of 82 companies listed on the Bombay Stock Exchange [56]

The remainder of the paper is organized as follows. Second section overviews main topics relating to the financing and management of innovation in India. Universal drivers of innovation and building blocks of financing and management of innovation in India are outlined in third section. Fourth section provides a list of unique features of innovation strategies as well as India-specific approaches to financing and managing innovation. A contrast between innovation practices at companies in India and firms worldwide is given in Fifth section. The final section of the paper gives a summary of the regularities highlighted by the preceding analysis and their application to new developments in the sphere of green innovation in India.

Overview of innovation research in India

Bibliometric reviews and searches of scientific databases using the keywords "finance of innovation in India" and "management of innovation in India" found the following aspects to be of most interest to international researchers writing in English:

a) Incentives of Indian entrepreneurs [26].
b) Innovation in the Indian telecom and automobile industries [11; 12].
c) India-specific forms of innovation [9; 10].
d) Innovation in Indian small and medium-sized enterprises [27; 28].
e) Innovation in Indian pharmaceuticals, IT and renewable energy [12; 29].
f) Green innovation and green innovation financing in India [8; 26; 30].

The prevailing research areas in Indian innovation are associated with key words "business, management, and accounting" [31] and "policy, economics, and governance" [32], while in China the focus would be placed on "IP and technology diffusion" [32].

The Indian economy is marked by high levels of inequality and regional disparity, high share of the agricultural sector (especially as regards the labor force [30]), relative cheapness of labor and high returns to labor [4; 25]. Accordingly, a large share of innovation research consists of case studies on innovation strategies in companies in selected geographic areas and industries. Most of the research emphasizes personnel management and many papers focus on production in the agricultural sector, as well as innovations targeted at the rural population. Only a few papers analyze large samples of data, but even those are often limited to statistical analysis of a hundred or fewer observations.

Universal building-blocks of innovation and the financing and management of innovation in India

India follows the classic example of modern innovative economies, where companies innovate to increase their profits by entering markets for new products or by expanding markets for their existing products [33–35]. Such innovation is generally agreed to be an important factor in economic growth: the paradigm of endogenous growth

models with technological change has received ample empirical support on the macro level for developed countries, such as the US, Japan, and the Netherlands [35–37]. Growth through innovation is also on the agenda of the BRICS countries. Specifically, there is "a close articulation of innovation policy with the countries' development strategy in China and India" [38, p. 15].

Similarly to other BRICS countries, the state plays the most important role in the innovation system in India [38, p. 15]. The public sector is the major source of R&D financing in India [39] in contrast with most other countries where the private sector bears most of the burden of R&D expenditure [40, Figure 5]. However, India stands out by the emphasis which the government places on creating incentives that are inseparable from free-market organization of the economy, such as the provision of R&D tax credits [38, p. 15; 39].

Other important instruments of R&D financing in many countries are research grants and venture capital [39]. The latter is still very small in India: the total amount of venture capital in the country is less than 40% of what it is in China and less than 10% of its value in the US [1, p. 26]. It is also notable that, despite the large share of public sources in total national R&D expenditure in India, the ratio of Indian R&D expenditure to GDP is less than 0.007. Moreover, the ratio has been declining over the past two decades (from over 0.08 in 2005-2009 to 0.064 in 2020–2021 [41]). This is low both by international standards (the international figure for the ratio is 0.02) and by the standards of other BRICS countries [38].

As regards green innovation financing in India, the government has carried out direct investment in green innovation as well as offering various policy measures to stimulate green investment by the private sector. Regulatory measures include:

1) Mandatory publication of business responsibility (ESG performance) reports by the top 100 listed companies, established by the Securities and Exchange Board of India in 2012 [42]. Mandatory reporting has been extended to the top 1000 listed companies since 2022–2023 [43].
2) ESG disclosure at the National Stock Exchange of India on a "comply-or-explain basis" since 2015 [44].
3) The policy of the Reserve Bank of India since 2015 prioritizes lending to the energy sector and the agricultural sector, where most of green innovation is accumulated.
4) Introduction in 2015 of green bonds as a capital market instrument and establishment by the Securities and Exchange Board of India of the requirement that large companies raise 25% of their debt through bonds [30; 45] (green bonds were first employed in the EU in 2007 and have been gaining popularity in the BRICS countries as a green financing tool [46–48]).
5) Adoption of the National Action Plan for Climate Change in 2010 and creation of the Ministry of New and Renewable Energy [45].

Government support for innovation is essential in all countries due to various market failures. Firstly, innovation is closely linked to the disclosure of knowledge, so new products are vulnerable to imitation. To prevent the loss of novelty through imitation governments design policies for the protection of IPRs. Governments address other causes of under-provision of innovation by improving an appropriate institutional climate and governance as well as by offering various types of financial, organizational and other support to companies in order to stimulate innovation. The higher the per capita GDP of the economy, the greater the ability of government to maintain the quality of its institutions [49] and hence to stimulate innovation.

The above-mentioned economic and policy regularities are well observed in India. It is therefore possible to outline a number of universal building blocks of innovation in India on the *macro-economic level* related to regulation, institutional climate and governance. They can be summarized as follows:

a) Regional variation in outcomes of innovation due to differing governance practices between Indian states [4; 31; 32].
b) Interrelation between IPR protection and incentives of firms to innovate [4; 20].
c) Links between firms, government and R&D universities, although such links remain weak in India due to poor governance of innovation and inadequate institutional incentives.
d) Use of traditional instruments by government to promote overall R&D investment and green investment by firms: liberalization, protection of IPR, R&D tax incentives, coal tax and research subsidies, ESG disclosure practice and green bonds [5,; 38; 39; 50].
e) Strengthening the national banking system by encouraging banks to avoid bad debts and to develop microfinance practices as a source of private R&D investment [7; 8; 50].
f) Introduction of green bonds as a long-term financing instrument with the ability to "relieve pressure on bank balance sheets" [50].

India has low per capita GDP, which, as cross-country evidence shows, is associated with low management scores of firms in various sectors [23]. This goes in line with a well-established inverse relationship between per capita GDP and quality of management. Low per capita GDP may be caused by deficiencies of the institutional climate (insufficient stimuli for non-predatory and innovative behavior [49]), which would also be a cause of ineffective management.

At the *company-level* (*micro level*) a number of empirical regularities concerning innovation and innovation finance and management at Indian firms may be noted. These regularities as regards innovation techniques and preferred tools for effective management of innovation, including green innovation, in India correspond to findings in the

empirical literature for the US, Japan, and other countries. Such managerial practices include effective leadership, firm organizational structure and capability, and collaboration in research, as well as people management and management of diversity [2; 14; 51; 52].

Universal (internationally observed) features of innovation that are observed in Indian firms include the following:

a) Innovation is driven by growth opportunities [29], diversification and the search for new product markets [9]. There are spillover effects among Indian firms as regards innovation and managerial practices [25; 32].

b) M&As and innovation are complementary strategies. Indian companies use M&As to compensate for lack of in-house R&D, and the same department of a company often deals with both R&D and acquisitions [4][4].

c) The will to implement green innovation is positively linked to financial performance of firms [2; 54]. Drivers of green innovation are organizational and technological capabilities, as well as corporate social responsibility [54, Appendix].

The quality of innovation management enhances performance of Indian firms [28; 54], which is in line with evidence for the US, EU and Japan (see our review in [53]). Specifically, there is a positive association between personnel management and successful innovation, including green innovation [9; 27; 28; 55]. ESG disclosure is positively related to financial and market performance of firms [56].

Examples of universal approaches to personnel management in order to pursue innovations at Indian firms are as follows.

Firstly, personnel management for innovation involves creating a favorable work climate [28], promoting collaborative culture at work and incentivizing research by providing workspace for the exchange of ideas (see a survey of 45 employees at a software firm in [27]), providing research grants to employees and promoting staff based on their performance [9], and advocating "participatory leadership culture" [28][5]. The importance of these factors is confirmed by the methodological analysis of X. Song and M. Parry (1993) which lists organizational structure, attitude of senior management and employee participation as key elements of marketing R&D [58].

Secondly, a widespread method of personnel management consists in training personnel for in-house R&D with an emphasis on interdisciplinary expertise and collaboration: "a month of training in each type of research activity" [6, p. 1]; "organization-wide" employee training [28]; and a 3–4 month training program that covers diverse fields [9]. This corresponds to practices in Japanese firms [53]. For instance, Sony pays attention to social interactions within the company and educates R&D personnel as generalists [59–62]. True to this logic, newly hired R&D researchers at Sony receive a one-month training in production and a three-month training in sales and marketing [59].

Thirdly, management of innovation personnel involves hiring competent engineers and networking [29], as well as collecting customer feedback on innovation.

As regards other universal forms of innovation management (including green innovation management) practiced in India, innovation in IT and pharmaceutical firms is associated with discovering new fields that offer growth opportunities [29] and exploring the possibilities of new technologies [63] as well as using "time" as a first-mover advantage [28]. According to the study of 44 SMEs in the electronics sector in India, introduction of new technologies ranks as the top strategy for company development over a 3-year horizon (Table 4 in [63]). It may be noted that the launch of new products and new product areas is also regarded as the most effective R&D strategy in the Japanese electronics industry [58].

Finally, "psychological empowerment" is an important part of innovation management and is used by companies in several Indian industries [26].

Unique features of innovation, innovation finance and innovation management in India

1. Unique instruments of innovation finance.

The Indian government and the public sector are the major sources of domestic R&D financing in general and of green financing in particular [5; 8; 38; 39; 41]. The government seeks to compensate for a lack of private investment in R&D, which is noticeable in industries as varied as fuels and higher education [41]. Venture capital is of minor importance in India in comparison to the BRICS countries [1].

It is important to note that green foreign direct investment in India is very large, exceeding the figure in China by almost 4 times [8, Table 2].

2. Indigenous forms of innovation

A unique feature of innovation in India is concentration of domestic firms on frugal, low-cost innovation under resource constraints [4; 10–12; 32]. In this regard, Indian firms show more resourcefulness and creative capacity than Chinese firms [32]. In the Indian context, frugal innovation (described by the Hindi word, "jugaad") can be defined as "the art of overcoming harsh constraints by improvising an effective solution using limited resources" [10, p. 847]. Indian R&D tends to focus on specific markets with low-income consumers, cost-cutting

[4] The strategy is similar to that observed at Japanese firms [53].

[5] In line with established management practices in the US [57].

[4; 29], and use of local materials. Below we list examples of cost-cutting innovation in various sectors of the Indian economy:

a) In the agricultural sector: milk powder made from buffalo milk; composite feed for cattle made from local nutrients and grains [9].

b) In the IT sector: innovation targeted at rural areas with hot climate and absence of air-conditioning (lower-powered microprocessors to reduce heat and longer circuitry [12]).

c) In the automobile industry: a low-cost car, the Nano by Tata Motors, priced at USD 2500, with small tires and wheel, 3 instead of 4 lug nuts, a 2-cylinder engine in the rear of the car to save space and only 1 windshield wiper [11].

Frugal innovation and cost-cutting have become major drivers of green innovation in India. For example, an innovative business model has been developed by a non-profit NGO, SELCO, to supply solar panels and batteries to poor Indians in rural areas in such a way that this renewable energy source is cheaper than kerosene, which has been used previously [10]. In another example, a fully biodegradable clay refrigerator that costs less than USD 50 and uses no electricity was introduced by Mitticool social ventures [10]

3. Unique innovation strategies

A number of unique innovation strategies are observed in India. Firstly, there is an emphasis on immaterial motivation for innovation, particularly as regards ecological innovation. Grass-root innovation, based on "links between traditional knowledge and ecological sustainability" is popular [32, p. 202].

Secondly, innovative firms in India often use forms of personnel management that are not commonly observed in other countries. Work engagement in India is the highest in the world [26]. Accordingly, personnel management in India aims at creating the most favorable climate for innovative workers. Companies focus on the technical proficiency and motivation of a newly hired job candidate, not on the ranking of his college [9]. For example, the Indian Space Research Organization, a public-sector research institute, does not seek to attract personnel by salary levels, which are lower than in the private sector, but by transparency of career paths and promotion according to merit [9]. Another example is the telecom company C-Dot, set up by Satyen Pitroda, which encouraged innovation by young engineers through "an open, non-hierarchical, and egalitarian organizational culture which promoted creativity" [5, p. 147].

4. Unique firm-level drivers of innovation

Unique innovation strategies and special features of the Indian economy explain unique forms of innovation management in the country.

a) Family ownership, which impedes innovation in the West, fosters innovation in the Indian context [57]. This is because in India family ownership provides innovation benefits through diversification [32]. Family ties are also an essential part of Indian business [4; 64].

b) Indian firms use an "ambidextrous strategy of innovation" combining explorative and exploitative forms of innovation [4; 29; 32], especially in response to changes in IPR policy [32].

c) SMEs in India are more open to innovation than large companies [14]. "Small team projects" are therefore the prevalent form of innovation [3].

d) SMEs often pursue several types of incremental innovation, e.g. "four or more types" ([65, p. 514], a study of 88 SMEs).

Innovation and management in India according to the World Management Survey

The World Management Survey is a tool developed in the early 2000s by a team headed by Professors Nicholas Bloom and John van Reenen [57]. It was an unprecedented standardized survey which could quantify management practices at firms in different industries and different countries. The seminal work by Bloom and van Reenen "Measuring and explaining management practices across firms and countries" appeared as an NBER working paper in 2006 and as an article in the Quarterly Journal of Economics in 2007. As of July 2024, the work has reviewed over 4500 citations in Google scholar and close to 2000 citations in the Web of Science, which marks it as one of the most influential papers in economics. The concept of management as part of a firm's technology was highlighted in Bloom and van Reenen [57] and in a series of subsequent works by the same authors as well as by many other researchers worldwide[6].

The World Management Survey examined 18 management practices at manufacturing firms and 19 at retail firms [57][7], including several practices particularly related to management of innovation (see in [21, Table 1, p. 206, Categories 1, 2, 17 and 18]). The practices investigated by the Survey included:

1) Introduction of modern manufacturing techniques.

2) Rationale for introduction of modern manufacturing techniques.

3) Attracting talented human capital.

4) Retaining talented human capital.

Answers to the Survey questionnaire were used to prepare a composite management score for each company which could shed light on the relationship between management

[6] See our research applying the concepts of Bloom and van Reenen [57] to measuring production at Japanese local public enterprises in [66; 67].

[7] The Survey also looked at 21 management practices in hospitals and 23 in schools [23].

and the firm's productivity and profitability. Just as institutional climate is regarded as a production factor at the macro-economic level [49], management can be viewed as a technology tool at the firm level [22; 57][8].

The scores of Indian firms in the first rounds of the Survey were among the lowest on average across all of the surveyed countries: Indian firms scored less than 2.7 points out of a possible 5, while US firms had an average score close to 3.4 (see in [21, Figure 1; 24]). Moreover, India was placed lower than any other country, including Brazil and China, as regards performance monitoring by management, scoring only 2.62 (see in [7] in [7, Table 2]).

The distribution of management scores is very skewed to the left in India, implying that very few firms have high scores. Moreover, the distribution is not compressed, meaning that the variation in management scores within India is high (see in [21, Table 2]).

The data from several rounds of the World Management Survey (2004–2014) reveal a positive association between management scores and GDP per capita (see in [23, Figures 2, 4]; and in [68, Figure 16]). This tallies with India's worse performance in the Survey compared with Brazil and China since India is poorer in per capita terms than these other two BRICS countries.

One striking finding of the Survey is that India is a rare example of a country which places more emphasis on people management than on operations, monitoring, and targets: the average scores for people management at Indian manufacturing firms are higher than for other areas of management (see in [21, Table 2] and in [23, Figure 3]). Similarly, people management was found to be an important productivity factor in Indian schools [68].

As regards the relation between management and firm performance (measured as firm production, profitability, and survival), a series of papers by the Survey designers, Bloom and van Reenen, support the theory that differences in management practices across firms in different countries lead to variation in productivity and firm performance [21; 57].

A special study by one of the authors of the Survey and other researchers (N. Bloom et al., 2013 [24]) examined impact from the introduction of modern manufacturing practices at Indian textile firms. Consulting on the new practices, which concerned operations, quality control, inventory, human resource management, sales and other management, was offered to firms free of charge as a field experiment for the purposes of the study [24]. The firms were keen to make use of the practices (see in [24, Figure 5]), which led to rises in output and total factor productivity (see in [24, Table 2]). The list of practices included garbage disposal, removing old stock and cleaning the machines [24, p. 11, 45–47], which all relate directly to environmental protection and green investment. Indeed, "waste management" is one of the items covered by ESG reports, which are now compulsory for publication by top listed firms in India [43].

A follow-up study by N. Bloom et al. (2020) investigated whether the new managerial practices were still in use by the firms 9 years after their adoption [25]. The adoption rate fell from over 0.6 to about 0.45 at treatment plants, but rose from 0.4 to 0.45 in other plants owned by the firms [19, Figure 1, p. 206]. The main causes for abandonment of the new managerial practices were managerial turnover (employment of new managers) and reduced director time, while the drivers for greater use of the practices were spillover from other plants in the same firm or other firms [19, Table 3, p. 210]. The practices that were dropped were those that created a burden on managers by increasing their routine duties due to the need for daily monitoring. The practices that remained rooted in the firms were associated with systematic quality management, disposing of old stock and preventive maintenance [19, p. 213].

Discussion and conclusion

India is a fascinating example of an emerging economy which adapts the concept of innovation-based growth to its own specific economic and cultural context. Innovation in India has attracted growing interest among researchers, with a steady increase in the number of published papers on the subject and in the number of their citations [31].

Research into efficient practice for the financing and management of innovation is important for assuring successful outcomes from the implementation and commercialization of innovation[9]. However, the experience of developed countries is often inapplicable to emerging economies. Hence the importance of studying both universal and unique forms of innovation in a major emerging economy such as India in order to identify the most effective practices for management of innovation there and in other emerging economies.

The present paper first carried out a meta-review of literature on innovation in India, focusing on the universal and unique features of innovation practices in that country. The paper then proceeded to summarize universal and India-specific methods of innovation finance and management (Table 2).

[8] The large-scale data of the World Management Survey confirmed the hypothesis that management is an important production factor in various countries, including India.

[9] In Western countries as many as six generations of R&D management practices have been formulated since WWII [15].

Table 2. Innovation, and the financing and management of innovation in India: universal and unique features

	Universal features	Unique features
Innovation	Drivers of innovation are growth opportunities, diversification, search for new products and possibilities offered by new technologies. M&As and innovation are complementary strategies. Institutional climate, governance and IPR protection foster innovation.	Ambidextrous strategy of combining exploration and exploitation innovation, as well as product and process innovation. Indigenous forms of resource-constrained innovation, targeted at domestic markets with low-income consumers.
Financing of innovation	As the major regulating body in the national innovation system, government has been employing standard policies to promote innovation. Overall R&D investment and green investment by firms. Liberalization, protection of IPR, R&D tax incentives, coal tax and research subsidies, regulations on ESG reporting.	Government is the major source of R&D financing and of green investment. Green bonds have been used in India only since 2015. Venture capital is of minor importance in India. The share of R&D expenditure in GDP is very low and has been decreasing in the past 15-20 years. There is no general agreement about the effectiveness of government policies as regards R&D expenditure growth. Green foreign direct investment in India is large.
Management of innovation	Ineffective management may be explained by low per capita GPD and high firm centralization. Effective human resource management is associated with successful innovation including green innovation. Examples of modern managerial practices are: collaborative culture at work, diversified training of personnel for in-house R&D, and psychological empowerment. There are spillovers across firms as regards innovation and modern managerial practices	Cost-cutting and use of local materials, especially for resource-constrained innovation, including green innovation. Immaterial motivation for innovation, including green innovation and grass-root innovation. Innovation is generally caused by the competitive environment rather than by customer demand. Family ownership fosters innovation. Unique examples of human resource management at Indian innovative firms: focus on technical proficiency and motivation of an employee, attracting personnel by promotion based on merit and transparency of career plans

A number of universal innovative practices are implemented in India, accompanied by internationally established practices for regulating the financing and management of innovation. There are clear parallels between companies in India and in Japan as regards the use of diversified training for in-house R&D and the creation of a collaborative culture in the workplace.

However, a number of innovation practices are specific to India and are accompanied by specific approaches to innovation. In particular, Indian firms prefer labor-intensive rather than capital-intensive technologies and focus on (green) human resources. The same phenomenon is observed in other low- and middle-income countries [23]. Accordingly, India uses various approaches that would be deemed inefficient by a Western analyst: government, not the private sector, as the major supplier of R&D and green R&D expenditure; family ownership drives innovation instead of impeding it; innovation may be encouraged by non-material motivations; there is a focus on low-income consumers and cost-cutting as key determinants for innovation; and preference is often given to indigenous forms of innovation and green innovation.

The above-mentioned combinations of universal and country-specific features of the national innovation system are well pronounced in green innovation in India. Regarded as "a fruitful research area" but lacking sufficient coverage in academic literature as of 2015 [32], by 2023 issues of sustainability, green innovation and green financing in India have entered the arena of discussion by international academic analysts [44], and there is much interest in the potential of green innovation to assist in "moving from growth to development" [50].

The universal features of green innovation and green financing that are observed in India include: reliance on regulatory measures, such as priority lending to the energy sector; requirements for ESG reporting; use of green bonds; and discouraging carbon emissions through coal tax. Specifically, ESG reporting is an important driver of green innovation in the pharmaceutical sector [71].

There are still a number of impediments to expansion of green innovation in India. But the studies that were summarized in this paper offer various approaches to overcome these impediments, and the proposed solutions leverage the opportunities offered by the strong role of government in India's economy. Firstly, an effective public-private partnership could be realized by helping private companies to conduct long-term investment in green technologies that often require large capital inputs (e.g. carbon capture and storage technology in the carbon sector [7]). Secondly, there is a need to strengthen the banking system and, particularly, to develop banking in rural areas. This could be accomplished by: reducing the non-performing asset ratio, which is among the highest in large economies [45]; providing micro-finance on a longer-term basis [50] in order to involve rural individuals who have collateral but are currently outside the bank system [10]; increasing the volume of deals and aggregating smaller assets to attract investment though green bonds [50]. It will also be important to develop capital markets using a range of financial instruments such as loans and bonds, to enhance institutional engagement at the international, national and grass-roots level, and to treat green innovation as a prime example of public-private partnership [45].

In conclusion we note that existing bibliometric reviews find that economics literature is increasingly interested in the contrast between universal and unique features of innovation financing and management in India – the contrast which has been the subject of the present paper. Specifically, N. Sharma (2016) stresses an increasing interest of the international scholarly audience in "India-specific innovations" [29], p. 258[. A. Nair et al. (2015) discuss whether it is possible to "develop a uniquely Indian perspective on innovation" [3, p. 948]. Finally, D. Chatterjee and S. Sahasranamam (2018) point to the existence of an "India-specific innovation paradigm" [32, Table 4, p. 219].

Acknowledgement

We are grateful to the Editor, Irina V. Ivashkovskaya, for helpful comments.

The paper was prepared in the framework of the Basic Research Program of the National Research University Higher School of Economics (Moscow, Russian Federation).

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The authors declare no conflicts of interests.

The article **was submitted on** 06.06.2024; **approved after reviewing on** 08.07.2024; **accepted for publication on** 30.07.2024.