“The Role of Imitation in Technological Learning and Catch-up: Evidence from the Indian Automobile Industry”

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LIST OF ABBREVIATIONS

ACMA – Automotive Components Manufacturers Association of India

AMP – Automotive Mission Plan

ARAI – Automotive Research Association of India

ASDC – Automotive Skill Development Council

ASPP – Across-submarket Product Proliferation

BAIC – Beijing Automotive Industry Holding Co.

BMW – Bayerische Motoren Werke AG

BRICS – Brazil, Russia, India, China, and South Africa

BS – Bharat Stage (I to VI)

CAR – Core Group on Automotive R&D

CI – Compression Ignition

CKD – Completely Knocked Down Kits

CO – Carbon Monoxide

CV – Commercial Vehicle

DPF – Diesel Particulate Filter

EEPC – Engineering Export Promotion Council

EGC – Electronic Governor Control

EU – European Union

EV – Electric Vehicle

FAME – Faster Adoption and Manufacturing of Electric and Hybrid Vehicles

FDI – Foreign Direct Investments

FE – Farm Equipment

GDP – Gross Domestic Product

GM – General Motors

GST – Goods and Service Tax

HC – Hydrocarbon

IIA – Independence of Irrelevant Alternatives

INR – Indian Rupee

IO – Industrial Organisation

IPR – Intellectual Property Rights

IT – Information Technology

ITI – Industrial Training Institutes

JV – Joint Venture

LCV – Light Commercial Vehicle

LNT – Lean NOx Trap

M&HCV – Medium and Heavy Commercial Vehicle

MNE – Multinational Enterprise

MoU – Memorandum of Understanding

MUL – Maruti Udhyog Limited

MUV- Multi Utility Vehicles

NAB – National Automotive Board

NATRIP – National Automotive R&D Infrastructure Project

NCR – National Capital Region

NEMMP – National Electrical Mobility Mission Plan

NIE – Newly Industrialised Economies

NO – Nitrogen Oxide

OBD – On-board Diagnostic

OECD – Organisation for Economic Cooperation and Development

OBM – Original Brand Manufacturer

ODM – Original Design Manufacturer

OEM – Original Equipment Manufacturer

OICA – Organisation Internationale des Constructeurs d'Automobiles

PC – Personal Computers

PI – Positive Ignition

PM – Particulate Matter

PSA – Peugeot Société Anonyme

PV – Passenger Vehicle

RBV – Resource-based View

R&D – Research and Development

SAIC – Shanghai Automotive Industry Corporation

SCR – Selective Catalytic Reduction

SIAM – Society of Indian Automobile Manufacturers

SKD – Semi Knocked Down Kits

SUV – Sports Utility Vehicle

UK – United Kingdom

US/ USA – United States / United States of America

UV – Utility Vehicle

VAT – Value Added Tax

WSPP – Within-submarket Product Proliferation

ABSTRACT

The role of innovation in firm catch-up and subsequent dethronement of the leader is well established in the extant literature. However, what appears to be less understood is the role of imitation in firm catch-up and industry evolution. This thesis argues that a thorough understanding of the dynamics of the catch-up process requires a comprehensive scholarship of both innovation and imitation, as firms have been observed to employ both innovation and imitation strategies in their persistent effort to catch-up. Drawing on the prior research on 'window of opportunity' suggesting that institutional, technological, and demand dimensions of the sectoral system present a diverse set of opportunities for firms to catch-up, and using it as a context, this thesis examines firms' catch-up strategies *vis-à-vis* innovation and imitation in the light of competitive dynamics and institutional theories.

The thesis utilised an extensive dataset of car models – which includes information on product-related attributes, and various firm and industry level variables – launched in the Indian automobile industry during 1999-2018 to empirically investigate the role of competitive imitation in firm catch-up. It is comprised of three research papers and concludes that firms, with or without strong innovation capabilities while exploiting different windows of opportunity, use competitive imitation to catch-up. While the use of imitation by firms in catch-up endeavours results in significant performance benefits, whether a firm will engage in innovation or imitation is influenced by firm-level technical capabilities and the competitive and regulatory environment.

The first paper analysed firms' strategic responses to the successive changes in the emission control regulations (i.e., BS I to BS IV during 1999-2018) and found that firms utilised imitation, innovation, or innovative imitation but the choice was moderated by firm innovation capabilities and industry clockspeed. The second paper analysed the competitive strategies of the dominant and the fringe firms and found that foreign fringe firms used innovation while the domestic fringe firms used imitation to catch-up. However, contrary to our assumption, domestic firms not only imitated the dominant firm's product innovations but also showed a tendency to imitate other innovative foreign rivals. The third paper examined the effectiveness of market leader's product proliferation strategy in preventing rivals' catch-up through imitation and found that, contrary to what is theorised in extant research, in a competitive action-reaction context, market followers will not desist from imitation, but instead imitate the market leader to avoid falling behind in an evolving market.

DECLARATION

I, Chaturbhuj Tripathi, declare that no portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning. In addition, I declare that I was in charge of developing the ideas, data collection and analysis, and drafting of the three papers which collectively form this thesis.

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CHAPTER 1 INTRODUCTION

1.1 Imitation and firm catch-up

Firm catch-up is broadly defined as the process of closing the gap in technological capabilities and market share between the leader and laggard firms (Lee & Malerba, 2017). It is often observed that when an incumbent leader fails to maintain its competitive advantages in technology, production and marketing, a laggard firm catches up and attains industry leadership – defined as *"being ahead of one's competitors in product or process technology, or in production and marketing"* (Mowery & Nelson, 1999, p. 2) – which is then dethroned by a new challenger in due course. For instance, the successive changes in the leadership of global automobile industry from German, to the US, and to Japanese firms; in the leadership of global steel industry, from the US firms in the early 20th century, to Japanese, and to current Korean and Chinese firms (Lee & Ki, 2017); and in the leadership of global mobile industry from Motorola (as a pioneer), to Nokia, and to Apple and Samsung (Giachetti & Marchi, 2017) are a few examples of catch-up and dethronement of incumbents by market challengers.

The extant literature suggests that a thorough understanding of firm catch-up requires one to examine the phenomenon at two levels: an examination of the external environment at the industry level that includes competitive conditions, actors, and networks (e.g., governments, suppliers networks, public and private research centres, and financial organizations, etc.), and institutions (e.g., policies, laws, IPRs, and culture, etc.); and catch-up activities at the firm level. While the external environment including the government policies and supporting infrastructure provide the enabling context and influence the firm level catch-up activities, what lies at the core of the catch-up phenomenon are the different ways in which firms learn and build superior capabilities that lead to the successive change in

leadership between incumbent and laggard firms often referred to as 'catch-up cycle' (Lee & Malerba, 2017; Mowery & Nelson, 1999; Shin, 2017; Lee & Ki, 2017; Morrison & Rabellotti, 2017; Malerba & Nelson, 2011).

Research suggests that firms engaged in catch-up often develop their indigenous way of learning and capability building, different from that of the pioneering firms that serve as industry standards, due to the differences in the organizational, managerial, and institutional context of the business environments they emerge from. Therefore, significant differences, in the trajectories of technological and product development, and the positioning among the leader and laggard firms have been observed (Katz, 1987; Kim, 1997; Malerba & Nelson, 2011; Lee & Kim, 2001; Bell & Figueiredo, 2012). Moreover, the extant literature on catch-up largely focuses on innovation as the most critical factor in a firm's technological advancement (e.g., new and disruptive technologies, product & process innovations etc.). Scholars have pointed out that the new technical capabilities developed through innovation then support firms to generate new products and processes which help the leader firms sustain their leadership, while helping the laggards move closer to their goal of becoming industry leaders (Artz, Norman, Hatfield, & Cardinal, 2010; Greenhalgh & Rogers, 2006; Bettis & Hitt, 1995). However, innovation also brings many challenges for firms as it is costly (high R&D costs), has a high degree of uncertainty in terms of success, and involves various management issues besides the fact that developing strong innovation capabilities requires a lot of time and other resources (Mansfield, Schwartz, & Wagner, 1981).

While the extensive role of innovation in catch-up is plausible if one views the catch-up process from the perspective of the firms with strong innovation capabilities, it seems a difficult proposition when it comes to the laggard firms that lack suitable innovation capabilities, especially the firms from developing countries (Kale & Little, 2007; Kim & Lee, 2002; Li & Kozhikode, 2008; Mathews, 2006; Kim, 1997). Moreover, innovation becomes

much more challenging for such firms as they often possess limited resources (e.g., financial and human resources, other supporting infrastructure, etc.), and do not have the luxury of time due to a fast-changing business environment, which further constraint their ability to quickly develop strong innovation capability. So, this leads us to an important issue that needs thorough examination as to how those firms that are unable to follow innovative strategy for the want of suitable innovation capabilities catch-up: an issue that has received limited attention owing to the greater focus of researchers on innovation in firm-level catch-up activities. This thesis argues that such firms try to catch-up by learning and adapting from their competitors that are endowed with superior assets and resources, and often imitate them. Many scholars, such as Levitt (1966) have argued that 'imitation' is found to be more prevalent and abundant than 'innovation' in firms' product and process development activities. Zander & Kogut (1995, p 76) also acknowledged the importance of imitation and argued that *"firms compete not only through the creation, replication, and transfer of their own knowledge, but also through their ability to imitate the product and process innovations of competitors"*. Malerba & Orsenigo (2002) argued that firms irrespective of their size and position engage in imitation and innovation to remain competitive and sustain their market share.

Imitation is broadly defined as 'the replication of an innovation by a competitor' (Zander & Kogut, 1995). It is less costly as compared to innovation (although it may require some R&D costs in imitating a technologically complex product/process) (Mansfield *et al.*, 1981), and provides strategic advantages over innovation by reducing environmental uncertainty, limiting rivalry, helping firms maintain market-share performance, and enabling them to take advantage of free-ride economies (Lee, Smith, Grimm, & Schomburg, 2000; Shankar, Carpenter, & Krishnamurthi, 1998; Lieberman & Asaba, 2006). This provides sufficient incentive for firms that lack strong innovation capability to pursue imitation to

catch-up. Research also suggests that imitation often leads to the development of innovation capabilities as firms engaged in imitation enhance their technical expertise and acquire new skills over time (Collins, 2015). Nelson & Winter (1982, p 124) highlighted that *"an imitator working with an extremely sparse set of clues about the details of the imitatee's performance might as well adopt the most prestigious title of "innovator," since most of the problem is really being solved independently. However, the knowledge that a problem has a solution does provide an incentive for persistence in efforts that might otherwise be abandoned"*. The rise of Japanese and South Korean auto manufacturers (Toyota, Honda, Nissan, Suzuki, Hyundai, Daewoo and Kia) into global players is well-documented evidence of developing innovation capabilities by embracing imitation.

There has been significant progress in research related to the technological development process in laggard firms and, more so, about the technological catch-up of the laggard firms from newly industrialised economies (NIE) from East and South-East Asia, and China (Hobday, 1994 & 1995; Hobday, 2005; Kim, 1997 & 2001; Xie & Wu, 2003; Mu & Lee, 2005; Jin & von Zedtwitz, 2008; Luo, Sun, & Wang, 2011; Xu & Li, 2014). These studies have analysed the technological evolution in a range of industries such as automobile, electronics and semiconductors, and telecommunications, and have identified several stages of technological development in firms – ranging from the acquisition of foreign technology, learning and adoption, and then gradually developing innovation capabilities by focusing on improving the existing technology – leading to many of them attaining technological leadership in their respective industries. Some studies have also highlighted the importance of imitation in that development process as to how these firms utilised imitation not only in developing new products and services but also in improving their technological know-how (Kim, 1997; Lieberman & Asaba, 2006; Lee & Malerba, 2017; Posen & Martignoni, 2018). Nelson & Winter's argument that an *"imitator's basic tactic is to follow the*

example…wherever possible…and to fill in the remaining gaps by independent effort" (1982, p 124), similarly points out to the post-imitation experiential learning, also termed as "generative effect of imitation" by Posen & Martignoni (2018) in their recent study. For instance, Kim (1997) examined the catch-up of the Korean automobile industry and highlighted the role of imitation in its technological advancement through three distinct stages in the development process namely: creative imitation; duplicative imitation; and innovation.

Similarly, in the Indian context, a few researchers (Kale & Little, 2007; Prahalad & Mashelkar, 2010) have studied the technological development in industries such as pharmaceuticals, IT/software, automobile, and other sectors, however, these studies have a strategic orientation (such as how these firms use creative cost-effective strategies such as 'frugal engineering' or creating new business models etc.) as opposed to focusing on building new technical capabilities. Although we observe significant growth in recent literature examining the nature and antecedents of imitation, and its strategic use as a low-risk resource to develop competitive advantage, the role of imitation in a firm's catch-up strategy is relatively under-researched. Moreover, when it comes to the empirical research on the strategic role of imitation in firm catch-up, the research gap is even more evident. Hence, to address this research gap, this thesis investigates the main research question as below. In addition, the study also recognises the valuable contributions of the external environment, namely regulations and competitive conditions, to understanding firm-level behaviour and thus takes into account the influence of competitive and institutional contexts while examining firm-level catch-up strategies.

> ***RQ:*** *What is the role of imitation in firms' technological learning and catch-up, and how do regulations and competitive dynamics influence a firm's imitation strategy during the catch-up cycle?*

A large body of research on the firm catch-up recommends the examination of interfirm catch-up within the framework of the sectoral system, in which industry is considered as a system comprised of actors and networks, institutions, knowledge and technology regimes, and demand conditions as building blocks (Malerba, 2002; Malerba & Nelson, 2011; Lee & Malerba, 2017). It is the multifaceted interactions of these different building blocks that generate industry structure and dynamics, outcomes such as innovation, firm performance, and growth. These interactions also cause various discontinuities in the functioning of the industry, termed as "window of opportunity" (Perez & Soete, 1988), which presents opportunities for catch-up for firms and, eventually, leads to industry evolution over time. Prior research has identified three broad windows of opportunity that firms can utilise to catch-up: institutional, technological, and demand (Lee & Malerba, 2017).

While this thesis investigates the overarching research question, i.e., the role of imitation in firms' technological learning and catch-up, by devising sub-research questions concerning institutional, technological, and demand windows of opportunity; we refer to the technological and demand windows of opportunity broadly as 'competitive dynamics' of the industry. In other words, the three sub-research questions examine the role of imitation in firm catch-up in the context of opportunities created by the discontinuities in institutions and policy, and competitive dynamics of the industry (especially related to changes in technology and demand conditions over time). In the following sections, we look at the main research question in-depth and develop three sub-research questions to understand the catch-up strategy of firms in three separate research papers of this thesis.

1.1.1 Regulations and firm catch-up strategy

The behaviour of the firm, whether imitative or innovative, is greatly influenced by the institutional and regulatory environment. So, in this thesis, regulations are regarded as

triggering top-down processes that exert a direct cross-level effect, where, in the words of Gupta, Tesluk, & Taylor (2007, p 889), "factors at a higher level of analysis influence outcomes or dependent level". Therefore, the context of regulations in understanding the role of imitation in the firm catch-up becomes critically important. Researchers have highlighted the critical role of public policies and regulations in catch-up processes in different industries across many countries. For instance, Malerba & Nelson (2011), Mu & Lee (2005), and Lee, Mani, & Mu (2012) highlights the prominent role of government policies in the catching-up of different sectors in Korea and China (e.g., telecommunication equipment industry). Similarly, Mathews (2002) and Guennif & Ramani (2012) showed the important role of government policies in the catch-up of high-tech industries in Taiwan and the pharmaceutical industry in India respectively. Past research shows that governments intervene in the catch-up of the domestic firms and industries through several institutional and regulatory changes. These changes range from establishing R&D programmes through the provisions of tax exemptions, subsidies, standards-setting, creating technical infrastructure and testing facilities, and setting up export promotion councils among others (Kim & Lee, 2008). These policy interventions provide a window of opportunity for domestic and other latecomer firms and support their catch-up with more advanced incumbents (Lee & Malerba, 2017).

Although the research that seeks to establish the impact of regulations on innovation has yielded mixed results (Ambec, Cohen, Elgie, & Lanoie, 2013), its role in facilitating learning and capability development in firms are generally well recognised. For instance, Porter (1991), and follow up research by Porter & van der Linde (1995), argues that regulations, if properly designed, can lead to innovation if managers, instead of resisting regulations, proactively comply by redesigning their products and processes. Several studies report the positive impact of regulations on innovation, concluding that regulations can push the development of cleaner technologies, help in the promotion and diffusion of existing

technologies, and induce new product and process innovations (Ashford, Ayers, & Stone, 1985; Lanjouw & Mody, 1996; Hart & Ahuja, 1996; Brunnermeier & Cohen, 2003; Türpitz, 2004; Popp, 2006; Ambec *et al.*, 2013; Parchomovsky & Stein, 2008; Gonzalez, 2009; Taylor, Rubin, & Hounshell, 2005). Similarly, Pontes (2017) argues that the policies adopted by the Chinese government to promote electric vehicles have created a huge market for electric vehicles domestically that are bigger than the US and the EU. Other studies, however, suggest that regulations have a negative impact on innovation as firms are forced to allocate resources away from strategically critical activities (Papadakis, Zollers, & Hurd, 1996; Blind, 2012; Marin, 2014).

Moreover, when it comes to understanding the impact of regulations on the imitative behaviour of firms, especially in the context of catch-up, the literature is limited and seeks to explain the imitative behaviour among firms, as a response to regulatory changes, by accounting for the "stringency" of regulations. The 'stringency' of the regulation is defined by how demanding it is for firms to comply with regulations that affect their business (Brunel & Levinson, 2016). The literature differentiates between "technology-following" (i.e., lower stringency) and "technology-forcing" (i.e., higher stringency) regulations (Bresnahan & Yao, 1985; Wesseling, Farlaa, & Hekkerta., 2015; Horbach, Rammer, & Rennings, 2012). Technology-following regulations allow manufacturers to achieve compliance by procuring or adapting existing technologies, thereby significantly reducing the risks associated with developing new technologies. In a scenario where regulations are less stringent (i.e., technology-following) firms are more likely to use proven off-the-shelf technologies that have been successfully adopted by other firms to meet compliance: i.e., imitation (Dechezlepretre, Neumayer, & Perkins, 2015). For example, the less stringent emission control regulations in developing countries allow automobile firms operating in those markets to achieve compliance through imitating solutions developed by automobile firms operating

in advanced markets, instead of innovating new technological solutions. In contrast, highly stringent, or technology-forcing regulations require manufacturers to research and develop commercially viable new solutions to achieve compliance. Imitation minimizes imitating firms' technical and financial risks, yet a successful imitation of a technical solution to achieve compliance facilitate new learning and technical capability development (Faiz, Weaver, & Walsh., 1996; Franckx, 2014; Wesseling *et al.*, 2015). However, how regulations impact the imitation behaviour of firms and thus support their catch-up needs comprehensive understanding. This thesis addresses this research gap by presenting insights from the Indian automobile industry by specifically examining the imitation and innovation behaviour of firms in the context of changes in the emission control standards over the last two decades with the help of the following research question.

> ***RQ1****: How do regulations affect the imitative and /or innovative behaviour of incumbent firms in an industry?*

1.1.2 Competitive dynamics and firm catch-up strategy

Like the institutional and regulatory environment, the competitive dynamics of the industry also provides a context in which catch-up activities take place. The competitive conditions, rapid growth in demand or changing demand of users and consumers for example, create opportunities for leader firms to sustain their leadership, at the same time, it creates a window of opportunity for laggards to catch-up if the production capacity of the leader firm is either unable to meet the growth in demand or should the leader firm decides to not respond to this new demand because they are satisfied with catering to the existing customers and markets: lack of effective responses from the leader owing to complacency, also recognised as 'incumbent traps' (Chandy & Tellis, 2000; Lee & Malerba, 2017). Similarly, competitive dynamics in an industry also drive much of the innovation and imitation activities of competing firms. For instance, in this case, rapid growth in the existing demand, as is often

the case in developing countries, is more likely to drive laggards to imitate leaders' existing products and processes, production and investment decisions, marketing strategies, and any other future competitive moves (e.g., new product innovations) in a bid to increase their market share (Ferrier, Smith, & Grimm, 1999; Mishra, Maggitti, Grimm, & Smith, 2019), whereas, change in the consumers' demand in terms of new features or substitute products is more likely to drive competing firms, and more so the laggards, to devote resources in innovating new products in a bid to cater to the new demand, especially when the leader firm decides to either not cater to the new demand or decides to wait till the new demand matures.

One aspect of market competition is the continuous aspiration of firms to not only achieve industry leadership but also to accumulate significant market power that further help them sustain their acquired status. Consequently, firms strive to achieve a dominant market position as a large market share not only creates opportunities for greater profits but also ensures market power and control (Rosenbaum, 1998). The regular presence of dominant firms across multiple industries and geographies have been the object of substantial research – especially in the field of economics – examining the specific industry conditions that could explain the emergence of a dominant firm (Shamsie, 2003; Geroski & Vlassopoulos, 1991; Rosenbaum, 1998). Dominance is defined as a firm's capability to attain and sustain a strong lead in the market share over its rivals (i.e., fringe firms) for an extended period of time (Shamsie, 2003; Geroski & Vlassopoulos, 1991). Microsoft (PC application software), Walmart (merchandise stores), Exxon Mobil (petroleum), General Electric (conglomerate), Boeing and Airbus (aircraft manufacturing), Amazon (internet sales), and Google (internet search engine) are some well-known examples of the dominant firms in recent times.

However, the evolution and the competitive behaviour of the dominant and fringe firms in an industry in a developed country significantly differs from that in an industry in a developing country due to the perceptible differences in their respective business

environments. The emergence of a dominant firm in developing countries is often a result of policy intervention in a specific country in which one firm is allowed to enter first and is given ample time to establish itself before rivals are allowed to compete (D'Costa, 2000; Bell & Pavitt, 1993). It is argued that the fledgling industries (and more so the technology-intensive industries) in developing countries require the latest technology for their development and one way to induce that technology is through FDI (Dunning & Lundan, 2008; Narayanan, 1998). Hence, governments in developing countries design policies to attract technologically advanced multinationals to invest in the local market with a trade-off (along with other subsidies) that in lieu of the development of the local industry through much-needed technology transfer, productivity enhancement, and local skill development they be given preferential access to the market to sell their products (Brewer, 1993; Bhagwati, 1993). Such government incentives, at first, facilitate the creation of a powerful monopolist (i.e., the sole seller of given products) as the incumbent firm exercises full control over the market resources thereby maximising its profit by achieving economies of scale and through its ability to control pricing.

Furthermore, it utilises the period with monopolistic advantages, during which the entry of other sellers is restricted in the market due to government regulations, in creating entry barriers and consolidating its position in the market through the development of strong capabilities, market knowledge, and brand reputation among others (Frynas, Mellahi, & Pigman, 2006; Geroski & Vlassopoulos, 1991; Mowery & Nelson, 1999). And by the time the government restrictions are lifted (i.e., as developing countries gradually liberalise their economies/industries) to allow other sellers entry into the market and due to which the competition increases, the incumbent firm changes from a monopolist into a dominant firm — a market structure where a single firm (i.e., the dominant firm) consistently commands large market share (generally 40% or more, OECD, 2017) despite the presence of several

large and equally capable firms as its competitors (late entrants including both foreign and domestic firms) that are often described as the 'competitive fringe'.

Although the dominant firm, like a monopolist, continues to enjoy several competitive advantages or market power over its competitors such as the ability to control pricing, ownership of critical market resources, copyright and patents, and economies of scale, these advantages no longer stem from the restrictive market access of other capable sellers but now stem from the firm capabilities developed through its past investments in critical resources from the high earnings that were achieved during the time it operated in a monopoly market (Klepper & Thompson, 2006; Kumaraswamy, Mudambi, Saranga, & Tripathy, 2012). Moreover, the dominant firm, unlike a monopolist, is required to maintain market equilibrium while exercising its market power to achieve its competitive goals (Rosenbaum, 1998; Gaskins, 1971). For instance, if the dominant firm sets a price which is considerably higher than the production costs of the competitive fringe it risks losing its market share. On the other hand, if it sets the price lower than the production costs of the fringe group it risks driving fringe firms out of the market. This would change market dominance into a monopoly situation inviting a risk of an anti-trust lawsuit (Salop & Scheffman, 1984). Consequently, the dominant firm sets a competitive price that allows it to achieve high market share and, at the same time, allows it to control the quantity of goods supplied by the competitive fringe to an extent that does not threaten its market dominance.

Similarly, the dominant firm also has the power to lead other market activities in terms of product and process innovation, new market or product development, development and adoption of new regulatory standards and regulations etc. (White, 1981), but is required to take into account the effect of such actions on the behaviour of the competitive fringe and on the market equilibrium to ensure a competitive space to its rivals (Clarkson & Toh, 2010). For instance, while introducing new products in a market, the dominant firm has to consider

to what extent it should innovate new products, or imitate products that have been successfully launched by its rivals so that it can maintain its market dominance. These considerations become more critical in developing country markets given the price-sensitive nature of the majority of the consumers.

The existence of a large dominant firm in an industry greatly increases the competitive intensity due to a continued battle between the dominant firm and the fringe firms in which the former strives to sustain its dominance and the latter endeavour to expand their market share and eventually achieve market leadership (Smith, Ferrier, & Grimm, 2001; Sharapov and Ross, 2019). The dominant firm enjoys significant advantages over the fringe firms when it comes to economies of scale and brand reputation (Shamsie, 2003). So, until the fringe firms achieve economies of scale, the only strategy they have to maintain or improve their position is via innovation or imitation. The role of innovation is well recognized in the catch-up of fringe firms (Danneels, 2002; Hult, Hurley, & Knight, 2004), however, it may not always be the best competitive strategy even for the firms that have proven innovation capabilities as it requires significant resources in terms of time and money with no guarantee of the intended outcome (Lee *et al*., 2000; Levitt, 1966). So, fringe firms across industries adopt multiple strategies (i.e., competitive actions and responses) - defensive and offensive - to create opportunities for a catch-up with the dominant firm (Chen & Miller, 2012).

The use of imitation as a competitive strategy is well established in the literature (Levitt, 1966; Lee *et al*., 2000; Smith *et al*., 2001; Lieberman & Asaba, 2006; Xu & Li, 2014; Giachetti & Marchi, 2017; Giachetti, Lampel, & Pira, 2017; Ross & Sharapov, 2015). However, despite recent advances in both competitive dynamics research and neo-institutional theory related to competitive imitation, no study thus far has systematically examined interfirm imitation in an industry dominated by a single firm and how the market

power disparity among the leader and rivals influence rivals' imitative catch-up strategy in the industry. Research also suggests that the extent to which firms resort to imitation, as opposed to innovation, will depend on the relative market power of the players in the industry. The question that arises is: *how* will firms engage in imitative, as opposed to innovative, strategies, in an industry dominated by a single firm? This helps us enrich our understanding as to how the competitive actions of the fringe firms aimed at challenging the dominance of the single firm ultimately not only improve consumer and social welfare but also spur technological development of the domestic industry.

Moreover, it is not always the rivals who respond to the leader firm's competitive actions, leader firm also responds to the competitive moves of its rivals to neutralise any threat to its leadership created by rivals' actions and to sustain its competitive advantage over rivals: the phenomenon is termed as Red Queen competition (Derfus, Maggitti, Grimm, & Smith, 2008; Giachetti *et al*., 2017). The competitive reaction of firms to each other's moves in a given industry, the continuous race to introduce new products and technologies through imitation and innovation for example, not only develop their knowledge and technological capabilities but also lead to the evolution of the industry by pushing the industry's technological frontier forward. The study of the firm catch-up in the context of competitive dynamics has the potential to understand the role of competitive interaction at the firm level in facilitating the evolution of the industry, and therefore scholars have called for future research in this area (Felin, Foss, & Ployhart, 2015; Giachetti *et al.*, 2017). This thesis contributes to this research gap by examining the firm catch-up with a focus on imitation, and the evolution of the Indian automobile industry with the help of the following research question.

> ***RQ2****: How do competitive dynamics in an industry influence incumbent firms' behaviour to imitate and /or innovate?*

In a highly competitive environment, where the leader and follower firms are engaged in a constant competitive race of actions and reactions, catching up with the leader entails chasing a moving target (Jiang, Tan, & Thursby, 2011). While the followers are busy catching up with the leader by imitating and assimilating its technological innovations, the leader firm, to sustain its lead, keeps moving on with a combination of offensive and defensive strategies – i.e., a combination of innovation and imitation strategies such as developing new technologies, entering in emerging fields, creating new dominant designs, or imitating and neutralizing the technical advancements achieved by rivals (Lieberman & Asaba, 2006; Jiang *et al.*, 2011). One such defensive strategy the leader firm may choose to adopt is making imitation hard for rivals by creating imitation barriers, especially when it recognizes that the latecomer firms can close the technological capability gap and derive performance gains by imitating its competitive actions. The greater the efficiency of rivals, in terms of scope and speed of imitation, the greater the leader firm's focus to devote means and resources to prevent imitation by rivals.

The competitive imitation of the leader by rivals, over the long run, leads to accumulation of learning and knowledge and development of capabilities (Nelson & Winter, 1982; Kim, 1997) which is not only critical during the catch-up, but also, is equally important when they forge ahead to achieve market leadership by changing their focus from imitation to innovation (Shin, 2017; Lee & Malerba, 2017). Hence, the leader firm is better served to create imitation barriers for rivals to hamper their learning and capability development through competitive imitation, thereby halting rivals' catch-up and ensuring its persistent market leadership. So, a comprehensive understanding of the role of imitation in the firm catch-up requires not only the investigation of the imitation strategies of the laggard firms

vis-à-vis the leader firm but also the examination of the strategies of the leader firm to prevent rivals' imitative actions that may lead to technological and market catch-up.

Extant research highlights the use by market leaders of product proliferation to build imitation barriers (Piazzai & Wijnberg, 2019; Mainkar, Lubatkin, & Schulze, 2006; Barroso, Giarratana, Reis, & Sorenson, 2016). Product proliferation refers to the strategy of a firm to extend its range of products in a market or submarket to reduce the unmet demand; to saturate the product space in an effort to dissuade rivals from introducing close substitutes; and to signal its rivals that the invasion of its turf will invite severe retaliatory response (Sorenson, 2000; Mainkar, Lubatkin, & Schulze, 2006; Piazzai & Wijnberg, 2019). By filling demand gaps with their range of products, market leaders raise imitation barriers that should make it less profitable for rival firms to introduce similar products (Piazzai & Wijnberg, 2019; Barroso *et al.*, 2016; Barroso & Giarratana, 2013). Research also suggests that by committing significant investments in a product submarket, investments in pursuing a technological change to design new products for example (Smith, Collins, & Clark, 2005; Pil & Cohen, 2006), the proliferating firm signals a more credible threat of retaliation (i.e., escalation of competitive intensity) to its potential imitators which discourage them from imitation and instead drives them to pursue product differentiation (Natividad & Sorenson; 2015).

This thesis examines the case of dominant market leaders, firms that in the words of Shamsie (2003: p. 200) have the capability to "both develop and to maintain a leading position for an extended period of time". We argue that the presence of a dominant firm alters the competitive dynamics within an industry in significant ways. The dominant firm is often able to control the price and output of goods (Salop & Scheffman, 1984), and develop product markets and submarkets due to its market power (resulting from large market share, economies of scale, and reputation) increases competitive intensity (Smith *et al.*, 2001). Such market power disparity influences followers' propensity to imitate the dominant firm's

actions. Moreover, research suggests that the high market share of the dominant firm indicates higher acceptability of its products among consumers, which in turn suggests that the dominant firm possesses superior market knowledge (Lieberman & Asaba, 2006) making imitation by followers more likely as they consider the threat of falling behind changing consumer tastes. At the same time, in many industries, the dominant firm also faces the threat of anti-trust lawsuits (Salop & Scheffman, 1984) and organization failure (Mellahi & Wilkinson, 2010), and decreasing economies of scale which limits its ability to increase the market share beyond a certain point. These constraints dilute the threat of retaliation, making imitation by followers more likely.

However, the current literature provides a limited explanation of whether product proliferation by the different kinds of leader firms has the same deterrent effect on followers' imitative behaviour (Mainkar, Lubatkin, & Schulze, 2006; Salop, 1979; Caves & Porter, 1977; Piazzai & Wijnberg, 2019). Not all market leaders are the same; some market leaders hold stronger positions than others. Market leaders run the gamut from firms that lead for a few years by virtue of innovative technologies for example, to firms that dominate their industry for decades. The impact of product proliferation as an imitation barrier may not be the same in the former than in the latter: Followers may react differently to product proliferation by market leaders that have recently gained their position, as opposed to market leaders that dominate their industry for many years. This thesis addresses this research gap by designing the following research question and investigating the issue using data drawn from the Indian automobile industry which is consistently dominated by a dominant market leader: Suzuki Motors.

> ***RQ3****: Does the creation of imitation barriers by the leader firm through product proliferation prevent rivals from catch-up through imitation?*

1.2 Positioning of research papers

This thesis addresses the main research question related to examining the role of imitation in firms' technological learning and catch-up, and to what extent do regulations and competitive dynamics influence a firm's imitation strategy during the catch-up cycle by formulating three sub-research questions as shown in Figure 1.1 below. The sub-research questions have been addressed by developing three independent yet interconnected research papers, which collectively form the core of the thesis. Research paper 1 explores the imitation and innovation behaviour of firms in the context of regulatory changes (i.e., implementation of different emission control regimes) and shows that different firms utilise innovation and imitation strategies to meet compliance with new regulations and to ensure competitive catch-up with the leader firm. Research paper 2 takes a competitive dynamics view of the catch-up process and highlights the role of imitation of the dominant firm's product innovations by the fringe firms in a bid to increase their market share. Whereas research paper 3 explores whether the imitation barriers created by the leader firm through product proliferation strategy prevents the catch-up of fringe firms through the imitation of the leader firm's products. A brief outline of the research papers has been provided below.

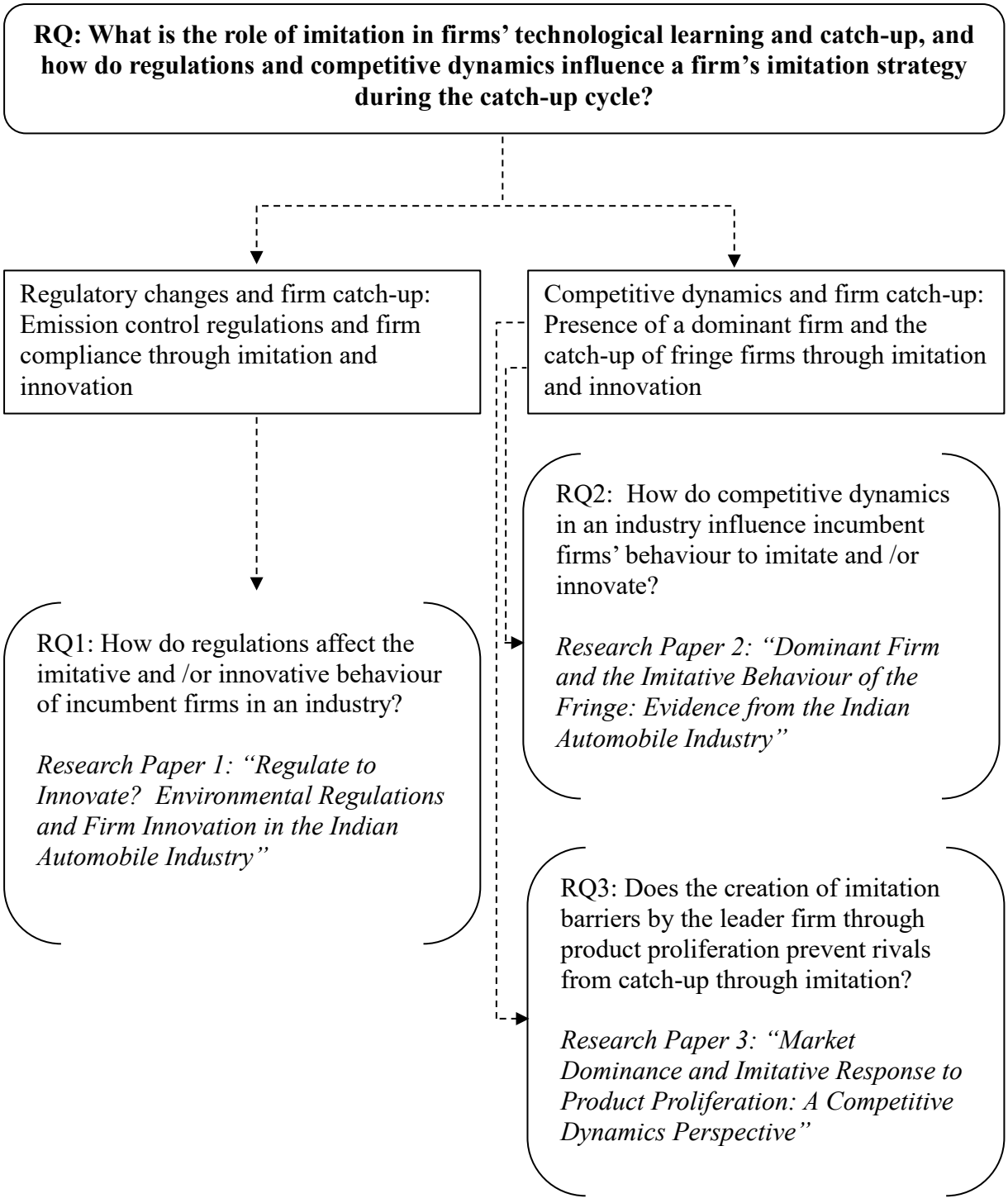


Figure 1.1 Research questions and respective papers

1.2.1 Research Paper 1

Title: Regulate to Innovate? Environmental regulations and firm innovation in the Indian automobile industry.

Research Question

> ***RQ1:*** *How do regulations affect the imitative and /or innovative behaviour of incumbent firms in an industry?*

Key Results

- The study showed that firms are not uniformly inclined to respond to stringent regulations with innovation or imitation contingent on their innovation capabilities. They choose innovation, imitation, or innovative imitation, depending on the stringency of environmental regulations, but the choice is moderated by firm innovation capabilities and industry clockspeed.
- Industry clockspeed influences firms' disposition to focus on improving value-adding features of their products in a way that when the clockspeed is low, firms with high innovation capabilities choose innovation when responding to the increase in the stringency of regulations, while firms with low innovation capabilities choose imitation. Whereas, when the clockspeed is high, even firms with high innovation capabilities largely respond to stringent regulations with imitation instead of innovation.
- The study highlights the fact that, in a business environment characterised by intense competition (i.e., higher industry clockspeed) and increasingly stringent regulations, companies do not always adopt innovation strategy, rather they engage in imitation, to catch-up with the leader firm: higher 'industry clockspeed' required firms to focus their R&D efforts on improving other value-adding dimensions of the product (i.e.,

design, new features, performance and safety aspects such as fuel efficiency, power, comfort etc.) as opposed to engaging in the innovative activities to improve the environmental performance of the product.

Key Contribution

- This study contributes to the growing literature examining the link between the regulations and innovation (Ambec *et al.*, 2013; Naimoli *et al.*, 2017; Franckx, 2014; Aversa & Guillotin, 2018; Blind *et al.*, 2017; Dechezlepretre *et al.*, 2015; Im & Shon, 2019) with specific contribution to the literature that looks at the extent of innovation (i.e., innovation to imitation).
- Using longitudinal data in the context of the Indian automobile industry, this study opens up a new line of enquiry by examining a multilevel interaction between regulations, innovation capabilities, and clockspeed and by highlighting the critical yet under-researched role of cross-level moderators that influence the firm reaction to regulations, namely: innovation capabilities supporting the ability of firms to pursue technological change (and their lack constraining such ability), and clockspeed influencing whether firms will innovate or imitate in response to regulations.
- The study contributes to imitation theories, particularly rivalry-based imitation theories which highlight that the followers tend to imitate the leader firm's innovations in an attempt to neutralize its competitive advantage (Lieberman & Asaba, 2006), by showing that in a highly competitive environment (i.e., medium to high industry clockspeed) the leader firm does not always lead innovation due to uncertainty and risks involved in the process, and instead quickly imitate a suitable solution developed by its rival(s).
- The study also contributes to policy research by highlighting that, when drafting regulations, policymakers appear to be too narrowly focused on increasing the

stringency of regulations to control the environmental degradation and induce socially beneficial innovation, and miss on the important industry dynamics (i.e., industry clockspeed) that affect the outcome, in terms of innovation, of regulatory change.

1.2.2 Research Paper 2

Title: Dominant firm and the imitative behaviour of the fringe: Evidence from the Indian automobile industry.

Research Question

RQ2: *How do competitive dynamics in an industry influence incumbent firms' behaviour to imitate and /or innovate?*

Key Results

- In an industry with a large dominant firm, the competitive fringe (including both domestic and foreign firms) operated in low volume niche segments and therefore showed a greater tendency to imitate the dominant firm's competitive actions in the key product segments they operate. Moreover, their propensity to imitate the dominant firm's actions is greatly influenced by their relative competitive positioning in the market as a whole.
- The findings showed that the dominant firm not always lead innovation in the market rather the foreign fringe firms showed a greater tendency to launch innovation in the large market segment dominated by the dominant firm, whereas domestic fringe firms preferred to imitate the dominant firm's product innovations in the large market and other foreign fringe firms' product innovations in fringe markets. The tendency of foreign fringe firms to lead innovation is attributed to their inability to match the dominant firm's cost advantages in the large market (e.g., economies of scale, tight control over local resources etc.), thus they are forced to resort to innovation strategy to catch-up. This is in contrast to the general notion that the market leader leads

innovation activities to stay ahead and avoid dethronement (Ferrier *et al.*, 1999; Smith *et al.*, 2001; Giachetti & Torrisi, 2017; Lieberman & Asaba, 2006).

- Also, the findings showed that foreign fringe firms used innovation (by launching innovative products) to catch-up with the dominant firm, while the domestic fringe firms used imitation (by launching imitative products) as a competitive strategy to catch-up with the dominant firm (Chen & Miller, 2012).
- The findings showed that the domestic fringe firms showed a higher propensity to imitate in order to remain competitive *vis-à-vis* rivals as they have limited scope to pursue innovation due to lack of superior innovation capability. This supports prior studies which argue that firms with low innovation capability tend to have a higher propensity to imitate (Kim, 1997; Kale & Little, 2007). However, contrary to our assumption, domestic firms not only imitated the dominant firm's product innovations but also showed a tendency to imitate product innovations of other foreign fringe firms. This finding suggests that firms do not always imitate the leader firm but they may choose to imitate other rivals if the competitive environment demands so and if such imitation results in capability development.
- Finally, our results also indicated that domestic fringe firms showed a higher propensity to imitate if the complexity of innovation was lower – making it easier to imitate – and assured quick performance gains. This highlights the fact that imitation activities of firms' are a function of their existing technical knowledge (i.e., absorptive capacity): firms with limited technical expertise tend to imitate innovations with low complexity until, in the process of doing so, they accumulate robust technical knowledge required to imitate complex innovations or eventually engage in innovation.

Key Contribution

- The study makes a significant contribution to the limited literature examining the imitative behaviour of firms in a dominant firm industry. Secondly, by undertaking a longitudinal enquiry, this study enhanced our understanding of competitive situations during which the leader and the rival firms deviate from their usual imitative behaviour and prefer other firms as a potential target for imitation.
- The study also contributes to the limited literature highlighting the importance of internal and external contingencies in competitive interaction (Ross & Sharapov, 2015) by introducing the dominant firm context in examining the competitive interaction among firms.
- The study potentially challenges some of the established assumptions of competitive imitation. Some of the reasons behind inter-firm imitation, as highlighted in the literature, include: imitation to neutralize the threat of competition from rival to catch-up with the leader (i.e., rivalry-based imitation); imitation of leader firm by rivals as it is perceived to possess superior market knowledge (i.e., information-based imitation); and imitation to maintain the competitive status-quo (i.e., competitive dynamics theory) among others. The literature also suggests that rival firms tend to imitate industry leader – assuming that leader firm always leads innovation in a given market – whereas the leader firm tends to imitate the nearest rival (Lieberman & Asaba, 2006; Sharapov & Ross, 2019; Posen *et al*., 2013; Smith *et al.*, 2001; Ferrier *et al.*, 1999). However, our findings suggest why a leader firm may sometimes prefer to imitate, not necessarily the nearest rival in terms of market share but eventually a rival that leads a particular market segment, instead of leading innovation activities within an industry. Similarly, rivals do not always imitate the industry leader (rivalry-based

imitation theory view), and some firms may continue imitating the rivals even if the situation demands innovative strategy due to their inability to innovate.

1.2.3 Research Paper 3

Title: Market dominance and imitative response to product proliferation: A Competitive Dynamics Perspective.

Research Question

> ***RQ3:*** *Does the creation of imitation barriers by the leader firm through product proliferation prevent rivals from catch-up through imitation?*

Key Results

- This study shows that the impact of product proliferation as an imitation barrier, as theorized in the extant research, may not always be the same. In a competitive action-reaction context, the use of product proliferation strategy by dominant market leaders to saturate product space in order to deter rivals from introducing close substitutes instead results in the increased propensity of imitation by followers firms: market followers will not desist from imitation, but instead imitate the market leaders in order to avoid falling behind in an evolving market.
- The study also finds that the imitative product proliferation by the rivals, as a response to the dominant firm's product proliferation in a given product submarket, results in performance gains for the imitating firms.
- The findings of the study confirmed that pursuing 'across-submarket' and 'within-submarket' product proliferation strategies together is more beneficial for firm performance than pursuing them individually.
- The study, contrary to the extant literature, did not find that when the dominant firm's product proliferation occurs in a more complex product submarket then the likelihood of imitative product proliferation from the rival firms in this submarket will decrease,

and similarly, rivals' imitative product proliferation in a complex product submarket result in greater imitating firm performance.

Key Contribution

- The study contributes to the extant research on product proliferation and imitation; and product proliferation and firm performance in many ways: (a) it makes a novel contribution to the literature by analysing product proliferation decision of a firm as a competitive response to another firm's product proliferation action as opposed to following the logic of pre-emption; (b) it highlights the contingencies in which product proliferation action of a firm will induce imitation from rivals; c) it advances the findings of a recent study by Piazzai & Wijnberg (2019) – who examined the effect of focal firm's product proliferation strategy and product submarket complexity on rivals' imitation and subsequent performance in an oligopolistic competition – by examining the dominant firm's product proliferation strategy on followers' imitation and subsequent performance in a dominant firm market competition; and d) it contributes to the limited literature connecting entry barriers (in industrial organization) and imitation (in strategic management).
- The findings of the study is likely to attract the attention of the managers as it showed that relying on product proliferation related benefits (e.g., achieving product diversification, creation of entry barriers, and harnessing synergies of one-stop shopping) can be detrimental to firm performance because product proliferation benefits are contingent on the competitive dynamics and a firm's standing in a given market: product proliferation strategy can create credible imitation barrier against rivals in oligopolistic market conditions, yet it induces rivals' imitation in a dominant firm market conditions.

- The study contributes to the management literature by highlighting imitation as an efficient strategy for laggard firms that are trying to catch-up in a highly uncertain competitive environment. Imitation of the dominant firm's product proliferation action not only result in significant performance gains for laggard firms, but at the same time, in the process, will help them accumulate critical knowledge that may be fruitful in their evolution.

1.3 Thesis structure

This thesis is organised into several chapters. Chapter 2 provides the literature review describing imitation as a concept, its different forms, and different theoretical perspectives that explain firm imitation behaviour. Although individual research papers discuss relevant theoretical and empirical literature related to specific sub-research questions they investigate, a comprehensive literature review chapter is presented to avoid the issue of slicing of literature in individual papers which may have led to overlooking of the literature related to the overarching research question of the thesis. Chapter 3 presents an overview of the research site: the Indian automobile industry. Since the individual research papers of the thesis investigate the firm catch-up *vis-à-vis* imitation in the context of competitive dynamics and changing regulatory environment (i.e., emission control regimes), it is critical to provide an overview and the evolution of the regulatory environment and competitive landscape of the Indian automobile industry. The subsequent chapters 4, 5 & 6 discuss three research papers of the thesis. In the end, Chapter 7 presents the conclusion and discusses the avenues for future research.

CHAPTER 2 LITERATURE REVIEW: IMITATION, TYPOLOGY, AND THEORETICAL UNDERPINNINGS

The significance of imitation in an organisation's survival and growth is, perhaps, best appraised in Theodore Levitt's quote: "Imitation is not only more abundant than innovation, but actually a much more prevalent road to business growth and profits" (1966, p 2). However, researchers have traditionally paid less attention to imitation until recently when scholars began to examine imitation as a complementary strategy to innovation, and in some cases as an enabler for innovation to ensure organisational survival and growth. Consequently, various forms of interfirm imitation have been discussed in the literature ranging from imitation of competitor's strategies (Rivkin, 2000; Fligstein, 1991; Haveman 1993; Davis *et al.,* 2000; Henisz & Delios, 2001; Ozmel *et al.,* 2017; Brouthers *et al.,* 2005; Sharapov & Ross; 2019), products and processes (Zander & Kogut, 1995; Sutton and Dobbin, 1996; Massini *et al.*, 2002; Giachetti *et al.,* 2017) to the imitation of organisational patterns and business models (DiMaggio & Powell, 1983; Haunschild & Miner, 1997; Ethiraj, Levinthal, & Roy, 2008; Casadesus-masanell & Zhu, 2013; Massini *et al.*, 2005). Similarly, interfirm imitation has also been examined from various theoretical lenses that highlight different motivations, pre-requisites, benefits, drawbacks, and constraints of interfirm imitation. Although relevant literature reviews have been conducted in the individual research papers of this thesis, this chapter provides a brief discussion on the concept of imitation, its different types, and various theories that have been utilised to study interfirm imitation.

2.1 Imitation as a concept and its typology

Imitation is broadly defined as 'the replication of an innovation, such as pioneering product or processes, by a competitor' (Zander and Kogut, 1995). Imitation, like innovation, is a strategic response to rivals' actions (Haunschild, 1993), an intelligent search of cause and effect (Shenkar, 2010) that can be a source of organizational learning and enhance firm

performance (Levinthal & March, 1993; Kim, 1997; Doha *et al.*, 2018). Imitation is understood to have both costs and benefits for imitators (Gary *et al.*, 2003). On the one hand, imitating firms acquire legitimacy that helps them gain access to resources (DiMaggio & Powell, 1983) while on the other hand, a high level of imitation among rivals results in strategy convergence and thereby erodes profitability (Porter, 1996). Porter argued (1996, p 68) "as rivals imitate one another's improvements in quality, cycle times or supplier partnerships, strategies converge and competition becomes a series of races down identical paths that no one can win". Yet, the critical role of imitation cannot be disregarded, as Giachetti *et al*. (2017) argue that in a fast-changing competitive environment it is not always necessary to win the competition but rather it is important for firms' survival to constantly adapt and evolve themselves *vis-a-vis* their rivals and therefore imitating one another makes strategic sense (i.e., Red Queen competitive imitation).

When it comes to what drives interfirm imitation, the extant research highlights several key motives such as environmental uncertainty and gaining legitimacy (DiMaggio & Powell, 1983), avoiding risks and costs associated with innovation (Lieberman & Asaba, 2006), to seek competitive parity and minimize the interfirm rivalry and competitive intensity (Smith *et al.*, 2001; Ferrier *et al.*, 1999), and to neutralise competitive advantages of rivals built on distinctive resources (Barney, 1991). Similarly, when faced with the question of: *which firm to imitate?* Following the logic of the uncertainty, information asymmetry, and herd mentality firms tend to imitate their successful rivals as they assume that the rival has better information about a given situation (Kennedy, 2002; Giachetti & Torrisi, 2017). However, imitating firms carefully consider several factors before deciding to engage in imitation ranging from the industry structure (Schmalensee, 1985), size and capability of the imitation target (Rivkin, 2000), the complexity of the activity to be imitated (Zander & Kogut, 1995), potential costs and benefits of imitation (Shankar *et al*., 1998; Schnaars, 2002).

Whereas the likelihood of the success of the imitation activity, apart from the precision, and the extent or likelihood of it being imitated by other rivals (Barney, 1991; Mansfield *et al.*, 1981), depends on the imitation speed — i.e., "the average time it takes for the focal firm to adopt the set of new product technologies introduced by rivals" (Giachetti *et al.*, 2017, p. 1887), and the imitation scope — "the extent to which a firm (in a given period) imitates a wide number (as opposed to a narrow number) of new product technologies introduced by competitors" (Giachetti *et al.*, 2017, p. 1886). Research shows that imitation scope (i.e., how much to copy) is an important factor considered by managers when they decide to adopt imitation strategy as the performance of the imitating firm (focal firm) is influenced not only by the imitation scope of its own activities but also by the imitation scope of its rival firms that engage in imitation as a strategic response to its actions (Csaszar & Siggelkow, 2010; Giachetti *et al.*, 2017). Moreover, a wider imitation scope allows the firm's product to stay abreast of new technologies thereby providing the firm avenues for performance gains (Narasimhan & Turut, 2013).

Since inter-organisational imitation is a broad concept that encompasses imitation of a specific strategy, decision, or action of another firm (i.e., action imitation) to the imitation of another firm's new or existing product or part thereof (i.e., product imitation) to the imitation of another firm's structure, process, or routines (i.e., process imitation) to the imitation of another firm's business model (i.e., business model imitation) and so forth, scholars have identified several typologies to understand the various aspect of the phenomenon. Levitt (1966), in one of the earliest research, while advocating the importance of imitation in improving firm performance, put forward the idea of "innovative imitation" and defines it as "a process of reversing the R&D, simply working backwards from what the others have done, and by trying to do the same thing for oneself". Haunschild & Miner (1997), identified three types of imitation namely trait-based imitation (i.e., imitation of the

behaviour or practices of large firms or firms in same strategic groups); frequency-based (i.e., imitation of behaviour or practices adopted by a large number of organisations); and outcome-based imitation (i.e., imitation of behaviour or practices widely perceived to bring significant performance benefits).

The extant research, based on the fact that imitation is not always a 'direct copy' of competitors' actions, product, or processes but also can take the form of 'copy-but-improve', suggests two types of imitation: pure imitation and creative imitation (Luo *et al.*, 2011; Shenkar, 2010; Grahovac & Miller 2009). Pure imitation occurs when "a firm clones its products to be identical to those of competitors" whereas creative imitation occurs when "a firm modifies or adds new features to its products based on competitors' originals" (Lee & Zhou, 2012, p. 2). Pure imitation allows firms to introduce new products, a direct replica of the competitor's product, relatively quickly and at a much cheaper price (Levitt, 1966), while creative imitation, although not new innovations, allows firms to introduce better products by taking advantage of competitor's R&D efforts and learning from their mistakes (Shankar *et al.*, 1998). Other notable forms of imitation, as defined in literature are: "rational imitation" which refers to imitating a firm taking into account the past choices of other actors in its decision-making process (Hedstrom, 1998); "reflective imitation" which refers to firm imitation that involves 'learning by watching' and further adaptations /modification of imitated activities in new user context (Bolton, 1993); and "Red Queen Competitive Imitation" which refers to "a process in which imitation by some of the firms in an industry puts competitive pressure on the rest to also imitate" (Giachetti *et al.*, 2017, p. 1883).

2.2 Imitation – innovation models and capability development

Whether imitation leads to the development of the innovation capabilities in imitating firms have been extensively studied in recent literature (Kim, 1997; Cho *et al.*, 1998; Waterings &

Boschma, 2009; Dobson & Safarian, 2008). Research has explored the role of imitation (of competitors' routines & practices, processes, products, technologies and so forth) in building innovation capabilities (refer to Figure 3.1). It has been argued that organisations often imitate the best practices, products, and services of their competitors in their quest to learn and to further improve and exploit the existing technological trajectories (McKendrick, 1995). Firms employ various strategies such as reverse-engineering, benchmarking, and competitor intelligence among others to acquire knowledge and capabilities from their rivals (Lane & Lubatkin, 1998). Hence, it will not be incorrect to assume that imitation does contribute to innovation through either fine-tuning the existing capabilities or acquisition of new knowledge and capabilities available externally. Many studies have found evidence supporting this assumption (*like* Cho *et al.*, 1998; Waterings & Boschma, 2009; Dobson & Safarian, 2008). However, the majority of these studies emphasised catch-up through learning from the imitating firms' perspectives while not taking into account the leader firm's perspective that create preventive imitation barriers to halt the followers' catch-up. In this aspect, this thesis attempts to fill the existing research gap.

The literature presents several models mapping the process of developing innovation capability through imitation. Scholars highlighted the differences in the technology trajectory of developed and developing countries, and the inapplicability of existing innovation models, that evolved in developed country environments, in explaining the catch-up of firms in developing country contexts, as primary reasons behind proposing these models (Hobday, 2005). For instance, Utterback & Abernathy (1975) argued that the evolution of technological trajectory in developed countries is characterised by three distinct stages – a turbulent period (period of radical innovation); a transition period (period of dominant design); and a stable period (period of incremental innovation). On the contrary, scholars argued that in developing countries the three stages of technology trajectory, as espoused by Utterback & Abernathy,

occur concurrently (i.e., the stable period for mature technologies and at the same time turbulent period for emerging technologies) (Kim, 1997; Lee *et al.*, 1988; Lee & Lim, 2001; Forbes & Wield, 2008). Consequently, Kim (1997), based on his study of the catch-up of Korea, suggested the model of acquisition, assimilation, and improvement (in some sense a reverse order evolution due to the presence of opportunity of acquisition of mature technology from the west), while Lee *et al* (1988) suggested the model of initiation, internalisation, and generation. Hobday (1994 & 1995) in his studies of electronics industries in Korea, Singapore, Hong Kong, and Taiwan also alluded to the reverse evolution process and found that firms based on their interaction with and expertise in technology attained a market transition from OEM to ODM and OBM over the time.

Scholars such as Lee & Lim (2001) indicated leapfrogging of stages in technology trajectory for catch-up firms, whereas Forbes & Wield (2008) suggested a five-stage innovation process model (based on imitation) to explain the evolution of a laggard firm into a potential technology leader. The different stages of that model comprised of: i) imitation to produce; ii) imitation to produce efficiently; iii) imitation to improve the product; iv) imitation to develop new products; and v) imitation to develop new technology. Similarly, a recent study by Xu & Li (2014) examined the technological innovation development processes of state-owned and private Chinese automobile firms and suggested two different three-stage process models. For state-owned firms, they suggested three stages as duplicative imitation; OEM (original equipment manufacturer) and technology acquisition through JVs; and ODM (original design manufacturer), OBM (original brand manufacturer) and Independent innovation whereas for private firms the three stages were duplicative imitation; creative imitation; and independent innovation.

The imitation process has also been found to vary in different developing countries as these countries differ in their historical background, geographic and economic

opportunities, and are beset with unique challenges. For instance, Chen & Qu (2003) argued that technological imitation in China differs from Kim's (1997) proposed model for Korea of acquisition, assimilation, and improvement and described new forms of imitation in China as operational, tactical and strategic imitation. Similarly, Xie & Wu (2003) argued that firms from Asian tiger economies relied on export markets for their imitation activities whereas Chinese firms rely more on the domestic market for imitation.

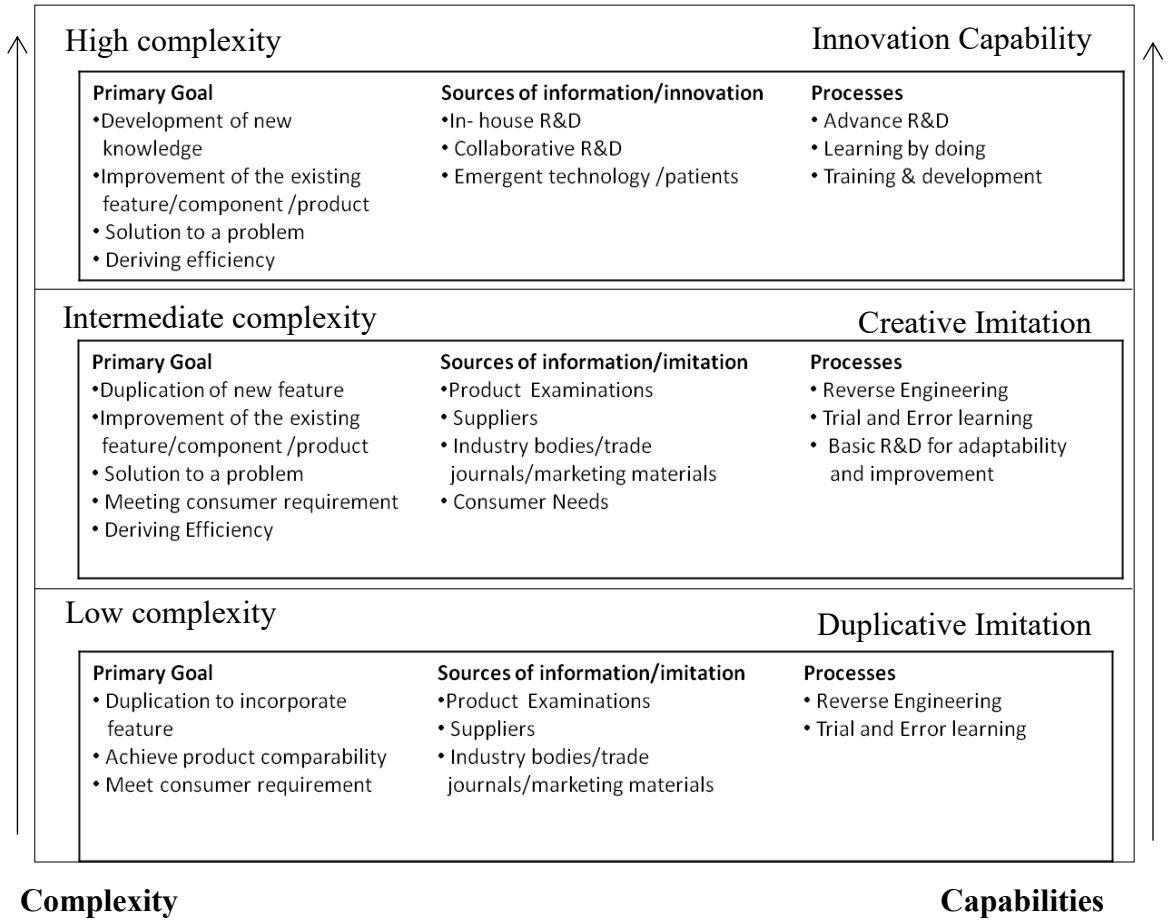


Figure 2.1 Product complexity, imitation and capability development

2.3 Imitation and theoretical underpinnings

Interfirm imitation has been analysed from different theoretical lenses, and the application of theories explains different aspects of interfirm imitation at different levels (Lieberman & Asaba, 2006; Ordanini, Rubera, & DeFillippi, 2008). For example, the neo-institutional

theory and related literature take a macro environment view (e.g., regulatory environment, institutions etc.) and suggest that firms tend to imitate one and another due to pressures — e.g., mimetic isomorphism due to high environmental uncertainty, to seek legitimacy within a group — exerted on them by institutional contexts they operate in (DiMaggio & Powell, 1983). Competitive dynamics and industrial organisation theories are focused more on the competitive environment level, suggesting interfirm rivalry and competition, as the main driver and incentives of imitation (Smith *et al.*, 2001; Porter, 1979). Whereas, organisational learning theory (Levitt & March, 1988; Levinthal & March, 1993), and resource-based view (RBV) (Barney, 1991; Lippman & Rumelt, 1982) theories are focused on organisational level motives, incentives and objectives of imitation. This section of the literature review chapter briefly discusses assumptions of these theories and their usefulness in examining different forms of interfirm imitation, however, it should be clarified at the outset that the aim is not to exhaustively review all the existing literature under these theory domains.

2.3.1 Imitation and Neo-Institutional Theory Literature

The seminal work of DiMaggio & Powell (1983) forms the foundation of the neo-institutional theory. Although DiMaggio & Powell (1983) highlights three main forces, namely: power (i.e., the dependence of membership among others, e.g. regulatory authority), uncertainty (i.e., limited information of current and future environment), and culture (i.e., socialisation norms influencing behaviour), to explain why firms operating in a given institutional environment tend to be homogenous, it is the environmental uncertainty that researchers emphasised as the main predictor of imitation behaviour of firms; while the power and culture being considered as the sources of isomorphism but not directly driving mimetic isomorphism. Research have theorised environmental uncertainty as the difficulty in predicting the probability of future environmental conditions, for example, future trajectory of technologies, consumer preferences etc. (Haunschild & Miner, 1997; Mizruchi & Fein,

1999; O'Neill *et al.*, 1998; Gaba & Terlaak, 2013). Since high environmental uncertainty put constraints on firms' ability to accurately assess the future course of action, in order to avoid the risk of making wrong choices, firms tend to imitate the actions of successful organisations, who they consider as norm setters in the industry, having superior information (Semadeni & Anderson, 2010), and imitating such organisations will provide them legitimacy (Barreto & Baden-Fuller, 2006). For instance, in the 1980s technological uncertainty prompted US firms to follow Japanese firms and adopt quality circles (DiMaggio & Powell, 1983).

While the neo-institutional theory domain emphasises the reduction of environmental uncertainty and seeking legitimacy as the main motives of imitation, the theory also provides useful insights in terms of the target of imitation, i.e., whom to copy and what to copy. Haunschild & Miner (1997) identified three imitation targets namely trait-based imitation (i.e., imitation of the behaviour of a large firm or firms in same strategic groups); frequency-based (i.e., imitation of most widespread behaviour); and outcome-based imitation (i.e., imitation of behaviour widely perceived to bring performance benefits). A recent study by Barreto & Baden-Fuller (2006) build on trait-based imitation and examined the role of reference groups in firms' imitation behaviour. Other studies, utilising neo-institutional theoretical framework and indicating the information-based motives of firms, have also highlighted the market leader, by virtue of its perceived superiority in terms of knowledge of the future technological trajectory and consumer preferences, as a potential target for rival firms' imitation (Lieberman & Asaba, 2006; Giachetti & Lanzolla, 2016; Giachetti & Torrisi, 2017). The neo-institutional theory has also been utilised to study interfirm imitation of different organisational actions or strategies such as imitation of diversification strategies (Fligstein, 1991); imitation of a new market entry (Haveman, 1993; Davis *et al.*, 2000); imitation of the FDI and plant locations (Henisz & Delios, 2001);

interfirm imitation of the high-tech venture acquisitions (Ozmel *et al.*, 2017); export decisions (Brouthers *et al.*, 2005); and interfirm imitation of the total quality management (TQM) practices among others (Westphal *et al.*, 1997). While some studies focused on the examination of imitation mechanisms such as the use of interlocking directorships which facilitated the interfirm imitation (Westphal *et al.*, 2001).

2.3.2 Imitation and Competitive Dynamics and Industrial Organization Theory

Competitive dynamics theory, as previously mentioned, stresses the competitive environment as the primary driver of interfirm imitation. Scholars suggest that firms tend to imitate rivals that are comparable in resources and size and their primary motive behind doing that is to seek competitive parity and at the same time they tend to avoid direct confrontation with the market leader (Chen & MacMillan, 2012; Ferrier *et al.*, 1999; Smith *et al*., 2001; Sharapov & Ross, 2019). Lieberman & Asaba (2006) termed it as 'rivalry-based imitation'. The research in this theoretical domain highlights several reasons behind the higher propensity of imitation among rivals with comparable resources. For instance, a higher resource gap between the target firm and imitating firm means higher constraints on the imitating firm to commit the requisite resources, related to the acquisition of new technology or development of a new product line for example, to successfully mimic the target firm's actions (Smith *et al.*, 1991). Moreover, it makes it hard for smaller rivals to accurately understand the tacit nature of the capabilities required to imitate complex products or strategies of the larger rival (Smith *et al.*, 2001; Clarkson & Toh, 2010) and hence it makes more sense for imitating firms to select firms with comparable size and resources as a target for imitation (Giachetti *et al.*, 2017; Ross & Sharapov, 2015). The selection of firms with comparable resources for imitation also allows the imitating firm greater ability to withstand the retaliatory response should the target firm decides to retaliate and increases the competitive intensity (Greve, 1998; Chen & Miller, 2012).

Another stream of literature that emphasises the competitive environment as the main driver of interfirm imitation is industrial organisation theory (IO). The early IO theory considered industry as a collection of homogenous firms in which inferior firms were anticipated to either imitate the market leader to survive or leave the industry: a conceptualisation that indicated imitation as convergence force — firms copying each other's competitive moves increases homogeneity — leading to intense competition, price erosion and competitive stalemate (Posen *et al.*, 2013). Later research relaxed this intra-industry homogeneity assumption and emphasised the strategic group homogeneity and interfirm imitation within strategic groups (Caves & Porter, 1977); thereby suggesting that structural barriers created around the strategic groups limit firms' mobility from one group to another: interfirm imitation within the strategic group leads to homogeneity within the group, but at the same time, the constraints on the movement of firms across strategic groups due to structural barriers allowed for intra-industry firm heterogeneity (Schmalensee, 1985). So, in IO theoretical domain imitation is considered as an undesired consequence of competitive activity, which firms hoped to prevent by creating barriers, while innovation assumed importance. Moreover, since IO theorists assume that firms, as rational actors, are perfectly placed to assess the alternative courses of action and chose the best one, it is obvious that in this view the focus is not on firms' choices at transitional points in times, such as whom or what to imitate, but on the industry structure (e.g., barriers to entry or mobility) as the determinant for firm and industry performance. Consequently, the usefulness of the IO theory is limited in understanding the imitation processes as it ignores the fact that imitation is a dynamic process, one firm may not perfectly imitate the other, but rather imitation is an iterative process with different consequences for imitating firm performance contingent on firm's abilities (i.e., diversity of knowledge in imitating firms) and complexity of elements

being imitated (Rivkin, 2000; Ethiraj *et al.*, 2008; Posen *et al*., 2013). However, these dynamics of the imitation processes are critical for firms trying to catch-up.

2.3.3 Imitation and Organisational Learning Literature

The organisational learning theory and related literature highlight the learning aspect of interfirm imitation: imitation as an efficient strategy to capture the experience of other organisations (Levitt & March, 1988; Haunschild, 1993). For example, the theory contends that firms can derive benefits by observing innovative firms' exploratory investments and experiments aimed at creating new knowledge which they can attempt to imitate if it results in a successful outcome (Levinthal & March, 1993). Jerez-Gomez *et al.* (2005, p. 716) define organisational learning as "the capability of an organisation to process knowledge—in other words, to create, acquire, transfer, and integrate knowledge, and to modify its behaviour to reflect the new cognitive situation, with a view to improve its performance". Research on organisational learning argues that a firm's competitive advantage is contingent on its ability to exploit existing knowledge, and develop new knowledge through the exploration of new learning opportunities (March, 1991; Lavie *et al.*, 2010; Lee *et al.*, 2017; Li *et al.*, 2008; Jansen *et al.*, 2009). Both exploitative learning and explorative learning is considered as critical for superior firm performance as on the one hand, exploitative learning helps firms to improve their existing processes and work routines, and allows them to acquire and assimilate external knowledge and develop innovation capabilities (Cohen & Levinthal, 1990; Zahra & George, 2002; Lavie *et al.*, 2010; Jensen & Clausen, 2017), while on the other hand, explorative learning helps firms to develop, through experimentation, new knowledge and technologies which leads to the development of new product, services, and new markets (Jensen & Clausen, 2017; Wang & Hsu, 2014). In other words, exploitative learning promotes imitation (Shenkar, 2010; Luo *et al.*, 2011) and related benefits whereas explorative learning promotes innovation (Katila & Ahuja, 2002; Benner & Tushman, 2003), however,

research, especially literature on organisational ambidexterity, recommends firms to simultaneously employ both exploitative and explorative learning strategy to achieve superior performance (He & Wong, 2004; Lavie *et al.*, 2010).

Organisational learning theory, concerning imitation, suggests that firms tend to copy and learn from the actions of their successful peers as they want to avoid the costs, and risk involved in exploratory search given the outcome uncertainty of such efforts — exploratory search can lead to several alternative discoveries with potentially uncertain pay-offs (Levitt & March, 1988), and would let others absorb the cost of experimentation and discovery (Baum *et al.*, 2000; Feldman, 2000). However, when it comes to the learning mechanism, the organisational learning scholars (e.g., Hagedoorn, 2006; McKendrick, 2001) point out that firm can either employ vicarious learning (i.e., learning from the target firm without having direct linkages; through conferences, competitive intelligence etc.) and (or) contact learning (i.e., through direct linkages such as formal relationships, social ties, network membership etc.). Several studies provide evidence of vicarious learning in firms' decisions such as an entry in foreign markets, location of units, and investing in emerging industries (McKendrick, 2001; Baum *et al.*, 2000; Srinivasan *et al.*, 2007). Similarly, research also provides evidence of contact learning among organisation and shows that strong (or even weak) ties between firms (e.g., through interlocking directorships) creates long-term relationships that facilitate frequent interactions, help and support, exchange of information, trust, and in some cases joint problem solving (e.g., firm alliances) between firms and may enable interfirm imitation (Williamson & Cable, 2003; Hagedoorn, 2006). However, both vicarious and contact learning may lead to imperfect or sub-optimal imitation outcomes, as firms may overestimate the strategic value of some practices of a successful firm as they do not have the opportunity to observe firms that failed to realise that value (Denrell, 2003). Although mimetic isomorphism (neo-institutional theory) and organisational learning

perspectives highlight uncertainty as the main driver of interfirm imitation, mimetic isomorphism points to environmental uncertainty forcing firms to imitate other firm's actions due to social pressures, while in organisational learning perspective, given the outcome uncertainty of explorative search, imitating firms tend to discriminate among the alternatives available before deciding what to imitate (Lieberman & Asaba, 2006; Ordanini *et al.*, 2008).

2.3.4 Imitation and Absorptive Capacity Literature

The previous section highlighted the critical role of organisational learning concerning imitation, however, the ability of a firm to learn, assimilate, and exploit external knowledge, especially complex knowledge, depends on the level of the firm's prior related knowledge – i.e. "absorptive capacity" (Cohen & Levinthal, 1990). Absorptive capacity (ACAP) is broadly defined as a firm's ability (as a function of its prior knowledge) to recognise, assimilate and exploit new knowledge (Cohen & Levinthal, 1990, p 128). Recent studies have advanced the initial construct proposed by Cohen & Levinthal (Zahra & George, 2002; Lewin & Massini, 2003; Lane *et al.*, 2006; Lewin *et al.*, 2011). For instance, Zahra & George (2002) reconceptualised the concept by advancing the three-dimension construct to a four-dimension construct that includes acquisition, assimilation, transformation, and exploitation; while defining ACAP as *"a set of organisational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organisational capability"* (p. 186). They further divided the four dimensions into potential-ACAP (i.e., firm's ability to value and acquire external knowledge based on the identification and assimilation dimensions proposed by Cohen & Levinthal (1990)), and realised-ACAP (i.e., firm's ability to transform and exploit the acquired knowledge).

Furthermore, Lewin & Massini (2003), citing the neglect of the exploration and assimilation of new knowledge within the boundary of the firm in the original

conceptualisation of the construct, distinguished the ACAP concept in *internal and external ACAP capabilities*. They conceptualise the *Internal ACAP capabilities* as the ability of the firm to manage the processes of internal variation, selection, and replication (VSR) whereas *external ACAP capabilities* refer to the management of exploration and assimilation of external knowledge. While Lewin *et al.* (2011) further identified the configuration of metaroutines underlying the internal and external ACAP capabilities and argue that it is the variability in the ability of firms to discern and implement the complementarities between internal and external ACAP routines that differentiates the early adopters from imitators.

Lane *et al.* (2006) highlighted the reification of the absorptive capacity as a concept and critiqued that it is the result of scholars largely viewing absorptive capacity as a 'firm's ability' instead of taking a process-oriented view (emphasising on knowledge flows). Consequently, they defined ACAP as *"a firm's ability to utilise externally held knowledge through three sequential processes: (1) recognising and understanding potentially valuable new knowledge through exploratory learning, (2) assimilating valuable new knowledge through transformative learning, and (3) using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning"* (Lane *et al.*, 2006, p 856). Thus, although this study is not directly focused on understanding the development of absorptive capacity in the firm, its role as a prerequisite in driving imitation is critical in the analysis of a firm's behaviour vis-à-vis imitation and innovation.

2.3.5 Imitation and Resource-Based View (RBV) Literature

Resource-based View (RBV) argues that the competitive advantages of a firm lie in its ability to exploit the unique bundle of diverse resources, ranging from knowledge and capabilities, managerial competencies, and organisation culture among others, as long as those resources are valuable, rare, imperfectly imitable, and non-substitutable (Barney, 1991). Likewise the

IO theory, RBV scholars have looked at imitation from an entry barrier vantage point, however, their examination of interfirm imitation remained focused on an organisational level, imitation of firm's strategic resources for example, as the main driving force, eroding the potential of distinctive resources (especially with low causal ambiguity) of the competitor firm to neutralise its competitive advantage as the basic purpose, and market leader as a potential target of imitation. Also, it looks at the imitation behaviour from the target firm perspective, as opposed to the imitating firm, in this view, firms with distinct resources need to create credible barriers to neutralise the threat of imitation (e.g., increasing the inimitability of rare resources by increasing their causal ambiguity), in order to prolong the competitive advantages originating from such resources (Barney, 1991; Mahoney & Pandian, 1992; Lippman & Rumelt, 1982). The research highlighted that some of the features of the process through which the resources are developed and accumulated, such as asset-mass efficiencies, interconnectedness, time-compression diseconomies, and causal ambiguity may act as potential imitation barriers (Dierickx & Cool, 1989; Rouse & Dallenbach, 1999).

However, causal ambiguity stands out as a strong barrier to imitation. It refers to the situations in which either the firm cannot determine the true causes of its success or deliberately makes it difficult for other firms to completely assess the link between a firm's resources and its performance, thus diminishing the scope for perfect imitation (Reed & DeFillippi, 1990; King & Zeithaml, 2001; Powell *et al.*, 2006). For instance, if the link between the target firm's critical resources and its performance is not completely understood, imitation will not provide the desired results. Also, such imperfect imitation may prove costly for the imitating firm as it will run the risk of combining the resources in a sub-optimal way (Rivkin, 2000). Causal ambiguity not only prevents imitation but may also lead to disruptive innovations as rivals are forced to look for resource substitution if they can't take the less costly route of resource imitation (McEvily *et al.*, 2000). However, in addition to causal

ambiguity, RBV scholars suggest that the propensity of imitation will also depend on the type of resources, for example, if a firm's comparative advantages come from manufacturing or marketing capabilities (Frynas *et al.*, 2006).

2.4 Conclusion

Although the individual research papers of this thesis have primarily utilised competitive dynamics and neo-institutional theories to understand the role of imitation in firm catch-up, the primary motivation behind reviewing other theories (i.e., RBV, organisation learning, and ACAP) and related literature has been, on the one hand, to have a comprehensive understanding of the concept before utilising it in examining its role in firm catch-up. On the other hand, to provide theoretical background and inform key variables that have been employed in empirical models: such as nature and degree of interfirm imitation, the complexity of products or technologies of rivals being imitated, possession of pre-requisite capabilities and technical knowledge and the development of new capabilities, and strategic motivations of firms behind the choice of imitation or innovation as a strategy to catch-up. For instance, the theoretical literature on organisational learning and ACAP provides background in understanding the role of prior related knowledge and capabilities, and further development of relevant capabilities through R&D, in interfirm imitation. Similarly, the RBV theory and related literature not only provide suitable background to understand the difficulties firms face in imitating complex products, technologies, or strategies as firms focus on developing inimitable resources in order to have a competitive advantage over rivals but also help us understand how firms create imitation barriers, to deter rivals from imitation of their products or resources, through increasing their causal ambiguity. Moreover, organisational learning, ACAP, and RBV theories, together with competitive dynamics and neo-institutional theories, provide suitable context to examine the different motivations and causalities concerning interfirm imitation.

CHAPTER 3 OVERVIEW OF THE INDIAN AUTOMOBILE INDUSTRY

3.1 Introduction

The Indian automobile industry has grown phenomenally over the last few decades and more so since 1990 when India began liberalising its economy. Considering the impressive growth of the industry in the last decade or so, it will not be an overstatement to say that the industry has come of age. As per the latest estimates (based on FY2018-19 data), the industry produces around 30 million vehicles annually (including 2-wheelers, 3-wheeler, passenger cars, tractors and commercial vehicles) – heavily skewed toward the two-wheeler production (24.5 million) as passenger vehicles only accounted for a little over 4 million – and provides direct and indirect employment to over 37 million people (SIAM, 2019; Indian Department of Heavy Industries Annual Report, 2019). Globally, India is the 5th largest passenger car manufacturer, 7th largest commercial vehicle manufacturer, 4th largest heavy truck manufacturer, 2nd largest bus manufacturer, and the largest tractor manufacturer (OICA, 2019). The Indian automobile sector is worth US$ 90 billion (£68 billion), constitutes almost half (i.e., 49%) of the total manufacturing GDP and contributes around 7.1% to national GDP (Indian Department of Heavy Industries Annual Report, 2016).

The growth of the industry has accelerated in the last two decades with the growing integration of the Indian economy with the world economy. This integration not only brought forward the structural changes in the Indian economy but also resulted in the influx of multinational enterprises from across the world with an aim to exploit the comparative advantages of the Indian economy and market opportunities. As a result, different sectors of the economy have been witnessing the tremendous transformation and the Indian automobile industry is no exception. At present, the industry is characterised by stiff competition among several foreign firms and domestic car producers such as TATA Motors and Mahindra among

others. This has pushed domestic firms to increasingly search for new ways and invest in capability development in terms of brand, quality, product design, hi-tech production processes, and innovation among others in order to compete with superior foreign firms (Elango & Pattnaik, 2007). The section below provides a brief account of the evolution of the Indian automobile industry over many decades and highlights the current competitive landscape in the end.

3.2 Evolution of the Indian automobile industry

During the first few decades since India's independence in 1947, the Indian economy was characterised as a protectionist economy (that restricted foreign firms' participation and discourages fair competition among companies), a pervasive system of regulation, strong licensing/permit regime (e.g. Development and Regulation Act 1951), and with limited participation of private firms in the various sectors of the economy as most of the sectors were reserved for state-owned enterprises. Private businesses struggled to obtain government permits for starting as well as for expanding the business operations and those with a strong link with the government and politicians enjoyed preferential treatments (Majumdar, 1997). However, the government policy began to change at the beginning of the 1980s due to growing opposition towards the policy of excessive regulation and growing support for allowing more private participation in protected sectors of the economy. The consistent dismal performance of the state-owned enterprises further provided credence to the demands for a policy change. Consequently, India embarked on the path of economic liberalisation that Bhagwati (1993) described as "reforms by stealth" (a period from 1980-1984 with small reforms), "reforms with reluctance" (a period from 1984-1991 with changes limited to few sectors of the economy), and "reforms by storm" (post-1991 period with economy-wide large scale reforms). That also paved way for the development of the Indian automobile sector. D'costa (2000) divides the evolution of the Indian automobile industry into two distinct

periods – the pre-reform era (Pre 1990s) and the post-reform era (Post 1990s) (refer Figure to 3.1). The sections below provide a brief account of the evolution of the industry during those periods.

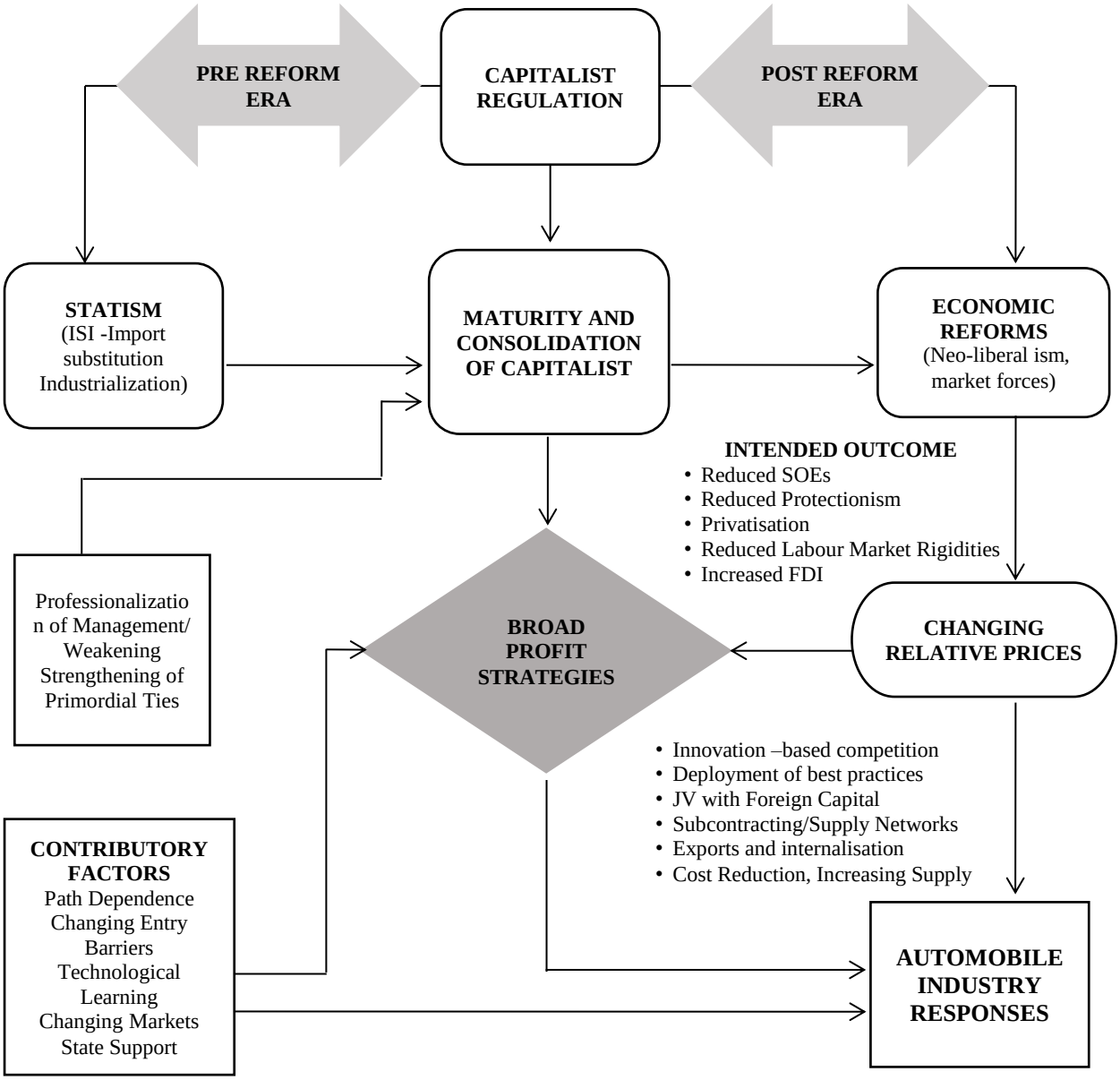


Figure 3.1 Structural Changes in Indian Automotive Industry; Source: D'costa (2000, p – 147)

3.2.1 Pre reform Era (1947-1990)

The rigid policy environment, market entry barriers, and import restrictions during the pre-reform era, on the one hand, led to the development of the domestic auto and component industry as it allowed domestic firms to develop and grow and, on the other hand, devoid the

industry of advanced production technologies that negatively affected the competitiveness of the domestic firms and the industry (refer Figure 3.2). During much of the 1950s, the Indian government adopted the policy of import substitution and local content requirements (up to 95%) that negatively affected the development of the fledgling auto industry. For instance, the local content requirement rule made it tough for auto manufacturers (mainly incumbent foreign firms at the time such as Ford and GM) to source quality components as most of the local suppliers lacked quality and production capability. Moreover, the government policy of reserving a significant portion of components manufacturing for privately owned small-scale firms further worsened the situation and, to the detriment of the industry, restricted some of the large capable domestic firms from venturing into component manufacturing. From the mid-1960s, the government further restricted auto manufacturers from expanding their internal components manufacturing capacity forcing them to buy components from these small-scale firms (Singh, 2004). Consequently, unable to cope with the regulations, Ford and GM (that were driving the development of the industry at the time) exited the Indian market (D'costa, 1995). On the other hand, the government's classification of cars as luxury goods compelled domestic firms to focus more on the commercial vehicle segment and tractors as opposed to the passenger cars segment leaving the industry producing and selling a few limited superannuated products /models.

The period between the 1950s and 1970s saw the establishment of various industry bodies. For instance, the Automotive Components Manufacturers Association of India (ACMA) and the Society of Indian Automobile Manufacturers (SIAM) were established in 1959 and 1960 respectively. These organisations served and continue to serve as the liaison between the government, companies and potential export markets, and engage in activities to promote quality, productivity and industry-level research. The government also established the Engineering Export Promotion Council (EEPC) in 1955 to promote exports and

vocational training institutes such as Industrial Training Institutes (ITI) in 1960 to ensure a steady supply of skilled labour. The automobile industry and the Indian government also jointly set up the Automotive Research Association of India (ARAI) in 1966 to promote research, product development and to meet the testing and certification needs of the industry. Despite the government efforts in creating necessary institutional infrastructure, the industry during much of the period remained small in size owing to the protectionist policies. The protected environment and lack of competitive pressures offered little incentive for the domestic manufacturers to engage in consequential research, product development and quality improvement. These manufacturers mostly developed arms-length relationships (based purely on price considerations) with component suppliers and seldom assisted them in capability development (Okada, 2004). Moreover, the lack of capital support and the inability of small-scale firms to employ relatively trained ITI graduates resulted in a fragmented auto components industry fraught with low production volumes, low-skilled labour, low quality, and poor technology. These companies did export a relatively small quantity of their production but due to poor quality, it was mainly limited to other developing countries in Africa and the Middle East.

In the early 1980s, the government reluctantly affected a few small regulatory changes for the automobile industry by allowing domestic commercial vehicle manufacturers to set up new plants, add manufacturing capacity, and engage in technical /financial collaborations with foreign players. In 1983, the government also set up a joint-venture company - Maruti Udhyog Limited (MUL), in collaboration with Suzuki Motors of Japan with the primary aim of leading the development of the Indian automobile sector and manufacturing low-priced small cars to meet the demands of the growing Indian middle class. However, the entry of new private firms was allowed only in the auto components manufacturing whereas the entry of new players in the growing passenger car market was

restricted up until major reforms started in 1991. The government continued with the local component requirement rule that - contrary to the period during the 1960s & 1970s - led to the development of the auto component industry and local suppliers' networks as MUL, commercial vehicle manufacturers, and two-wheeler manufacturers promoted entrepreneurial start-ups and existing domestic component manufacturing firms by providing technical and managerial support and encouraging JVs between their foreign (mostly Japanese) and local component suppliers (Okada, 2004).

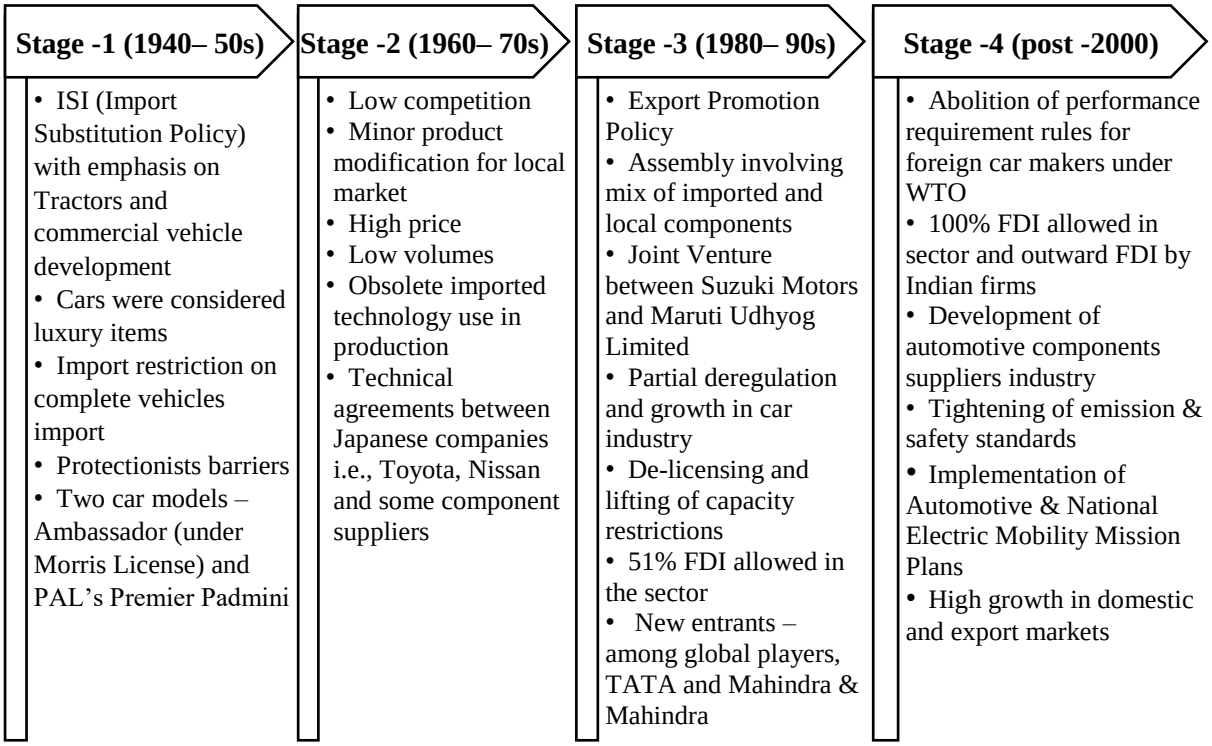


Figure 3.2 Development of Automotive Sector in India

3.2.2 Post reform era (1990 onwards)

The character of the Indian automobile industry began to change with the start of gradual liberalisation of the industry in 1990-1991 (that coincided with the wider economic liberalisation undertaken by the Indian government) and the subsequent easing of the FDI norms (Lee & Anderson, 2008). Some of the early steps taken by the government were the

end of the license/permit regime, encouragement of foreign technology licensing/transfer, and permission to foreign automobile manufacturers to enter the Indian market through majority-owned or wholly-owned ventures albeit on a case-by-case basis. The government also allowed domestic and foreign firms to take up to 24% stake in small indigenous components suppliers (Kumaraswamy, Mudambi, Saranga, & Tripathy, 2012). This provided the much-needed impetus for growth as sensing the opportunity many automobile manufacturers from North America, Japan and Europe – such as Daewoo, Daimler, Ford, Honda, GM, Peugeot, Hyundai, and Toyota – made their entry in the Indian automobile market from 1992 to 1997. The majority of these firms initially formed JV assembly operations with Indian partners which facilitated the much-needed infusion of capital, knowledge, technology, and production techniques in the industry. Moreover, the successive entries of foreign manufacturers also resulted in multiple product launches and the relocation of multiple global models into the Indian auto market (D'costa, 1995). The government initially, in a bid to promote local businesses, restricted foreign firms in importing completely knocked down kits (CKDs) and other components, however as it became evident that the foreign firms were unable to begin low-volume operations without importing CKDs and other components the government offered to lift the restriction provided individual firms signed a memorandum of understanding (MoU) with government including non-public commitments on production volume, local content usage, and promising exports equivalent of the value of imported CKDs/components (Humphrey, Mukherjee, Zilbovicius, & Arbix, 1998). The government also levied high customs duties on such imports until foreign firms fulfilled their commitments (Kumaraswamy *et al*., 2012).

The opening of the hitherto protected passenger car market also prompted domestic firms such as TELCO (now TATA Motors) and Mahindra, which until then operated in the commercial vehicle segment, to enter the passenger car market by offering multi-utility

vehicles (MUVs) initially and small cars later. In the initial years of the reform era, domestic firms exploited the new opportunities of capability development available through different channels of contact with the more advanced foreign firms and through spillovers. For instance, the competitive environment pushed domestic firms to seek technological up-gradation, exploit scale advantages (which was limited during the licensing era), and motivated firms to improve their products, production processes, discover new ways to find solutions to emerging problems, and invest in internal R&D (Narayanan, 1998). The de-regulation of the industry allowed firms to acquire technologies through licensing, FDI or through buying the available technology at lump sum cost and absorb and assimilate imported technologies using in-house R&D (Kumar & Siddharthan, 1994). Firms were also allowed to import relevant components due to the ease of local components requirement rules that further led to significant product improvements. Later on (and more so in the last decade), some of the domestic firms (regarded as national champions) that successfully developed significant levels of capabilities and competences started engaging in outward FDI (in both developing and developed countries) to acquire strategic assets and/or to exploit market opportunities (Pradhan & Singh, 2008; Humphrey & Memedovic, 2003).

Following the encouraging results of initial reforms, in 1997, the government implemented a uniform policy for the automobile industry (instead of the practice of case-by-case MoUs adopted in 1995) to encourage existing/new entrants to set up manufacturing operations and not just assembly operations. The new policy required entrants to: a) meet 50% local content requirement in the first three years gradually increasing it to 70% by the end of the fifth year of operation; b) meet the exports requirement of an equivalent amount of imported CKDs or semi knocked-down kits (SKDs) with the start of the third year of operations; and c) invest a minimum of US$50 million (£30 million) to set-up wholly-owned subsidiaries in India (Tewari, 2001). The gradual deregulation and subsequent

implementation of the uniform policy also helped in the development of the auto component industry. The entry of foreign auto manufacturers in India was soon followed by their component suppliers, many of which preferred JV with domestic firms to avoid the requirement of high-level investment in setting up wholly-owned subsidiaries, competition, pricing pressures in a low-volume market, and overreliance on licensing route. These linkages allowed domestic firms to develop production capability, improve productivity, and encourage them to adopt new work practices, training programmes and professional management (Okada, 2004). The well-operational institutional infrastructure that the government established during the 1950s and 1960s also supported the development of domestic firms significantly. Consequently, during the 1990s, several domestic firms namely Sunder Fasteners, Bharat Forge, and Wheels India among others developed capabilities to supply directly to auto manufacturers or Tier-1 suppliers (Humphrey *et al.*, 1998; Okada, 2004). Furthermore, based on the favourable business policies, and incentives and subsidies offered by different states in India, three major automobile clusters evolved in Northern (Delhi/Gurgaon), Western (Pune), and Southern (Chennai) parts of the country (refer Table A1 in the appendix for placement of firms in different clusters). By the end of the 20th century, the growth in the industry also prompted banks and other financial corporations (State Bank of India, HDFC and ICICI among others) to provide consumer finance that significantly increased demand. Although, during the period from 1991-2000, the industry grew significantly in terms of demand, production volumes, quality and variety of product offerings the Indian automobile industry lagged behind other emerging Chinese, Korean, and Brazilian industries (Kumaraswamy *et al.*, 2012).

In the year 2002, the Indian government developed and implemented a comprehensive auto policy with an aim to make India a hub of small cars, for both domestic as well as global market, and an Asian hub for automobile components. The 2002 automobile

policy further liberalised some of the restrictions limiting full-fledge growth of the Industry. For instance, the new policy that allowed 100% foreign ownership with no local content limitation and minimum investment requirements together with the lifting of export obligation requirements (that were already revoked in 2001) encouraged increased participation of foreign firms in the Indian automobile industry. For instance, over the last decade, the FDI inflows in the automobile sector grew consistently from total FDI inflows of US$ 0.9 billion (£0.56 billion) in 2011 to US$ 2.5 billion (£1.95 billion) in 2019. Whereas, the industry received a cumulative FDI of US$ 24 billion (£18 billion) during 2000-2019 (refer to Table A2 & A3 in appendix). Many automobile and components manufacturers increased their ownership in Indian JVs resulting in a significant number of these entities either becoming 100% foreign-owned or 100% domestic firm owned. The full ownership also allowed foreign firms to integrate the Indian subsidiaries into their global operations and employ a more technology-driven strategy in the Indian market. Domestic firms also took advantage of the ease in government regulations and started engaging in outward FDI to access more advanced technologies (Parhi, 2007).

The Indian outward FDI in developing countries are mostly aimed at exploiting market opportunities whereas investments in developed countries are primarily targeted towards accessing knowledge and technological assets for capability development and to be exploited in the domestic market (Thomas & Narayanan, 2017). The much-publicised takeover of Jaguar Land Rover by TATA in 2008 and the recent acquisition of SsangYong Motor Company (South Korean manufacturer) by Mahindra in 2011 are some of the recent examples of outward FDI by Indian automobile companies. Most of these foreign investments formed a part of the 'catch-up' strategy of Indian firms and were aimed at accessing knowledge, technology, and managerial expertise to close the capability gap *vis-a-vis* foreign firms (Pradhan, 2017). Since 2003, the Indian government has taken various

supporting measures to enhance the growth of the Indian automobile sector. For instance, Core Group on Automotive R&D (CAR) in partnership with the industry was established in 2003 to decide future priorities for the industry. The government also established several advanced facilities to meet the testing and certification requirements of the industry. Starting in 2004, the government gradually began to minimise the tariffs and customs duties on key raw materials such as steel and in 2005 allowed auto manufacturers to take a weighted reduction of 150% of their R&D expenditure. Subsequently, the government also signed free trade agreements with Thailand (in 2004), EU nations and South Korea that further helped the development of the Indian automobile industry and exports markets.

Following on, the government launched a 10- year 'Automotive Mission Plan – 2006-2016' in 2005 with an aim "To emerge as the destination of choice in the world for design and manufacture of automobiles and auto components with output reaching a level of US$ 145 billion (£110 billion) accounting for more than 10% of the GDP and providing additional employment to 25 million people by 2016." (AMP 2006-2016, 2005, p 1). However, at the end of the FY2016 the industry missed the target by a clear margin as it was worth US$90 billion (£68 billion) and accounted for 7.1% of the GDP. Nevertheless, the considerable success of the policy resulted in the launch of the 'Automotive Mission Plan 2016-2026' with an aim to achieve a total output of US$290 billion (£220 billion), contribution of 12% to national GDP, generation of an additional 65 million jobs, and developing Indian automobile industry among the top three globally in terms of engineering, manufacture, and exports of vehicles and automobile components by the year 2026 (SIAM, 2016). In addition to the automotive mission plan, the government also launched the National Electrical Mobility Mission Plan- 2020 (announced in 2012) and FAME (Faster Adoption and Manufacturing of Electric and Hybrid Vehicles) scheme in 2015 to accelerate the development of electric mobility in the country. The scheme provided various tax incentives

for manufacturing and R&D for the development of electric vehicles. In phase-1 of the FAME scheme, the Indian government sanctioned approx. US$ 10 million (£7.5 million) worth of projects during 2015-16 to 2018-2019. These projects included pilot projects for developing EV charging infrastructure, technology development initiatives, and the creation of policy and standards for electric mobility among others. Following the success of FAME-I, the government launched FAME-II in early 2019 with a planned outlay of approx. US$ 1.4 billion (£1.05 billion) for three years, to create charging infrastructure and encourage faster adoption of EV and hybrid vehicles (Indian Department of Heavy Industries Annual Report, 2019). Other government initiatives taken during the last decade include the establishment of the Automotive Skill Development Council (ASDC), the National Automotive R&D Infrastructure Project (NATRIP) to develop world-class testing infrastructure, and the National Automotive Board (NAB) as a repository of auto R&D expertise and to coordinate and synergize the activities of NATRIP.

The recent policy initiatives such as 'Make in India' and the implementation of GST in July 2017 are likely to further improve the competitiveness of the Indian automobile industry. 'Make in India' is a three-pronged strategy focusing on infrastructure development, policy reforms, and maximising the ease of doing business. The government aims to increase the share of the manufacturing sector to 22 per cent of the national GDP. The development of infrastructure is likely to help boost automobile demands in the country, whereas policy reforms which are aimed at reducing labour market rigidities by changing outdated labour laws, the introduction of new laws such as bankruptcy, and simplification of taxation system (through GST) among others are likely to provide much-needed support for further development of the automobile sector. Improvement in ease of doing business is further likely to enhance the business operations of automobile and components manufacturers alike.

3.3 Evolution of emission control regulations in India

The emission control rules in the Indian automobile industry have evolved following the economic liberalization in the early 1990s. The Indian government has adopted a phased implementation by imposing stricter emission controls as the industry grew and in line with its international obligations. For instance, separate emission limits and implementation time were adopted for automobiles using petrol and diesel (see Table 3.1 & Table 3.2). The regulations were first implemented in high growth markets (i.e., metropolitan cities), followed by tier-2 and tier-3 cities and the rest of India in a phased manner. Firms were provided with ample time to prepare themselves for the impending regulatory change. The first emission control policy was adopted in the year 1991 that stipulated very lenient limits for the emission of harmful carbon and nitrogen compounds which automobile firms were able to meet easily by using the most basic technology available (i.e., oxidation catalysts). It was replaced by a new policy in 1996 that reduced the emission limits to nearly half of what was allowed in the previous policy which was quickly replaced by another policy in 1998 that enforced separate emission limits for non-catalytic and catalytic engine types (for which that limits were reduced to half of the previous policy).

At the start of the 21st century, the government decided to harmonize the emission control regulations with international standards and adopted the new policy with a nomenclature – the Bharat Stage (BS) – that was built on European norms. The timeline of the implementation of these norms is highlighted in Table 3.1 & 3.2 which present the evolution of these norms. At present, the country has BS-VI norms in place, which is comparable to Euro-VI, and was implemented in April 2020 after leapfrogging from BS-IV norms. The phased implementation of BS norms during the last two decades not only paved the way for the adoption of cleaner technologies such as exhaust after-treatment /three-way catalysts, electronic control, and onboard diagnostics but significant technological

innovations (e.g. changes in engine design, development of hybrid and electric vehicles). It also indicates how technology-forcing regulations can lead to the development and (or) diffusion of new pollution control technologies.

Table 3.1 Changes in emission limits threshold in different control standards adopted for passenger cars (Petrol/Gasoline) in India (1991- 2020)

Standards	Implementation Timeline	Engine Type	CO		HC		NOx		HC + NOx		Introduction of Technology
			Min	Max	Min	Max	Min	Max	Min	Max	
1991	1st April, 1991		14.3	27.1	2	2.9	-	-	-		Conventional Engine/ oxidation catalysts
1996	1st April, 1996		8.68	12.4	-	-	-	-	3	4.36	
1998	1st April, 1998	Non-catalytic	8.68	12.4	-	-	-	-	3	4.36	
		Catalytic	4.34	6.2	-	-	-	-	1.5	2.18	
BS I	1st June, 1999 - NCR, 1 April, 2000 – Nationwide		2.72	-	-	-	-	-	0.97	-	
BS II	1st April, 2000 - NCR/ 1st January, 2001- Mumbai/1st Jul, 2001 - Kolkata & Chennai/ 1st April, 2005 – Nationwide		2.2	-	-	-	-	-	0.5	-	
BS III	1st April, 2005- NCR, 11 cities/ 1st Oct, 2010- Nationwide		2.3	-	0.2	-	0.15	-	0.35	-	Exhaust after-treatment/ three-way catalysts
BS IV	1st April, 2010- NCR, 13 cities/ 1st July, 2015 - 20 cities more/ 1st Oct, 2015 - 9 states in North India / 1st April, 2016 - Western India and part of South and East India/ 1st April, 2017- Nationwide		1	-	0.1	-	0.08	-	0.18	-	Electronic controlled/ Onboard Diagnostic
BS VI	1st April, 2020	CI	0.5	-	0.1	-	0.06	-	0.16	-	OBD/ Catalytic converters
		PI	1	-	0.1	-	0.08	-	0.18	-	

***** CI – Compression Ignition; PI – Positive Ignition

Table 3.2 Changes in **e**mission limits threshold in different control standards adopted for passenger cars (Diesel) in India (1991- 2020)

Standards	Implementation Timeline	Engine Type	CO		HC		NOx		HC+ NOx		Introduction of Technology
			Min	Max	Min	Max	Min	Max	Min	Max	
1992	1st April, 1992		14.3	27.1	-	-	-	-	4.7	6.9	Conventional Engine/ oxidation catalysts
1996	1st April, 1996		5	9	-	-	-	-	2	4	
BS I	1st June, 1999 - NCR, 1 April, 2000 - Nationwide		2.72	6.9	-	-	-	-	0.97	1.7	
BS II	1st April, 2000 - NCR/ 1st January, 2001- Mumbai/1st Jul, 2001 - Kolkata & Chennai/ 1st April, 2005 - Nationwide		1	1.5	-	-	-	-	0.7	1.2	
BS III	1st April, 2005- NCR, 11 cities/ 1st Oct, 2010- Nationwide		0.64	0.95	-	-	0.5	0.78	0.56	0.86	Exhaust after-treatment/ three-way catalysts
BS IV	1st April, 2010- NCR, 13 cities/ 1st July, 2015 - 20 cities more/ 1st Oct, 2015 - 9 states in North India / 1st April, 2016 - Western India and part of South and East India/ 1st April, 2017- Nationwide		0.5	0.74	-	-	0.25	0.39	0.3	0.46	Electronic controlled/ Onboard Diagnostic
BS –VI	1st April, 2020	CI	0.5	-	0.1	-	0.06	-	0.16	-	OBD/ Selective Catalytic Reduction (SCR) Module & Diesel Particulate Filter (DPF)
		PI	1	-	0.1	-	0.08	-	0.18	-	

***** CI – Compression Ignition; PI – Positive Ignition

3.4 Recent growth trends in the Indian automobile industry

Despite apparent policy paralysis that stifled the competitiveness of the industry during much of the period until the 1990s, the Indian automobile industry continued to show resilient growth, primarily owing to continuous growth in domestic demand. The Indian automobile industry (based on 2019-20 data) is mainly composed of four segments i.e., i) passenger vehicles (cars, SUVs/UVs) that accounts for 13% of the market; ii) commercial vehicles that account for 3% of the market; iii) three-wheelers (LCVs) that accounts for 3% of the market; and iv) two-wheelers (Scooters, motorcycles & mopeds) that account for 81% of the total market (refer Figure 3.3). Moreover, the passenger vehicles segment is heavily dominated by small cars (3400mm - 4000 mm, <1200 cc) that account for 3/4th of the domestic passenger vehicle market followed by mid-size sedans (4000-4500 mm, 1200cc-1500cc) and SUVs/MUVs (>1500 cc) together account for 23.5%, and luxury cars (>1500 cc) with meagre 1.5% share of the market (SIAM, 2020, Automotive News Europe, 2019). The market is still heavily dominated by the two-wheelers segment and thus offers a huge potential for the expansion of the passenger vehicles segment in near future considering the optimism surrounding the potential economic growth – one of the fastest growing economies in the world that grew at the rate of 5.02% in 2019 – and the rising per capita income (expected to cross US$ 3000 (£2250) in a few years from the current US$ 2100 (£1575) (World Bank, 2019).

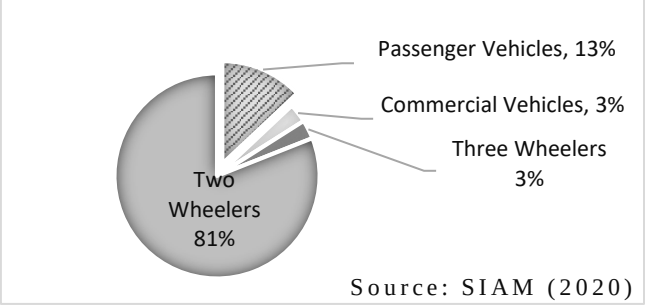


Figure 3.3 Segment-wise market share (2019-2020)

In the last few decades, automobile production and sales have recorded decent growth – albeit not commensurate with the size and population of the country. Over the period 1975-2015, the total automobile production and sales volumes grew six-fold from approx. 0.6 million in 1975 to nearly 3.5 million in 2015 (refer to Table 3.3). It is also evident from the data that although the steep growth occurred in all product segments, the growth in the two-wheeler segment outpaced all other segments for the entire period. Also, if we look at the growth in the passenger vehicle segment, it is quite evident that much of the growth occurred in the post-reform era (i.e., after 1990) and the segment grew fastest during the period 2000-2010 during which the production and sales of the passenger vehicles nearly doubled every five years. Moreover, the growth in the passenger vehicles segment has been largely led by small and mid-sized cars and the same is expected to continue in the light of stagnating growth in the two-wheeler segment as evident from the production and sales figures for the years 2010 and 2015.

The performance of the industry in terms of exports (refer to Table 3.4), based on the data available for the period 2013-14 to 2019-20, is not as impressive as automobile production and sales, nevertheless, have been growing consistently. The exports have largely been driven by two-wheeler and passenger cars (primarily small cars) and a weak exports performance is also an indication of domestic demand being the growth driver for the passenger vehicle segment. Moreover, market dynamics such as high domestic demand for small cars (that provide scale advantages to manufacturers) together with government emphasis to develop India as a global hub for small cars continue to present opportunities for decent growth in exports going forward.

Table 3.3 Growth of the Indian Automobile Industry in India

	1975	1980	1985	1990	1995	2000	2005	2010	2015
Production									
Passenger Cars	**31,246**	**45,606**	**129,332**	**218,765**	**396,531**	**641,799**	**1,264,446**	**2,820,427**	**2,563,464**
Cars	23,075	30,538	102,456	176,821	329,879	514,185	1,068,535	2,510,208	2,057,891
Jeep/MUV/UV	8,171	15,068	26,876	41,944	66,652	127,614	195,911	310,219	505,573
Commercial Vehicles	**43,034**	**68,311**	**101,228**	**145,628**	**237,247**	**155,789**	**377,966**	**723,139**	**561,966**
LCV	6,777	19,659	34,912	57,525	113,077	63,307	164,747	391,501	315,830
M&HCV	36,257	48,652	66,316	88,103	124,170	92,482	213,219	331,638	246,136
Three-Wheelers	**12,223**	**26,519**	**49,267**	**95,528**	**155,801**	**220,421**	**413,330**	**763,196**	**708,773**
Two-wheeler	**207,697**	**417,602**	**1,125,606**	**1,875,522**	**2,551,166**	**3,942,657**	**7,296,200**	**12,776,781**	**13,836,842**
Scooters	101,763	209,943	422,307	968,443	1,170,071	1,034,969	993,283	2,017,272	3,703,015
Motorcycles	69,739	101,586	248,001	478,528	776,998	2,164,950	5,936,689	10,084,974	9,576,471
Mopeds	36,195	106,073	455,298	428,551	604,097	742,738	366,228	674,535	557,356
Tractors	**32,378**	**67,105**	**78,258**	**128,775**	**168,167**	**234,529**	**-**	**-**	**-**
	608,555	**1,156,662**	**2,839,857**	**4,704,133**	**6,693,856**	**9,935,440**	**18,290,554**	**33,403,890**	**34,633,317**
Sales									
Passenger Cars	**31,345**	**46,633**	**123,926**	**216,054**	**396,686**	**730,524**	**1,278,470**	**2,828,419**	**2,496,361**
Cars	23,066	31,048	102,365	174,633	330,496	603,069	1,086,065	2,511,493	2,013,756
Jeep/MUV/UV	8,279	15,585	21,561	41,421	66,190	127,455	192,405	316,926	482,605
Commercial Vehicles	**43,340**	**68,392**	**98,929**	**141,098**	**239,617**	**155,778**	**371,939**	**721,973**	**558,044**
LCV	6,932	19,503	34,416	56,008	113,703	63,232	158,621	382,463	321,513
M&HCV	36,408	48,889	64,513	85,090	125,914	92,546	213,318	339,510	236,531
Three-Wheelers	**12,028**	**26,417**	**48,944**	**95,812**	**155,637**	**217,356**	**411,860**	**757,889**	**708,648**
Two-wheeler	**194,973**	**373,668**	**1,107,185**	**1,853,991**	**2,557,313**	**3,867,774**	**7,289,524**	**12,736,745**	**13,841,230**
Scooters	90,253	167,852	414,533	940,504	1,177,153	1,013,737	970,409	2,004,099	3,723,233
Motorcycles	69,835	101,270	242,874	475,256	776,465	2,122,489	5,951,221	10,058,472	9,568,339
Mopeds	34,885	104,546	449,778	438,231	603,695	731,548	367,894	674,174	549,658
Tractors	**30,502**	**68,178**	**76,978**	**129,232**	**168,278**	**237,024**	**-**	**-**	**-**
	581,846	**1,071,981**	**2,786,002**	**4,647,330**	**6,711,147**	**9,962,532**	**18,291,726**	**33,332,163**	**34,499,918**

Source: SIAM India

Table 3.4 Indian Automobile Exports (2011-12 – 2019-20)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Passenger Cars	596,142	621,341	653,053	758,830	748,366	676,192	677,311
Commercial Vehicles	77,050	86,939	103,124	108,271	96,865	99,933	60,713
Three-Wheelers	353,392	407,600	404,441	271,894	381,002	567,683	502,169
Two-wheeler	2,084,000	2,457,466	2,482,876	2,339,273	2,815,003	3,280,841	3,520,376
Total	3,110,584	3,573,346	3,643,494	3,478,268	4,041,236	4,624,649	4,760,569

Source: SIAM India

The passenger car market of India has also grown in strength (particularly more so in the last decade) in comparison with the respective car markets in BRICS (Brazil, Russia, India, China and South Africa) nations as well as with the leading passenger car markets worldwide (refer Table 3.5 & 3.6). In terms of the sales of passenger cars throughout 2005-2019, India has grown to become the second-largest passenger car market (approx. sales of 3 million cars in 2019) among other BRICS countries ahead of Brazil (2.2 million), Russia (1.5 million), South Africa (0.3 million), and behind China (21.4 million) by a long margin which is almost seven times of the total number of cars sold in India. The gap between India and China has widened steeply over the last decade from a relatively narrow gap in sales in 2005 (India: 1.1 million; China: 3.9 million). The growth in the sales volume in India and China has been largely consistent during the last decade, however, Russia (decent growth during 2005-2008 & 2010-2014), Brazil (decent growth during 2005-2013 & 2016-2019), and South Africa (decline over 2005-2009; slight improvement 2010 onwards) showed cycles of good growth and subsequent decline. The large gap between India and China in terms of production and sales of passenger vehicles can be attributed to the rapid economic growth of China during the last two decades that fuelled the domestic sales of passenger cars and high exports, unlike India where the growth is mostly due to domestic demands and relatively low exports.

If compared to the sale of passenger cars in the USA and other Asian big markets such as Japan and South Korea, in 2019, India sold nearly twice (2.9 million) the number of cars sold in South Korea (1.5 million), nearly 2/3rd of the number of cars sold in USA (4.7 million), and nearly 3/4th of the cars sold in Japan (4.3 million). However, considering the size and population of India as compared to these countries (i.e., South Africa, Japan, & USA) and the large sales volume recorded by China (21.4 million in 2019) – a country comparable to the size of India – Indian automobile industry still to go a long way to realise the full market potential. Moreover, the passenger car markets in the USA, South Korea, and Japan continue to saturate after a long period of impressive growth and market dynamics in these countries relative to the Indian market (one of the fastest-growing in Asia, and the world) also indicate towards the fact that Indian automobile industry is lagging by a good margin.

India currently is the 5th largest automobile producer (with 4.5 million vehicles produced in 2019) (refer Table to 3.6) in the world, only behind China (1st, 25.7 million), the USA (2nd, 10.8 million), Japan (3rd, 9.6 million), and Germany (4th, 4.6 million). The total production includes passenger and commercial vehicles. Recently, it overtook Mexico and South Korea which is now the 6th (3.98 million) and 7th (3.95 million) largest automobile producers in the world respectively. In the last 15 years, India has consistently recorded growth in automobile production and moved from 15th position in the world (in 2000, with 0.8 million vehicles) to 12th position (in 2005, with 1.6 million vehicles) to 6th position (in 2010, with 3.5 million vehicles) and the current 5th position (in 2019, with 4.5 million vehicles). However, during the same period China achieved a leadership position in production in 2010 (with 18.26 million vehicles) from 8th (in 2000, with 2.06 million vehicles) and 4th (in 2005, with 5.7 million vehicles). China continues to lead global

production with a large margin as total vehicles produced in China, in 2019, was twice of the vehicle production of USA (i.e., 10.8 million) at 2nd position.

Similarly, domestic Indian automobile manufacturers (i.e., TATA Motors, Mahindra, and Ashok Leyland) considerably lag behind their Asian or Chinese counterparts in global production ranking (refer Table to 3.7). For instance, TATA Motors ranked 22nd in 2000 (with 0.16 million vehicles) and although since then the total vehicle production of the company has risen to nearly 1 million in 2017, it is still the 23rd largest producer in the world. Mahindra and Ashok Leyland also follow the same pattern and even after growth in production volume over the years, in 2017, they were 26th (with 0.6 million vehicles) and 38th (with 0.16 million) largest producers in the world respectively. Maruti Suzuki consistently ranked in the top 15 global producers during 2000-2015 however it cannot be considered a domestic firm as it became the wholly-owned subsidiary of Suzuki Motors following the divestment of government stake in 2007.

Table 3.5 Passenger car sales in BRICS and major countries (in millions)

Year	BRICS					Other major countries/region				
	Brazil	Russia	India	China	South Africa	South Korea	Japan	USA	Europe	World
2005	1,439,822	1,520,225	1,106,863	3,971,101	419,868	893,159	4,748,482	7,659,983	17,906,455	45,407,298
2006	1,632,947	1,911,240	1,311,373	5,175,961	481,558	932,650	4,612,318	7,761,592	18,685,556	47,955,259
2007	2,085,718	2,514,920	1,511,812	6,297,538	434,653	1,010,790	4,325,508	7,562,334	19,618,588	50,834,531
2008	2,341,300	2,897,459	1,545,414	6,755,609	329,262	1,017,595	4,184,266	6,769,107	18,821,599	49,978,237
2009	2,643,862	1,465,742	1,816,878	10,331,315	258,129	1,221,118	3,905,310	5,400,890	16,608,761	49,654,985
2010	2,856,540	1,912,794	2,387,197	13,757,794	337,130	1,237,482	4,203,181	5,635,432	16,499,863	55,818,570
2011	2,901,647	2,653,688	2,510,313	14,472,416	396,292	1,293,501	3,509,036	6,089,403	17,167,600	57,839,953
2012	3,115,223	2,755,384	2,781,919	15,495,240	440,002	1,256,403	4,572,333	7,241,900	16,191,269	60,936,407
2013	3,040,783	2,649,181	2,553,979	17,927,730	450,561	1,243,868	4,562,282	7,585,341	15,942,273	63,429,200
2014	2,794,687	2,333,067	2,570,736	19,707,677	439,264	1,359,834	4,699,591	7,689,110	16,154,279	65,708,230
2015	2,123,009	1,282,740	2,772,270	21,210,339	412,670	1,533,670	4,215,889	7,516,826	16,410,563	66,314,155
2016	1,676,722	1,239,680	2,966,637	24,376,902	361,289	1,533,813	4,146,459	6,872,729	17,291,819	69,464,432
2017	1,856,450	1,448,700	3,229,109	24,718,321	361,289	1,526,660	4,386,378	6,080,229	17,974,281	70,694,834
2018	2,102,114	1,606,676	3,394,729	23,709,782	365,242	1,525,150	4,391,160	5,303,580	17,909,677	68,678,212
2019	2,262,069	1,567,743	2,962,052	21,444,180	355,378	1,539,060	4,301,091	4,715,005	17,972,774	64,341,693

Source: OICA

Table 3.6 Top 20 Automobile Producing Countries in the World

Rank	2019		2015		2010		2005		2000	
1	China	25,720,665	China	24,567,250	China	18,264,761	USA	11,980,912	USA	12,799,857
2	USA	10,880,019	USA	12,105,988	Japan	9,628,920	Japan	10,799,659	Japan	10,144,347
3	Japan	9,684,298	Japan	9,278,238	USA	7,743,093	Germany	5,757,710	Germany	5,526,615
4	Germany	4,661,328	Germany	6,033,364	Germany	5,905,985	China	5,707,688	France	3,348,351
5	India	4,516,017	South Korea	4,555,957	South Korea	4,271,741	South Korea	3,699,350	South Korea	3,114,998
6	Mexico	3,986,794	India	4,160,585	India	3,557,073	France	3,549,008	Spain	3,032,874
7	South Korea	3,950,617	Mexico	3,565,218	Brazil	3,381,728	Spain	2,752,500	Canada	2,963,830
8	Brazil	2,944,988	Spain	2,733,201	Spain	2,387,900	Canada	2,688,363	China	2,069,069
9	Spain	2,822,355	Brazil	2,429,421	Mexico	2,342,282	Brazil	2,528,300	Mexico	1,934,927
10	France	2,202,460	Canada	2,283,307	France	2,229,421	UK	1,803,049	UK	1,814,152
11	Thailand	2,013,710	France	1,972,000	Canada	2,068,189	Mexico	1,670,403	Italy	1,738,315
12	Canada	1,916,585	Thailand	1,909,398	Thailand	1,644,513	India	1,626,755	Brazil	1,671,093
13	Russia	1,719,784	UK	1,682,156	Iran	1,599,454	Russia	1,351,199	Russia	1,202,589
14	Turkey	1,461,244	Russia	1,378,246	Russia	1,403,244	Thailand	1,125,316	Belgium	1,033,294
15	Czech Rep.	1,433,963	Czech Rep.	1,246,533	UK	1,393,463	Italy	1,038,352	India	796,185
16	UK	1,381,405	Indonesia	1,098,780	Turkey	1,094,557	Belgium	928,965	Poland	556,365
17	Indonesia	1,286,848	Slovakia	1,038,503	Czech Rep.	1,076,384	Turkey	879,092	Czech Rep.	455,481
18	Slovakia	1,100,000	Italy	1,014,223	Poland	869,474	Iran	817,200	Turkey	430,947
19	Italy	915,305	Iran	982,337	Italy	838,186	Poland	625,443	Taiwan	361,800
20	Iran	821,060	Poland	660,692	Argentina	716,540	Czech Rep.	604,930	Australia	348,270

Source: OICA Data

Table 3.7 Top 20 Automobile Producing Companies in the World

Rank	2017		2015		2010		2005		2000	
1	Toyota	10,466,051	Toyota	10,083,831	Toyota	8,557,351	G.M.	9,097,855	G.M.	8,133,375
2	Volkswagen	10,382,334	Volkswagen	9,872,424	G.M.	8,476,192	Toyota	7,338,314	Ford	7,322,951
3	Hyundai	7,218,391	Hyundai	7,988,479	Volkswagen	7,341,065	Ford	6,497,746	Toyota	5,954,723
4	G.M.	6,856,880	G.M.	7,485,587	Hyundai	5,764,918	Volkswagen	5,211,413	Volkswagen	5,106,749
5	Ford	6,386,818	Ford	6,396,369	Ford	4,988,031	Daimler AG	4,815,593	Daimler AG	4,666,640
6	Nissan	5,769,277	Nissan	5,170,074	Nissan	3,982,162	Nissan	3,494,274	PSA	2,879,422
7	Honda	5,236,842	Fiat	4,865,233	Honda	3,643,057	Honda	3,436,164	Fiat	2,641,444
8	Fiat	4,600,847	Honda	4,543,838	PSA	3,605,524	PSA	3,375,366	Nissan	2,628,783
9	Renault	4,153,589	Suzuki	3,034,081	Suzuki	2,892,945	Hyundai	3,091,060	Renault	2,514,897
10	PSA	3,649,742	Renault	3,032,652	Renault	2,716,286	Renault	2,616,818	Honda	2,505,256
11	Suzuki	3,302,336	PSA	2,982,035	Fiat	2,410,021	Suzuki Maruti*	2,071,707	Hyundai	2,488,321
12	SAIC	2,866,913	B.M.W.	2,279,503	Daimler AG	1,940,465	Fiat	2,037,695	Mitsubishi	1,827,186
13	Daimler AG	2,549,142	SAIC	2,260,579	Fiat Chrysler	1,578,488	Mitsubishi	1,331,060	Suzuki Maruti*	1,457,056
14	B.M.W.	2,505,741	Daimler AG	2,134,645	B.M.W.	1,481,253	B.M.W.	1,323,119	Mazda	925,876
15	Geely	1,950,382	Mazda	1,540,576	Mazda	1,307,540	Mazda	1,287,561	B.M.W.	834,628
16	Changan	1,616,457	Changan Auto	1,540,133	Mitsubishi	1,174,383	Daihatsu	1,011,249	Avtovaz	755,997
17	Mazda	1,607,602	Mitsubishi	1,218,853	Changan Auto	1,102,683	Avtovaz	721,492	G.M.-Daewoo	716,250
18	Dongfeng	1,450,999	Dongfeng	1,209,296	Tata Motors	1,011,343	Dongfeng	593,055	Fuji	581,035
19	BAIC	1,254,483	BAIC	1,169,894	FAW	896,060	Fuji	591,825	Isuzu	539,085
20	Mitsubishi	1,210,263	Tata Motors	1,009,369	Geely	802,319	BAIC	559,190	Gaz	227,673
	Tata Motors (23rd)	932,387	Mahindra (31st)	422,121	Mahindra (32nd)	292,149	Tata Motors (25th)	419,445	Tata Motors (22nd)	193,580
	Mahindra (26th)	612,595	Ashok Leyland (38th)	134,603			Mahindra (33rd)	125,994		
	Ashok Leyland (38th)	160,208								

Source: OICA Data; *SUZUKI –MARUTI was a JV with a 75% Indian government stake, the govt sold its stake in 2007 making Maruti Suzuki a wholly-owned subsidiary of Suzuki Motors (owns 56%)

3.5 Competitive Landscape of Indian Automobile Industry

There is no doubt that the competitive landscape of the Indian automobile industry has changed substantially during the last two decades. In the 1980s, Maruti Suzuki operated in a monopoly situation with only two other relatively small domestic competitors (i.e., Hindustan Motors, and Premier) that sold obsolete models in limited numbers. The situation was such that Maruti Suzuki struggled to meet demand as customers would generally have to endure a long waiting list before they could get the delivery of their purchased cars, much like the customers who wanted telephone connections in those days. Moreover, buyers did not have much of a choice as half of the cars produced by Maruti Suzuki at the time used to be white (i.e., to save cost). Consequently, Maruti Suzuki controlled as much as 70 percent of the total market in those days. The industry has transformed tremendously since then in terms of competition, range of products, customer service, and production volumes. For instance, during the 1990s, following the successive entries of Hyundai (in 1996) and other manufacturers, the number of automobile manufacturers increased from five in 1996 (that together sold 0.5 million passenger vehicles) to over 17 in 2019 that together sold nearly 4.5 million units (OICA, 2019). The range of products has also increased from a few basic types available in 1996 to over 100 different models with advanced features, in various product segments being sold in India at present. The industry has also grown substantially over the years in terms of revenue that has nearly doubled from US$36.6 billion (£20 billion) in 2007-08 to US$ 67.7 billion (£50 billion) in 2016-17 (refer Figure 3.4). The increase in the number of market players also resulted in improvement of quality, customer care and service.

However, there is one character of the industry that has remained constant over the years and that is the dominance of one market player i.e., Maruti Suzuki amid other competitors. Although the market share of Maruti Suzuki has declined from its peak of 70 percent, it has continued to control nearly half of the market share over the years with

Hyundai continuously at 2nd position with 16.2 percent (in 2018-19; never achieved beyond 21% since its entry), and others sharing the remainder of the pie (refer Table 3.8 and Figure 3.5). It is surprising that even after stiff competition, in 2019, Maruti Suzuki has only ceded around 10% of its market share from 60% in 1996 to 51% in 2018-19. In 1996, out of the top six selling car models (accounting for 93.4% of total sales) Maruti Suzuki had 5 (with lead selling model - Maruti 800, with 47% share) and in 2016 the company still had top 4 bestselling car models followed by Hyundai with the other two and together the top-six models account for 34% of the market (Economic Times, 2017).

The industry has been predominantly a small car market (during much of the 1990s with the gravity of focus being in < INR 0.4 million or <US$ 5500 (£4250) price range). The last decade saw the growing interest of consumers for mid-size cars in the price range of INR0.4 (US$ 5500 or £4250) to INR 1 million (US$ 14500 or £10500) due to rise in young buyers mostly employed in metro, tier-1, and tier-2 cities with relatively higher per capita income than the national average of US$ 1750 (£1300). Likely, the gravity of focus will further shift to cars priced over INR 1 million (> US$ 14500 or £10500) by 2021 as affordability of the consumers increases in line with the expected rise in per capita income to US$ 3000 (£2250) by the year 2021. Also, the average prices of the cars will increase in response to proposed changes in safety and emission norms which will further shift the gravity of focus to cars priced over INR 1 million (£10500).

As far as the competitive positioning of the domestic car manufacturers such as TATA Motors and Mahindra is concerned, they continue to maintain their position in the top 5 with erratic performances over the last decade. For instance, in 2018-19 Mahindra and TATA Motors occupied 3rd and 4th place with a market share of 7.3% and 7% respectively. However, much of their business is driven by products in MUV (multi-utility vehicles) segment as they continually struggle to introduce a competitive product in the small and mid-

size cars segments. The utter failure of TATA Nano is an example of that incompetence although TATA enjoyed some success with TATA Indica and recently launched TATA Triago, Nexon, Harrier and Altroz models. TATA Motors on the other hand also derives much of its growth from the commercial vehicle segment. Both these companies plan to aggressively launch new models over the course of the next few years. In terms of the number of units sold, both TATA and Mahindra registered a continuous competitive pressure since 2011-12 (refer to Table 3.9). In 2011-12 TATA and Mahindra sold 370,000 and 245,700 units respectively as opposed to 286,730 and 236,901 units respectively in 2018-2019. These companies face extreme competitive challenges going forward with an increase in competition due to planned entries of new manufacturers such as PSA Group, Kia, Daihatsu, and SAIC among others in the near future.

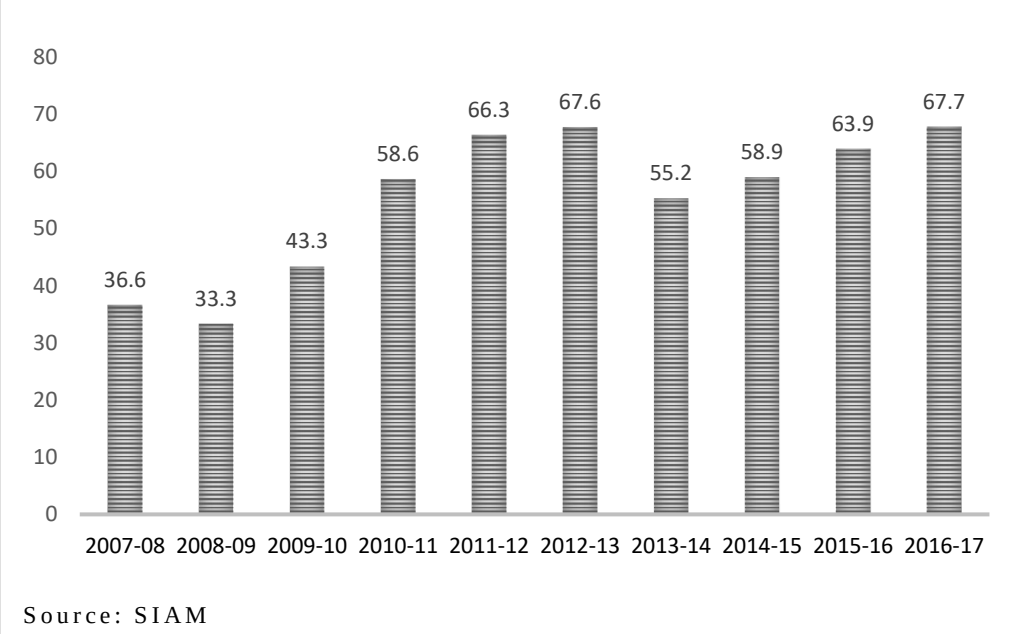


Figure 3.4 Annual Turnover of Indian Automobile Industry (in US$, billion)

Table 3.8 Market share of leading manufacturers in the Indian passenger car market (%)

	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Maruti Suzuki	47	46.3	45	38.43	39.12	43.62	42	46.79	47.38	49.7	51
Hyundai	16	21.3	14	14.84	14.27	20.5	15	17.36	16.72	16.4	16.2
TATA	15	10.5	12	14.16	11.7	11.7	8	4.82	5.66	5.9	7
Mahindra	7	7	9.38	11.56	13.2	9.6	10	8.47	7.75	7.5	7.3
GM	3.10	3.7	3.4	4.2	3.28	3.04	2	1.2	0.84	0	0
Honda	3.04	3.1	2.4	2.07	2.73	3.19	5	6.88	5.15	5.5	5.2
Toyota Kirloskar	3.40	3.3	4.3	6.12	5.25	4.84	5	5.66	4.7	4.3	4.5
Others	5.46	4.8	9.52	8.62	10.45	3.51	13	8.82	11.8	10.7	8.8

Source: SIAM India and company annual reports of various years

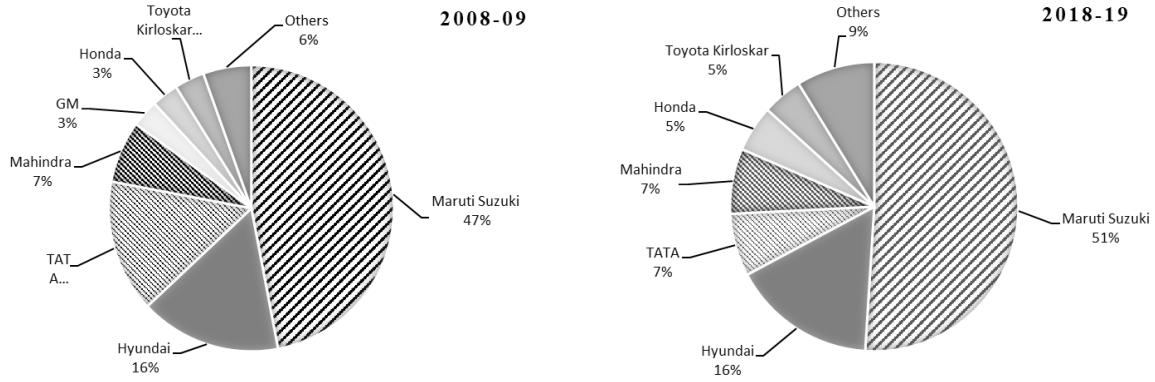


Figure 3.5 Market share of leading passenger car manufacturers (2008-09 & 2018-19)

Table 3.9 Sales and production of passenger vehicles by leading companies in India (in nos)

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Sales								
Maruti Suzuki	1,006,316	1,051,046	1,053,689	1,170,702	1,429,248	1,443,641	1,653,500	1,753,700
Hyundai	388,779	383,611	380,253	420,668	484324	509,705	536,241	545,243
Mahindra	245,700	310,707	254,344	223,968	236,307	236,130	234,640	236,901
Honda Cars	54,427	73,483	134,339	189,062	192059	157,313	170,026	183,787
Tata Motors	370,834	314,464	198,812	161,791	127,118	172,504	291,299	286,730
Production								
Maruti Suzuki	1059671	1,072,458	1,142,496	1,414,000	1,514,338	1,581,329	1,780,000	1,862,449
Hyundai	638775	633,006	610,650	645,012	665,017	678,017	690,184	707,348
Mahindra	455444	510,950	433,718	446,885	449,776	467,250	493,883	541,408
Honda Cars	75768	118,997	184,656	197,465	158,651	178,755	175,636	188,581
Tata Motors	382,684	231,833	164,740	494,307	369,642	390,625	N/A	N/A

Source: OICA, SIAM India, and various company annual reports

3.6 Conclusion

The Indian automobile industry has made significant progress, especially in the post-reform era (i.e., following the liberalisation of the Indian economy during the early 1990s). The industry went through massive changes, and at present, factors such as availability of low-cost skilled labour, production of low-cost steel, rising per capita income, growing domestic demand, and presence of a globally competitive automobile component suppliers industry further strengthen its ability to develop into a leading industry in near future. The international competitiveness of the industry has also significantly improved due to improvement in its innovation capabilities and, at present, the industry accounts for 40% of the global automotive sector's R&D spending (nearly US$ 31 billion or £23.4 billion) (Indian Department of Heavy Industries Report, 2019). In conclusion, where on one hand, favourable business environment and focused government policies such as Automotive Mission Plan - 2026, changes in emission and safety regulations, and ambitious government plans to reduce industry carbon footprints by 30-35% and achieve 100% electrical mobility by 2030 is likely to propel the development of the industry into a leading production hub, on the other hand, infrastructure bottlenecks, if not addressed in time, are likely to dampen the speed of the growth of the industry.

Appendix-A

Table A1 Location of Indian and foreign companies in regional automobile clusters

Auto Clusters	Company Name	Country of Origin	Year of Entry in India	Product Type	Location City
Northern (States: Haryana, Punjab, Uttar Pradesh, Rajasthan, Uttarakhand)					
	BMW India Pvt. Ltd.	Germany	2007	PV	Gurgaon
	Honda Cars India Ltd.	Japan	1995	PV	Noida, Alwar
	Maruti Suzuki India Ltd.	Japan	1982	PV	Gurgaon, Pantnagar
	International Cars & Motors Ltd.	India	2003	PV	Hoshiarpur
	Tata Motors Ltd.	India	1945	PV &CV	Pantnagar
	Ashok Leyland Ltd.	India	1948	CV	Pantnagar, Alwar
	Swaraj Mazda Ltd./ SML Isuzu	Japan	1985	CV	Shahid Bhagat S. Nagar
	Scooters India Ltd.	India	1972	CV	Lucknow
	VE Commercial Vehicles Ltd.	India	2008	CV	Gurgaon
	Eicher Motors Ltd.	India	1948	Two Wheelers & CV	Gurgaon
	Hero MotoCorp Ltd.	India	1984	Two Wheelers	Gurgaon
	Honda Motorcycles & Scooters India	Japan	1999	Two Wheelers	Gurgaon
	Suzuki Motorcycles India Pvt. Ltd.	Japan	2006	Two Wheelers	Gurgaon
	Yamaha Motor India Pvt. Ltd.	Japan	2001	Two Wheelers	Noida
	H D Motor Company India Pvt. Ltd.	USA	2009	Two Wheelers	Gurgaon,
	International Tractors Ltd.	India	1969	Tractors	Hoshiarpur
	New Holland Tractors India Ltd.	Italy	1998	Tractors	Noida
	Escorts Ltd.	India	1960	Tractors & FE	Faridabad
Western (States: Maharashtra, Gujrat)					
	Fiat India Automobiles Ltd.	Italy	1997	PV	Pune/ Ahmedabad
	General Motors India Pvt. Ltd.	USA	1995	PV	Halol/ Pune
	Maruti Suzuki India Ltd.	India	1982	PV	Ahmedabad
	Mercedes-Benz India Pvt. Ltd.	Germany	1994	PV	Pune
	Skoda Auto India Pvt. Ltd.	Czech Rep.	2001	PV	Aurangabad
	Volkswagen India Pvt. Ltd.	Germany	2007	PV	Pune
	Mahindra & Mahindra Ltd.	India	1945	PV & CV	Pune
	Premier Ltd.	India	1944	PV & CV	Pune
	Tata Motors Ltd.	India	1945	PV & CV	Pune/ Ahmedabad
	Mahindra Navistar Automotive Ltd.	India	2005	CV	Pune
	Ashok Leyland Ltd.	India	1948	CV	Bhandara
	Force Motors Ltd.	India	1958	CV	Pune
	Atul Auto Ltd.	India	1986	CV	Rajkot
	Asia Motor Works	India	2002	CV	Kutch
	Piaggio Vehicles Pvt. Ltd.	Italy	1999	CV	Baramati
	Foton Motors India Pvt. Ltd.	China	2011	CV	Pune
	Kinetic Motor Company Ltd.	India	1972	Two Wheelers	Pune
	Electrotherm India Ltd.	India	2005	Two Wheelers	Kutch
	Bajaj Auto Ltd.	India	1945	Two Wheelers & CV	Pune
	Mahindra Gujarat Tractors Ltd.	India	1964	Tractors	Vadodara
	SAS Motors/ Angad Tractors	India	2003	Tractors	Pune
	John Deere Equipment Pvt. Ltd.	USA	1998	Tractors/ FE	Pune
Southern (States: Tamilnadu, Karnataka, Kerala)					
	BMW India Pvt. Ltd.	Germany	2007	PV	Chennai
	Ford India Pvt. Ltd.	USA	1995	PV	Chennai

Hyundai Motor India Ltd.	South Korea	1996	PV	Kanchipuram
Mahindra Reva Pvt. Ltd.	India	2010	PV	Bangalore
Renault India Pvt. Ltd.	France	2005	PV	Chennai
Toyota Kirloskar Motor Pvt. Ltd.	Japan	1997	PV	Bangalore
Nissan Motor India Pvt. Ltd.	Japan	2005	PV & CV	Chennai
Tata Motors Ltd.	India	1945	PV & CV	Dharwad
Daimler India CV Pvt. Ltd.	Germany	2007	CV	Chennai
Volvo India Pvt. Ltd.	Sweden	2001	CV	Bangalore
Ashok Leyland Ltd.	India	1948	CV	Hosur/ Chennai
Kamaz Vectra Motors Ltd.	Russia	1997	CV	Hosur
Kerala Automobiles Ltd./ KAL	India	1978	CV	Thiruvananthapuram
Same Deutz-Fahr India Pvt. Ltd.	Italy	1996	Tractors	Vellore
TAFE Ltd.	India	1960	Tractors	Chennai
VST Tillers Tractors Ltd.	India	1967	Tractors	Bangalore
HMT Ltd.	India	1953	Tractors & FE	Bangalore
Royal Enfield	India	1955	Two Wheelers	Chennai
TVS Motor Company Ltd.	India	1978	Two Wheelers	Chennai
Eastern (States: West Bengal, Jharkhand)				
Hindustan Motors Ltd.	India	1942	PV & CV	Kolkata
Tata Motors Ltd.	India	1945	PV & CV	Jamshedpur
Tata Cummins Ltd.	India	1994	CV	Jamshedpur
Central (State: Madhya Pradesh)				
Force Motors Ltd.	India	1958	CV	Pithampur
Mahindra Two Wheelers Ltd.	India	2008	Two Wheelers	Indore
Vehicle Factory Jabalpur	India	1969	Military MV	Jabalpur
Man Trucks India	Germany	2006	CV	Pithampur

- PV = Passenger Vehicles; CV = Commercial Vehicles; FE = Farm Equipment

Source: Compiled from company websites and other public sources

Table A2 Inward FDI in the automobile sector and other sectors in India (2011- 19, in US$, million)

Sector	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20[1]	Cumulative Inflow[2]
Services Sector	5216	4833	2225	4443	6889	8684	6709	9158	6521	80671
Construction Development & Infra.	3141	1332	1226	769	113	105	540	213	326	25371
Telecommunications	1997	304	1307	2895	1324	5564	6212	2668	4291	37116
Computer Software & Hardware	796	486	1126	2296	5904	3652	6153	6415	6349	43587
Drugs & Pharmaceuticals	3232	1123	1279	1498	754	857	1010	266	414	16397
Chemicals (Other Than Fertilizers)	4041	292	878	763	1470	1393	1308	1981	860	17442
Power	1652	536	1066	707	869	1113	1621	1106	337	14653
Automobile Industry	923	1537	1517	2726	2527	1609	2090	2623	2506	23893
Metallurgical Industries	1786	1466	568	359	456	1259	-	-	-	11458
Hotel & Tourism	993	3259	486	777	-	-	-	-	-	14426

[1] for the period Apr'2019 – Dec'2019; [2] for the period Apr'2000 – Dec'2019
Source: Foreign Investment Inflows (https://dipp.gov.in/publications/fdi-statistics/archives)

Table A3 Recent major FDI in the automobile sector in India (2014 - 16, in US$, million)

Foreign Collaborator	Country	Indian Company	Investments
Ford International Services and Ford Motors	U.S.A	Ford India Limited	979.50
SAIC General Motors Investment Limited	China, Hong Kong, USA	General Motors India Pvt. Ltd	973.93
Suzuki Motor Corporation	Japan	Suzuki Motor Gujarat Private Limited	477.61
Daimler AG	Germany	Daimler India Commercial Vehicles Pvt. Ltd.	389.04
Nissan Motor Co. Ltd	Japan	Renault Nissan Automotive India Pvt.	169.20
Isuzu Motors Asia Limited	Singapore/ Japan	Isuzu Motors India Pvt. Ltd	116.67
FCC Co. Ltd.	Japan	FCC Clutch India Private Limited	95.19
Continental Automotive GMBH	Germany/Netherlands	Continental Automotive Components & Brake Systems	72.53
Renault Group BV	Netherlands	Renault Nissan Automotive India Pvt. Ltd	72.51
Caparo India Limited	United Kingdom	Caparo Engineering India Private Limited	56.77
Blue Elephant Finance Limited	Mauritius	Caparo Engineering India Private Limited	53.90
Showa Corporation	Japan	Showa India Private Limited	52.85
Lear Automotive Services (Ned) & Mauritius	Netherlands	Lear Automotive India Private Limited	49.64
Fiat Group Automobiles S.P.A	Italy	Fiat India Automobiles Limited	48.49
MAN Truck & Bus	Germany	Man Trucks India Private Limited (Man Force Truck)	42.70
Yorozu Corporation	Japan	Yorozu JBM Automotive Tamilnadu Private Limited	33.09
NHK Spring Co. Limited	Japan	NHK Automotive Components India Private Limited	31.31
Bussan Automotive Singapore Pte Limited	Singapore	India Yamaha Motors Private Limited	29.72
Toyoda Iron Works Co Limited	Japan	Toyotetsu India Auto Parts Pvt Ltd/Stanzen Toyotetsu India Pvt Ltd	27.77
AINOS Holdings Limited	Mauritius	Bill Forge Private. Limited.	24.88
Valeo Bayen	France	Valeo Lighting Systems India Private Ltd	22.30

Source: Department of Heavy Industries, Government of India Report, 2016

CHAPTER 4 RESEARCH PAPER 1

Regulate to innovate? Environmental regulations and firm innovation in the Indian automobile industry

4.1 Introduction

Whether regulations encourage or discourage innovation has been an important theme in the literature on regulations (Blind, 2012; Blind, Petersen, & Riillo, 2017; Gann, Wang, & Hawkins, 1998; Aversa & Guillotin, 2018) that has become even more relevant in recent times (from both policy-making and firm strategy perspectives) as firms confront tightening environmental regulations by national and local governments. Ideally, regulations that aim at reducing negative externalities of industrial production should also encourage innovation for social good. As Porter & van der Linde (1995) point out, in this scenario both industry and society benefit. However, research suggests that this scenario is by no means certain. Scholars that have examined the issue more from an industry perspective (and as a public policy issue) have concurred that the enforcement of strict emission control standards in the US and European countries during the latter part of the 20th century induced technological innovations (Lee, Veloso, Hounshell, & Rubin, 2004, 2010; De Vries & Withagen, 2005; Zapata & Nieuwenhuis, 2010). In contrast, other scholars have taken a firm-level strategy perspective and have argued that environmental regulations have a negative impact on the innovation capability of firms because firms are compelled to allocate critical resources away from activities that are essential to maintaining competitive advantage (see Palmer, Oates, & Portney, 1995; Gray & Shadbegian, 2003; Ambec, Cohen, Elgie, & Lanoie, 2013; Naimoli, Kodjak, German, & Schultz, 2017).

A number of researchers have sought to resolve this debate by pointing out that looking for a link between regulations and higher or lower innovation is not sufficient; it is

also necessary to stipulate the level of regulations – the 'stringency' of regulations. Stringent regulations that impose high costs and constraints on existing technology and operations can be expected to drive innovation because they lead to the abandonment of old technologies, scrapping of outdated plant and machinery, the development of new production techniques, and cleaner technologies (Kemp & Pontoglio, 2011; Porter & van der Linde, 1995; Horbach, 2008; Barbieri, Marzucchi, & Rizzo, 2020). Prior research suggests that the concept of 'stringency' conflates multiple dimensions of environmental change ranging from the magnitude, the direction, the frequency, and the predictability (Aversa & Guillotin, 2018; McCarthy, Lawrence, Wixted, & Gordon, 2010; Nadkarni & Narayanan, 2007). For example, while responding to a new regulatory change, a firm needs to take into account the magnitude of the change (i.e., how large or small is the change), the direction of the change (i.e., whether the new regulation is restrictive which reduces and binds firms' allowances and actions, or permissive which increases firms' freedom in specific domain or activities), the frequency of the change (i.e., how often the change occurs), and the predictability of the change (i.e., if all firms learn about the enforcement of new regulation in advance which indicates the time available to firms to fashion their responses).

We argue that most of the time, the firms are likely to be able to predict (i.e., high predictability) and be aware of the frequency of the impending change in regulations, as new regulations are largely enforced after due diligence, consultation, and sometimes due to the lobbying efforts of the relevant stakeholders (e.g., enforcement of emission control regulations) (Blind, Petersen, & Riillo, 2017). Thus, the magnitude and the direction of the regulatory change amongst the other dimensions, in terms of whether the new regulation increases or decreases firms' degrees of freedom and if that change is low or high, will contribute more to the resulting environmental change and its influence on firms' responses — i.e., the decision to innovate or imitate other firm's solution to meet compliance. For

example, regulations aimed at increasing the limits on car emissions might force different firms to respond differently: some firms may respond with optimizing traditional engines or reinventing a specific component, some may take a more radical approach of moving towards hybrid or electric engines, while those unable to develop their own solution might decide to source a compliant engine from other manufacturers. However, recent studies have argued that the extant research has a limited understanding of the impact of regulations, particularly concerning the multiple dimensions of the regulatory change in a longitudinal perspective, on firm innovation (Blind, 2012; Aversa & Guillotin, 2018). Moreover, the research has also highlighted the tendency of scholars to club together the multiple dimensions of the regulatory change while examining its impact on the firm innovation and not paying enough attention to the impact of the dynamics of change brought forward by individual dimensions of the regulatory change on firm innovation (McCarthy *et al.*, 2010). In this regard, our study aims to provide a valuable contribution by investigating the research question: *How do the direction and the magnitude of a regulatory change (i.e., low and high restrictive regulations) influence firms' innovative or imitative behaviour?*

However, we argue, while the case for stringent regulations driving innovation is plausible, it is incomplete unless it takes into account firm capabilities. Firms with strong innovation capabilities are more able to respond to regulations by innovating, whereas firms with limited innovation capabilities may not be able to innovate in response to regulations. These firms are more likely to look to the solutions developed by other firms; they are more likely to imitate. While our starting point is that response to stringent regulations depends on innovation capabilities, we also maintain that the decision on whether to innovate or imitate is also influenced by the rate at which the industry is changing. Specifically, because innovation may require major changes to products and operations, and this takes time, firms must take into account the industry's clockspeed (Fine, 1996 & 2000): the industry's rate of

introduction of new generations of products in the marketplace (Carrillo, 2005; Patel, Fernhaber, McDougall-Covin, & Van der Have, 2014). An industry with fast clockspeed may not allow firms with weak innovation capabilities sufficient time to innovate – forcing them instead to imitate – whereas in contrast competitors with strong innovation capabilities can choose to innovate.

To sum up, in this paper, we argue for a multilevel interaction between regulations, innovation capabilities, and clockspeed (Gupta, Tesluk, & Taylor, 2007). We regard regulations as triggering top-down processes that exert a direct cross-level effect, where, in the words of Gupta *et al.* (2007, p 889), "factors at a higher level of analysis influence outcomes or dependent level". The outcome of interest in this paper is the extent to which firms embrace technological change. However, while we start with regulations as the direct cross-level effect that influence technological change, we also take into account further cross-level moderators that influence firm reaction to regulations, namely: innovation capabilities supporting the ability of firms to pursue technological change (and their lack constraining such ability), and clockspeed moderation of the interaction between regulations and capabilities – influencing whether firms will innovate or imitate in response to regulations.

In this paper, we explore how the multilevel interaction between changing environmental regulations, innovation capabilities, and industry clockspeed influence technological choices in the Indian automobile industry. We do this with a longitudinal study of emission control standards that were mandated by the Indian government on the domestic industry during the period 1999-2018. The Indian automobile industry is particularly suitable for studying how firms respond to regulations because the stringency of emission control regulations has been periodically and gradually increased. Moreover, as changes in emission control regulations are periodic (i.e., frequency) and have a high degree of predictability (i.e., all firms learn about the change in advance before enforcement), in this paper, we have kept

frequency and predictability dimensions of the regulatory release as constant. This allows us to achieve a more nuanced understanding of the impact of the direction and magnitude of the regulatory change (i.e., permissive or restrictive; low or high) which is assumed to have more relevance when it comes to influencing the competitive dynamics and the variations in the firm's responses (Blind *et al.*, 2017; Aversa & Guillotin, 2018). We track the interaction of emission control regulations with the innovation capability growth of firms, and the increase in the speed of new product introductions during the period of study (i.e., industry clockspeed).

Our paper is organized as follows. The next section provides a literature review of the extant theoretical and empirical research. We then develop hypotheses about the impact of environmental regulations on the innovation strategic response choices of firms and the moderating effect of firm capability and the industry clockspeed. In the following section, we present the theoretical model and discuss the research site (i.e., the Indian automobile industry) including a brief discussion on the sources of vehicular emissions and the evolution of emission control regulations in India. We then provide details of the data collection, measures, and research methodology. Finally, we present the findings and discuss their implications for theory and policy.

4.2 Theoretical overview

4.2.1 Environmental regulations and innovation

Environmental regulations, from the regulators' perspective, are generally restrictive and are framed and implemented with a view towards addressing negative externalities. When corporations resist environmental regulations, they are more likely to cite higher costs and impact on pricing, than the impact on innovation (Rugman & Verbeke, 2000). Research that seeks to establish whether environmental regulations negatively or positively impact

innovation has yielded mixed results (Ambec *et al.*, 2013). Porter (1991), and follow up research by Porter & van der Linde (1995), argues that environmental regulations, if properly designed, can lead to innovation if managers, instead of resisting regulations, proactively comply by redesigning their products and processes. Several studies report the positive impact of regulations on innovation, concluding that regulations can push the development of cleaner technologies, help in the promotion and diffusion of existing technologies, and induce new product and process innovations (Ashford, Ayers, & Stone, 1985; Lanjouw & Mody, 1996; Hart & Ahuja, 1996; Brunnermeier & Cohen, 2003; Türpitz, 2004; Popp, 2006; Ambec *et al.*, 2013; Parchomovsky & Stein, 2008; Gonzalez, 2009; Taylor, Rubin, & Hounshell, 2005). Other studies, however, suggest that regulations have a negative impact on innovation as firms are forced to allocate resources away from strategically critical activities (Papadakis, Zollers, & Hurd, 1996; Blind, 2012; Marin, 2014).

4.2.2 Regulatory Stringency and Innovation

The 'stringency' of the environmental regulations is defined by how demanding it is for firms to comply with regulations that affect their business (Brunel & Levinson, 2016). Prior research suggests that the concept of 'stringency' conflates multiple dimensions of environmental change ranging from the magnitude (i.e., how large or small is the change), the direction (i.e., whether the new regulation is restrictive which reduces and binds firms' allowances and actions, or permissive which increases firms' freedom in specific domain or activities), the frequency (i.e., how often the change occurs), and the predictability (i.e., if all firms learn about the enforcement of new regulation in advance which indicates the time available to firms to fashion their responses) (Aversa & Guillotin, 2018; McCarthy, Lawrence, Wixted, & Gordon, 2010; Nadkarni & Narayanan, 2007). As previously argued, prior research has advised that a nuanced understanding of the impact of regulations on firm innovation requires one to examine the impact of the dynamics of change brought forward by

individual dimensions of the regulatory change on firm innovation (McCarthy *et al.*, 2010) and since, in this paper, we only focus on disentangling the direction and the magnitude dimensions of the regulatory change (i.e., keeping the frequency and the predictability dimensions of the regulatory change as constant), it is important to clearly state the key aspects and the boundary conditions of our study. Our study is based in a competitive setting (i.e., the Indian automobile industry) where regulations are generally 'restrictive' in nature (rather than 'permissive') which means they are aimed at reducing competitors' degrees of freedom with respect to certain business activities to promote social good (Blind, 2012). Yet, they vary in magnitude i.e., they either can be characterised as less restrictive or more restrictive. The literature differentiates between "technology-following" (i.e., low restrictive regulations) and "technology-forcing" (i.e., high restrictive regulations) regulations (Bresnahan & Yao, 1985; Wesseling, Farlaa, & Hekkerta, 2015; Horbach, Rammer, & Rennings, 2012). Technology-following regulations allow manufacturers to achieve compliance by procuring or adapting existing technologies, thereby significantly reducing the risks associated with developing new technologies. In a scenario where regulations are less restrictive (i.e., technology-following) firms are more likely to use proven off-the-shelf technologies that have been successfully adopted by other firms to meet compliance (Dechezlepretre, Neumayer, & Perkins, 2015). For example, the first emission control regulations (e.g., BS-I) in the Indian automobile industry mandated firms to reduce the emission levels moderately, which firms were able to achieve easily using existing off-the-shelf pollution control technologies (such as tail-end pipe solutions, e.g., attachments and exhaust-after treatment catalysts) and thus those regulations eventually did not induce any innovative response.

In contrast, highly restrictive, or technology-forcing regulations require manufacturers to research and develop commercially viable new solutions to achieve

compliance. This significantly increases firms' technical and financial risks but, if successful may result in significant competitive advantage (Faiz, Weaver, & Walsh., 1996; Franckx, 2014; Wesseling *et al.*, 2015). Generally, therefore, as regulations become more restrictive, firms are more likely to innovate, rather than adopt technology and solutions that are already employed by other firms. We can therefore hypothesize as follows:

> H1: Highly restrictive regulations reduce the likelihood that firms imitate and increase the probability that firms innovate.

4.2.3 Industry clockspeed and firm innovation capability

Thus far we argued that, in general, when faced with more restrictive regulations firms are more likely to meet compliance by innovating as the increase in stringency of regulations diminishes the scope for imitation – especially for pure imitation (i.e., implementation of off-the-shelf solutions). However, strategy research suggests that firms' response to highly restrictive regulations will depend on the resources and capabilities at their disposal (Barney, 1991; Teece, Pisano, & Shuen, 1997). Because firms are heterogeneously endowed with resources and capabilities, they tend to respond differently to existing or impending regulations. Firms that have strong innovation capabilities are more likely to innovate when environmental regulations become more stringent. In contrast, firms that lack the requisite innovation capabilities are more likely to imitate when confronted with more stringent regulations. Particularly, in the context of a dominant firm industry, we observe a significant gap in firms' resources and capability between the dominant firm and the competitive fringe. The dominant firm and the foreign fringe firms, on the one hand, in general, have high innovation capabilities, and thus may choose to respond to highly restrictive regulations either with innovation (if the situation demands so) or with innovative imitation as these firms would already have faced tightening of regulations in other developed markets in the past and have technology available to them to meet compliance, while all they need to do is

to adapt the existing technology to local market conditions that may require them to undertake some innovative research and development activities. Also, the firms that already possess relevant technology, especially the foreign fringe firms, attempt to take a lead in introducing compliant vehicles in the market — before the dominant firm and well before the scheduled regulations come into force — in order to increase sales and in an attempt to be seen as more innovative in the eyes of the customers which further improves their brand reputation. On the other hand, the domestic fringe firms, with limited resources and innovation capabilities, are required to balance their focus while allocating resources to improve the other functionalities of their vehicles or to engage in innovating emission control technology. In addition, their relatively weak market position will also deter them from taking a more risky option of innovation instead will motivate them to imitate other firms' solutions. However, when the stringency of regulations is higher, the imitation choices available to firms are usually technologically more complex as compared to the imitation choices available when regulations are less stringent. The challenge of imitating complex solutions is that they are not amenable to pure imitation because imitation of complex solutions requires a certain degree of innovative adaptation (especially if the solution is completely new for the imitating firm) (Lee, Smith, Grimm, & Schomburg, 2000; Posen, Lee, & Yi, 2013; Posen & Martignoni, 2018). For example, imitation of sophisticated emission control solutions (e.g., exhaust gas recirculation, incorporation of electronic control systems etc.) requires changes in engine design to function efficiently (see Table 4.1). Therefore, firms that lack the ability to respond to more restrictive regulations by developing a new solution tend to combine imitation with innovation in order to meet regulatory compliance, to deliver what has been referred to as creative imitation or innovative imitation strategy (Levitt, 1966; Lee & Zhou, 2012). This gives us the following hypothesis:

H2a: Under conditions of high restrictive regulations, there is a negative relationship between firms' innovation capability and firms' likelihood to engage in innovative imitation rather than in innovation.

H2b: Under conditions of high restrictive regulations, there is a negative relationship between firms' innovation capability and firms' likelihood to engage in imitation rather than in innovation.

Innovation capabilities play an important role in the firm's response to regulations. But the decision on how to employ these capabilities will also be influenced by the rate of change in the industry, what Fine (1996) refers to as 'industry clockspeed'. Industry clockspeed has three main aspects, namely product, process, and organizational. Product clockspeed refers to the rate of new product introduction and obsolescence. Process clockspeed refers to the rate at which process technologies are substituted in an industry. Organizational clockspeed refers to the rate of change in firms' organizational structures and strategies in a given industry. Cumulatively, the concept of industry clockspeed captures the endogenous changes in an industry, which is the sum of the endogenous changes (i.e., product, process, and organizational) of all the firms operating in that industry at a given time (Nadkarni & Narayanan, 2007; Ferrier, 2001; Dedehayir & Makinen, 2011; Patel *et al.*, 2014).

Let us first look at situations when firms operate in an industry where clockspeed is low. Low clockspeed puts less constraints on innovation capabilities. Firms are not forced to focus their R&D efforts on improving competitive value-adding features of their products at the expense of devoting their R&D efforts to innovate their products' environmental performance. They can pursue innovative product, technology, and organization effort, while at the same time providing sufficient resources for innovative solutions to environmental regulations. The stringency of environmental regulations can further influence the firm's decision on whether to push for innovative solutions or settle for imitation of existing

solutions. To simplify our discussion, let us once again take a scenario where the industry clockspeed is low. In general, firms in this scenario can pursue a broad range of imitative, innovative-imitative, and innovative response choices while responding to changing regulatory environment. So, if the stringency of regulations increases, low industry clockspeed allows firms more time and resources to respond to regulatory change with innovation in comparison to situations when clockspeed is high, in which firms will find that their ability to choose innovation over imitation is constrained. Moreover, the potential opportunity for firms to develop a competitive advantage over their rivals, should they decide to respond to the regulatory change with innovation, will motivate firms to innovate than imitate (Wesseling *et al.*, 2015; Porter & van der Linde, 1995). This gives us the following hypothesis:

> H3a: Under conditions of high restrictive regulations, firms operating in a low industry clockspeed are less likely to imitate and more likely to innovate.

In contrast, let us look at situations when firms operate in an industry where the clockspeed is high. We argue that as clockspeed increases, firms are often forced to direct their innovation capabilities towards new products and technologies needed to shore up their position. This reallocation of innovation resources comes at the expense of reducing the resources needed to devise innovative solutions to environmental problems (Ambec, Cohen, Elgie, & Lanoie, 2013). It puts constraints on firms' ability to innovate new technological solutions in response to environmental regulations (Naimoli, Kodjak, German, & Schultz, 2017). So, in this scenario, if the stringency of regulations increases, the increasing constraints will pressure firms to forego innovation for imitation. This means that even firms with strong innovation capabilities, let alone firms with weak innovation capabilities, are more likely to forgo innovation for imitation while responding to environmental regulations. The situation may be more challenging for the competitive fringe in the dominant firm

industry. For instance, firms in the competitive fringe are locked in a relatively close contest while catering to the demand left unfulfilled by the dominant firm. When the clockspeed increases, they focus more on keeping up with the market by launching new or refreshed models (Nadkarni & Chen, 2014) to remain competitive and have less capacity to devote energy to develop new solutions in response to environmental regulations. We argue, that in this situation, they are more likely to look for an immediate solution (i.e., sourcing of the compliant engines or imitating and adapting an existing technology) that does not hamper their rate of the introduction of new products and provide them time to devise a long-term solution. Thus, the increase in the stringency of regulations, when the clockspeed is high, is less likely to drive firms to innovate environmental solutions in response to regulations, rather firms will find imitating and improving existing solutions (i.e., innovative imitation) as a less risky and more attractive response to environmental regulations (Pacheco-de-Almeida, 2010; Makadok, 1998; Jonsson & Regner, 2009; D'Aveni, Dagnino, & Smith, 2010). This gives us the following hypothesis:

> H3b: Under conditions of high restrictive regulations, firms operating in a high industry clockspeed are more likely to engage in innovative imitation than in innovation.

Figure 4.1 presents the theoretical model of the study. Regulatory stringency (low/high restrictive regulations) is shown to influence a firm's strategic response to regulations – with three basic choices indicated: imitation strategy, innovative imitation strategy, and innovation strategy. Moderating the relationship between the stringency of regulations and strategic response choices are firm innovation capability and industry clockspeed.

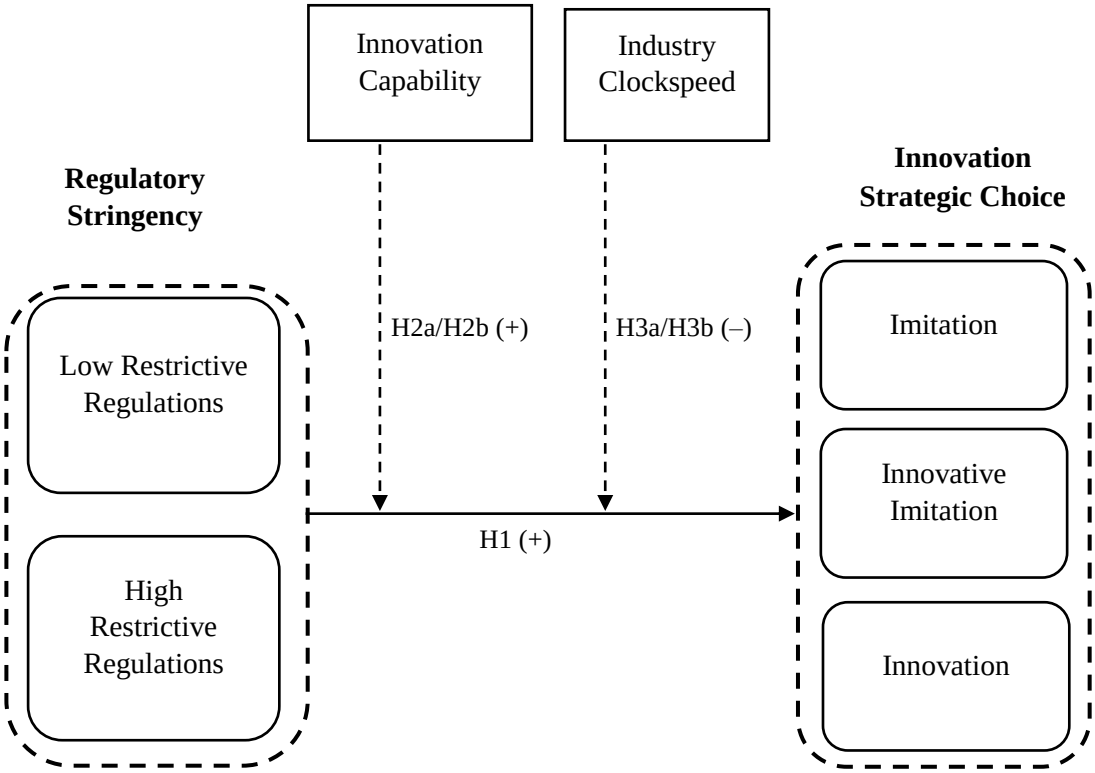


Figure 4.1 Regulatory stringency, innovation strategic responses of firms and the moderating role of firm capability and industry clockspeed

4.3 Research Setting: Indian Automobile Industry

4.3.1 Pollution control in the automobile industry

Motor vehicles are a major source of air pollution in developed and increasingly in developing countries, particularly in urban centres that are highly motorized, and this poses a great health risk for the urban population. Some of the major air pollutants emitted by motor vehicles are carbon monoxide (CO), hydrocarbons (HC), nitrogen oxide (NOx), sulphur dioxide (SO_2), Particulate Matter (PM10), lead (Pb) and ozone (O_3) (Faiz, Gautam, & Burki,

1995). Faiz *et al.* (1995) and Faiz & de Larderel (1993) have listed three primary factors that influence the extent of the emission of harmful gases and particulate matter from motor vehicles that any effective emission control system must take measures to control/manage all of them: vehicle/fuel characteristics; operating characteristics; and fleet characteristics. Table 4.1 provides a summary of emission control strategies and relevant emission control technologies. Firms may comply with emission standards by adopting an innovative strategy (e.g. new designs), or an imitative strategy, off-the-shelf Technology Adoption (e.g. after-exhaust treatment focused emission control technologies). However, the strategic choice of the firm is contingent on the firm's innovation capability, the stringency of standards, and competitive pressure that result from the frequent introduction of new or improved products to market (i.e., industry clockspeed).

Table 4.1 Firm strategies to meet emission regulations compliance

Strategic Orientation	**Sub strategies**	**Description**
Imitation	Sourcing of compliant engines or emission-control technologies from external suppliers/companies that can be attached to existing engines to meet compliance without requiring to undertake any complex engine design modifications to fit (i.e., use of off-the-shelf available solutions).	
	1. *Gasoline Engine (Spark-Ignition)*	
	a) Catalytic converters	Such as oxidation catalysts that are used as an attachment that facilitates after-exhaust treatment of harmful gases and has limited capability to reduce emissions.
	b) Evaporative Emission control	Gasoline is a volatile fuel and when stored in a vented tank it evaporates even at normal temperatures. It can be controlled by venting the fuel tank to the atmosphere using the method of canister purging i.e., use of canister charcoal that absorbs HC vapours which are purged by drawing air into and burned when the engine is running.
	2. *Diesel Engine (Compression- Ignition)*	
	a) Lean NOx Trap (LNT)*	It is a catalytic converter that includes an oxidation catalyst, an absorber (to store NO_2 produced due to

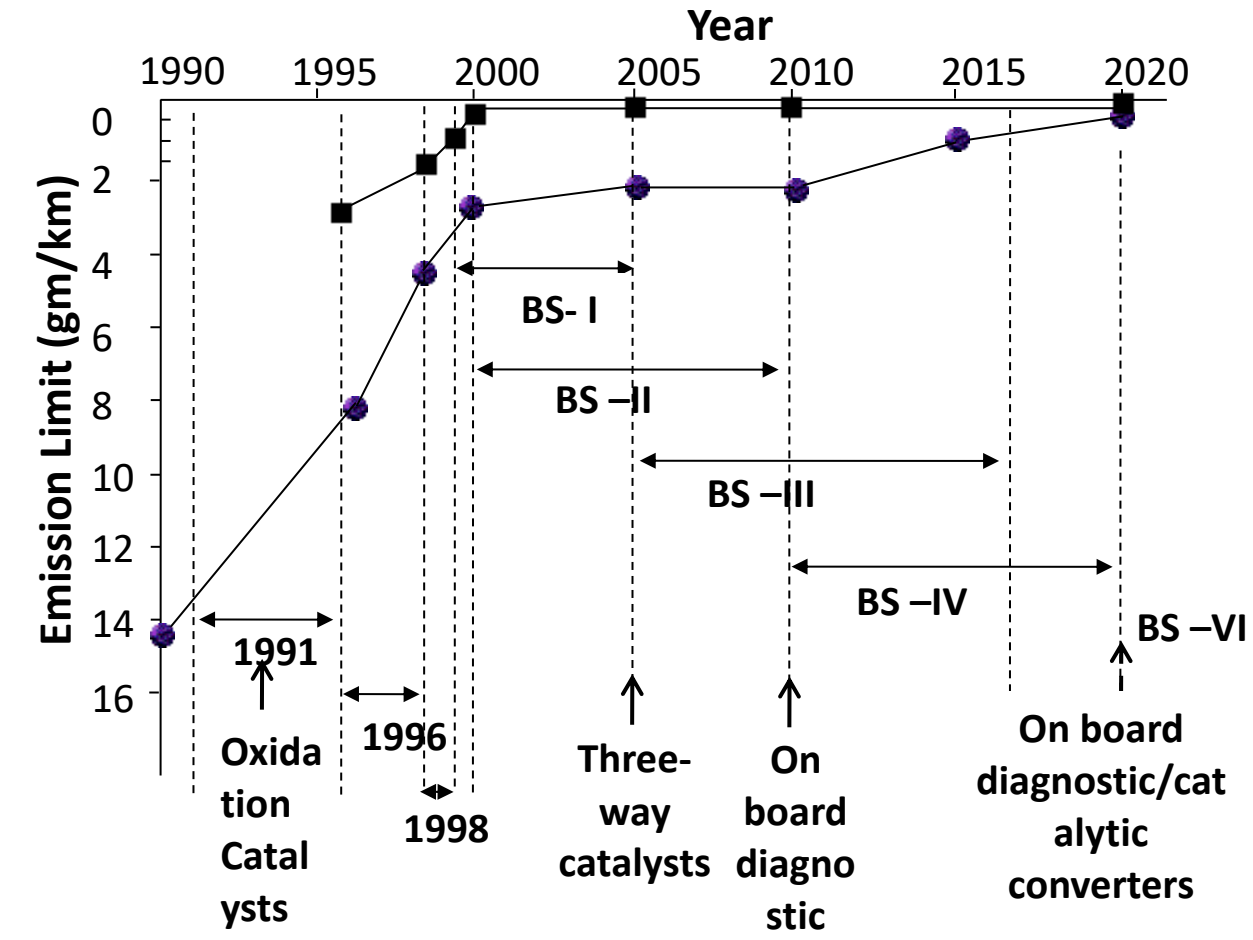
		lean-burn conditions), and a reduction catalyst. It reduces NOx significantly but hampers fuel efficiency due to the regeneration cycle involving fuel injection for a short time to produce HC, CO and H required for reduction of NOx to Nitrogen.
	b) Selective Catalytic Reduction (SCR)*	An advance catalytic converter that reduces the NOx to Nitrogen using an external urea-based reducing agent stored in a separate tank in the vehicle. It is highly effective but with a drawback that the reducing agent tank needs to be refilled once utilized.
	*Note: *there is an increasing trend of using SCR and LNT together in cars to realize the benefits of both technologies.*	
Innovative Imitation	Sourcing of advanced emission-control technologies /equipment from external suppliers/companies to meet compliance, implementation of these technologies/equipment in vehicles however requires firms to undertake complex engine design modifications.	
	1. *Gasoline Engine (Spark-Ignition)*	
	a) Three-Way Catalytic converters	The most sophisticated catalytic converter available uses a combination of platinum, palladium and rhodium as catalysts helping the oxidation of CO and HC and reducing the NO emissions. It requires an electronically controlled engine with a rich air-fuel ratio to work effectively and hence the implementation of three-way catalytic converters in vehicles require firms to undertake significant engine modification).
	2. *Diesel Engine (Compression- Ignition)*	
	a) Diesel Particulate Filter (DPF)	DPF involves a wall-flow filter that traps the solid PM from the exhaust gas. However, this affects the fuel efficiency (as it incurs a small fuel penalty) during the regeneration process to remove accumulated PM and therefore it must be integrated into the electronic engine control system to ensure efficient functioning.
Innovation	In-house development of fuel-efficient and low-emissions engines by altering engine design and /or through the development of electronic control systems or a breakthrough emission control technology (*some of the ways through which engines are modified to reduce harmful emissions are highlighted below for reference*).	
	1. *Gasoline Engine (Spark-Ignition)*	
	a) Air-Fuel Ratio	The air-fuel ratio is a key design parameter in spark-ignition engines thus lean air-fuel mixture (i.e., 50% more air than fuel) is more efficient due to less heat loss, higher compression ratio, favourable thermodynamic properties, and low throttling loss at

		different loads further help in the reduction of harmful emissions.
b)	Electronic Control System	Development of electronic control systems. It not only adjusts air-fuel ratios in different situations but also controls features (such as spark timing, exhaust gas recirculation, idle speed, air injection system, and evaporative canister purging) that were earlier used to be controlled by vacuum switches and the host of other devices.
c)	Crankcase modifications	Closure of crankcase vent port and venting the crankcase to the air intake system by incorporating a check valve allows treatment of unburned or partly-burned HC that otherwise gets released in the air and help reduce HC emissions.
2.	*Diesel Engine (Compression- Ignition)*	
a)	Injection nozzle sack modifications	Reduction in injection nozzle sac volume and oil consumption minimizes HC and PM emissions.
b)	Engine refinement with a turbocharger	Incorporation of turbocharger along with engine reduces PM emissions and improves fuel efficiency and power output.
c)	Provision of cooling compressed-charge air with aftercoolers	Cooling of compressed-charge air with the use of aftercoolers helps reduce PM and NOx emissions.
d)	Flexible fuel injection timings, increasing fuel injection pressure and rate	Retarding fuel injection timings (with a flexible timing system) over the speed-load range reduces the HC emissions and also manages the adverse effects of fuel injection retardation on starting and exhaust smoke. Retarding the fuel injection timing controls HC emissions but increases PM emissions that can be controlled by increasing fuel injection pressure and rate.
e)	Provision of exhaust gas recirculation	Recirculation of exhaust gas to the engine significantly reduces NOx emissions.
f)	Improving air utilization and optimizing air circulation within the cylinder	Reduction of parasitic volumes in the combustion chamber through the clearance between piston and cylinder head, and between the piston and cylinder walls improves air utilization and result in a reduction of HC and PM. Design changes in combustion chamber geometry and intake air swirl to provide adequate mixing of fuel and air at low and high speeds result in a reduction of smoke and PM without compromising on the fuel efficiency.
g)	Electronic governor control	Improvement in governor curve shape and use of electronic governor controls help limit transient smoke and PM emissions.

Source: Faiz *et al.* (1996) & Nesbit *et al.* (2016)

4.3.2 Emission control standards in the Indian automobile industry

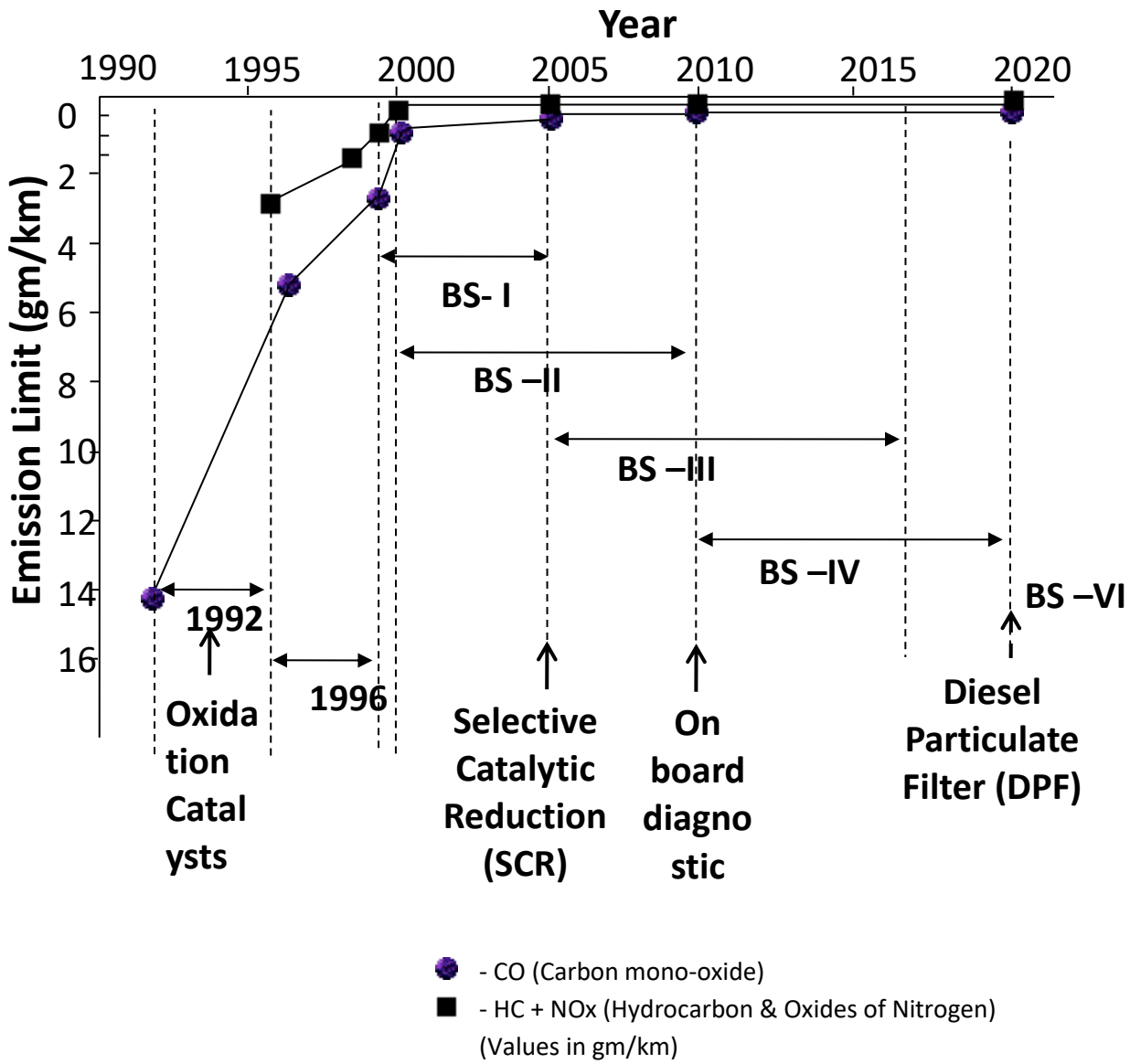
The emission control rules in the Indian automobile industry have evolved following the economic liberalization in the early 1990s. The Indian government has adopted a phased implementation by imposing stricter emission controls as the industry grew and in line with its international obligations (Figure 4.2 & Figure 4.3). For instance, separate emission limits and implementation time were adopted for automobiles using petrol and diesel. The regulations were first implemented in high growth markets (i.e., metropolitan cities), followed by tier-2 and tier-3 cities and the rest of India in a phased manner. Firms were provided with ample time to prepare themselves for the impending regulatory change. At the start of the 21st century, the government decided to harmonize the emission control regulations with international standards and adopted the new policy with a nomenclature – the Bharat Stage (BS) – that was built on European norms. The timeline of the implementation of these norms is highlighted in Figures 4.2 & 4.3 which present the evolution of these norms. At present, the country has BS-VI norms in place, which is comparable to Euro-VI, and was implemented in April 2020 after leapfrogging from BS-IV norms.



Source: ARAI, India

* BS – Bharat Stage

Figure 4.2 Emission control standards changes for passenger cars (Petrol/Gasoline) in India (1991-2020)



* BS – Bharat Stage

Source: ARAI, India

Figure 4.3 Emission control standards changes for passenger cars (Diesel) in India (1991- 2020)

4.3.3 Indian automobile industry

This study uses the Indian automobile industry as a research site for many reasons. First, as previously highlighted, one of the primary issues raised by researchers is that most studies are based on cross-sectional analyses, and therefore cannot provide a longitudinal assessment of the impact of regulations and subsequent firm responses). The evolution of the emission control standards in the Indian automobile industry over the last two decades provides a suitable context for addressing this. Second, this study assumes that the stringency of the regulations and the heterogeneity in firms' innovation capabilities greatly influence their strategic responses vis-à-vis a change in regulations. The current profile of the Indian automobile industry (comprising operating firms with observable differences in firm-level capabilities) and the gradual increase in the stringency of emission control regulations over time can be used to test these assumptions. Third, the growth in firms' innovation capabilities, as reflected in the corresponding evolution in their strategic responses to different regulatory changes throughout the study (1999-2018), provides much-needed variance to identify multi-level effects.

4.4 Methodology

4.4.1 Data collection

To examine product changes (especially related to engine design and use of emission control technologies), we built a dataset of car models launched by different car manufacturers from 1999 to 2018, during which emission control standards from BS-1 to BS-IV were enforced by the Indian government. The study utilized different sources to collect the required information. We used 'Factiva' (a DowJones database that collects news articles related to company announcements/product launches) as a source to construct a list of all the product model/variants along with their features (as provided in the news articles/company announcements) launched in the Indian market during the study period. We employed the

search function of the database to extract relevant news articles sorting them by year and month and carefully examined them for collecting the required information (i.e., textual data). In total, we examined nearly 30,000 news articles that were published by different newspapers over the last 20 years. To ensure that the relevant engine or emission control technology-related information was not missed, we paid special attention to news articles published around the critical points, i.e., preceding years around the time when different standards were enforced such as BS-1 (the year 1999), BS-2 (the year 2000), BS-3 (the year 2005), and BS-4 (the year 2010).

This resulted in a sample list of more than 1,500 product models (including their variants) launched by 20 car manufacturers operating in the Indian market (including both Indian and subsidiaries of foreign firms that manufacture vehicles in India). The scope of this study required examining engine modifications, design changes, and the use of available emission control technologies in cars aimed at limiting vehicular emissions under the prescribed limits. The news articles allowed us to place product models in chronological order. However, they did not always contain engine related data required to make informed judgments about strategic response choices (i.e., imitation, innovative imitation, and innovation) of firms. Therefore, specific engine data critical to minimize vehicular emissions (e.g. valve technology, air injection system, ignition chamber, use of electronic engine control such as On-board diagnostics (OBD) etc.) and data related to the use of emission control technologies (such as catalytic converters, exhaust gas recirculation components, etc.) were sourced from popular online car review portals (e.g., Cardekho, Zigwheel, Autocar India, Carfolio, etc.) that collect different performance and price-related data on car models, dedicated company product (car models) websites, and other product catalogues available online. Once these data were compiled, we excluded from the analysis all the product variants that did not include significant engine design changes and did not use new emission control

technology, but only added new functionality or cosmetic changes to the old model without modifying the engine. Automobile manufacturers often use the same engines for different product models (for instance TATA Indica and TATA Indigo two products in different product segments that shared the same 1396cc diesel engine) and thus, to avoid duplication, we included only one of all product models that shared the same engine. This resulted in a final sample of 549 product models. The data for the other independent and control variables were collected from relevant sources. Data related to R&D intensity, firm age, cluster location of the company in India, and information on whether the firm exports to international markets were sourced from Capital IQ and ThomsonONE databases, and company annual reports for different years. Data related to market share were obtained from the Society of Indian Automobile Manufacturers (SIAM).

4.4.2 Variables and Measures

Dependent Variable

Innovation Strategic Response Choice: As previously discussed, the study assumes that the stringency of the emission standards will influence firms' strategic response choice. It is argued that when firms foresee a change in emission control standards within a timeframe, contingent upon the stringency of impending regulations and other factors such as industry clockspeed and firm innovation capability, three primary strategic response choices are available to them to meet compliance: imitation strategy (using short-term and low-cost solutions, e.g., catalytic converters based on imitating rival firms or sourcing compliant engines from other OEMs); innovative imitation (adopting technological solutions that require modifications in engine design, which, in turn, requires some innovation capabilities and R&D investments); and innovation strategy (development of new solutions and technologies). The study operationalizes the three strategic response choices by assigning them the numerical values ranging from 1 to 3 (i.e., 1= imitation strategy; 2 = innovative

imitation strategy; and 3 = innovation strategy) after assessing the collected data on engine parameters (e.g., engine type, engine description, valve configuration, fuel supply system, engine turbocharge provisions, and emission control technology used, e.g., catalytic converter, DPF, EGC, SCR etc.) for product models launched during the study period (i.e., 1999-2018) based on the criteria mentioned below:

1. Imitation Strategy: i) Adopting technologies that do not necessitate engine modification; ii) compliant engines sourced from other OEMs.
2. Innovative Imitation Strategy: i) Adopting engine electronic control systems, onboard diagnostics, DPF, LNT and SCR that require engine design modifications to fit; ii) Improvement of engine performance and cut back emissions using fuel inject system, valve configurations, etc.
3. Innovation Strategy: i) Development of fuel-efficient engines in-house that meet emission norms; ii) Development of breakthrough technology or solution.

For example, the product models that either utilise compliant engines sourced from the other OEM manufacturers (as part of a contractual arrangement), or use off-the-shelf emission control technologies (e.g., basic oxidation catalysts etc.) that are sourced from the market but adoption of such technologies do not require modifications in the existing engine, have been coded as 1 (i.e., imitation). While, if a given product model meets compliance by utilising more advanced emission control technologies (e.g., three-way catalytic converter, DLF, Electronic engine control systems etc.) from external sources that require significant modification in the engine design to adapt or to further improve its efficiency then such product models have been coded as 2 (i.e., innovative imitation) as this indicates that the firm has undertaken significant R&D efforts (for example trial and error activities), and in some cases, the engine design innovation, to fit the sourced technology to its existing engine. All product models that used new engines or breakthrough emission control technologies that

were developed in-house in response to the changes in emission control regulations have been coded as 3 (i.e., innovation).

Independent and moderator variables

Regulation Stringency: Environmental regulations, from the regulators' perspective, are generally restrictive and are framed and implemented with a view towards addressing negative externalities. As argued earlier, in this study, we accounted for the magnitude and the directions of the regulatory change in our analysis while keeping the frequency and the predictability dimension of regulatory change as constant as the emission control regulations are not only enforced periodically (i.e., low frequency) but also the firms have prior knowledge of the impending regulatory change (i.e., high predictability as they are given ample time to prepare for the change). Thus, concerning the direction of change dimension, we define emission control regulations as 'restrictive' in nature (rather than 'permissive') which means they are aimed at reducing competitors' degrees of freedom with respect to certain business activities in order to promote social good (Blind, 2012), and its magnitude as less restrictive (i.e., technology-following) or more restrictive (i.e., technology-forcing). Technology-forcing emission control standards require firms to drastically cut down the vehicular emissions, whereas technology-following emission standards require firms to achieve vehicular emissions reductions that are significant, but easily made using existing emission control technology or solutions already tried and tested in other markets. Traditionally, the literature suggests, governments develop and enforce emission control standards and increase their stringency progressively in order to avoid disruption in the industrial activity (Horbach *et al.*, 2012; Saikawa, 2013; Ambec *et al.*, 2013). As the industry matures, governments tighten emission regulations requiring automobile firms to cut down the level of vehicular pollutants (such as CO, NOx, Hydrocarbon (HC), Particulate matter) significantly. Figures 4.2 & 4.3 show successive implementations of new emission standards

(BS-I to BS-IV) for gasoline and diesel motor vehicles in India in the last two decades. For gasoline vehicles, emission standards required firms to reduce the emission limit of CO and HC+NOx from 6.2 and 2.18 g/km at the time of implementation of BS-I in the year 2000 to 1.0 and 0.18 gm/km respectively when BS-IV came into force in 2010. Furthermore, earlier standards allowed companies to control the emission limits of HC+NOx combined to the prescribed limits. However, the implementation of BS-III and BS-IV standards also required firms to limit, along with other pollutants, the vehicular emission of HC and NOx separately to 0.2 and 0.15 gm/km (as per BS-III) to 0.1 and 0.08 gm/km (as per BS-IV) respectively (ARAI, India). Similar reductions in emission limits were also enforced for diesel vehicles (see Figure 4.3). This not only clearly indicates the increase in the stringency of regulations over time, but because complying with these standards pushed firms to move away from employing pure imitation (e.g., use of attachments such as oxidation catalysts) towards developing and employing more sophisticated innovative solutions that require substantial changes in engine design (e.g., three-way catalytic converters, onboard diagnostics, SCR and DPF modules), it also shows how regulatory stringency can influence firms' strategy with respect to imitation and innovation. Hence, to operationalize the change in the restrictive nature of the emission standards we create an ordinal variable that captures the increasing degree of stringency mandated by successive environmental regulations, from the first less strict regulations, to the more recent and more stringent regulations. We assign numerical values, from 1 to 4, in increasing order of stringency of emission control norms. This tracks the changes in emissions regulations (in the increasing order of stringency) so as to measure their influence over time.

Firm innovation capability: The study assumes that firm-level capabilities, especially a firm's innovation capability, will play a moderating role in the relationship between the emission standards stringency and strategic response choice of the firm. The

study utilizes R&D intensity (R&D expenditure/Sales) to measure firm innovation capability, as firms will need to invest in enhancing their innovation capabilities to improve the performance of existing products or adapt existing solutions (i.e., to support innovation or innovative imitation activities). In order to avoid data skewness, natural log values of the R&D intensity have been used in the analysis.

Industry Clockspeed: Industry clockspeed, as defined by Fine (1996), is a multidimensional concept that includes the rate of changes in product, process, and organization over a given timeframe. Because of the main research question of our study, we focus specifically on the rate of changes in the products, but not on the changes of process or organization. We, therefore, measure the industry clockspeed as the count of new product introductions in a given year by operating firms. This measure has been used to measure the product dimension of the industry clockspeed in a variety of research settings and different industrial contexts (e.g., Greve, 2003; Smith, Collins, & Clark, 2005; Nadkarni & Barr, 2008; Nadkarni & Chen, 2014; Patel *et al.*, 2014). In the case of the Indian automobile sector, it is worth noting that the liberalization of the sector in the mid-1980s, led to the increasing number of foreign companies setting up manufacturing operations in India (Narayanan, 1998; D'Costa, 2000). However, by 1999, the starting point of our study, the number of firms in the market stabilized. The introduction of new products resulted from increasing demand and competition for market share, rather than from new entry. Overall, during our study period (1999-2018) these factors led to the increasing number of car models being introduced annually. The annual count of new product introductions, therefore, increased steadily during the period of study, resulting in a skewed distribution of data (e.g., low values for initial years and higher values for more recent years), therefore the values have been transformed using a natural log to address data skewness (Ives, 2015).

Control Variables: Firms' strategic response choice may be affected by other factors than those identified in the hypotheses, therefore, a number of control variables have been included in the analysis.

a) *Age of firm*: Research suggests that the age of the firm is likely to have an effect on the innovation capability of the firm (Sinkula, 1994; Calantone, Cavusgil, & Zhao, 2002). Firms that have been in operation for a long time are likely to have accumulated more knowledge and developed higher innovation capability. The study uses the year of incorporation of the firm as a point to calculate the age of the firm. Further, the log transformation of the values is performed to correct for skewness.

b) *Size* and the *market share* of the firm: Research suggests that firm size and market share affect firm innovation (Cohen & Klepper, 1996; Blundell, Griffith, & Van Reenen, 1999) and are likely to influence the strategic response choice of the firm in the context of regulatory change. For instance, the bigger the size of the firm, the higher the manufacturing resources needed to speedily implement innovative solutions, thus making it more likely that it will adopt innovative strategic response. Similarly, if the firm has a bigger market share, it can either take an innovative strategic response (in the long-term to build the capability to respond to future further tightening of regulations), or an imitative response (in the short-term to defend the market share if it lacks the capability/technology to meet the emission norms) (Ross & Sharapov, 2015; Sharapov & Ross, 2019; Ferrier, Smith, & Grimm, 1999). The study has utilized the natural log of a firm's revenue as a proxy to measure the firm size and the log values of market share of automobile firms (obtained from SIAM) in a given year to control for these effects. We used log values of market share instead of actual percentages to avoid skewness as the skewness test of the data on actual market share reported positive skewness (skewness = 1.694), which was corrected by the log transformation (skewness=

0.428). Prior studies have also utilized log transformation of share data to avoid estimation errors (Gerdes, 2011; Andersson, Opper, & Khalid, 2018).

c) *Firm Location* effect: There are three major automobile clusters in India: North (Delhi NCR); West (Mumbai/Pune); and South (Chennai) and a number of automobile firms currently operating in India are located in more than one cluster. The location of a firm in a specialized cluster results in more industry engagement, support, and access to information, and these factors may influence the strategic response choice of the firm (Ozer & Zhang, 2015; Posen *et al.*, 2013; Cooke, 2001; Dobrev, 2007; Sofka, Shehu, & Faria, 2014; Im & Shon, 2019). A categorical variable is utilized to control for the location effect (1 = located in one cluster, 2= located in two; and 3= located in all three major clusters).

d) *Firm origin* and *export market* effect: The study also controls for the firm origin (i.e., foreign or domestic) and if a firm exports its products to other markets, because both of these factors will have a significant effect on the strategic response choice and firm-level capability as firms may be exposed to other regulatory standards (Mate-Sanchez-Val & Harris, 2014). Dummy variables have been utilized to control for these factors: Firm origin (0=domestic; 1= foreign) and Export market (0= no export to developed countries; 1= Exports to developed countries).

4.5 Results

Due to the categorical nature of the dependent variable (i.e., innovation strategic response choice), we selected a multinomial logistic regression (e.g., Cassiman & Veugelers, 2006) to estimate the models to test if stringency of regulations (i.e., low/high), industry clockspeed, and firm innovation capability influence the likelihood of a firm adopting a specific strategy. Before testing the hypotheses, we evaluated if our data met the assumptions required to perform multinomial logistics regression.

Table 4.2 Descriptive statistics

		Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10
Dependent Variable															
1	Innovation Strategic Choice	2.41	0.749	1	3	1.000									
Independent Variable															
2	Regulatory Stringency	3.20	0.926	1	4	0.250 (0.000)	1.000								
Moderating Variables															
3	Industry Clockspeed	3.42	0.391	1.38	4.11	0.139 (0.001)	0.489 (0.000)	1.000							
4	Firm Capability (R&D Intensity) (log)	3.19	1.752	0.18	6.54	0.336 (0.000)	0.233 (0.000)	0.219 (0.000)	1.000						
Control Variables															
5	Firm Size (log)	10.80	1.300	6.65	12.53	0.551 (0.000)	0.368 (0.000)	0.280 (0.000)	0.605 (0.000)	1.000					
6	Firm Age (log)	2.95	0.792	0.69	4.32	-0.357 (0.000)	0.252 (0.000)	0.104 (0.014)	-0.401 (0.000)	-0.525 (0.000)	1.000				
7	Market Share (log)	2.12	1.068	0.15	4.42	-0.299 (0.000)	-0.138 (0.001)	-0.168 (0.000)	-0.441 (0.000)	-0.506 (0.000)	0.332 (0.000)	1.000			
8	Export Orientation	0.89	0.312	0	1	0.358 (0.000)	0.268 (0.000)	0.101 (0.017)	0.422 (0.000)	0.700 (0.000)	-0.484 (0.000)	-0.070 (0.102)	1.000		
9	Location Effect	1.73	0.780	1	3	-0.505 (0.000)	-0.145 (0.001)	-0.092 (0.030)	-0.513 (0.000)	-0.684 (0.000)	0.763 (0.000)	0.239 (0.000)	-0.554 (0.000)	1.000	
10	Firm Origin	0.78	0.412	0	1	0.444 (0.000)	0.079 (0.062)	0.070 (0.100)	0.652 (0.000)	0.715 (0.000)	-0.683 (0.000)	-0.048 (0.260)	0.651 (0.000)	-0.786 (0.000)	1.000

NOTE: N=549; p –values in parenthesis

Table 4.2 reports descriptive statistics and bivariate correlations among all the variables. As previously mentioned, our dependent variable is nominal and we have both ordinal (Regulatory Stringency) and continuous (R&D intensity, Industry Clockspeed, Age, Location Effect etc.) variables among the independent variables. The independent variables showed no multi-collinearity as the VIF scores for regulatory stringency (1.210), industry clockspeed (1.165), R&D intensity (1.048), and innovation strategic choice (1.141) were below the acceptable threshold of 10 (Gujarati, 2003). We checked the data for outliers or any high values, and missing values. The model fitting information test confirmed the fitness of the model as the full model significantly predicted the dependent variable than the intercept only model (χ^2 (df =24, N = 549) = 333.347, Nagelkerke R^2 = 0.535, p= 0.000).

The dependent variable identifies three alternative innovation strategic choices in firms: innovation, innovation-imitation and imitation. The multinomial logistic regression model is considered a good predictive model if the independence of irrelevant alternatives (IIA) assumption is not violated. IIA assumption suggests that the ratios of probabilities of alternatives in the full model do not systematically change significantly when compared to the model with a subset of the alternatives (Hausman & McFadden, 1984). We conducted the Hausman & McFadden (HM) test to ascertain the IIA property. The HM test compares the estimates of the full model with the estimates of the models with restricted choices. An HM test outcome either negative or positive with a p-value greater than 0.05 indicates strong support that the model holds the IIA assumption (Vijverberg, 2011; Salum, Kitali, Bwire, Sando, & Alluri, 2019). The results confirm that the IIA property holds for each of the three alternatives that were removed from the model (see Table 4.3). Specifically, the omission of the imitation strategy and innovative imitation strategy alternatives from the model yielded positive HM test values (0.62 and 7.60 respectively) with a p-value greater than 0.05 (1.000

and 0.668 respectively), whereas the omission of the innovation strategy alternative yielded negative outcome (-105.63). Hausman & McFadden (1984:1226) note that the HM test can sometimes produce a negative outcome if $\widetilde{Var}(\tilde{\beta}^r) - \widetilde{Var}(\tilde{\beta}^f)$ is not a positive semidefinite, but they conclude that this is evidence that the IIA assumption is not violated. Several other studies have also highlighted negative HM test outcomes as evidence that the IIA assumption is not violated (Vijverberg, 2011; Salum *et al.*, 2019; Long & Freese, 2006).

Table 4.3 IIA Test results for the model (Hausman & McFadden Test outcomes)

Omitted Strategic Option	**HM Test**	**P-Value**	**IIA Property**
Imitation Strategy	0.62	1.000	Holds
Innovative Imitation Strategy	7.60	0.668	Holds
Innovation Strategy	-105.63	-	Holds

We created three models: base model (Model 1) which included only control variables, Model 2 added the main effect variables, and Model 3 (final model) then added the interaction effects. For brevity, we interpret the results from the final model, i.e., Model 3. Results show that (see Table 4.4) as under conditions of high restrictive regulations (i.e., higher stringency), firms are less likely to choose imitation (β = -3.629; OR=0.027; *p-value* = 0.017) and more likely to choose innovation imitation strategy (β = 2.944; OR=0.810; *p-value* = 0.067) as opposed to innovation strategy. The positive β coefficient suggests firms prefer to imitate than innovate when the regulatory stringency is higher. In other words, as the stringency of regulations increases, the scope of pure imitation for firms diminishes due to an increase in the complexity of the solutions or technologies being imitated, and thus imitation under highly restrictive regulations requires firms to adapt the imitated solution to their product: element of some R&D required to achieve that. Thus the results indicate that, under conditions of high restrictive regulations, firms choose imitation (albeit innovative imitation) over innovation. Therefore, Hypothesis H1 is not supported. With respect to firm

innovation capability, as shown in Table 4.4, the regression of the stringency of regulations and firm innovation capability (i.e., Regulatory Stringency x R&D Intensity) on strategic response choice provided a statistically significant negative β value indicating that, under conditions of high restrictive regulations, firms with higher innovation capabilities adopted innovative response as opposed to imitation strategy (β = -0.284; OR=1.328, *p-value* =0.055) or innovative imitation strategy (β = -0.115; OR=1.122, *p-value* =0.003). Moreover, with every unit change in regulatory stringency and firm innovation capability, the probability of firms selecting innovation over imitation or innovative imitation strategies, increased by 32% (OR=1.328) and 12% (OR=1.122) respectively. It also indicated that firms with lower innovation capabilities chose imitation over innovation, yet, with the increase in the stringency of regulations, these firms showed greater propensity to choose innovative imitation (β = -0.115) over imitation (β = -0.284), providing support for Hypothesis H2a and H2b respectively.

Table 4.4 Multinomial Logistic Regression Results

Independent Variables	χ^2	Df	Model 1				Model 2				Model 3			
			Imitation		Innovative Imitation		Imitation		Innovative Imitation		Imitation		Innovative Imitation	
			β	OR	β	OR	β	OR	β	OR	β	OR	β	OR
Intercept			6.213	—	-9.386	—	4.718	—	-9.477	—	5.667	—	-9.069	—
Regulatory Stringency	8.308 [0.016]	2					-0.452 (0.229) [0.048]	0.636	0.072 (0.217) [0.741]	0.931	-3.629 (1.519) [0.017]	0.027	2.944 (1.609) [0.067]	0.810
Industry Clockspeed	19.277 [0.000]	2					-0.396 (0.419) [0.345]	1.485	0.733 (0.409) [0.073]	2.081	-1.273 (.825) [0.123]	3.570	6.170 (1.703) [0.000]	8.032
Firm Capability (R&D Intensity) (log)	8.100 [0.017]	2					0.390 (0.200) [0.052]	1.477	0.207 (0.139) [0.032]	1.230	2.555 (1.114) [0.022]	2.877	2.236 (1.127) [0.047]	9.357
Regulatory Stringency x R&D Intensity	17.895 [0.000]	2									-0.284 (0.148) [0.055]	1.328	-0.115 (0.116) [0.003]	1.122
Regulatory Stringency x Industry Clockspeed	10.776 [0.005]	2									-0.686 (0.413) [0.097]	0.374	-0.999 (0.452) [0.027]	0.368
R&D Intensity x Industry Clockspeed	13.314 [0.001]	2									0.888 (0.364) [0.015]	0.412	0.667 (0.328) [0.042]	0.513
Firm Size (log)	24.806 [0.000]	2	-0.946 (0.341) [0.005]	0.388	0.759 (0.295) [0.010]	2.136	-0.675 (0.369) [0.067]	0.509	0.818 (0.312) [0.009]	2.266	-0.680 (0.389) [0.081]	0.507	0.747 (0.320) [0.020]	2.110
Firm Age (log)	30.140 [0.000]	2	-0.420 (0.433) [0.333]	0.657	-1.191 (0.305) [0.000]	0.304	-0.548 (0.583) [0.347]	0.578	-1.581 (0.462) [0.001]	0.206	-0.485 (0.607) [0.424]	0.615	-1.819 (0.488) [0.000]	0.162

Market Share (log)	20.60 [0.000]	2	0.149 (0.276) [0.588]	1.161	0.892 (0.239) [0.000]	2.440	0.545 (0.368) [0.139]	1.725	1.170 (0.305) [0.000]	3.221	0.489 (0.372) [0.189]	1.630	1.228 (0.315) [0.000]	3.414
Export Orientation	4.429 [0.109]	2	0.645 (0.949) [0.497]	1.906	-0.888 (0.833) [0.287]	0.412	0.523 (1.009) [0.604]	1.686	-1.111 (0.883) [0.208]	0.329	0.875 (1.105) [0.405]	2.398	-0.870 (0.913) [0.341]	0.419
Location Effect	19.527 [0.000]	2	1.597 (0.505) [0.002]	4.939	1.059 (0.310) [0.001]	2.884	1.354 (0.530) [0.011]	3.875	1.073 (0.343) [0.002]	2.925	1.443 (0.548) [0.008]	4.232	1.093 (0.356) [0.002]	2.985
Firm Origin	38.750 [0.000]	2	0.164 (0.983) [0.868]	0.849	-4.723 (0.800) [0.000]	0.454	-1.974 (1.504) [0.189]	0.199	-5.884 (1.153) [0.000]	0.275	-2.042 (1.562) [0.189]	0.703	-6.458 (1.235) [0.000]	0.749
N *Pseudo* R^2			549 0.495				549 0.510				549 0.535			

Notes: 1) The reference category is Innovation; 2) Standard errors in parenthesis; 3) p –values in square brackets; 4) OR – Odds Ratio

Testing the moderating role of Industry Clockspeed and Firm's Innovation Capability

Among the main theoretical assumptions of the paper is that firm innovation capabilities (measured by R&D Intensity) and industry clockspeed change the relationship between the stringency of the regulations and the strategic response choices of firms. As shown in Table 4.4, firms preferred innovative imitation (β = 2.944; OR=0.810; *p*-value =0.067) over innovation while responding to stringent regulations. However, the interaction effect of firm innovation capability with the regulatory stringency (i.e., Regulatory Stringency x R&D Intensity) significantly increased the likelihood of firms choosing an innovation strategy over an imitation strategy (β = - 0.284; OR=1.328; *p-value* = 0.055) or innovative imitation strategy (β = - 0.115; OR=1.122; *p-value* = 0.003). Similarly, the interaction effect of industry clockspeed with regulatory stringency (i.e., Regulatory Stringency x Industry Clockspeed) also increased the likelihood of firms selecting innovation strategy in comparison to imitation strategy (β = - 0.686; OR=0.374; *p-value* =0.097) or imitative innovation strategy (β = -0.999; OR=0.368; *p-value* =0.027). In other words, when the clockspeed is low, every one unit increase in the stringency of regulations, increased the propensity of firms selecting innovation over imitation by 62% (OR=0.374), whereas under conditions of high industry clockspeed, every one unit increase in the stringency of regulations, increased the propensity of firms selecting innovative imitation over innovation increased by 64% (OR=0.368) respectively. Therefore, Hypothesis H3a and H3b is supported.

In terms of control variables, the regression results indicate that as Firm Size increased, firms showed greater propensity to choose innovative imitation strategy (β = 0.847; OR=2.110; *p-value* = 0.020) than innovation strategy in response to regulatory change. Firm Age also influenced strategic choice of firms as older firms showed greater propensity to innovate as opposed to imitation (β = -0.485; OR=0.615; *p-value* = 0.424) or

innovative imitation (β = -1.819; OR=0.162; *p-value* = 0.000). Similarly, firms with higher market share tend to adopt innovative imitation strategy (β = 1.228; OR=3.414; *p-value* = 0.000) as opposed to innovation strategy.

Firms that were located in more than one automobile clusters (i.e., Location Effect) showed greater propensity to imitation (β = 1.443; OR=4.232; *p-value* = 0.008) or innovative imitation (β = 1.093; OR=2.985; *p-value* = 0.002) as opposed to innovation. Foreign firms, as compared to domestic firms, showed greater propensity to innovation than imitation (β = -2.042; OR=0.703; *p-value* = 0.189) or innovative imitation (β = -6.458; OR=0.749; *p-value* = 0.000). Export orientation of firms was not significant. Ultimately the model predicted these outcomes (Table 4.5) 71.6% of the time correctly (overall prediction success rate) with significant rate of correct prediction for innovation (92%), innovative imitation (50%), and imitation (34.5%) response choices. A summary of the hypotheses tests results are shown in Table 4.6.

Table 4.5 Actual vs Predicted Cases: Multinomial Logistics

Innovation Strategic	**(Predicted)**			
Response Choice (Observed)	**Imitation**	**Innovative Imitation**	**Innovation**	**Percent Correct**
Imitation	30	15	42	34.5%
Innovative Imitation	7	73	66	50.0%
Innovation	16	9	288	92.0%
Overall Percentage	9.7%	22.0%	72.5%	71.6%

Table 4.6 Hypotheses test results

Hypotheses		Accept	Reject
H1	Highly restrictive regulations reduce the likelihood that firms imitate and increase the likelihood that firms innovate.		✔
H2a	Under conditions of high restrictive regulations, there is a negative relationship between firms' innovation capability and firms' likelihood to engage in innovative imitation rather than in innovation.	✔	
H2b	Under conditions of high restrictive regulations, there is a negative relationship between firms' innovation capability and firms' likelihood to engage in imitation rather than in innovation.	✔	

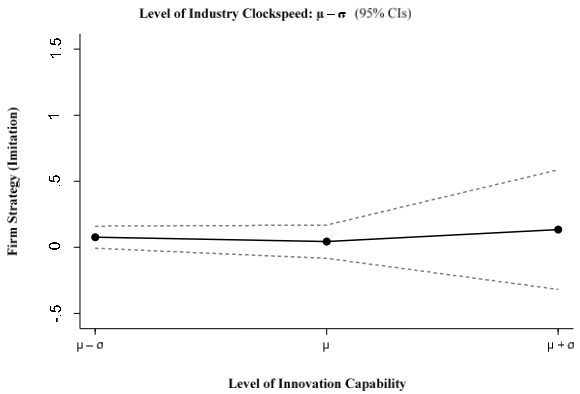
H3a	Under conditions of high restrictive regulations, firms operating in a low industry clockspeed are less likely to imitate and more likely to innovate.	✔
H3b	Under conditions of high restrictive regulations, firms operating in a high industry clockspeed are more likely to engage in innovative imitation than in innovation.	✔

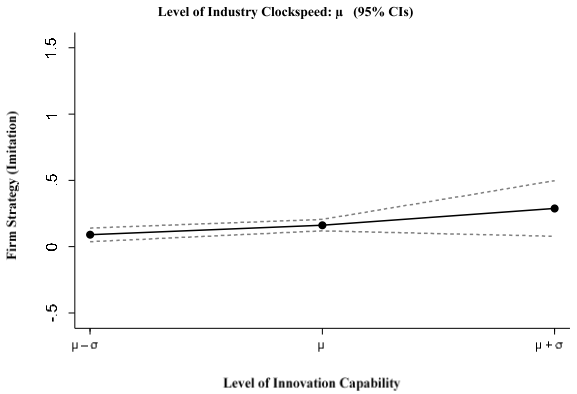
4.6 Discussion and Conclusion

In this paper, we analysed the impact of regulations on innovation. We highlighted that past studies examined the issue from either industry-level or firm-level perspectives and emphasized the need for an integrative approach that takes into account both the firm-level and industry-level perspectives. We further argued that firm innovation capability and industry 'clockspeed' shape how firms respond to regulations and proposed that both firm innovation capability and industry clockspeed are likely to have a moderating effect on the relationship between the stringency in regulations and innovation strategic response choice of firms.

Our findings provide empirical support to the moderating role of industry clockspeed and firm innovation capability as hypothesized (see Figure 4.4). Many studies have indicated that stringent regulations encourage innovation (e.g., De Vries & Withagen, 2005; Brunnermeier & Cohen, 2003; Gonzalez, 2009; Ambec *et al.*, 2013; Kesidou & Demirel, 2012; Aversa & Guillotin, 2018). Surprisingly, we found that firms engage more in imitation, as opposed to innovation, in their response to the increasing stringency of regulations. A possible explanation for this could be that governments consult stakeholders (i.e., industry bodies and firms) and provide them reasonable time to prepare and adapt before enforcing a regulatory change, and given the uncertainty involved in the development of new solutions, the majority of firms may prefer to wait and imitate (instead of engaging in innovation) once a new solution has been introduced by a rival firm. However, the interaction effect of the stringency of regulations with industry clockspeed and firm innovation

capability moderated this relationship. To shed more light on the interaction effects, we present, in Figure 4.4, the confidence bands for the moderating effects of industry clockspeed and firm innovation capability on the regulatory stringency and firms' innovation strategy choice relationship. The confidence bands, drawn based on the results, showed that when the stringency of regulations increases, in a low clockspeed industry, firms, in general, prefer to take an innovative approach to meet compliance and the likelihood of firms taking an innovative approach will be stronger in firms with high innovation capability. However, when the industry clockspeed increases, firms' propensity to imitate increases even in the firms with high innovation capability. This is arguably because higher 'industry clockspeed' required firms to focus their R&D efforts on improving other value-adding dimensions of the product (i.e., design, new features, performance and safety aspects such as fuel efficiency, power, comfort etc.) as opposed to engaging in the innovative activities to improve the environmental performance of the product, thereby compelling them to adopt imitation strategy that complies with regulatory change, regardless of the firm's innovation capability. However, it is worth noting that this is far less likely to take place if the response to regulatory change requires solutions that are not available off-the-shelf. The underlining assumption is that as regulations become more stringent, the imitation option becomes less viable, or that available solutions require a substantial amount of innovation capabilities to imitate competitors, thereby forcing firms to innovate.


Level of Industry Clockspeed: μ – σ (95% CIs)
Firm Strategy (Imitation)
-.5
0
.5
1
1.5
μ – σ
μ
μ + σ
Level of Innovation Capability


Level of Industry Clockspeed: μ (95% CIs)
Firm Strategy (Imitation)
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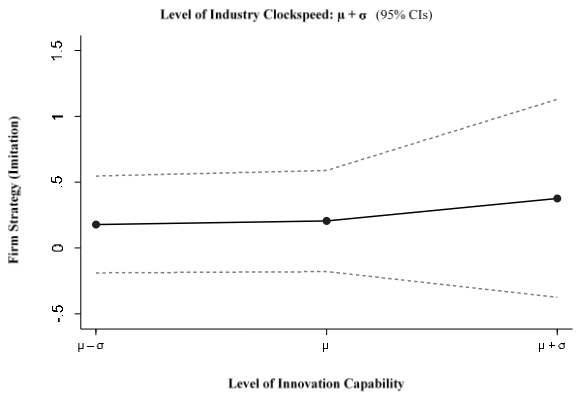
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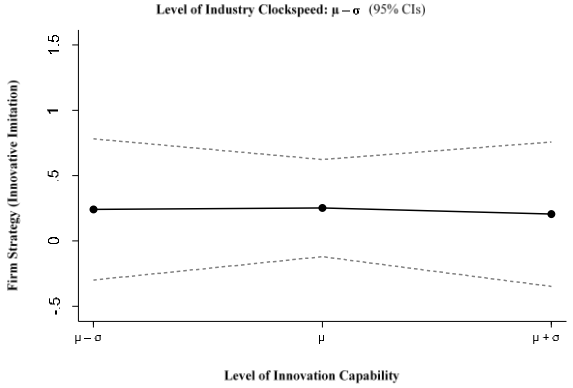
Level of Industry Clockspeed: μ – σ (95% CIs)
Firm Strategy (Innovative Imitation)
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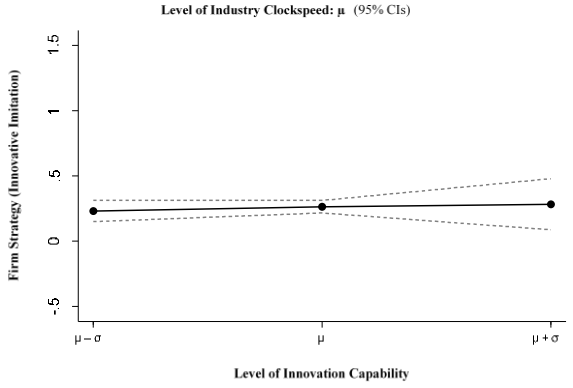
Level of Innovation Capability


Level of Industry Clockspeed: μ (95% CIs)
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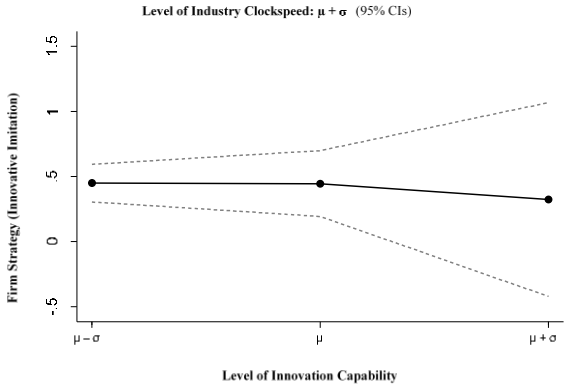
Level of Industry Clockspeed: μ + σ (95% CIs)
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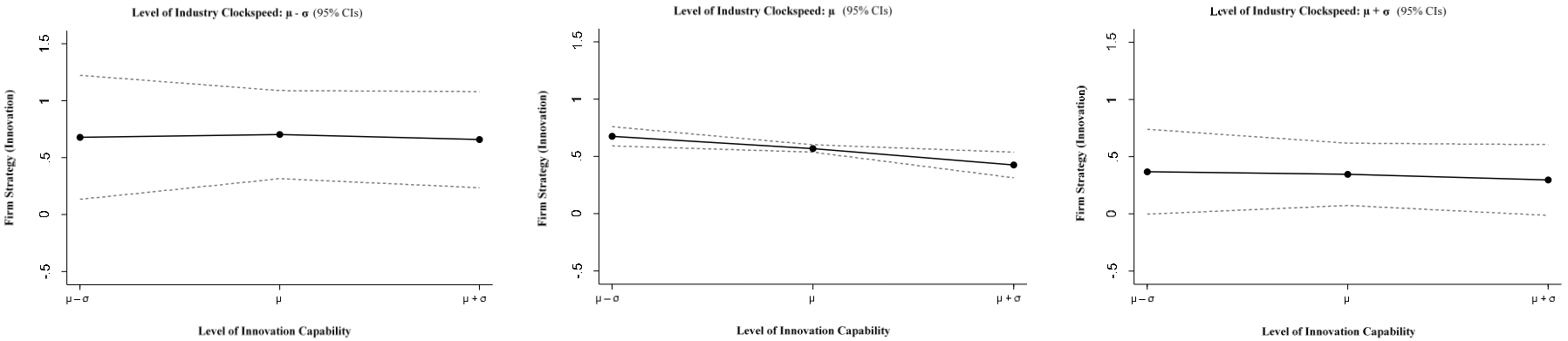

Figure 4. 4 Moderating effects of firm capability and industry clockspeed on regulatory stringency and innovation strategic response relationship

Our study contributes to the literature examining the link between the regulations and innovation (Ambec *et al.*, 2013; Naimoli *et al.*, 2017; Franckx, 2014; Aversa & Guillotin, 2018; Blind *et al.*, 2017; Dechezlepretre *et al.*, 2015; Im & Shon, 2019) with specific contribution to the literature that looks at the extent of innovation (i.e., innovation to imitation). Using longitudinal data in the context of the Indian automobile industry, we extend the literature by highlighting that industry clockspeed and firm innovation capability moderates the relationship between environmental regulatory stringency and innovation strategic response choices of firms, and therefore determines if the regulatory change will result in significant innovation. The findings have important implications for theory, particularly rivalry-based imitation theories. The underlining assumption of the rivalry-based imitation theories is that firms tend to imitate the leader in an attempt to neutralize its competitive advantage (Lieberman & Asaba, 2006). We argue that, especially with respect to regulatory change, the stricter the regulations the more likely firms devise innovative solutions to meet compliance. In such a scenario, the firm that pioneers solutions tends to move towards differentiation (i.e., innovation) while the rivals are motivated to strategically conform (i.e., imitation) to neutralize the lead (Deephouse, 1999). Moreover, if competition is high (i.e., medium to high industry clockspeed) and the leader firm enjoys significant production cost advantages over its rivals (as Maruti Suzuki have in this context, Malhotra & Sinharay, 2013), the leader might deliberately choose not to pursue the search for new solutions due to uncertainty and risks involved in the process, and instead quickly imitate a suitable available solution developed by its rival(s). The findings of this study support this argument as we find that firms, despite having high innovation capability, tend to respond with imitation strategy to a regulatory change when the industry clockspeed is high.

The study also offers important implications for policymakers. Economic growth and development bring prosperity, but, at the same time, pose the challenge of environmental degradation. Governments across the world try to minimize the impact through environmental regulations that are updated periodically. However, governments are also concerned that regulations may have a negative impact on the performance of firms, by imposing heavy compliance costs (Ramanathan, Black, Nath, & Muyldermans, 2010). Our findings suggest that policymakers appear to be too narrowly focused on increasing the stringency of regulations to control the environmental degradation and induce socially beneficial innovation, and miss on the important industry dynamics (i.e., industry clockspeed) that affect the outcome, in terms of innovation, of regulatory change. Hence, taking into account industry clockspeed when drafting regulations may be important. Thus, introducing stringent regulations when the industry clockspeed is lower, or legislating additional incentives along with longer implementation time-frame while introducing stringent regulations when industry clockspeed is higher (e.g., fiscal incentives for breakthrough innovation, and other R&D support especially for firms with low innovation capability), maybe a more effective policy than imposing regulations without regard to industry clockspeed.

In conclusion, the findings of the study caution policymakers that regulatory changes alone may not result in innovation. Regulatory change must take into account whether they are technology-following or technology-forcing. Beyond that, they must be cognizant that the strategic responses of firms (be it innovative or imitative) are influenced by industry dynamics (industry clockspeed) and firm innovation capability.

4.7 Limitations and directions for future research

Our study is not exempt from limitations. A single industry study helps researchers achieve robust results due to a clearly defined industry environment (in terms of industry concentration, firms' performance, the extent of competition, and uniqueness), as opposed to a multi-industry study. However, a single industry study, as opposed to a multi-industry study, inevitably places limits on the generalizability of the results. While aware of these limits, we nevertheless believe that our study allows for some generalizability. First, the context of the Indian automobile industry is comparable to automotive industries in other rapidly developing countries such as Brazil and China, and thus the findings of our study may be relevant in such environments. Moreover, our findings may also be generalizable to other mid-size developing countries such as Thailand, Turkey, South Africa, Mexico and other eastern European countries that seek to develop their domestic automobile industries.

Secondly, our study takes a longitudinal view of the impact of regulations on innovation. We argue that, due to the evolution of the industry (i.e., from nascent to growth stages), as witnessed in the Indian automobile industry during the study period, both the industry clockspeed and firm-level capabilities are likely to vary significantly. Therefore, albeit not fully, the results of our study are relevant to automotive industries that are evolving towards maturity. Thirdly, our findings confirm that the industry clockspeed and firm-level capability have a moderating effect on the relationship between regulatory changes and the innovation strategic response choices of firms. We argue that the industry environment plays a significant role in determining industry clockspeed and firm-level capability development.

In other words, the variability in the environment of different industries will be reflected in the clockspeed (i.e., if a given industry is a fast-clockspeed or a slow-clockspeed industry) as well as in the extent and scope of capabilities of firms operating in that industry.

We tested our hypotheses in a medium-clockspeed industry (i.e., the automobile industry) and believe that our findings are most likely to be applicable to other industries with varying clockspeed. It will be interesting to validate our findings in other industries in developing as well as developed countries, where the change in regulations may be technology-forcing in nature. Further research may also enrich our understanding by incorporating in the study other aspects of industry clockspeed (i.e., process and organizational) and by devising and utilizing proxy measures for process and organizational aspects, or a composite measure for industry clockspeed that accounts for the rate of change in product, process, and organizational aspects of the phenomenon.

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CHAPTER 5 RESEARCH PAPER 2

Dominant Firm and the Imitative Behaviour of the Fringe: Evidence from the Indian Automobile Industry

5.1 Introduction

Firms strive to acquire and sustain a dominant market position as large market share not only creates opportunities for greater profits but also ensures market power and control (Rosenbaum, 1998). The regular presence of dominant firms across multiple industries and geographies have been object of substantial research – especially in the field of economics – examining the specific industry conditions that could explain the emergence of a dominant firm (Shamsie, 2003; Geroski & Vlassopoulos, 1991; Rosenbaum, 1998). Dominance is defined as a firm's capability to attain and sustain a strong lead in the market share over its rivals (i.e., fringe firms) for an extended period of time (Shamsie, 2003; Geroski & Vlassopoulos, 1991). Microsoft (PC application software), Walmart (merchandise stores), Exxon Mobil (petroleum), General Electric (conglomerate), Boeing and Airbus (aircraft manufacturing), Amazon (internet sales), and Google (internet search engine) are some well-known examples of the dominant firms in recent times. The evolution and the competitive behaviour of the dominant and fringe firms in an industry in a developed country significantly differ to that in an industry in a developing country due to the perceptible differences in their respective business environments. However, in this paper, our analysis focuses mainly on the competitive behaviour of the fringe firms vis-à-vis the dominant firm in an industry in a developing country.

The emergence of a dominant firm in developing countries is often a result of policy intervention in a specific country in which one firm is allowed to enter first and is given ample time to establish itself before rivals are allowed to compete. It is argued that the

fledgling industries (and more so the technology-intensive industries) in developing countries require latest technology for their development and one way to induce that technology is through FDI (Dunning & Lundan, 2008). Hence, governments in developing countries design policies to attract technologically advanced multinationals to invest in the local market with a trade-off (along with other subsidies) that in lieu of the development of the local industry through much needed technology transfer, productivity enhancement, and local skill development they be given preferential access to the market to sell their products (Brewer, 1993). Such government incentives often facilitate the creation of a powerful dominant firm and a competitive setting that can be best described as an industry with a dominant foreign player while other competitors (late entrants including both foreign and domestic firms) constitute the 'competitive fringe'.

The existence of a large dominant firm in an industry greatly increases the competitive intensity due to a continued battle between the dominant firm and the fringe firms in which the former strives to sustain its dominance and the latter endeavour to expand their market share and eventually achieve market leadership (Smith *et al*., 2001; Sharapov & Ross, 2019). The dominant firm has significant competitive advantages over its rivals which have been developed over several decades of its monopolistic operation in a protected market (until the markets were liberalised) and primarily stem from the dominant firm's tight control and ownership of critical market resources and assets (e.g., plant and equipment, patents, strong supplier and distribution networks etc.), the economies of scale and scope, high production and innovation capability, market knowledge, and the strong brand reputation among others (Shamsie, 2003; Klepper & Thompson, 2006; Kumaraswamy, Mudambi, Saranga, & Tripathy, 2012). These advantages further translate into a large market share and high market power which, in turn, provide the dominant firm with the ability to control the market in terms of industry output, advancements in product and process technologies and

innovation, and provide the ability to drive the evolution in consumer tastes and develop new product submarkets (Klepper & Thompson, 2006; White, 1981). However, the dominant firm tends to exercise this market power to such an extent that, on the one hand, it ensures that its market share is intact and, on the other hand, its competitive actions do not drive the rivals out of the market in order to avoid the risk of turning itself, from being the dominant firm, into a monopolist (Gaskins, 1971; Rosenbaum, 1998). So, until the fringe firms develop comparable or superior competitive advantages with respect to economies of scale and brand reputation, the only strategy they have to maintain or improve their position is via innovation or imitation.

Innovation is recognized as one of the main sources of competitive advantage for firms to stay ahead of the competition and to achieve market leadership (Danneels, 2002; Hult *et al.*, 2004). However, innovation may not always be the best competitive strategy, even for the firms that have proven innovation capabilities, as it requires significant resources in terms of time and money with no guarantee of the intended outcome (Lee *et al*., 2000; Levitt, 1966). So, firms across industries adopt multiple strategies (i.e., competitive actions and responses) – defensive and offensive – to either maintain their dominance by neutralizing the threat of competition or to create opportunities to catch-up with the market leader (Chen & Miller, 2012). Firms that lack requisite innovation capability often opt for defensive strategies and imitate new products and technologies, rather than to innovate, to avoid potential loss of market share (Kale & Little, 2007; Kim, 1997; Nelson & Winter, 1982; Xu & Li, 2014; Zhou & Wu, 2010). Similarly, a firm that enjoys a dominant position in the market, despite possessing superior innovation capabilities, may decide not to innovate in order to avoid any disruption to the status quo if the status-quo is beneficial to its competitive positioning (Lieberman & Asaba, 2006; Giachetti *et al.*, 2017); and may engage in imitation

to restore competitive equilibrium in a response to the disruptions created by its innovating rivals (Ross & Sharapov, 2015).

The use of imitation as a competitive strategy is well established in the literature (Levitt, 1966; Lee *et al*., 2000; Smith *et al*., 2001; Lieberman & Asaba, 2006; Xu & Li, 2014; Giachetti & Marchi, 2017; Giachetti *et al.*, 2017; Ross & Sharapov, 2015). However, research also suggests that the extent to which firms resort to imitation, as opposed to innovation, will depend on the relative market power of the players in the industry. The question that arises is: *how* will firms engage in imitative, as opposed to innovative, strategies, in an industry dominated by a single firm? Furthermore, this market power disparity will influence the propensity to imitate. This raises a further question about the difference between the imitation strategies of the non-dominant firms as opposed to the dominant firm in the industry. As previously argued, in a competitive environment where the dominant firm exerts high market power and tightly controls the industrial activities (e.g., industry output, R&D and innovation activities, development of new institutions and regulations etc.), rivals have limited capacity to take the high-risk option of increasing their market share by creating new demand for innovative products instead they are more likely to increase their market share by selling products that are similar to the successful products offered by the dominant firm and cater to the demand gaps that the dominant firm is unable to fulfil. Moreover, among the rivals, those who have relatively higher market power (i.e., the nearest rival to the dominant firm in terms of the market share) with respect to others are likely to engage in some innovation along with imitation while others with small market shares (i.e., low market power) are likely to have a high propensity to imitate. We argue that the examination of these questions is important as it allows us to enrich our understanding of inter-firm imitation in a competitive setting in which there is a large gap between the market share of the leader firm (in this case the dominant firm) and the fringe firms as opposed to a

competitive setting in which the leader and the rival firms are locked in a relatively close contest. Moreover, it also helps us enrich our understanding as to how the competitive actions of the fringe firms aimed at challenging the dominance of the single firm ultimately not only improves consumer and social welfare but also spur technological development of the domestic industry.

In this paper, we address these questions using data from the Indian automobile industry. Analysis of nearly 30,000 news articles allows us to build a sample list of more than 600 product models (including their variants) launched by both Indian and foreign manufacturers operating in the Indian market over the period 1999- 2018. We chose the period of 1999-2018 as it was characterized by the entry of a high number of domestic and foreign firms and the expansion of the existing firms, multiple product model launches, and consistent market dominance by a large single firm (i.e., Maruti Suzuki) that provides significant variations for our investigation of interfirm imitation. Moreover, the presence of a significant number of foreign firms along with much developed domestic firms significantly adds to the competitive landscape that not only provides a rich context for examining the imitative actions and responses of competing firms but also help in a significant amount of data collection providing much-needed variance to achieve reliable results. The paper is organized in the following sections. The next section provides a discussion of the extant literature. We then develop hypotheses to test our theoretical assumptions. We then provide details of the data collection, measures, and research methodology. Finally, we present the findings and discuss their implications for the theory and practice of firm strategy.

5.2 Theoretical Overview

Dominant firm theory suggests that in highly concentrated industries, a single firm (i.e., dominant firm) serves a majority of the market (generally 40% or more, OECD, 2017) while

the remaining firms serve the rest. The economic theory of market dominance focuses primarily on the ability of the dominant firm to control price and output (Gaskins, 1971; White, 1981; Salop & Scheffman, 1984). The dominant firm would normally set a competitive price that allows it to gain profits, achieve high market share and, at the same time, allows it to control the quantity of goods supplied by the competitive fringe to an extent that it does not drive fringe firms out of the market as that will make the dominant firm susceptible to an anti-trust lawsuit (Salop & Scheffman, 1984). The economic theory provides a rich understanding of the rise of a dominant firm and its sources of competitive advantages but much of the analysis is centred on structural indicators of competition (i.e., price and output).

However, there is a rich stream of literature on competitive dynamics, which focuses on the relational nature of competition and examines inter-firm rivalry as the constant exchange of actions and reactions among the competing firms (Chen & Miller, 2012). Research suggests that in a highly competitive context new product introduction constitutes an important part of competitive strategy and therefore invites intense competitive reaction from rival firms in the form of either a matching product (often imitative) or a superior product (innovative product) (Smith *et al*., 2001; Debruyne *et al*., 2002). However, whether a rival will respond with an imitative or a more innovative product will depend on the competitive environment, firm capability, and the attributes of the newly launched competitor product (Smith *et al.*, 2001; Chen *et al.*, 2007). Hence, all firms, whether dominant or not, have to consider to what extent they should develop innovative new products, or imitate the product that has been launched by a rival firm.

The mimetic tendencies of the competing firms have been explained by competitive dynamics and neo-institutional theories, although these theories identify different motives behind the imitative behaviour of firms. The competitive dynamics perspective suggests that

firms tend to imitate rivals that are comparable in resources and size, and their primary motive behind doing that is to seek competitive parity but at the same time, they tend to avoid direct confrontation with the market leader (Chen & Miller, 2012). Lieberman & Asaba (2006) termed it as 'rivalry-based imitation'. The imitation of firms with similar endowments also makes strategic sense as imitating firms may find it difficult to match the superior resources of the market leader (Lippman & Rumelt, 1982). In addition, the potential risk associated with the retaliatory response (to their imitative behaviour) of the market leader refrain rival firms from imitating the market leader (Smith *et al.*, 2001).

On the other hand, neo-institutional theory suggests that rival firms, when faced with the uncertain business environment characterized by a high degree of unpredictability for managers, prefer to imitate the market leader as they believe that the market leader possesses superior market knowledge (DiMaggio & Powell, 1983; Baum *et al.*, 2000; Giachetti & Torrisi, 2017). Lieberman & Asaba (2006) termed such an imitation as 'information-based imitation' as a high degree of uncertainty leads to information asymmetry (Gaba & Terlaak, 2013) and since the dominant firm is highly visible due to its market share, it is also an inevitable target of imitation by the rivals (Barreto & Baden-Fuller, 2006).

Extant theories of imitation are general and apply to all markets – though they were developed and empirically tested mostly in developed economies. The competitive landscape in developing countries is often different than in the developed countries and the presence of a dominant player endowed with and in control of comparatively a greater degree of resources than the rivals, further makes the competitive environment more challenging. We argue that, despite recent advances in both competitive dynamics research and neo-institutional theory related to competitive imitation, no study thus far has systematically examined interfirm imitation in an industry dominated by a single firm and how the market

power disparity among rivals influences imitation strategies of the dominant firm as opposed to other firms in the industry.

5.3 Hypotheses

In this section, we discuss various competitive dynamics aspects which include competitive environment (i.e., market segment, product segment & firm types), competitors' capability (i.e., firms' innovation capabilities), and product-related attributes (i.e., product feature complexity & product introduction intensity) will influence interfirm imitation behaviour. We explain these factors and their role in specific competitive conditions in detail while explaining the hypotheses.

Market structure in developing countries is such that the majority of the consumers represent the sizable middle-class that tend to be price-sensitive and a tiny upper-class that tend to be more quality sensitive (Ramachandran, 2000; Keller & Moorthy, 2003). The dominant firm, through the strategic use of its power to control output and price in the market (Salop & Scheffman, 1984), controls the large market segment represented by the growing middle-class consumers that often has a cost-effective product with basic and limited (but sufficient) features as customers in that segment tend not to be overly demanding. So, the product innovations introduced by the dominant firm in this segment (barring some highly technical innovations like engines etc.) are more likely to have a low degree of complexity and can be imitated with relative ease. The chances of successful imitation of a product function increase if the mapping between the product function and the components are obvious or simpler and the interdependencies of the components and subsystems or easy to decipher (Baldwin & Clark, 2000). Furthermore, given the price sensitivity of this large market segment, the dominant firm carefully avoid introducing complex product innovations as it often regards such strategy as potentially disruptive to the status-quo from which it

benefits the most (Lieberman & Asaba, 2006; Giachetti *et al*., 2017). However, when it comes to introducing products in other niche markets that are not price-sensitive, the dominant firm, given its high innovation capabilities, tends to launch high-end products as customers in such niche markets are willing to pay higher prices for products with more innovative features.

In contrast, the foreign fringe firms with superior innovation capabilities often use their capabilities to compete with high-quality products that are less price-sensitive (i.e., competing in the niche segment or fringe market segment) as they lack the economies of scale needed to match dominant firm's prices in the large market. Also, the operation in the niche segment provides these firms the opportunity to introduce sophisticated product innovations that are only available to the customers in the highly developed markets. While these firms focus and get the majority of their sales from the niche market segments, in order to increase their market share, they tend to compete in the price-sensitive large market by launching products that are relatively higher in price but package more advanced features in comparison to the products offered by the dominant firm in this segment. The strategic goal here is to cater to the unmet demand (either left unfulfilled by the dominant firm, or the new demand generated due to the growth in the market) and to attract those middle-class customers that are willing and capable to pay a little higher price for a more innovative product. So, the product innovations of the foreign fringe firms, whether introduced in a niche or price-sensitive large market segments, are not easy to imitate as the innovating firm attempts to prolong commercial benefits of its critical innovations through strategic interventions such as increasing the complexity of product design to hinder reverse engineering or imitation (McGaughey, 2002). For instance, a product design in which a product function is dependent on multiple components and subsystems, in which the mapping of components to the function is discretely concealed in a complex way, is hard to decipher

and imitate (Pil & Cohen, 2006). This complexity and many interdependencies among components in a product require expert knowledge and information that are often not at the disposal of the imitating firms and hence limit the chances of successful imitation (McGaughey, 2002).

Thus, we argue that the domestic fringe firms, that lack innovation capabilities, are likely to focus more on imitating the dominant firm's product innovations, as compared to the product innovations of the foreign fringe firms, because the product innovations introduced by the dominant firm, given its focus on controlling the price-sensitive large market segment, tend to be less complex and easy to imitate. Moreover, the domestic fringe firms continue to follow this strategy until they develop capabilities and skills to be able to imitate sophisticated product innovations of the foreign fringe firms or innovate. Imitation helps these firms accumulate knowledge – much of which is tacit and path-dependent (Teece, 1998) – required to engage in more complex problem-solving activities or innovation (Cohen & Levinthal, 1990; Kim, 1997). Hence, the domestic fringe firms' imitation of the dominant firm's product innovations in the price-sensitive large market thereby producing similar products or close substitutes to cater to the demand left unfulfilled by the dominant firm appears to be a rational strategy considering their endeavour to catch-up, or trying to survive rather than thrive (Ross & Sharapov, 2015). Also, the imitation of the dominant firm's products helps domestic fringe firms avoid huge costs and uncertainty associated with innovation, and reduce the time required for introducing new products and processes to the market (Mansfield *et al*., 1981). Hence, we hypothesize that:

> H1: The domestic fringe firms are more likely to imitate the product innovations of the dominant firm than the product innovations of the foreign fringe rivals.
>
> H2: The domestic fringe firms are more likely to imitate the product innovations of the dominant firm in the price-sensitive large market segment than in the fringe market segment.

As far as the imitative behaviour of the foreign fringe rivals of the dominant firm is concerned, we argue that the constant need to adapt and evolve *vis-a-vis* rivals (i.e., Red Queen competitive imitation) in order to seek competitive parity compels these firms to imitate the dominant firm's competitive actions in both the price-sensitive large market as well as in the fringe market segments (Lieberman & Asaba, 2006; Giachetti *et al*., 2017). We argue that, in the large market segment, the foreign fringe firms are less likely to imitate the dominant firm's product innovations as in this market segment they are more likely to compete by launching more innovative products (i.e., a product differentiation strategy) as, given their low production volume, they are unable to match the dominant firm's product prices. The strategic goal of the foreign fringe firms in this market segment will not be to create new demand for their products (as the scope for doing that is limited in a price-sensitive segment) but instead will be to cater to the demand left unfulfilled by the dominant firm, especially by attracting the customers that are willing to pay a little extra for more innovative products, or to cater to the extra demand generated due to the regular growth in the market. Thus, in the large market segment, foreign fringe firms' products tend to be relatively high priced but are more likely to have segment-leading innovative features and therefore limiting the need for these firms to imitate the dominant firm's product innovations unless the dominant firm introduces an innovative product feature that is new to this segment.

On the contrary, we argue that the propensity to imitate the dominant firm's product innovations by the foreign fringe firms will be high in the niche market segments. We argue that, as the industry matures, the successive entry of several foreign firms, that possess a comparable level of resources and capability as the dominant firm, further increases the competition. The new entrants, in a bid to gain market share, constantly challenge the dominant firm and aggressively find new ways to undermine its competitive advantages (D'Aveni, 1999). Moreover, unable to meet the cost advantages of the dominant firm, these

firms engage in developing new product segments with different price points through launching new products that incorporate new and advanced innovative features. Research shows that the strategic product launches invite swift competitive reaction, especially in product segments that together not only accounts for the majority of the customers in the market but also have a high growth potential (e.g., the large market segment comprising small and medium-size cars in the Indian market with nearly 70% of the total customers), and more so for radically new products that can potentially reshape the market (Smith *et al.*, 2001; Debruyne *et al*., 2002) as failure to react to the competitive actions of the rivals results in the loss of market share (Ferrier *et al*., 1999). However, the intensity of a firm's reactionary response to a rival's competitive move is determined by the perceived competitive tension that largely depends on the operational scale, capability, and the frequency of the attack of the rival firm (Chen *et al.*, 2007).

Hence, we argue that the new product innovations launched by the foreign fringe firms in the niche market segment are confronted by a retaliatory response of equally more innovative product launch strategy of the dominant firm in a bid to neutralize the competitive threat, maintain strategic supremacy, and to signal to the market its innovative superiority (D'Aveni, 1999; Ross & Sharapov; 2015). For instance, since the subsequent entry of Hyundai and other foreign firms in the Indian automobile market from 1998 onwards, the number of new car models launched by Maruti Suzuki has increased significantly. The company has launched over 15 models in various product segments in the last five years (2013-2018) as compared to only 7 models launched during the 1984 -2000 period. Moreover, the competitive advantages of the dominant firm over its rivals in terms of developing new market segments, product development, and marketing along with brand reputation help it thrive in the niche market segments created by the rival firms. On the one hand, the dominant firm exploits its market power to match the new product innovations of

the rival firms at a cost-effective price, and, on the other hand, it utilizes its superior innovation capabilities in launching innovative products to achieve leadership in the newly created product segment (Gary *et al*., 2003). Eventually, given the dominant firm's reputation and cost-effective value proposition, the products introduced by it in the niche market segments tend to find greater acceptability among consumers (Shamsie, 2003), which, in turn, is likely to drive foreign fringe firms to imitate the dominant firm's product innovations in these segments. Therefore we hypothesize that:

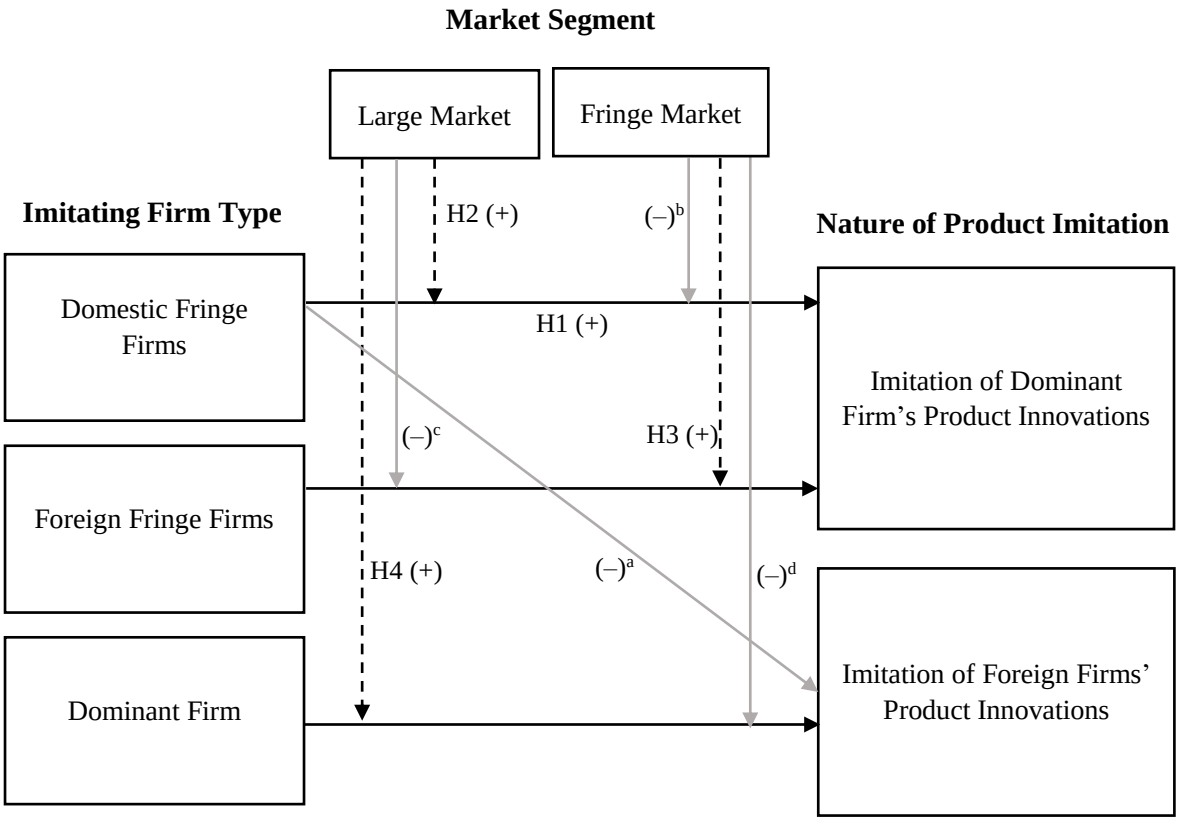
> H3: The foreign fringe firms are more likely to imitate the product innovations of the dominant firm in the fringe market segment than in the price-sensitive large market segment.

As previously argued, the dominant firm carefully avoids introducing complex product innovations in the large market segment (e.g., price-sensitive small and compact cars & mid-size sedan/SUVs/MUVs in the Indian auto industry) as it often regards such strategy as potentially disruptive to the status-quo from which it benefits the most (Lieberman & Asaba, 2006; Giachetti *et al*., 2017). So, we argue that in this market segment, the dominant firm is more likely to follow (as opposed to lead) rival firms' product innovations and will simultaneously engage in Red-Queen competitive imitation (Giachetti *et al*., 2017) to keep up with the innovation activities of the rival firms. Once a new product feature is introduced in a rival product, it will quickly incorporate that in its product offerings at a much cheaper price to maintain the lead. Prior studies also highlight that the leader firm tends to imitate followers' activities (termed as 'action imitation') in order to neutralise the disruptive actions rivals take to catch-up with the leader (Ross & Sharapov, 2015; Sharapov & Ross, 2019).

We also argue that, during the course of the time, it is likely that a few of the rival firms, through strategic investments in capacity and other input costs strategies (i.e., contractual agreements, supplier integration, etc.), will be able to narrow down the gap with

respect to the absolute cost advantages the dominant firm is endowed with. Rivals may also aggressively pursue non-price strategies such as branding and advertisement, and product differentiation among others. All of these could eventually result in market share gain for the rival firms in the large market segments controlled by the dominant firm. It can be argued that as rivals gain market share through their innovative actions the respective dissonance between the course of action taken by the dominant firm and their rivals will increase (Hedstrom, 1998). This will further compel the dominant firm to conform to the new competitive norms defined by the rival firms through imitation. Hence, we hypothesize that:

> H4: The dominant firm is more likely to imitate the product innovations of the foreign fringe firms in the price-sensitive large market segment than in the fringe market segment.



Note: The propositions in the model are comparative in nature; a, b, c, d (with grey arrows) show corollary to Proposition H1 to H4 respectively.

Figure 5.1 A Model of Interfirm Imitation in the Context of the Dominant Firm

Figure 5.1 presents the theoretical model of the study. As previously mentioned, the extant literature examines the interfirm imitation from either 'follow the leader' or 'follow the follower' perspectives suggesting that the rivals tend to imitate the leader firm's product innovations whereas the leader firm tends to imitate the product innovations of the nearest rival. However, we argue that in an industry with a dominant firm (i.e., where a single firm consistently controls 40% or more market share and there is a large difference between the market share of the leader firm and the nearest rival), the imitation behaviour of the leader and the follower firms will depend on the relative market power of the competing firms and other competitive dynamics of the market (e.g., the relative positioning of competing firms in different market segments, innovation capabilities, product feature complexity etc.).

5.4 Methodology

5.4.1 Data Collection

In order to examine the imitative behaviour of the dominant and rival firms, we built a dataset of car models launched by different car manufacturers from 1999 to 2018. We utilized different sources to collect the required information. First, we used 'Factiva' (a DowJones database that collects news articles related to company announcements/product launches) as a source to construct a list of all the product model/variants along with their features (as provided in the news articles/company announcements) launched in the Indian market for the study period. We employed the search function of the database to pull out relevant news articles sorting them year and month-wise and carefully examined them for collecting the required information (i.e., textual data). In total, nearly 30,000 news articles were examined that were published by different newspapers over the last 20 years. News articles published around the critical points, i.e., preceding years around the time when different emission standards were enforced such as BS-1(the year 1999), BS-2 (the year 2000), BS-3 (the year

2005), and BS-4 (the year 2010), were paid special attention to ensure that the relevant product-related changes in terms of engine or emission control technologies were not missed, because as the date of regulation enforcement was approaching, the more likely it is that firms would make significant product changes to meet compliance with regulatory changes, thus, relevant to our analysis, the likelihood of interfirm imitation increase.

This resulted in a sample list of more than 700 product models (including their variants) launched by both Indian and foreign manufacturers operating in the Indian market. The scope of this study required examining the introduction of new product innovations in the market and subsequent imitation of those product innovations by rival firms. Moreover, we needed detailed product features related to various sub-components of the automobile (such as engine and transmission; suspension, steering & brakes; safety; interior & exterior; comfort & convenience; entertainment & communication; and environmental technologies) for two reasons. First, we needed the information to assess whether the new product feature launched by a firm is an innovation or an imitation of a product feature launched earlier either by the dominant or the competitive fringe firms. Second, we needed detailed information to assess the degree of complexity of the new product innovations. The news articles allowed us to place product models in chronological order. However, they did not always contain detailed product features – related to sub-components mentioned above – required to identify imitation activities of firms and the complexity of product features being imitated. Therefore, we sourced further data on product features related to various sub-components of each product model from the popular online car review portals (such as Cardekho, Zigwheel, Autocar India, Carfolio, etc., that collect different performance and price-related data on car models), dedicated company product (car models) websites, and other product catalogues available online. Table 5.1 provides the details of the categorization of various product features that were used to assess the complexity of the product features. Once this data was

compiled, we excluded from the analysis all the product variants that did not indicate significant product feature changes as automobile manufacturers often do minor facelifts of old models to retain the interest of the buyers. This resulted in a final sample of 630 product models.

The data for the other independent and control variables were collected from relevant sources. We utilized Capital IQ and ThomsonONE databases primarily to collect data related to R&D Intensity, Age, and Firm Sales. We further utilized company annual reports to obtain firm revenue and R&D intensity data not available from the databases. Data related to market share were obtained from the Society of Indian Automobile Manufacturers (SIAM).

Table 5.1 Product Features/Innovations and Complexity

Automobile Features /Innovations	Degree of Complexity
Engine and Transmission	
Sourcing of complete built-in engines from other OEMs	Low
Joint development of engines with other OEMs /modification of engines to improve performance /development of new engines (e.g., multijet, MPFI, CRDI, VTEC, hybrids, turbo-charged engines, engine with electronic fuel injection systems etc.)	High
Innovation related to transmission (e.g., CVT, IVT, DSG, Electric & Tiptronic transmission systems etc.)	High
Suspension, Steering & Brakes	
Manual Steering (e.g., rack and pinion or steering box system) /conventional suspension system /drum and disc brakes etc.	Low
Power-assisted steering system /collapsible & adjustable steering columns /advance suspension systems (e.g., wishbone, Mac Pherson strut type, air suspension such as DRC & Airmatic etc.) /Power-assisted & Electronic braking systems such as AED etc.	High
Safety	
Anti-Lock Braking System /Central Locking /Power Door Locks /Child Safety Locks /Anti-Theft Alarm /Airbags /Seat Belts /Seat Belt & Door Ajar Warning /Adjustable	Low

Seats /Crash Sensor /Speed Sensing Auto Door Lock /Auto Door Unlock /360 View Camera etc.	
Brake Assist /Traction Control /Adaptive cruise control /Engine Immobilizer /Clutch Lock /EBD Advance Safety Features /Emergency Brake Signal /Blind-Spot Monitor /Hill Assist /Reversing Assistant /Active Roll mitigation etc.	High
Interior and Exterior	
Tachometer /Electronic Multi-Tripmeter /Leather Seating /Digital Clock /Outside Temperature Display /Digital Odometer /Adjustable Driver Seat /Ventilated Seats /Console Box With Soft LED /Adjustable Headlights /Fog Lights /Power Adjustable mirror /Rain Sensing Wiper /Defogger /Alloy Wheel /Power Antenna /Convertible Roof /Projector Headlights etc.	Low
Electric Adjustable Seats /intelligent seating /DeCo Control etc.	High
Comfort and Convenience	
Power Windows /Rear Air Conditioner Heater /Low Fuel Warning Light /Reading Lamp /Height Adjustable Seat Belts /Heated Seats /Navigation System /Voice Control	Low
Automatic Climate Control /Air Quality Control /Parking Sensors /Smart Access Card Entry /Key Less Entry /Gearshift Paddles etc.	High
Entertainment & Communication	
Audio system /CD&DVD Player /CD Changer /Speakers /Integrated 2DIN Audio /USB & Auxiliary input /Bluetooth Connectivity /Touch Screen /Internal Storage	Low
In-vehicle integrated infotainment system (combining entertainment, multimedia, vehicular controls, and support vehicle functions)	High
Environmental Technologies	
Off-the-shelf technologies e.g. Catalytic converters, Lean NOx Trap (LNT), Selective Catalytic Reduction (SCR), Diesel Particulate Filter (DPF) etc.	Low
Engine design modification e.g. Injection nozzle sack modifications, turbocharger, flexible fuel injection timings, increasing fuel injection pressure and rate, exhaust gas recirculation, Electronic governor control, Electronic Control System etc.	High

5.4.2 Variables and Measures

Product Imitation: We determined the evidence of product imitation by carefully analysing the data collected for different product features under seven broad sub-component levels (refer to Table 5.1 for a summary of different sub-components and features used to

assess the occurrence of imitation) using a set of criteria proposed by Haunschild (1993) that are: i) the rival firm presently exhibits the product or product-related feature(s) that have been subject to imitation at a given time; ii) the imitating firm is exposed to the product; iii) the imitating firm exhibits the product or product-related feature(s) being imitated within a time frame (the time frame of up-to 2 years have been utilized for this study as rival firms tend to imitate a new innovation quickly to maximize the economic rents). The collection of the product launches in chronological order helped us in determining the original product innovations launched in the market and their subsequent imitation by competing rivals. After evaluating the data for the above criteria, we created a dichotomous variable and assigned values 1 if imitation occurred and 0 if imitation did not occur.

Nature of Product Imitation: In order to examine the pattern – if any – in imitation activities of firms, we categorized the product innovations based on the nature of imitation activities. For instance, we sought to understand if there was a specific type of firm (e.g., dominant or fringe firms including foreign and domestic) that was used as a potential target for product imitation among competing firms. Similarly, if there was a specific type of firm that engaged in imitation more than others or innovated more than others, and how that behaviour changed under different competitive situations. Consequently, we assigned numerical values to new product features introduced by firms in their new product models to categorize the nature of imitation/innovation activities: 0=If the introduced feature is innovation; 1= If the introduced feature is an imitation of the dominant firm product's feature; 2= If the introduced feature is an imitation of the other advance foreign firms' product feature. We then transformed it into a set of dummy variables to be used in the empirical analysis using the SPSS transform variable function that recodes each category in a dummy variable.

Firm innovation capability: A firm's innovation capability affects its innovative and imitative behaviour. New product innovation and successful imitation of a product (or product function) both require a significant amount of R&D and therefore incur costs, however, the R&D costs involved in innovation are usually significantly higher than the R&D costs incurred in imitation (Kale & Little, 2007). Moreover, the extent of the imitative R&D increases with the increase in the complexity of the product or product function being imitated as imitating firms may require to make adjustments in their processes; acquire, learn, adopt new technologies; or engage in searching and sourcing components/materials from the new supplier if product imitation requires modification in existing component or need a new component (Kale & Little, 2007; Kim, 1997). Research suggests that firms that lack strong innovation capability are more likely to devote their limited R&D budget towards developing capabilities required to engage in creative imitation or innovative imitation activities instead of investing in developing breakthrough innovation. However, creative imitation over time may result in enhanced innovation capability as firms, having successfully imitated a rival's product, are increasingly drawn into more complex imitation/innovation activities (Kim, 1997). We used R&D intensity (R&D expenditure/Sales) as a proxy to measure firm innovation capability. In order to avoid data skewness, we utilized the log values of the R&D intensity in the analysis (Ives, 2015).

Firm Type: We sought to examine the imitative behaviour of the dominant firm *vis-à-vis* its rivals and thus, categorize product models based on the firm type (e.g. dominant, foreign fringe, and domestic fringe). This categorization helped us understand which category of firms imitated or innovated more, or which category of firms was the most likely target for imitation in different competitive situations. We assigned numerical values to identify firm categories (i.e., 1= dominant; 2= domestic fringe firm; 3= foreign fringe firm) and transformed it into a set of dummy variables for the empirical analysis.

Product Segment: We categorized the car models launched by firms during the study period into different product segments. We did this to examine if the imitation behaviour of firms differed in different product categories as the complexity of product innovations tend to differ in those categories. For instance, product innovations introduced in the small and compact cars segment will greatly differ, in terms of sophistication, from product innovations introduced in the high-end SUV/Luxury segment and hence successful imitation of innovative product features in different product segments will require different levels of innovation capabilities. We utilized the passenger car segments defined by the Society of Indian Automobile Manufacturers (SIAM) based on the length and the engine capacity of car models (see Table 5.2). For our analysis, we merged closely related sub-segments (out of 9 sub-segments as defined by SIAM) into three broad product segments such as Small and Compact Cars (Length: < 4250 mm, engine capacity: <1600 cc); Mid-size Sedan/SUVs/MUVs (Length: 4250 to 4700 mm, engine capacity: 1600 to 3000 cc); and High-end SUV/Luxury (Length: >4700 mm, engine capacity: up to 5000 cc). We then transformed these categories into a set of dummy variables for the empirical analysis by using the SPSS transform variable function.

Table 5.2 Product Segments in Indian Car Market

Society of Indian Automobile Manufacturers (SIAM) Classification		
Segment	***Car Length (mm)***	***Engine Capacity/ or Price***
Micro	<3200	Up to 800 cc
Mini	3200 - 3600	Up to 1000 cc
Compact	3600 - 4000	Up to 1400 cc
Super Compact	4000 - 4250	Up to 1600 cc
Mid Size	4250 - 4500	Up to 1600 cc
Executive	4500 - 4700	Up to 2000 cc
Premium	4700 - 5000	Up to 3000 cc
Compact SUV (UV1)	<4400	Up to 1600 cc

		up to US$ 20000 (< INR 1.5 million; or <£15000)
MPV (UV2)	4400-4700	up to US$ 20000 (< INR 1.5 million; or <£15000)
Economy SUV (UV3)	4400-4700, >4700	Between US$ 20000 – 40000 (INR 1.5 to 3 million; or £15000 to £30000)
Premium SUV (UV4)	>4700	Above US$ 40000 (Above INR 3 million or £30000)
Luxury	> 5000	Up to 5000 cc
Vans	Hard Tops/ Soft Tops	Generally 1 or 1.5 box; seats up to 5 to 10/ Price Up to US$20000 (<£15000)

Source: SIAM

Market Segment: Based on the product segment category, we further categorized product models into different market segments based on price (e.g. low price segment; medium price segment, and high price segment). In the Indian automobile industry 'small and compact cars' (i.e., low price) and 'mid-size sedan/SUVs/MUVs' (i.e., medium price) form the large chunk (more than 70%) of the total passenger car sales however the 'high-end SUV/Luxury cars' (i.e., high price) constitute a small part of the pie. Hence, we further combined the low and medium-priced market segments and categorised them as 'large market' while high-priced market segments as 'fringe market' respectively. Moreover, in developing countries, the 'large market' segment, to a large extent, is represented by the growing middle-class consumers with high demand for low-end automobiles with basic features and posts significantly higher growth (i.e., high growth market) whereas the 'fringe market' segment is represented by tiny upper-class consumers that are willing to pay more for a high-end automobile that is packed with the advance innovative features generally available to customers in the developed markets, however, this segment has limited growth prospect as it is hard for the automobile firms to attract new customers (i.e., low growth market). We did this to examine if the imitation behaviour of firms differed in different market segments as we assume that firms trying to gain market share in the large market segment heavily dominated by the dominant firm will be inclined to focus on the dominant firm as a potential

target for imitation. We further transformed the market segment categorization into a dummy variable for the empirical analysis.

Product Feature Complexity: We determined the product feature complexity to examine its effect on the imitation behaviour of firms. The automobile manufacturers cluster car specifications in several broad categories such as engine and transmission, steering and suspension, interior and exterior, and safety features among others. Utilizing these broad categories, we first summarized various key product features available across a range of car models launched in India under seven broad sub-components (refer to Table 5.1 for a summary of different sub-components and features). Furthermore, we utilized the textual data/information available in the news articles, product brochures, and other technical information available on car review portals in determining the level of complexity (i.e., low or high) of the new product features introduced. Later we transformed this data into a dummy variable where 0 = low complexity and 1=high complexity.

Product Introduction Intensity: We argue that the gradual increase in the number of new product models launched over time will raise the product model complexity. The rate of new product introductions in an industry – industry clockspeed (Fine, 1996) – exerts competitive pressure on firms forcing them to increase their rate of new product introductions (i.e., firm clockspeed) in order to keep-up with the industry clockspeed. This increased competitive pressure to launch new products, in turn, is likely to affect the imitative behaviour of the competing firms. In order to create a proxy variable to measure this effect, we first measured the industry clockspeed as the count of new product introductions in the Indian market in a given year by all operating firms (Nadkarni & Chen, 2014). We then measured the firm clockspeed as the count of new product introductions in the Indian market by each firm in a given year. We used this measure to calculate product introduction intensity (i.e., firm clockspeed / industry clockspeed) for each firm.

Control Variables

The imitation behaviour of the firms in response to the competitive actions of rivals may be affected by other factors such as firm size and age and hence we introduced these variables in the analysis as control.

a) Firm Age: Research suggests that the age of the firm is likely to have an effect on the innovation capability of the firm (Sinkula, 1994; Calantone *et al.*, 2002) and thereby its ability to imitate. Firms that are in operation for a long time are likely to accumulate more learning and hence develop their innovation capability to a higher level. The study uses the year of incorporation of the firm as a point to calculate the age of the firm. Further, the log transformation of the values is undertaken to address the issue of skewness (Ives, 2015).

b) Firm Size: Research suggests that the firm size significantly impact firm innovation capabilities (Cohen & Klepper, 1996; Blundell *et al.*, 1999). Similarly, firm size is likely to influence the imitative behaviour of the firms (in terms of imitation target and complexity of the product innovation being imitated) as large firms tend to have superior innovation capability and greater R&D resources at their disposal as compared to their smaller rivals. For instance, big firms tend to imitate rivals that are comparable in size. The study utilized a natural log of the firm's total sales to control for firm size effects.

5.5 Results

This study utilizes more than one dependent variable to understand interfirm imitation and our dependent and independent variables include both categorical and continuous variables. We used logistics regression to model our categorical dependent variables – product imitation; and nature of product imitation – (Cassiman & Veugelers, 2006). We first assessed that our data met the required assumptions to perform the regression test.

Table 5.3 illustrates the descriptive statistics and bivariate correlations between all the variables. As shown in Table 5.3, the product imitation measure was highly correlated with firm type (0.418, p <0.01), firm innovation capability (-0.292, p <0.01), product feature complexity (0.335, p <0.01), and product segment (0.136, p <0.01). Similarly, the nature of product imitation measure was also highly correlated with firm type (-0.501, p <0.01), firm innovation capability (0.271, p <0.01), product feature complexity (-0.277, p <0.01), and product segment (-0.126, p <0.01). This provides evidence for the validity of our theorization of interfirm imitation in a dominant firm industry. The variables in our data showed no multi-collinearity among the independent variables as the VIF scores for all the variables were in acceptable limits i.e., less than 10 (Gujarati, 2003). For instance, the VIF scores were found to be in the range of 1.097 to 2.668 out of which Firm Innovation Capability (VIF: 1.097) and Firm Size (VIF: 2.668) reported the lowest and the highest values respectively. We checked the data for outliers or any high average values, but this was not an issue. Also, our sample did not have any missing values (Schwab, 2002).

We first conducted a logistics regression on product imitation (a dichotomous dependent variable) with all independent variables in the model to examine the probability of firms engaging in imitation (as opposed to innovation) and how that behaviour is affected by other variables such as product introduction complexity, product segment, market segment etc. The logistics regression results are reported in Tables 5.4 & 5.5. Before interpreting the results, we checked if the model was a good fit for the data being analysed by conducting Hosmer & Lemeshow test which reported a non-significant test result (χ^2 (df 8, N = 630) = 13.46, p = 0.097) indicating a good fit. Moreover, the Nagelkerke R^2 value of 0.47 confirmed that independent variables in the model explained the outcome variable to a significant degree. Similarly, the model predicted these outcomes (refer to Table 5.5) 77.9% of the time

correctly (overall prediction success rate) with a significant rate of correct prediction for imitation (73.8%) vis-à-vis no imitation (82.3%) outcomes (refer to Table 5.5).

Table 5.3 Descriptive Statistics

		Mean	SD	1	2	3	4	5	6	7	8	9	10
1	Product Imitation	0.49	0.500	1.000									
2	Nature of Prod. Imitation	0.80	0.852	-.918**	1.000								
3	Firm Innovation Capability (log)	0.60	0.184	-.292**	.271**	1.000							
4	Product Introduction Intensity	0.06	0.028	.002	.012	-.032	1.000						
5	Firm Type	1.46	0.757	.418**	-.501**	-.359**	-.062	1.000					
6	Market Segment	0.44	0.497	.078	-.044	-.019	-.164**	.200**	1.000				
7	Product Segment	0.82	0.614	.136**	-.126**	-.152**	-.092*	.317**	.627**	1.000			
8	Product Feature Complexity	0.75	0.434	.335**	-.277**	-.152**	-.013	.129**	-.013	.082*	1.000		
9.	Firm Size (log)	10.77	1.532	.426**	-.476**	-.525**	.118**	.764**	.103**	.229**	.152**	1.000	
10.	Firm Age (log)	2.93	0.830	-.364**	.421**	.317**	.100*	-.680**	-.206**	-.235**	.037	-.578**	1.000

NOTE: ***N=630; **p < 0.01; *p <0.05; (2-tailed)***

The results (as shown in Table 5.4) indicated that when it comes to product imitation the propensity of domestic firms to imitate (β = 2.653; OR=14.196; *p-value* = 0.000) was found to be higher as compared to other firms including the dominant firm. This is in line with the generally held assumption that domestic firms that lack innovation capabilities tend to imitate more as compared to their superior foreign rivals to keep-up with the competition. The dominant firm also showed a higher propensity to imitate (β = 0.650; OR=1.916; *p-value* = 0.143) as compared to foreign fringe firms but the result was not statistically significant. With respect to the imitation activities in product segments, also shown in Table 5.4, results indicated that the imitation activities of firms were higher in 'small and compact cars' (β = 1.048; OR=2.853; *p-value* = 0.045) and 'Mid-size Sedan/SUVs/MUVs' (β = 1.612; OR=5.011; *p-value* = 0.000) product segments as compared to the 'High-end SUV/Luxury cars'. In other words, firms focused more on imitating the product innovation/features introduced in small and compact cars and mid-size sedans and focused less on imitating product features introduced in high-end SUVs/cars.

Table 5.4 Logistics Regression Results for Product Imitation

Product Imitation (DV)	**B**	**SE**	**OR**
Firm innovation Capability (log)	-0.833	0.696	0.435
Product Introduction Intensity	1.963	1.354	7.123
Firm Type			
Dominant	0.650	0.444	1.916
Domestic Fringe	2.653**	0.680	14.196
Foreign Fringe	Ref	-	-
Market Segment			
Large Market	0.029	0.262	1.030
Fringe Market	Ref	-	-
Product Segment			
Small and Compact Cars	1.048*	0.524	2.853
Mid-size Sedan/MUVs	1.612**	0.447	5.011
High-end SUV/Luxury Cars	Ref	-	-

Product Feature Complexity			
Low	1.835**	0.253	6.267
High	Ref	-	-
Firm Size (log)	-0.270	0.182	0.764
Firm Age (log)	0.263	0.209	1.301
Constant	*0.139*	*2.158*	
Chi-square	*276.86***		
Df	*10*		
Pseudo R^2	*0.474*		
N	*630*		

Notes: 1) The reference category is No product imitation; 2) Df = degree of freedom; 3) *Coefficients significant at 1%**, 5%**;* 4) Reference categories for: Firm Type (Foreign Firms), Product Segment (High-end SUV/Luxury Cars), Market Segment (Fringe Market), and Product Feature Complexity (High).

Product feature complexity also affected the imitating behaviour of the firms significantly. The findings suggest that firms imitated more when the product feature complexity was low (β = 1.835; OR=6.267; *p-value* = 0.000) than when complexity was higher. In other words, firms focused more on imitating product features that were simple to decipher than those with higher degree of complexity. All other predictor variables such as firm innovation capability (β = - 0.833; *p-value* = 0.231), Product introduction intensity (β = 1.963; *p-value* = 0.147), firm size (β = - 0.270; *p-value* = 0.138), and firm age (β = 0.263; *p-value* = 0.209) did not report statistically significant effect on the outcome.

Table 5.5 Actual vs Predicted Cases: Logistics Regression for Product Imitation

Product Imitation	**(Predicted)**		
(Observed)	**Yes**	**No**	**Percent Correct**
Yes	236	84	73.8%
No	55	255	82.3%
Overall Percentage			77.9%

To test hypotheses *H1* to *H4* we conducted the multinomial logistics regression using the nature of product imitation as the dependent variable. First of all, we checked the model fitting information which confirmed the fitness of the model as the full model significantly predicted the dependent variable (i.e., nature of product imitation with p-value=

0.000) than the intercept only model (χ^2 (*df* 20, N = 630) = 456.84, Nagelkerke R^2 = 0.588, p < 0.001). The multinomial logistics regression reveals that independent variables – firm type, product segment, market segment, and product feature complexity – played a different role when it comes to influencing the imitation behaviour of competitive fringe (i.e., imitation of dominant firm, imitation of other foreign firms, or new innovation). Table 5.6 provides the individual contributions of all variables (including the independent and control variables) affecting the dependent variable (i.e., nature of product imitation). Among all the predictor variables, firm type (χ^2 = 128.945, *p-value* =0.000), product segment (χ^2 = 23.980, *p-value* =0.000), market segment (χ^2 = 22.483, *p-value* =0.000) and product feature complexity (χ^2 = 81.512, *p-value* = 0.000) substantially contributed in predicting the outcome variables. However, other variables such as firm innovation capability (χ^2 = 1.687, *p-value* =0.430), product introduction intensity (χ^2 = 4.070, *p-value* =0.131), and firm age (χ^2 = 4.677, *p-value* =0.096) in the model were found to have statistically non-significant effect on the outcome variable.

Table 5.6 Multinomial Logistics Regression Results

(Independent Variables)	χ^2	**Df**	**Dominant Firm Imitation**		**Other Firm Imitation**	
			B	**OR**	**B**	**OR**
Firm Innovation Capability (log)	1.687	2	-0.685(0.903)	0.504	-1.099(0.912)	0.334
Product Introduction Intensity	4.070	2	2.722(1.683)	15.21	2.770(1.587)	15.96
Firm Type	128.945**	4				
Dominant			-	-	1.980(0.545)**	7.245
Domestic Fringe			1.979(0.733)**	7.234	3.302(0.851)**	27.15
Foreign Fringe			Ref	-	Ref	-
Product Segment	23.980**	4				
Small and Compact Cars			2.362(1.105)*	10.61	0.521(0.607)	1.683
Mid-size Sedan/MUVs			2.903(1.059)**	18.23	1.204(0.493)*	3.334

High-end SUV/Luxury Cars			Ref	-	Ref	-
Market Segment	22.483**	2				
Large Market			0.854(0.320)**	2.349	-0.756(0.343)*	0.470
Fringe Market			Ref	-	Ref	-
Product Features Complexity	81.512**	2				
Low			2.514(0.302)**	12.35	1.494(0.309)**	4.453
High			Ref	-	Ref	-
Firm Size (log)	5.083	2	-0.407(0.198)*	0.667	-0.223(0.206)	0.800
Firm Age (log)	4.677	2	0.147(0.228)	1.158	0.518(0.271)	1.678
Constant			*-0.461 (2.554)*		*-1.274 (2.472)*	
Chi-square	*456.84***					
Df	*20*					
Pseudo R^2	*0.588*					
N	*630*					

Notes: 1) The reference category is New Innovation; 2) Df = degree of freedom; 3) Coefficients significant at 1%** & 5%*; 4) Standard errors in parenthesis.

Hypothesis (H1) proposed that the domestic firms are more likely to imitate the dominant firm's product innovations as compared to the product innovations of the other foreign rivals. As shown in Table 5.6, results showed that when it comes to making a strategic choice between innovation or imitating the dominant firm, domestic firms preferred to imitate the dominant firm (β = 1.979; OR=7.234, p-value =0.007). However, contrary to what was hypothesized, domestic firms showed greater inclination in imitating product innovations of the other foreign firms (β = 3.302; OR=27.154, p-value =0.000) than imitating the product innovations of the dominant firm. The odds ratio (OR= 27.154) further indicated that the probability of the domestic firms imitating other foreign rivals, instead of innovating, increased by more than 27 times with each unit change in the predictor variable. Whereas, the probability of the domestic firms choosing to imitate the dominant firm, instead of innovating, increased only by 7 times (OR = 7.234) with each unit change in the predictor variable. We argue that when it comes to imitation choice of the domestic firms, imitating the

leader's (i.e., dominant firm) product innovations make more economic sense as the high market share of the dominant firm indicates greater acceptability and success of its products among consumers. However, the greater propensity of the domestic firms' imitation of the product innovations of the foreign fringe firms that are likely to be complex, as compared to the product innovations of the dominant firm, suggests their inclination towards imitating complex product innovations in a bid to increase their knowledge (e.g., through trial and error, R&D activities) and enhance their innovation capabilities. Therefore, H1 was not supported.

Hypothesis 2 (H2) proposed that the domestic firms are more likely to imitate the dominant firm's product innovations in the large market segment than in the fringe market segment. As shown in Table 5.4, in general, the propensity of the product imitation by the domestic firms was higher among competing firms (β = 2.653; OR=14.196; *p-value* = 0.000) and the domestic firms instead of innovating preferred to imitate other foreign firms more (β = 3.302; OR=27.154, p-value =0.000) than the dominant firm (β = 1.979; OR=7.234, p-value =0.007). However, as shown in Table 5.6, results indicated that in the large market segment, the domestic firms showed high propensity to imitate the dominant firm's product innovations (β = 0.854; OR=2.349, p-value =0.008) in comparison to the other foreign rivals (β = -0.756; OR=0.470, p-value =0.028). Moreover, as shown in Table 5.6, the domestic firms showed high propensity to imitate the dominant firm in the large market products that includes small and compact cars (β = 2.362; OR=10.614, p-value =0.033) and Mid-size sedan/MUVs (β = 2.903; OR=18.237, p-value =0.006) as compared to imitating the product innovations of the other foreign firms in those segments – small and compact cars (β = 0.521; OR=1.683, p-value =0.391) and Mid-size sedan/MUVs (β = 1.204; OR=3.334, p-value =0.015). Therefore, H2 was supported.

Table 5.7 Multinomial Logistics Regression Results

(Independent Variables)	χ^2	Df	New Innovation		Other Firm Imitation	
			B	OR	B	OR
Firm Innovation Capability (log)	1.687	2	0.685(0.903)	1.985	-0.414(1.110)	0.661
Product Introduction Intensity	4.070	2	-2.722(1.683)	0.066	0.048(1.799)	1.049
Firm Type	128.945**	4				
Domestic			-1.979(0.733)**	0.139	1.323(0.692)*	3.754
Foreign			Ref	-	Ref	-
Product Segment	23.980**	4				
Small and Compact Cars			-2.362(1.105)*	0.094	-1.842(1.167)	0.159
Mid-size Sedan/MUVs			-2.903(1.059)**	0.055	-1.700(1.105)	0.183
High-end SUV/Luxury Cars			Ref		Ref	
Market Segment	22.483**	2				
Large Market			-0.854(0.320)**	0.426	-1.610(0.355)**	0.200
Fringe Market			Ref		Ref	
Product Features Complexity	81.512**	2				
Low			-2.514(0.302)**	0.081	-1.021(0.306)**	0.360
High			Ref		Ref	
Firm Size (log)	5.083	2	0.407(0.198)*	1.502	0.183(0.128)	1.201
Firm Age (log)	4.677	2	-0.147(0.228)	0.862	0.371(0.229)	1.449
Constant			*0.461 (2.554)*		*-0.813 (2.047)*	
Chi-square	*456.84***					
Df	*20*					
Pseudo R^2	*0.588*					
N	*630*					

Notes: 1) The reference category is Dominant Firm Imitation; 2) Df = degree of freedom; 3) Coefficients significant at 1%** & 5%*; 4) Standard errors in parenthesis.

We proposed in the hypothesis (H3) that the propensity of the foreign firms' imitation of the dominant firm's product innovations in the fringe market will be higher than the imitation of the product innovations in the large market segment. As shown in Table 5.7, results indicated that the foreign firms preferred imitating the dominant firm's product

innovations over their other foreign rivals (β = -1.610; OR=0.200, p-value =0.000) with higher propensity in the fringe market as compared to the large market segment. The odds ratio (OR= 0.200) further indicated that the probability of the foreign firms choosing to imitate the dominant firm's product innovation in the large market as compared to the fringe market decreased by 80% with each unit change in the predictor variable. Therefore, H3 was supported.

We proposed in hypothesis H4 that the dominant firm is more likely to imitate the product innovations introduced by its foreign rivals in the large market segments than in the fringe market segment. As shown in Table 5.6, results indicated that the foreign firms preferred to innovate than imitate in the large market segment (β = -0.756; OR=0.470, p-value =0.028) as compared to the fringe market segment to create opportunities for growth. Whereas, the dominant firm, instead of launching innovative products, preferred imitating foreign firms' new product innovations (β = 1.980; OR=7.245, p-value =0.000) in the large market segment to neutralize the lead. Therefore, H4 was also supported. Our findings also indicated that firms, in general, preferred to imitate more when the product feature complexity was lower and preferred to innovate more when the complexity was higher. However, for product innovations with lower complexity, the rivals' propensity to imitate the dominant firm (β = 2.514; OR=12.35, p-value =0.000) was higher than imitating the other foreign firms (β = 1.494; OR=4.453, p-value =0.000). In the end, the model predicted these outcomes (as shown in Table 5.8) 70.3% of the time correctly (overall prediction success rate) with a significant rate of correct prediction for the dominant firm imitation (54.7%), other firm imitation (61.2%), and innovation (83.2%) outcomes.

Table 5.8 Actual vs Predicted Cases: Multinomial Logistics Regression

	(Predicted)			
Nature of Imitation (DV) (Observed)	**New Innovation**	**Dominant firm Imitation**	**Other Firm Imitation**	**Percent Correct**
New Innovation	253	18	33	83.2%
Dominant Firm Imitation	45	81	22	54.7%
Other Firm Imitation	43	26	109	61.2%
Overall Percentage	54.1%	19.8%	26.0%	70.3%

5.6 Discussion and Conclusion

In this paper, we examine one of the fundamental issues in competitive imitation strategy – i.e., *when do firms imitate and /or innovate; and when imitating, which firm do they prefer to imitate?* We investigated the issue in a competitive environment where a large dominant firm not only consistently holds a huge market share but also has the power (through different pricing and production strategies) to manage and control the supply of goods in the market making it more difficult for rivals to compete. Unlike past studies which have examined the interfirm imitation from either 'follow the leader' or 'follow the follower' perspectives (Ross & Sharapov, 2015; Ross & Sharapov, 2019; Lieberman & Asaba, 2006; Posen *et al*., 2013), we combined the differing perspectives and examined interfirm imitation as a dynamic competitive relationship among rivals in which the dominant firm and the competitive fringe (including both the domestic and foreign firms), in different competitive conditions, imitated each other's competitive actions.

We argue that, in most cases, the dominant firm controls high market share in the market segments (i.e., large market) that represent the biggest part of a given market. This forces the competitive fringe, based on their competitive advantages, to operate in the niche market segments. We present the confidence bands of the results in Figure 5.2 to shed more light on the interfirm imitation and innovation behaviour of the competitive fringe (i.e., the domestic fringe firms and foreign fringe firms) and the dominant firm in different market

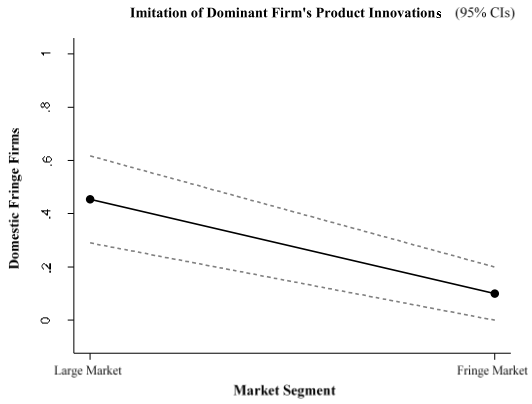
segments in terms of which market segments they imitate and innovate, and while imitating which firm(s) are they more likely to target. Our findings suggest that in the context of a dominant firm industry, the dominant firm and its rival's tendency to imitate each other's competitive actions is not only greatly influenced by their relative competitive positioning in the market as a whole, but also by their competitive position in the key product segments they operate. We found that the dominant firm showed a greater tendency to imitate the rival firms' competitive actions (i.e., launch of new product innovations by rivals) in the market segments it dominated (i.e., large market segment comprising small and compact cars, and mid-size Sedans/MUVs) while in the fringe market, mostly dominated by the rivals, it showed less tendency to imitate but high tendency to innovate. Similarly, the foreign fringe firms showed a greater tendency to imitate the product innovations introduced by the dominant firm in the fringe market segment (i.e., High-end SUV/Luxury cars) in which it commanded a leading share while greater tendency to innovate in the large market segment. As both the dominant firm and the foreign fringe firms lead in their respective product segments, their imitation behaviour in the segments they dominated represented equilibrating action to maintain their respective lead (Ross & Sharapov, 2015), while their respective competitive actions to launch innovative products in product segments dominated by the rivals represented an attempt to seek competitive parity and to catch-up with the product segment leader (Chen & Miller, 2012).

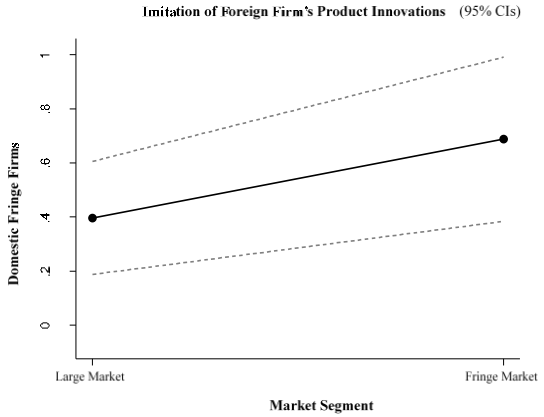
Moreover, when it comes to leading the innovation in different market segments and in the industry as a whole, our findings showed that, in a dominant market industry, leading firms, despite possessing high innovation capabilities, did not always lead innovations in the product segments they heavily dominated but rather led innovations in the product segments controlled by the rival firms. On the contrary, leading firms led imitation activities in the product segments they controlled as both the dominant and the foreign firms showed a higher

propensity to imitate rival's competitive actions in the product segments they dominated heavily. This indicates towards the tendency of product segment leaders (e.g., the dominant firm in the large market and foreign rivals in the fringe market) try not to increase innovation intensity, unless the market demands so, in their respective market segments and avoid altering the status-quo from which the product segment leaders benefit the most. Moreover, when it comes to leading the innovation in the industry as a whole, the findings suggest that the foreign fringe firms, and not the dominant firm, took the lead primarily, because the foreign fringe firms dominated in a fringe market segment that provided them with the higher bandwidth to innovate (due to the greater willingness of customers to pay for innovative product features) and secondly, they were compelled to create catch-up opportunities through innovation (pursue differentiation to develop a strong brand identity) given their inability to match the dominant firm's product prices in different market segments. These findings are in contrast to the general notion that the market leader leads innovation activities to stay ahead and avoid dethronement (Ferrier *et al*., 1999; Smith *et al*., 2001; Giachetti & Torrisi, 2017; Lieberman & Asaba, 2006).

As far as the imitative behaviour of the domestic firms is concerned, our results showed that, in general, domestic firms showed higher a propensity to imitate as compared to the dominant firm, and the other foreign firms in the competitive fringe. The primary incentive that drives domestic firms to imitate is to remain competitive *vis-à-vis* rivals as they have limited scope to pursue innovation due to lack of superior innovation capability. This supports prior studies which argue that firms with low innovation capability tend to have a higher propensity to imitate (Kim, 1997; Kale & Little, 2007). However, contrary to our assumption, domestic firms showed a greater propensity to imitate the foreign fringe firms in the market as a whole, and only showed a higher propensity of imitating the dominant firm in the large market segment. This finding suggests that firms do not always imitate the leader

firm but they may choose to imitate other rivals if the competitive environment demands so. For instance, in this situation, the domestic firms may have chosen to imitate product innovations of the other foreign firms in the large market, instead of the product innovations of the dominant firm, simply because, even after the successful imitation, it will be difficult for them to match the dominant firm's price for the products with similar features and so is less likely to attract new customers. Instead, what will make more commercial sense, if they attempt to imitate product innovations introduced by the foreign fringe firms in the large market segment and package these extra features in their cars to sell them at price points that are relatively higher than the price points of the dominant firm but slightly lower in comparison to the price points of the foreign fringe firms. Moreover, by successful imitation of the product innovations of the foreign fringe firms, that are likely to be complex, the domestic firms are likely to accrue valuable knowledge (e.g., through trial and error, R&D activities) that will further enhance their innovation capabilities. Finally, the higher tendency of the domestic fringe firms to target foreign fringe firms for imitation may also be motivated by similarity in their strategic goals, i.e., to catch-up with the dominant firm, thus it makes more sense for the domestic fringe firms, subject to their capabilities, to follow the competitive moves of the foreign fringe firms. However, our results also indicated that the ability of the domestic firms to imitate the product innovations of the foreign fringe firms decreases as the complexity of the product innovations being imitated increases.


Imitation of Dominant Firm's Product Innovations (95% CIs)
Domestic Fringe Firms
0
.2
.4
.6
.8
1
Large Market
Fringe Market
Market Segment


Imitation of Foreign Firm's Product Innovations (95% CIs)
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Large Market
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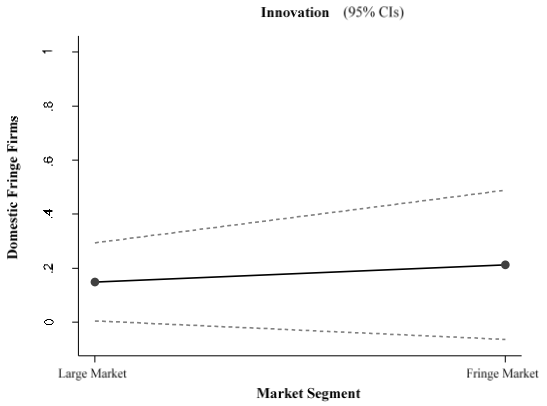
Market Segment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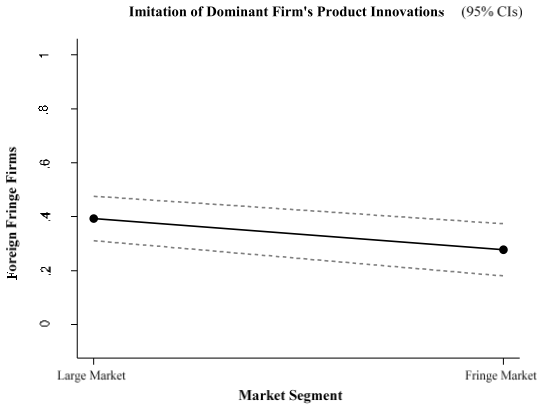
Imitation of Dominant Firm's Product Innovations (95% CIs)
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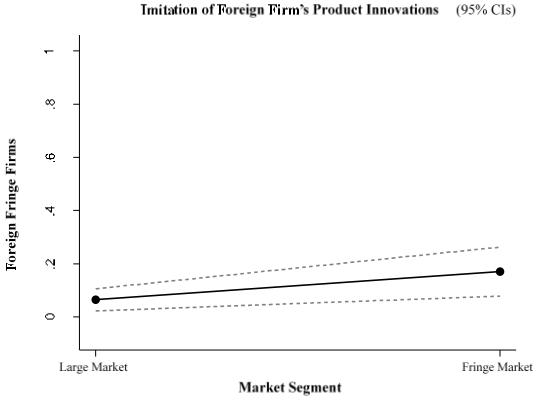
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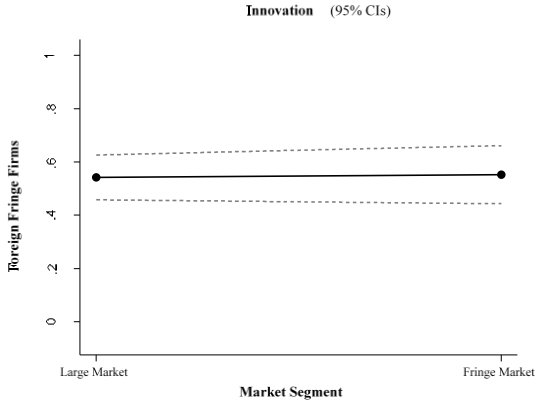
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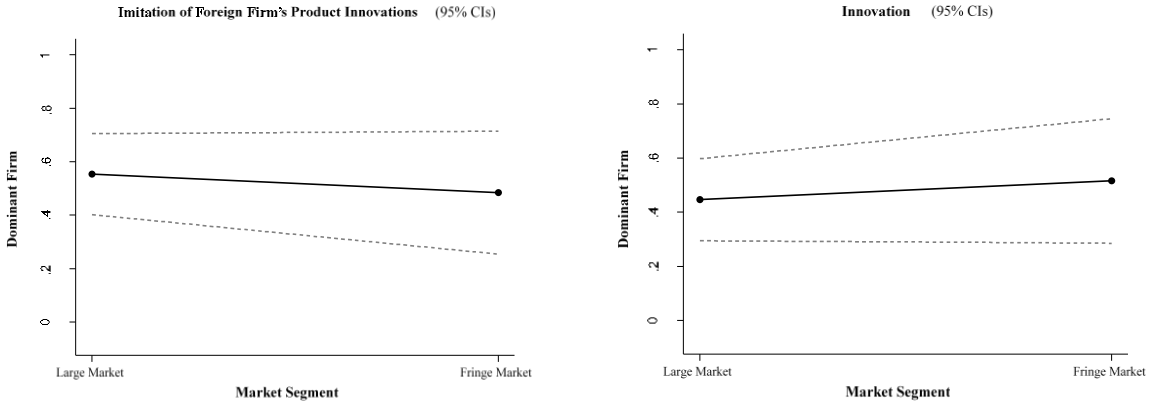

Figure 5. 2 Inter-firm Imitation Behaviour in Different Market Segments

Our study contributes to the literature in two ways. First, this paper makes a significant contribution to the limited literature examining the imitative behaviour of firms in a dominant firm industry. Secondly, by undertaking a longitudinal enquiry, this study enhanced our understanding about competitive situations during which the leader and the rival firms deviate from their usual imitative behaviour and prefer other firms as a potential target for imitation. The findings of this study highlighted a few of those situations. Moreover, our study also contributes to the limited literature highlighting the importance of internal and external contingencies in competitive interaction (Ross & Sharapov, 2015) by introducing the dominant firm context in examining the competitive interaction among firms. Our findings have important implications for theory and potentially challenge some of the established assumptions of competitive imitation. Some of the reasons behind inter-firm imitation, as highlighted in the literature, include: imitation to neutralize the threat of competition from rival to catch-up with the leader (i.e., rivalry-based imitation); imitation of leader firm by rivals as it is perceived to possess superior market knowledge (i.e., information-based imitation); and imitation to maintain the competitive status-quo (i.e., competitive dynamics theory) among others. The literature also suggests that rival firms tend to imitate industry leader – assuming that the leader firm always leads innovation in a given market – whereas the leader firm tends to imitate the nearest rival (Lieberman & Asaba, 2006; Sharapov & Ross, 2019; Posen *et al*., 2013; Smith *et al.*, 2001; Ferrier *et al.*, 1999). However, our findings suggest why a leader firm may sometimes prefer to imitate, not necessarily the nearest rival in terms of market share but eventually a rival that leads a particular product segment, instead of leading innovation activities within an industry. Similarly, rivals do not always imitate the industry leader (rivalry-based imitation theory view), and some firms may continue imitating the rivals even if the situation demands innovative strategy due to their inability to innovate.

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CHAPTER 6 RESEARCH PAPER 3

Market Dominance and Imitative Response to Product Proliferation: A Competitive Dynamics Perspective

6.1 Introduction

Extant research highlights the use by market leaders of product proliferation – i.e., introducing a range of products within or across different submarkets – to build imitation barriers (Piazzai & Wijnberg, 2019; Mainkar, Lubatkin, & Schulze, 2006; Barroso, Giarratana, Reis, & Sorenson, 2016). By filling demand gaps with their own range of products, market leaders raise imitation barriers that should make it less profitable for rival firms to introduce similar products (Piazzai & Wijnberg, 2019; Barroso *et al.*, 2016; Barroso & Giarratana, 2013). Moreover, introducing a range of products across different submarkets requires the market leader to commit to significant investments, for example, investments in pursuing a technological change to design new products (Smith, Collins, & Clark, 2005; Pil & Cohen, 2006) or sinking investments in designing complex organizational structures to offset coordination costs (Zhou & Wan, 2017) and, by doing so, it signals a more credible threat of retaliation (i.e., escalation of competitive intensity) to its potential imitators which discourages them from imitation.

What is commonly assumed in this research is that product proliferation has the same deterrent effect on followers' imitative behaviour. However, not all market leaders are the same; some market leaders hold stronger positions than others. Market leaders run the gamut from firms that lead for a few years by virtue of innovative technologies for example, to firms that dominate their industry for decades. The impact of product proliferation as an imitation barrier may not be the same in the former than in the latter: Followers may react differently to product proliferation by market leaders that have recently gained their position,

as opposed to market leaders that dominate their industry for many years. In this paper we examine the case of dominant market leaders, firms that in the words of Shamsie (2003: p. 200) have the capability to "both develop and to maintain a leading position for an extended period of time". We argue that extant research on how firms use product proliferation as imitation barriers takes a static perspective in which using product proliferation follows the logic of pre-emption. In this perspective, the market leader builds up an imitation barrier using product proliferation, and followers – calculating costs relative to benefits (for example, huge costs involved in developing and launching a similar car model with limited scope of profits due to the small size of unmet demand) – desist from imitation. Our argument, in contrast, is that the interaction between dominant market leaders and followers is better understood using the competitive dynamics view of interfirm rivalry (Smith, Ferrier, & Grimm, 2001; Sharapov & Ross, 2019). In this view, the actions of the dominant market leader trigger response from the followers, and the actions of followers lead to a response by the dominant market leader.

We argue that the presence of a dominant firm alters the competitive dynamics within an industry in significant ways. The dominant firm is often able to control the price and output of goods (Salop & Scheffman, 1984), develop product markets and submarkets due to its market power (resulting from large market share, economies of scale, and reputation) and increase competitive intensity (Smith *et al.*, 2001). Such market power disparity influences followers' propensity to imitate the dominant firm's actions. Moreover, the high market share of the dominant firm indicates higher acceptability of its products among consumers, which in turn suggests that the dominant firm possesses superior market knowledge (Lieberman & Asaba, 2006) making imitation by followers more likely as they consider the threat of falling behind in changing consumer tastes. At the same time, in many industries, the dominant firm also faces the threat of anti-trust lawsuits (Salop & Scheffman,

1984), organization failure (Mellahi & Wilkinson, 2010), and decreasing economies of scale which limits its ability to increase the market share beyond a certain point. These constraints dilute the threat of retaliation making imitation by followers more likely. For example, in an industry dominated by a single large firm, the dominant firm despite having the market power akin to a monopolist, unlike monopoly markets, is required to maintain the market equilibrium to ensure that its competitive actions do not drive out the competitive fringe (consists of several large global firms and new entrants) and turning the market into a monopoly thereby increasing the risks of anti-trust lawsuits (Salop & Scheffman, 1984). This obligation on the dominant firm of providing a competitive space (Clarkson & Toh, 2010)) to the rivals decreases the threat of retaliation by the dominant firm should the rivals decide to imitate its product proliferation actions. Also, especially in a developing country context, the increase in the scope of demand due to the continuous growth of the industry further increases the benefits for the rivals to imitate and profit from introducing similar products.

Thus, we argue that, in a dominant firm industry, the product proliferation strategy of the leader firm (i.e., dominant firm) in a given product submarket, despite the presence of a certain threat of retaliation, albeit lower as compared to monopoly or oligopoly markets, (Piazzai & Wijnberg, 2019), is less likely to create a strong imitation barrier for followers. Rather, it may motivate followers to increase imitation because they wish to keep up with the dominant market leader. What we have, in this case, is a competitive situation where the benefits of imitation (e.g., profits from introducing similar products; prospects of learning; and the performance gains achieved in terms of demand synergies, and the economies of scale and scope with respect to increasing the variety of products etc.) outweigh the costs of overcoming the imitation barrier (e.g., high investments in pursuing a technological change to design similar products; potential increase in the coordination costs; and the costs involved in sustaining the possible escalation in competitive intensity etc.) created by the focal firm

through product proliferation strategy (Smith *et al.*, 2001; Sharapov & Ross, 2019; Lieberman & Asaba, 2006).

We test our predictions using data drawn from the Indian automobile industry which is consistently dominated by a dominant market leader: Suzuki Motors. We particularly focus on the Indian automobile market between 2009 and 2019, as it offers rich data related to firms' product proliferation strategies: during this period several firms introduced a large number of car models, with different features, and in multiple submarkets, which provide necessary product portfolio heterogeneity and complexity to perform the analysis. However, to examine whether the product proliferation strategy of the market leader created a credible imitation barrier, our analysis only focus on the rivals' product proliferations that are imitative: where rivals followed the market leader's introduction of a new product (or a new version of an old product) in a given product submarket by introducing a similar product in the same submarket. Our study contributes to the extant research on product proliferation and imitation; and product proliferation and firm performance in several ways (Ramdas, 2003; Barroso *et al.*, 2016; Piazzai & Wijnberg, 2019). First, we make a novel contribution to the literature by (a) analysing the product proliferation decision of a firm as a competitive response to another firm's product proliferation action, and (b) by highlighting the contingencies in which product proliferation action of a firm will induce imitation from rivals (Salop, 1979; Caves & Porter, 1977; Barroso *et al*., 2016; Piazzai & Wijnberg, 2019). Second, we contribute to the extant research by examining the effect of the dominant firm's product proliferation strategy on followers' imitation and subsequent performance in a dominant firm market competition.

Our paper is organized as follows. The next section provides a literature review of the extant theoretical and empirical research. We then develop hypotheses to examine the impact of the dominant firm's product proliferation action on the rival firms' product

proliferation response and its subsequent effect on their performance, and how the complexity of the product space being proliferated impacts this relationship. In the following section, we present the theoretical model and discuss the research site i.e., Indian automobile industry. We then provide details of the data collection, measures, and research methodology. Finally, we present the findings and discuss their implications for theory and practice.

6.2 Theory and hypotheses

Product proliferation refers to the strategy of a firm to extend its range of products in a market or submarket so as to reduce the unmet demand; to saturate the product space in an effort to dissuade rivals from introducing close substitutes; and to signal its rivals that the invasion of its turf will invite severe retaliatory response (Sorenson, 2000; Mainkar, Lubatkin, & Schulze, 2006; Piazzai & Wijnberg, 2019). So, if we take the example of the automobile industry, the market leader may achieve product proliferation in several ways. For instance, by launching a new car model in a given product submarket (e.g., introducing a new sedan model) or by simultaneously launching new car models across multiple product submarkets (e.g., introducing new car models across mini, sedan, SUV etc. categories), or sometimes, by launching a new car model in a submarket it was never present earlier, or by launching a new car model that results in the creation of a new product submarket altogether (e.g., 'compact SUV' submarket created by the market leader Suzuki, a category very specific to the Indian market). However, the market leader usually launches a new product in different versions with a range of features (e.g., different models of a sedan type car such as Suzuki Dzire, Suzuki Ciaz etc.) with an aim, at first, to ensure that the range of products it offers is sufficient to cater to the majority of the demand leaving limited scope for rivals (i.e., small size of the unmet demand for rivals to cater to) thereby deterring them to profit from introducing similar products, and secondly, if the rivals still decide to imitate the market

leader's product proliferation action and introduce a similar product as a response, then to ensure that they are unable to infringe on its market share.

Product proliferation is a strategic choice that a firm has to make with respect to across-submarket product proliferation and (or) within-submarket product proliferation (Eggers, 2012; Ramdas, 2003). Firms categorize a product submarket (or niche) based on a particular range of product characteristics (e.g., price, features) (Klepper & Thompson, 2006). In the automobile industry for example, compact cars, sports utility vehicles (SUVs), and minivans indicate various submarkets of passenger vehicles. Thus, a firm with a product portfolio spread across multiple submarkets is referred to as across-submarket product proliferation whereas a firm with a product portfolio comprising different product variants in a single submarket is referred to as within-submarket product proliferation – also termed as product versioning (Ramdas, 2003; Sorenson, 2000; Siggelkow, 2003; Dobrev, Kim, & Hannan 2001; Dobrev, Kim, & Carroll, 2002).

Product proliferation entails both benefits and costs and hence have important implications for a firm's performance (Li & Greenwood, 2004; Kotha, 1995). The benefits of product proliferation include the creation of entry barriers for rivals (including the barrier to avoid imitation) and saturated product niches (Mainker *et al.*, 2006; Piazzai & Wijnberg, 2019; Barroso & Giarratana, 2013; Swaminathan, 1998; Connor, 1981; Schmalensee, 1978; Judd, 1985), economies of scale and scope (Tanriverdi & Lee, 2008), ability to exploit technological expertise and brand name (Li & Greenwood, 2004), generate demand synergies with respect to a variety of products (Siggelkow, 2003; Ye, Priem, & Alshwer, 2012), and prospects for learning (Stern & Henderson, 2004); however, if not carefully calibrated, it may also lead to a negative firm performance by increasing significant control and coordination

costs (Jones & Hill, 1988), by pushing the firm in learning traps (Stern & Henderson, 2004), and by inducing product cannibalization[1] (Hui, 2004).

Recent studies have highlighted the role of product proliferation as a credible imitation barrier suggesting that the proliferating firm tightens the demand gap in a given product submarket that not only reduces the potential demand for rivals' products but also limits rivals from capturing the demand that the proliferating firm intends to meet in the future; thereby discouraging rivals from launching similar products (Piazzai & Wijnberg, 2019; Barroso *et al*., 2016; Barroso & Giarratana, 2013). Research also suggests that by committing significant investments in a product submarket, for example, investments in pursuing a technological change to design new products (Smith, Collins, & Clark, 2005; Pil & Cohen, 2006) or sinking investments in designing complex organizational structures to offset coordination costs (Zhou & Wan, 2017), the proliferating firm signals a more credible threat of retaliation (i.e., escalation of competitive intensity) to its potential imitators which discourage them from imitation and instead drives them to pursue product differentiation (Natividad & Sorenson; 2015). Piazzai & Wijnberg (2019) in a recent study further confirmed that, in oligopolistic market competition, product proliferation serves as a credible barrier to imitation.

In this paper, we argue that the presence of a dominant firm in an industry significantly alters the competitive dynamics where rival firms at the margins of the industry constantly try to catch-up with the dominant firm and because they compete in multiple product submarkets often launch products that match the products of the dominant firm. The imitation behaviour of the rivals in this scenario has been explained by rivalry-based imitation theories (Lieberman & Asaba, 2006), and competitive dynamics literature (Smith *et*

[1] Cannibalization refers to the decline in the sales of entire product line due to the perceived similarities (e.g., in terms of brand or attributes) between the different product variants in a given product category (Hui, 2004).

al., 2001; Ross & Sharapov, 2015; Sharapov & Ross, 2019; Giachetti, Lampel, & Pira, 2017). Rivalry-based imitation theories highlight risk and rivalry mitigation as primary motivations behind interfirm imitation. It is argued that firms imitate the leader firm to minimize the risk – as pursuing a differentiation strategy that is based on novelty and innovation may be unacceptably uncertain. Moreover, 'follow the leader' behaviour prevents followers from falling behind, minimally ensuring a status quo (Klemperer, 1992; Lieberman & Asaba, 2006).

Thus, we argue that contrary to extant research which focuses on oligopolistic market competition, product proliferation by a dominant firm will lead to an increase in competitive imitation. Our argument is based on competitive dynamics literature which suggests that competitive imitation action (and response) helps firms to either defend (i.e., ensuring status quo) or enhance their relative performance (Smith *et al.*, 2001; Ross & Sharapov, 2001). Modelling the mobile phone industry, Giachetti *et al.* (2017) observe that competitive imitation among close rivals, what they describe as Red Queen Competitive Imitation, forces laggard firms in the competitive cycle to respond to the threat of competitive action of these rival firms through imitation, which in turn puts pressure on the other firms in the industry to imitate resulting in a higher imitation intensity for the industry as a whole. Building on this observation, we argue that, in a market which is dominated by a single large firm, the dominant firm's product proliferation action, in response, will lead to a high degree of imitative product proliferation by rivals as in highly uncertain market conditions rivals will prefer to catch-up by following the dominant firm's competitive moves. For example, in the Indian automobile industry which is dominated by Suzuki Motors, we argue that the competitive action of launching a new car model by Suzuki Motors in a given product submarket would encourage, instead of deterring, its rivals to imitate its product proliferation action and, in response, launch a matching car model in the same product submarket (i.e., a

car with attributes similar to the one launched by Suzuki Motors). Rivals' will engage in imitative product proliferation in order to maintain or increase their market share by catering to the unmet demand and, at the same time, to avoid the risk of failing in an uncertain market by launching more innovative products than the one launched by Suzuki Motors. Also, Suzuki Motors, in order to avoid the risk of driving fringe rivals out of the market, is less likely to retaliate to the rivals' imitation of its product proliferation action with full force (i.e., dilution in the threat of retaliation) thereby making rivals' imitation more likely. Hence, we hypothesize that:

> H1: The dominant firm's product proliferation in a product submarket has a positive effect on the rivals' imitative product proliferation in this submarket.

While researchers have highlighted the importance of product proliferation as a barrier to imitation, they have also pointed out the product submarket complexity as the key determinant of the effectiveness of that constraint (Piazzai & Wijnberg, 2019; Barroso *et al*., 2016; Barroso & Giarratana, 2013). Product submarket complexity is defined "as a function of heterogeneity and interdependence in the attributes of products offered" in a given submarket (Piazzai & Wijnberg, 2019, p. 946). Research shows that both components of complexity – interdependence and heterogeneity – prevent imitation. Interdependence of product attributes induces causal ambiguity making complex strategies hard to imitate, complex knowledge hard to transfer, and complex product hard to reverse-engineer (Rivkin, 2000; Sorenson, Rivkin, & Fleming, 2006; Pil & Cohen, 2006; Reed & Defillippi, 1990). Whereas, achieving product feature heterogeneity in a given product submarket requires firms to significantly invest in new technologies and develop complex structures and routines (e.g., coordination mechanisms for manufacturing and distribution) which in turn creates high exit costs should the firm decides to leave and infiltrate another submarket (Hannan, Pólos, & Carroll, 2003; Siggelkow & Rivkin, 2005; Zhou & Wan, 2017). So, the higher the exit costs

for the proliferator with respect to an occupied submarket, the greater its threat of retaliation for potential imitators. It is the high risk of credible retaliation from the proliferating firm together with the high degree of complexity of the product or product feature being imitated that discourages potential imitators from introducing imitative products in a complex product submarket. Other recent studies, such as Giachetti *et al*. (2017), also provide support to this line of argument by indicating that high product heterogeneity prevents imitation by increasing imitative uncertainty: uncertainty with respect to which product feature to imitate and which to ignore. Hence, we argue that if the dominant firm decides to engage in a product proliferation strategy by launching a new product in a complex product submarket then the ability of rivals to neutralize the threat through a matching product proliferation response (through launching imitative products) diminishes. Hence, we hypothesize that:

> H2: Product submarket complexity will negatively moderate the relationship between the dominant firm's product proliferation and the rivals' imitative product proliferation.

Now let us turn our focus on the performance implications of the imitative product proliferation strategy adopted by imitators, as a response, to the dominant firm's product proliferation strategy. The extant research suggests that product proliferation yields product differentiation and one-stop shopping benefits, thereby leading to better firm performance. Yet, as also highlighted by Barroso & Giarratana (2013), the empirical research is divided on the nature of the relationship between product proliferation and firm performance, for example, while some studies observed positive association (Bayus & Agarwal, 2007; Barroso & Giarratana, 2013; Sorenson, 2000; Tanriverdi & Lee, 2008), others have found negative or no link (Bayus & Putsis, 1999; Stern and Henderson, 2004; Li & Greenwood, 2004; Kekre & Srinivasan, 1990). As prior research on the relationship between product proliferation and firm performance have highlighted both positive and negative implications for the

proliferating firms, we anticipate a need to examine the impact of product proliferation on firm performance in our analysis. We argued earlier that, in an industry dominated by a single large firm, the product proliferation strategy of the dominant firm in a given product submarket will not result in a reliable constraint for imitation; instead in such a situation the likelihood of rivals introducing imitative products in this submarket increases. However, the probability of the continuation of imitative product proliferation strategy by a rival over a period of time will also depend on whether or not this strategy results in significant performance improvement.

Product proliferation across submarkets within an industry, apart from capturing new customers, allows a firm to exploit operational synergies and save costs even if the firm has limited or no prior experience of operating in that submarket (Siggelkow, 2003). Also, across-submarket proliferation increases a firm's ability to offer a range of products under one brand thereby providing a positive experience of one-stop shopping to brand loyalists which in turn increases their consumption frequency and willingness to pay (Fosfuri & Giarratana, 2007; Ye *et al.*, 2012). Thus, across-submarket proliferation is likely to result in a positive performance gain for the proliferating firm as it does not limit the success of the firm to one product submarket (Dobrev *et al.*, 2002). Yet, across-submarket proliferation has costs: costs associated with operational and management adjustments (Dobrev *et al*., 2001; Dobrev *et al.*, 2002); and potential loss of submarket loyalists due to disruption in existing brand-submarket association given the firm's decision of across-submarket product line expansion (Meyvis & Janiszewski, 2004; Barroso & Giarratana, 2013). For example, a firm that is more focused on a few product submarkets (i.e., offers a range of products in select niches), may decide to introduce products in another submarket in which it has no prior experience. To do this, it has to make operational and managerial adjustments that will incur higher adjustment costs as compared to the firm with prior experience of across-submarket

product proliferation. Likewise, firms that operate in a few selective submarkets often create a strong brand identity with that submarket (e.g., strong brand identity of Porsche with sports cars) and dilution of that association due to the across-submarket product proliferation may cause loss of submarket loyalists. Thus, if these costs (i.e., high adjustments costs; loss of sales from submarket loyalists) are higher than the potential gains (i.e., the potential of learning and knowledge; potential new sales from brand loyalists by operating in multiple submarkets) from across-submarket product proliferation then this could lead to negative performance for the firm.

Similarly, within-submarket product proliferation also entails advantages and disadvantages for proliferating firm's performance. Firms engaging in within-submarket proliferation has prior experience and knowledge and thus such product portfolio expansion provides greater operational and management efficiencies (Eggers, 2012). It further improves the quality of the product (due to high levels of specialization in a niche), and cement customer's brand loyalty as continuous improvement of products in a submarket results in the development of the product versions that exactly meet customers' needs (Smith *et al.*, 2005; Hsu, Hannan, & Kocak, 2009). However, within-submarket proliferation may affect a firm's performance negatively due to cannibalization: reduction in the sales of a firm's existing products in a given submarket due to the introduction of new versions or close substitutes (Hui, 2004).

In a dominant firm industry, as we argued earlier, the majority of the rivals of the dominant firm are likely to operate in niche submarkets due to their inability to compete in all or several product submarkets controlled by the dominant firm as they are unable to match the dominant firm's competitive advantages that have been developed over several decades of monopolistic operation in a protected market (until it was liberalised) and mainly stems from its control of the critical market resources, the economies of scale and scope, high production

and innovation capability, market knowledge, and the strong brand reputation among others. Besides, the overreliance of these rivals on the niche submarkets not only limits their ability to match the dominant firm's competitive advantages which it derives from engaging in both across-submarket and within-submarket product proliferation, but also poses to them a perpetual threat of product cannibalization as they engage more in within-submarket product proliferation to increase sales. Hence, these rivals, as they move forward and build more resources and capabilities, will strive to gradually reduce their performance dependency on niche submarkets. This, together with a strong motivation to catch-up, and to accrue knowledge and learnings that come from across-submarket product proliferation, is likely to propel rivals to engage in across-submarket product proliferation. However, given the uncertainty involved in introducing new products in another submarket, these followers tend to look to product submarkets proliferated by the dominant firm despite the threat of retaliation. In this situation, we argue that the potential performance gains for rivals undertaking both the across-submarket and within-submarket product proliferation, as opposed to continuing to operate in niche submarkets, in terms of the increased sale, the costs savings due to operational and demand synergies, superior ability to provide a one-stop shopping experience to the existing and prospective brand loyalists by offering an increased range of products leading to repeat purchases, the potential of new learnings in terms of product and process innovation, the reduced threat of cannibalization due to the operation in multiple submarkets, and product quality improvements among others are likely to be greater than the potential costs of across-submarket product proliferation such as high coordination costs, the requirement of new investments in the technology, and the potential loss of sales from submarket loyalists due to the dilution of the brand identity. Hence we hypothesize that:

> H3a: Rivals' imitative product proliferation, in response to the dominant firm's product proliferation, has a positive effect on the imitating rivals' performance.

However, research also suggests that the effect of the product proliferation on the firm performance will be moderated by the product submarket complexity: the higher the complexity of product submarket being proliferated the greater the positive and negative effects that it will have on firm performance (see Barroso & Giarratana, 2013). We argue that the imitation of the dominant firm's products by rivals, apart from attracting new customers, will result in performance improvement due to the scope for new knowledge and learning to be had while designing and production of a similar product. For instance, the imitating rival might need to acquire new technology or manufacturing process or might need to alter the existing design to achieve the product performance similar to the product being imitated which is likely to result in new and valuable technical knowledge. This knowledge is likely to be more valuable for the rival if it is derived as a result of the imitation of the dominant firm's products that were launched in a complex product submarket as a successful imitation of complex product features or functions, over time, leads to the development of strong innovation capability in the imitating firm (Rivkin, 2000; Rivkin, & Fleming, 2006; Pil & Cohen, 2006; Smith *et al.*, 2005). Moreover, when a rival firm attempts to imitate the dominant firm's products in a complex submarket it can also utilize the acquired knowledge in improving its existing products within other submarkets. Thus, the ability of a firm to launch close substitutes of the dominant firm's products in a complex product submarket is not only likely to bring performance gains in terms of sales in this submarket but also is likely to improve the firm's performance in other niche submarkets in which it operates. Hence we hypothesize that:

> H3b: Product submarket complexity will positively moderate the relationship between the rivals' imitative product proliferation and their performance.

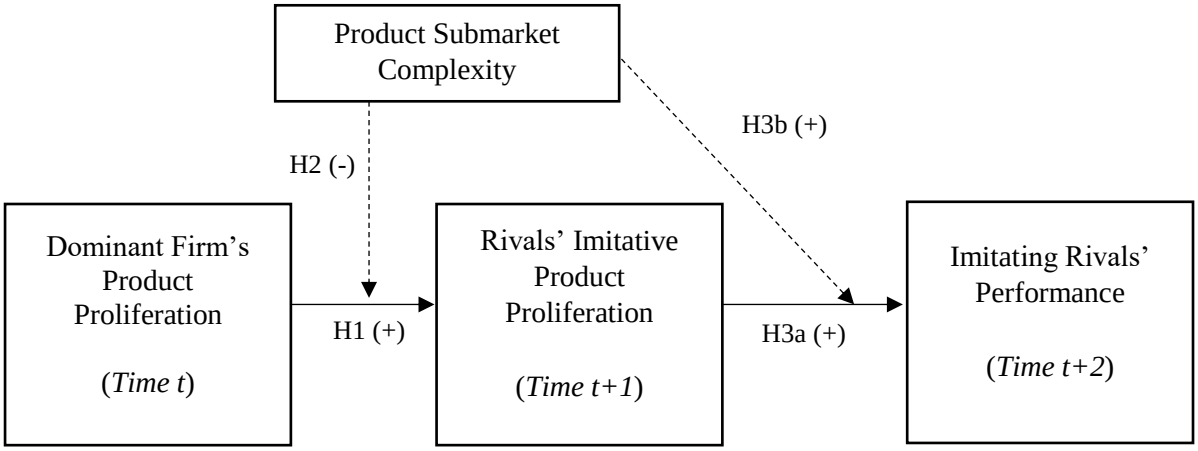

Figure 6.1 Dominant Firm Product Proliferation, Rival Imitation, and Firm Performance

Figure 6.1 presents the theoretical model of the study. As previously mentioned, the extant literature suggests that product proliferation not only has significant implications for firm performance but also, in oligopolistic market competition, acts as a barrier to interfirm imitation. However, we argue that in an industry with a dominant firm, product proliferation in a given product submarket will increase interfirm imitation intensity. Moreover, the intensity of the imitation response by competing firms and its effect on their performance will be moderated by the product submarket complexity.

6.3 Research Setting: Indian Automobile Industry

We utilize the Indian automobile industry as a research site as it provides a rich context in terms of a dominant firm and several other firms competing with multiple product models that appeal to well-defined product niches or submarkets. So, it provides an appropriate empirical setting to examine the impact of product proliferation on interfirm imitation and

firm performance. Also, the industry has been consistently dominated by a single large firm and thus provides suitable context to test our theory in a dominant firm industry: Suzuki Motors controls nearly half of the market share (51% as in 2018-19) followed by Hyundai at a distant second with 16.2 per cent market share. Indian manufacturers – Mahindra and TATA Motors, hold 7.3 and 7 per cent market share respectively, whereas others share the remainder of the pie (SIAM Reports, 2019). Our analysis focuses on the Indian automobile industry during 2009-2019 due to limitations in the availability of model-wise sales data of passenger vehicles that we have used in estimating firm performance. We have utilized the Society of Indian Automobile Manufacturers (SIAM) classification (as detailed in Table 6.1 & 6.2) that categorizes car models into ten submarkets based on mechanical, design and equipment characteristics (e.g., car length, engine capacity, price etc.): Micro; Mini; Compact (Hatch); Super Compact; Mid-Size (Sedan); Executive; Premium; Luxury; Utility vehicles (UV1, UV2, UV3, UV4); and Vans. SIAM is an industry association and its classification is considered as norms in product segmentation in the Indian automobile industry, and past studies have utilized auto industry association's classification of submarkets in their studies (e.g., Barroso & Giarratana, 2013). Moreover, the growth of the Indian automobile industry over the last two decades has led to a significant increase in the number of car models offered by competing firms in the Indian market: from nearly 70 models in 2011 to 150 models in 2019 within different submarkets. Thus, providing required heterogeneity and complexity with respect to product portfolio to examine the relationship among product proliferation, product submarket complexity, interfirm imitation, and performance.

Table 6.1 Product Submarkets in the Indian Car Market

Segment	Car Length (mm)	Engine Capacity/ or Price
Micro	<3200	Up to 800 cc
Mini	3200 – 3600	Up to 1000 cc
Compact	3600 – 4000	Up to 1400 cc
Super Compact	4000 – 4250	Up to 1600 cc
Mid-Size	4250 – 4500	Up to 1600 cc
Executive	4500 – 4700	Up to 2000 cc
Premium	4700 – 5000	Up to 3000 cc
Compact SUV (UV1)	<4400	Up to 1600 cc up to US$ 20000 (< INR 1.5 million; or <£15000)
MPV (UV2)	4400-4700	up to US$ 20000 (< INR 1.5 million; or <£15000)
Economy SUV (UV3)	4400-4700, >4700	Between US$ 20000 – 40000 (INR 1.5 to 3 million; or £15000 to £30000)
Premium SUV (UV4)	>4700	Above US$ 40000 (Above INR 3 million; or £30000)
Luxury	> 5000	Up to 5000 cc
Vans	Hard Tops/ Soft Tops	Generally 1 or 1.5 box; seats up to 5 to 10/ Price Up to US$20000 (<£15000)

Source: Society of Indian Automobile Manufacturers (SIAM) Classification

Table 6.2 Means of Key Attributes of the Indian Automobile Submarkets

Submarket	No of Models	Car Length (mm)	Price (US$)	Engine Capacity	Horse power	Mileage (km/l)	Cars Sold
Mini	24	3497.1	4793.3	956.6	60.2	19.7	107723.2
Compact	81	3802.1	7981.5	1231.7	79.1	20.7	55458.0
Super Compact	35	4117.1	9270.7	1320.9	84.5	20.2	40724.9
Mid-Size	45	4377.8	10991.9	1459.0	97.0	18.1	26998.5
Executive	27	4585.9	19712.5	1732.3	128.8	16.8	5926.9
Premium	19	4805.4	36685.2	2562.0	194.0	13.1	1130.3

Compact SUV (UV1)	33	4136.1	12775.5	1546.5	98.5	19.5	54372.9
MPV (UV2)	36	4569.5	16099.6	2060.6	116.1	15.4	43448.6
Economy SUV (UV3)	26	4681.7	30029.3	2365.7	163.2	13.6	7457.2
Premium SUV (UV4)	6	4726.8	88342.4	3057.0	197.5	11.9	518.3
Vans	5	3669.0	5219.0	1157.8	62.9	17.4	52035.4

Total Car Models (2009-2019): N 337

6.4 Methodology

6.4.1 Data Collection

We built and utilized a database of car models that included product information on various car models launched in the Indian automobile market during 1999-2019. We collected the information in chronological order and from multiple sources such as the Factiva database (that provides a rich source of archival data in terms of company announcements of new products or services), product catalogue, car review portals such as Cardekho, Autocar, Zigwheels, and Carwale among others. These sources allowed us to collect car attributes such as price, engine capacity, mileage, length of the car, and information related to multiple product submarkets in India which is critical for our study. Since we operationalized our dependent variables using model-wise car sales data from SIAM which was only available for the period of 2011-2019, in this study, we only analysed the car models launched during the 2009-2019 period that give us approximately 350 car models and variants. Out of which we removed high-end luxury models from the sample as these were mostly, imported into the Indian market, and consisted less than 0.5% of total cars sold in India: put together luxury models sold a few thousand cars as individual models sold less than a few hundred units each year during the study period. We also removed product variants of the old models with only

cosmetic changes and without a comprehensive upgrade. This gives us a final sample of 316 product model observations for analysis.

The data for the control variables were collected from relevant sources. We utilized Capital IQ and ThomsonONE databases primarily to collect data related to R&D intensity, age, and firm sales. We further utilized company annual reports to obtain firm sales and R&D intensity data not available from these databases. Data related to market share were obtained from the Society of Indian Automobile Manufacturers (SIAM).

6.4.2 Variables and Measures

Following Giachetti, Lampel, & Pira (2017), we have modelled the relationship among focal firm's product proliferation actions (i.e., dominant firm in this case), rivals' imitative product proliferation actions, and imitator's performance in a logical temporal sequence (see Figure 6.1). We assume that the dominant firm's product proliferation action at a time (*t*) will trigger an imitative product proliferation response from rivals in time (*t+1*) as rivals will take some time to assess the market response to the newly introduced product of the dominant firm before deciding on introducing a matching product model. In general, when a car manufacturer introduces a new model, it opens up advance customer booking, so the market response to the new model will be reflective of the initial number of bookings; a piece of information that is readily available that helps rivals to evaluate an appropriate response. So, once a rival firm decides to introduce a matching product (i.e., imitative product proliferation) the same will reflect on the imitator's performance in time (*t+2*). Thus, considering the time lag of our variables, our empirical analysis captures dominant firm's product proliferation between 2009 and 2017, rivals' imitative product proliferation between 2010 and 2018, and imitating firm performance from 2011 -2019. A detailed description of the variables is as follows:

Dependent and independent variables

Imitating Firm Performance (t+2): Prior studies have employed various indicators – e.g., product quality (Eggers, 2012); firm survival (Dobrev *et al.*, 2002; Fosfuri & Giarratana, 2007; Sorenson, 2000); market share (Bayus & Putsis, 1999); and unit sales (Giachetti *et al*., 2017) – to capture firm performance. Due to the availability of model-wise sales data from automobile industry body in India (i.e., SIAM), we operationalized the imitating firm performance as the number of units sold at time (t+2) of rival firm's imitative car model launched in a particular product submarket at the time (*t+1*) in response to the dominant firm's new model launched in the same product submarket at the time (*t*). This allows us to capture the impact of rivals' imitative product model launch on their firm performance at the time (*t+2*). Also, sequential collection of car model data allows us to ascertain that the rivals' imitative actions (i.e., product proliferation of rivals in submarkets proliferated by the dominant firm at time *t*), as a response to dominant firm's actions, are deliberate.

Dominant firm product proliferation: We follow Barroso & Giarratana (2013) in computing the variables for product proliferation. Also, as advocated by Barroso & Giarratana (2013), we account for both across-submarket and within-submarket product proliferation while measuring product proliferation in our study. We first calculated both within-submarket product proliferation (WSPP) and across-submarket product proliferation (ASPP) for car models launched each year by the dominant firm during the study period. To calculate WSPP, we used the count of car models sold by a firm *i* at a time *t* in a given submarket with the highest density of car models for firm *i* (Dowell, 2006). To calculate the ASPP, we used the Berry index[2] of dispersion as defined below:

[2] The measure is adopted from Barroso & Giarratana (2013, p. 1443), Strategic Management Journal article based on the study of Spanish automobile industry that have employed the Berry Index to measure the across-submarket product proliferation of firms.

$$ASPP_{it} = \left[1 - \sum_{s} (N_{ist}/N_{it})^2\right] \text{X } 100$$

Where N_{ist} is the number of car models sold by a firm (*i*) in a submarket (*s*) at a time (*t*). Then, we used the product of WSPP and ASPP as the final measure of product proliferation as it captures the interaction effect of both WSPP and ASPP. This measurement also allows us to control for any potential effect of pursuing two product proliferation strategies simultaneously (Barroso & Giarratana; 2013; Fosfuri & Giarratana, 2007).

Rivals' imitative product proliferation: We followed a similar method, as described previously, to calculate the rivals' imitative product proliferation. The sequential collection of data allowed us to distinguish between the imitative product proliferation of rival firms in time (*t+1*) as a response to the dominant firm's product proliferation in time (*t*). In other words, the sequential data collection allowed us to determine the imitation of the dominant firm's product proliferation action by rivals which reflected in the launch of similar car models by rivals in the same product space in which the dominant firm launched a new model sometime earlier. For instance, the dominant firm's launch of new car models either within-submarket or across-submarkets or both at a given time (time *t*) is reflected in its product proliferation measurement. Similarly, while counting the car models to calculate the within-submarket or across-submarket product proliferation for rival firms in the following year (time *t+1*), we have only included the car models that were launched by the rival firms in a submarket as a response to the dominant firm's new car model launched in the same submarket a year ago and, to a large extent, exhibited similar attributes/features (e.g., size, car specifications/ design, engine capacity etc.) which were indicative of the imitation of the dominant firm's car model.

Product submarket complexity: Research suggests that product complexity is a function of the product heterogeneity and interdependence of product attributes (McEvily & Chakravarthy, 2002; Barroso & Giarratana; 2013; Piazzai & Wijnberg; 2019). We follow McEvily & Chakravarthy (2002) and Barroso & Giarratana (2013) in measuring the product submarket complexity: by measuring heterogeneity of the product attributes of car models offered in various submarkets while keeping the interdependence constant. We used several product attributes such as length of the car, engine capacity, horsepower, mileage, and price on offer in different submarkets in a given year to compute product submarket complexity for that period. For example, we first divided the sample into 10 intervals of equal size for a product attribute – let's say price – based on the minimum and maximum values observed in the sample for that attribute. Then for each interval of the price, we counted the total number of car models being offered by all firms. Then out of the total car models, in a given interval of the price, we computed the proportion of car models being offered in specific submarkets (e.g., Mini, compact, super compact) in a given year to calculate the Berry index of dispersion for each submarket based on the price attribute. We performed similar steps for each product attribute to calculate the Berry Index of dispersion for each submarket in a given year for that product attribute. Finally, we used the average of the Berry indices of all attributes for a submarket in a given year as a measure of the complexity for that product submarket. We multiplied the averages by 100 for scaling.

Control variables

Firm Size: We control for the firm size as we argue that rivals' firm size will influence the imitative product proliferation response vis-à-vis the dominant firm's product proliferation. Firms of comparable size and resources of the dominant firm (e.g., Indian subsidiaries of advanced foreign firms) will be more motivated to respond with imitative product proliferation and will be able to sustain the threat of retaliation from the dominant

firm whereas small or medium-sized firms, although will be better equipped to reposition themselves in the product space (Liu *et al*., 2018), will find it hard to sustain the retaliatory response of the dominant firm and hence will avoid imitative product proliferation. Also, firm size will affect a firm's ability to proliferate a complex product submarket (Piazzai & Wijnberg; 2019). The study utilized a natural log of the firm's total sales to control for firm size effects.

Firm age: We control for the firm age as older firms will not only have greater experience (in terms of customers' needs and demands) in the local market but have accumulated learning and knowledge (i.e., higher innovation capabilities) that are critical for competitive imitation and pursuing a product proliferation strategy, more so in a complex product submarket (Sinkula, 1994; Calantone *et al.*, 2002). The study uses the year of incorporation of the firm as a point to calculate the age of the firm. Further, the log transformation of the values is undertaken to address the issue of skewness.

Firm innovation capability: We control for the firm innovation capability as it affects the firm's innovative and imitative behaviour. Research suggests that successful imitation of a product (or product function) requires a significant amount of R&D (Kale & Little, 2007). Moreover, the extent of the imitative R&D increases with the increase in the complexity of the product or product function being imitated as imitating firms may require to make adjustments in their processes; acquire, learn, adopt new technologies; or engage in searching and sourcing components /materials from a new supplier if the product imitation requires modification in existing component or need a new component (Kale & Little, 2007; Kim, 1997). Thus, innovation capability will impact rivals' ability to imitate the dominant firm's product proliferation, and more so in a complex product submarket. We used R&D intensity (R&D expenditure/Sales) as a proxy to measure firm innovation capability.

Market share: Research shows that the relative market position of the incumbent firms influences its performance as well as the competitor's response to its strategic actions (Giachetti *et al*., 2017; Derfus, Maggitti, Grimm, & Smith, 2008). We used the market share of automobile firms in a given year to control for this factor.

Industry concentration: Research has shown that industry concentration impacts the competition intensity which in turn may affect imitative product proliferation responses of the rivals as firms with higher market shares tend to collude in their marketing strategies to maintain their competitive position (Giachetti *et al*., 2017; Derfus *et al*., 2008). We have utilized the cumulative market share of the top four car manufacturers in the Indian automobile industry as a measure to control for the effect of industry concentration.

6.5 Results

We provide descriptive statistics in Table 6.3 and the results of the regression analysis in Table 6.4 and 6.5. We tested the hypotheses with two random-effects GLS regression models: (1) random-effects regression model when the dependent variable is rivals' product proliferation (Table 6.4); (2) a robust random-effects regression model when the dependent variable is imitating firm performance (Table 6.5). We conducted a Hausman test that confirmed that random-effects over fixed-effects regression suited to our 316 observations-unbalanced panel data. Model 1-3 in Table 6.4 present the regression results related to the effect of the dominant firm's product proliferation and the product submarket complexity on rivals' imitative product proliferation (Hypotheses H1 and H2). Model 4-6 in Table 6.5 presents the regression results examining the effect of rival's imitative product proliferation – as a response to dominant firm's product proliferation – and product submarket complexity on the imitating firm performance (Hypotheses H3a and H3b). We checked for multicollinearity in our analyses by calculating the VIF scores. The VIF scores confirmed the absence of multicollinearity as the average VIF scores were all below 2.67 and no individual

VIF score was above 4.66 i.e., VIF scores were well below the recommended threshold of 10 (Gujarati, 2003; Chatterjee & Hadi, 2006).

Before we discuss the regression results of the main variables related to the hypotheses let's first examine the coefficients of the control variables in full Model 3 (in Table 6.4) and Model 6 (in Table 6.5). Results showed that the effect of firm innovation capability (measured by R&D intensity) on rivals' product proliferation, as shown in Model 3 (Table 6.4) found to be significant (β=12.47, p-value = 0.000). This suggests that rival firms with higher innovation capability engaged more in imitative product proliferation in response to the dominant firm's product proliferation as compared to rivals with lower innovation capability. Whereas, we found the effect of firm innovation capability on imitating firm performance (β=1.81, p-value = 0.434), as presented in Model 6 (Table 6.5), to be not significant. We also found that the firm size has significant effect only on imitating firm performance (Model 6: β= -7.69, p-value = 0.003) and not on rivals' imitative product proliferation (Model 3: β= -0.96, p-value = 0.927). The negative coefficients of firm size showed that smaller rivals of the dominant firm achieved higher performance gains from imitative product proliferation as compared to the relatively large rivals. We found that the control variable firm age has a significant effect on both imitating firm performance (Model 6: β= -11.23, p-value = 0.000) and on rivals' imitative product proliferation (Model 3: β= 55.63, p-value = 0.000) showing that older rivals of the dominant firm, as compared to recent entrants in the Indian market, engaged more in imitative product proliferation however recent entrants achieved higher performance gains by engaging in imitative product proliferation, as compared to the older rivals of the dominant firm.

Table 6.3 Descriptive Statistics

		Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Imitator Firm Performance [a] *(t+2)*	43.31	50.99	0.68	311.37	1.000												
2	Dominant WSPP *(t)*	4.84	0.499	4	6	0.044	1.000											
3	Dominant ASPP *(t)*	83.88	5.82	77.04	95.55	-0.042	-0.022	1.000										
4	Dominant Firm Product Proliferation *(t)*	406.60	50.28	330.61	493.33	0.013	0.815***	0.560***	1.000									
5	Rival WSPP *(t+1)*	2.56	1.23	1	6	0.527***	0.209***	0.001	0.175***	1.000								
6	Rival ASPP *(t+1)*	86.21	7.95	50	99.17	0.013	0.145***	-0.070	0.079	-0.032	1.000							
7	Rival Firm Product Proliferation *(t+1)*	220.39	104.68	50	493.33	0.523***	0.238***	0.009	0.203***	0.984***	0.117**	1.000						
8	Product Submarket Complexity	98.16	2.04	90.85	99.91	0.026	0.006	-0.501***	-0.285***	0.126**	0.228***	0.145***	1.000					
9	Firm Innovation Capability (R&D Int)	3.95	1.44	1.01	6.75	-0.114**	0.060	-0.081	0.002	0.042	-0.025	0.032	0.029	1.000				
10	Firm Size (log)	11.15	0.96	8.86	12.53	-0.307***	0.115**	0.008	0.101*	-0.494***	0.193***	-0.461***	-0.082	0.338***	1.000			
11	Firm Age (log)	3.13	0.65	1.10	4.34	0.220***	0.149***	-0.153***	0.035	0.530***	-0.047	0.527***	0.216***	-0.250***	-0.647***	1.000		
12	Market Share (log)	1.96	1.04	0.24	3.93	0.620***	0.068	-0.046	0.030	0.800***	-0.035	0.784***	0.082	-0.257***	-0.439***	0.432***	1.000	
13	Industry Concentration	79.47	4.09	74.68	88.91	-0.050	-0.837***	-0.172***	-0.797***	-0.189***	-0.088	-0.213***	0.156***	-0.002	-0.118**	-0.059	-0.060	1.000

NOTE: N=316; *p< 0.10, **p< 0.05, ***p< 0.01; [a] Unit sold are in thousands; WSPP – within submarket product proliferation, ASPP – across submarket product proliferation

Table 6.4 Random-Effects Regression Analysis: Dominant Firm's Product Proliferation on Rivals' Imitative Product Proliferation

		Model 1 Rivals' Product Proliferation *(t+1)*	**Model 2** Rivals' Product Proliferation *(t+1)*	**Model 3** Rivals' Product Proliferation *(t+1)*
Constant		407.16***	-235.99	-312.21
		(2.92)	(-1.16)	(-1.46)
Independent variables				
Dominant Firm Product Proliferation *(t)*	**H1**		0.36***	0.42***
			(4.78)	(4.46)
Product Submarket Complexity			1.94	2.93*
			(1.55)	(1.85)
Interactions				
Dominant Firm Product Proliferation *(t)* x Product Submarket Complexity	**H2**			-0.12
				(-0.99)
Controls				
Firm Innovation Capability (R&D Int)		13.76***	12.52***	12.47***
		(5.36)	(5.02)	(4.96)
Firm Size (log)		-8.69	-4.52	-0.96
		(-0.90)	(-0.46)	(-0.09)
Firm Age (log)		52.66***	51.55***	55.63***
		(4.59)	(4.34)	(4.23)
Market Share (log)		18.07**	15.06**	11.89
		(2.36)	(2.01)	(1.55)
Industry Concentration		-4.50***	-1.09	-1.57
		(-7.37)	(-1.15)	(-1.46)
N		316	316	316
Within R^2		0.30	0.35	0.36
Between R^2		0.74	0.71	0.66
Overall R^2		0.60	0.56	0.52
Wald Chi-square		161.21	192.03	189.18

Notes: 1) *z*- statistics in parenthesis; 2) *p< 0.10, **p< 0.05, ***p< 0.01

Table 6.5 Robust Random-Effects Regression Analysis: Rivals' Imitative Product Proliferation on Imitating Firm Performance

		Model 4 Imitating Firm Performance *(t+2)*	**Model 5** Imitating Firm Performance *(t+2)*	**Model 6** Imitating Firm Performance *(t+2)*
Constant		125.20**	126.77	124.96
		(2.09)	(1.19)	(1.14)
Independent variables				
Rival Firm Product Proliferation *(t)*	**H3a**		0.051**	0.17*
			(2.03)	(1.69)
Product Submarket Complexity			-0.29	-0.14
			(-0.32)	(-0.15)
Interactions				
Rival Firm Product Proliferation *(t)* x Product Submarket Complexity	**H3b**			-0.12
				(-1.12)
Controls				
Firm Innovation Capability (R&D Int)		2.20	1.05	1.81
		(1.45)	(0.65)	(0.78)
Firm Size (log)		-7.46***	-6.49***	-7.69***
		(-3.19)	(-2.92)	(-2.95)
Firm Age (log)		-10.02***	-11.32***	-11.23***
		(-5.58)	(-6.12)	(-6.63)
Market Share (log)		30.91***	27.24***	28.90***
		(19.72)	(10.17)	(6.93)
Industry Concentration		-0.46	-0.19	-0.22
		(-0.90)	(-0.41)	(-0.44)
N		316	316	316
Within R^2		0.006	0.006	0.009
Between R^2		0.96	0.97	0.97
Overall R^2		0.39	0.40	0.40
Wald Chi-square		913.47	3279.25	5117.79

Notes: 1) *z*- statistics in parenthesis; 2) *p< 0.10, **p< 0.05, ***p< 0.01

The control variable market share also has a significant effect only on imitating firm performance (Model 6: β= 28.90, p-value = 0.000) and not on rivals' imitative product proliferation (Model 3: β= 11.89, p-value = 0.120) indicating that the rivals of the dominant firm with relatively higher market share benefitted more from engaging in imitative product proliferation as compared to rivals with smaller market share. We believe this is because a high market share indicates greater product acceptability among consumers. As far as the industry concentration (an industry level control variable) is concerned, we did not find significant effect on both the imitating firm performance (Model 6: β= -0.22, p-value = 0.658) and rivals' imitative product proliferation (Model 3: β= -1.57, p-value = 0.146).

Let us now turn our attention to the hypotheses test. We posited in hypothesis H1 that the dominant firm's product proliferation has a positive effect on the rival firm's imitative product proliferation. As shown in Model 3 (Table 6.4), the result is in line with our prediction (β=0.42, p-value = 0.000). Therefore hypothesis H1 is supported. We predicted in hypothesis H2 that the product submarket complexity will negatively moderate the effect of the dominant firm's product proliferation on the rival firm's imitative product proliferation. In other words, if the dominant firm's product proliferation occurs in a more complex product submarket then the likelihood of imitative product proliferation from the rival firms in this submarket will decrease whereas the decrease in the product submarket complexity will result in an increase in the rival firm's imitative product proliferation. While the negative coefficient (β = -0.12), as shown in Model 3 (Table 6.4), does indicate the predicted relationship, we found that to be not significant (p-value = 0.323). Therefore hypothesis H2 is not supported. Hypothesis H3a states that rival firms' imitative product proliferation, in response to the dominant firm's product proliferation, has a positive effect on its performance. As shown in Model 6 (Table 6.5), we found a statistically significant result (β=0.17, p-value = 0.092) in line with our prediction. Therefore hypothesis H3a is supported.

We also predicted in hypothesis H3b that the product submarket complexity will positively moderate the effect of the rival firm's imitative product proliferation on its performance, however, our analysis did not yield statically significant result in support of our prediction (Model 6: β=-0.12, p-value = 0.262). Therefore hypothesis H3b is not supported.

6.6 Discussion

We examined product proliferation, interfirm imitation, and firm performance from a competitive dynamics perspective in the Indian automobile market between 2009 and 2019. Our focus is on the competitive dynamics in a dominant firm industry. We find that product proliferation by the dominant firm, in a product submarket, induces imitative product proliferation from the rivals. Thus, our finding qualifies the established view in the literature: which concludes that product proliferation leads to the creation of imitation barrier (Piazzai & Wijnberg, 2019; Mainkar *et al.*, 2006; Salop, 1979; Caves & Porter, 1977); by highlighting certain contingencies in which the imitation barrier created by product proliferation may not prove to be effective. For example, contingencies such as the presence of a dominant firm in an industry that significantly alters the competitive action-reaction dynamics (e.g., through exerting market power), strong motivation of rivals to catch-up, and pressure on firms to maintain competitive parity, renders the imitation barriers created by product proliferation ineffective, despite the presence of credible threat of retaliation from the proliferator. Rather, the benefits of imitation outweigh the costs of overcoming the imitation barrier created by product proliferation, thereby increasing the propensity of rivals to introduce similar products.

We also examined the impact of product proliferation of rivals, in response to the dominant firm's product proliferation, on their performance. We found empirical support for our prediction that product proliferation by rivals, as a competitive response to the dominant

firm's product proliferation, positively affects their performance. Our finding is consistent with previous studies (Bayus & Agarwal, 2007; Barroso & Giarratana, 2013; Sorenson, 2000; Tanriverdi & Lee, 2008) that reported a positive relationship between product proliferation and firm performance. Prior research also highlights the significant effect of product submarket complexity on the relationship between product proliferation and interfirm imitation (Barroso & Giarratana, 2013; Piazzai & Wijnberg, 2019; Sorenson *et al.*, 2006). While we found a negative effect of product submarket complexity on the relationship between product proliferation and interfirm imitation, as also reported in past studies, it was statistically not significant.

To shed more light on our results, we present, in Figure 6.2, the confidence bands for the moderating effects of product submarket complexity on the dominant firm's product proliferation and rival firm's imitative product proliferation relationship and on the rival firm's imitative product proliferation and imitating rivals' performance relationship respectively. The confidence bands, drawn based on the results, showed that the product submarket complexity negatively moderated the dominant firm's product proliferation and the rival firm's imitative product proliferation relationship. In other words, the intensity of the rival firm's imitative product proliferation decreased at the higher levels of both the product submarket complexity and the dominant firm's product proliferation. This showed that if the dominant firm proliferated new products in a complex product submarket (e.g., fringe market), then the rivals, in response, will avoid launching a similar product model in that submarket. They do so to avoid over-crowding the product submarkets they are leading to reduce the risk of cannibalization — as in a dominant firm industry, the foreign fringe rivals often lead the fringe market while the dominant firm leads the large market — unless the new product being proliferated by the dominant firm is capable of altering the status quo in that product submarket to its advantage.

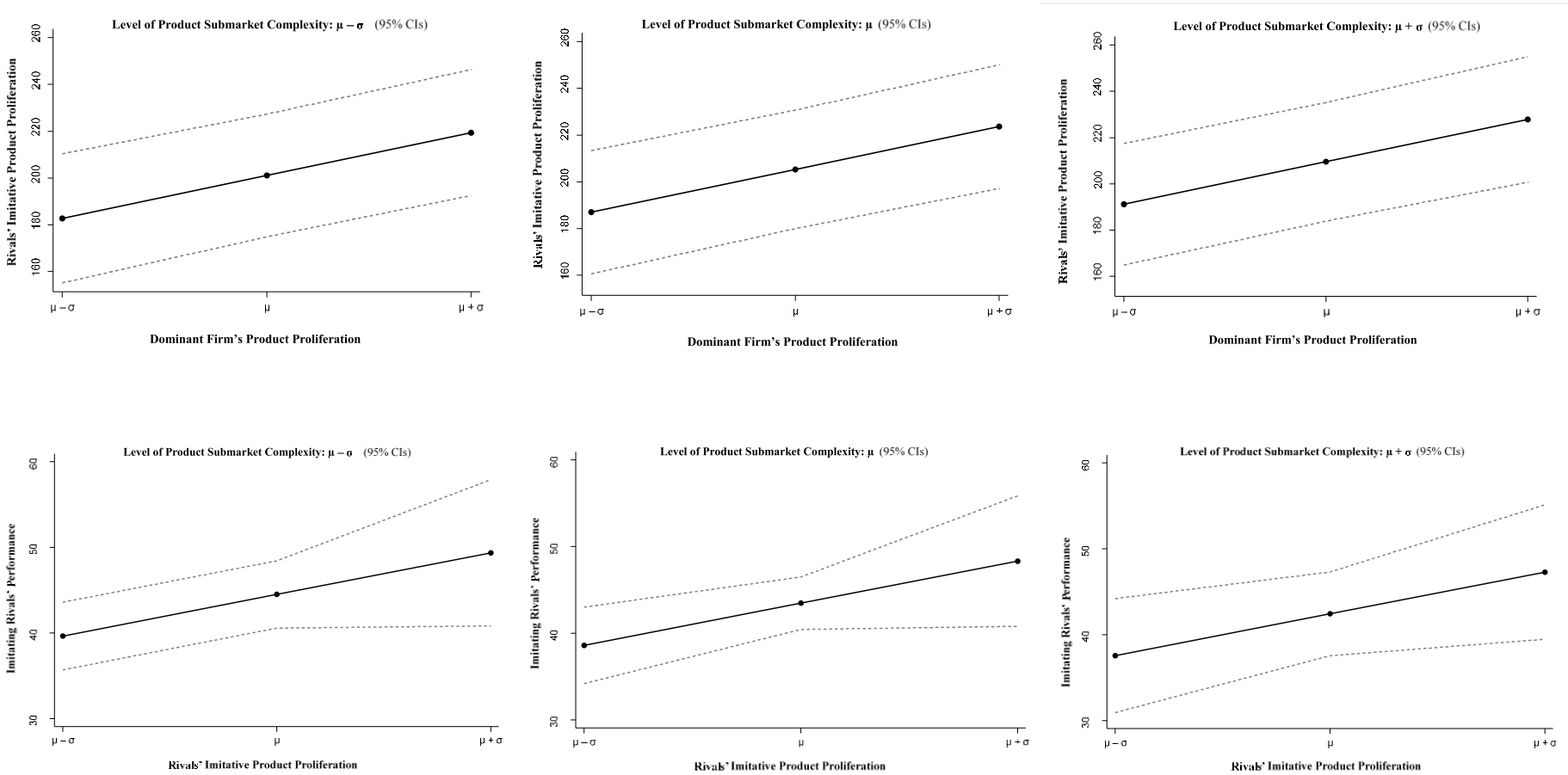

Figure 6. 2 Interaction Effect of Product Submarket Complexity on the Rivals' Imitation of the Dominant Firm's Product Proliferation and its Performance

Similarly, the product submarket complexity, contrary to what we predicted, negatively moderated the rivals' imitative product proliferation and imitating rivals' performance relationship. In other words, it showed that if the rival firms continue to engage in the imitative product proliferation even when the dominant firm's product proliferation is high then it will result in a negative performance that will be even greater if the rivals' imitative product proliferation occurs in a complex product submarket. This showed that although rivals' imitative product proliferation brings performance gains they should be mindful of blindly following the dominant firm's every product proliferation move as it may increase the risk of product cannibalization and lead them into a learning trap resulting in a negative firm performance.

Our study offers important implications for managerial practice. First, we showed that relying on product proliferation related benefits (e.g., achieving product diversification, creation of entry barriers, and harnessing synergies of one-stop shopping) can be detrimental to firm performance because product proliferation benefits are contingent on the competitive dynamics and a firm's standing in a given market. For example, if product proliferation can create a credible imitation barrier against rivals in oligopolistic market conditions, it can very well induce rivals' imitation in a dominant firm market conditions. Also, in a given market, the imitation barriers created through product proliferation have been found to be effective for new entrants, and small incumbents, but at the same time, they are inefficient in preventing a large firm from introducing similar products. Thus, managers are well-advised to calibrate their product proliferation decisions vis-a-vis competitive environment, market standing of their rivals, and their chosen strategy in terms of across-submarket and within-submarket product proliferation in order to achieve product proliferation related competitive advantages. If the sole intention of product proliferation is to create an imitation barrier for rivals, then firms operating in a dominant firm industry are advised to instead rely on other

effective methods of avoiding interfirm imitation (e.g., intellectual property protection, complex and discrete product design etc.). Second, effective management of across-submarket product proliferation and within-submarket product proliferation requires critical support of complementary organizational designs and routines; involves different learnings; and thereby yield different performance outcomes. For example, it will be hard for firms to optimally exploit across-submarket product proliferation if they are unable to exploit economies of scale and scope of production and demand, likewise, firms that are unable to respond quickly to customers' feedback, should not pursue within-submarket proliferation to avoid the threat of cannibalization. Thus, managers are advised to build requisite complementary competences before deciding to pursue either across-submarket or within-submarket product proliferation, especially if they lack prior experience.

Third, our findings confirmed that pursuing across-submarket and within-submarket product proliferation strategies together are more beneficial for firm performance than pursuing them individually. This is because pursuing both within-submarket and across-submarket product proliferation certainly provides competitive advantages over the rivals that are more focused on either of the two. Firms pursuing across-submarket and within-submarket product proliferation simultaneously, on the one hand, have a greater ability to increase their brand reputation by providing better customer service to both brand and submarket loyalists and, on the other hand, have a greater ability to harness demand and operational synergies and are better positioned to improve the quality of their products or services through prompt consumer feedback. In addition, pursuing both kinds of product proliferation simultaneously increases a firm's scope for acquiring new knowledge and applying the knowledge gained while operating in a given niche submarket to improve its performance across several other product submarkets. Finally, we recommend imitation as an efficient strategy for laggard firms that are trying to catch-up in a highly uncertain

competitive environment. Imitation of the leader firm's product proliferation action will not only result in significant performance gains for laggard firms, but at the same time, in the process, will help them accumulate critical knowledge that may be fruitful in their evolution. Such a strategy will also allow specialists laggard firms (those that operate in single product submarket), time to build competences to pursue across-submarket product proliferation.

We make significant contributions to the extant research on product proliferation and imitation; and product proliferation and firm performance (Ramdas, 2003; Barroso *et al*., 2016; Piazzai & Wijnberg, 2019). First, we make a novel contribution to the literature by analysing the product proliferation decision of a firm as a competitive response to another firm's product proliferation action, unlike past studies that assume product proliferation as a firm's voluntary choice to exploit product proliferation related benefits (e.g., differentiation, entry barriers etc.). Second, our study also complements recent research on product proliferation and firm performance (Barroso *et al*., 2016; Piazzai & Wijnberg, 2019) by highlighting the competitive conditions (e.g., competitive dynamics in a market which is dominated by a dominant firm) in which product proliferation action of a dominant firm will induce imitation from rivals instead of preventing it. Third, we advance the findings of a recent study (Piazzai & Wijnberg, 2019) by examining the effect of focal firm's product proliferation strategy and product submarket complexity on rivals' imitation and subsequent performance in a non-oligopolistic competition i.e., dominant firm market competition. Finally, our study also contributes to the limited literature connecting entry barriers (in the industrial organization) and imitation (in strategic management) (see Piazzai & Wijnberg, 2019; Ethiraj, Levinthal, & Roy, 2008).

6.7 Limitation and direction for future research

Our study has limitations, some of which may provide avenues for future research. First, we expect that the findings of our study, like other recent studies (Barroso & Giarratana, 2013; Piazzai & Wijnberg, 2019), can be generalized to industries characterized by economies of scale, and well-recognized submarkets or niches with significant heterogeneity in product characteristics and customers' demand. However, firms over time, in a bid to take a lead, tend to venture into developing new product submarkets or niches (Klepper & Thompson, 2006) and so an interesting future avenue for our research could be examining how the interfirm imitation of product proliferation plays out in a completely new or nascent product submarket as that will entail more uncertainty for the imitating rivals while committing to follow the first-mover. Second, as we know, the global automobile firms are organized in such a way that the parent company or firm alliances operate several brands in different geographies (e.g., Volkswagen Group with Audi, Bentley, Bugatti, Lamborghini, Porsche etc.; Renault-Nissan-Mitsubishi alliance with Renault, Nissan, Dacia, Datsun etc.). Research suggests that in highly complex and heterogeneous product markets customers screen available products based on either brand (e.g., brand loyalists: Honda, VW, Ford, Toyota etc.) or product submarkets (e.g., submarket loyalists: Compact cars, Sedans, SUVs, sports car, vans etc.) (Barroso & Giarratana, 2013). Our study focused on product submarkets examining the interfirm product proliferation imitation and its effect on imitating firm performance. Future research may examine how product proliferation under different brands may affect proliferating and imitating firm performance.

Third, we tested our hypotheses in an industry that requires a significant amount of time and resources to develop and introduce new products in the market. For example,

introducing a new car model or a variant with additional features (even for the imitative products) requires manufacturing firms to develop and test the prototype in local driving conditions and obtain necessary regulatory approvals (e.g., certifications with regards to emissions, safety etc.) which takes a considerable amount of time. Consequently, it produces different action-reaction dynamics vis-a-vis product proliferation among the competing firms. Future research can extend our findings to other multi-product industries, for example, computers and electronics, telecommunication etc., where new product introduction is relatively fast and thus produces different action-reaction dynamics than the automobile industry. Fourth, in our analysis, we treated product submarket complexity as an exogenous factor (to account for the complexity of product space at the industry level) but we are aware of the fact that in highly concentrated industries (e.g., the Indian automobile industry) the complexity of the product submarkets may be driven by the choices of a single firm or a few leading firms (Barroso & Giarratana, 2013). So, future research may extend our findings by also analysing product submarket complexity as an endogenous variable while examining highly concentrated industries.

Finally, interfirm product proliferation imitation also has an important learning dimension for imitating firms. While the variety of learning (e.g., mimetic, experiential or vicarious learning) (Lieberman & Asaba, 2006) is determined by imitating firm's resource endowment, imitation scope, and imitation speed (Giachetti *et al.*, 2017), the learning accumulated by the imitating firm over time will impact the extent and effectiveness of its imitative actions. This could represent a starting point for future research examining interfirm product proliferation imitation and organizational learning.

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CHAPTER 7 CONCLUSION

This chapter provides a summary of the key findings, discusses their implications for research and practice, and suggests avenues for future research. The chapter is organised in various sections. The first section, section 7.1, revisits the overarching research question as introduced in the introduction chapter of the thesis: *What is the role of imitation in firms' technological learning and catch-up, and how do regulations and competitive dynamics influence a firm's imitation strategy during the catch-up cycle?*, and explains how the findings of the three research papers, based on the analysis of interfirm imitation in the context of 'windows of opportunity' created by changes in the institutions and policy, and competitive dynamics (comprised of opportunities created by changes in technology and demand conditions), addresses it. The next section (Section 7.2) discusses the implications of the findings of these studies with respect to theory and literature. The following section (Section 7.3) briefly discusses the implications of the findings for managers from the catching-up and leader firm's perspectives, and policymakers. The final section, section 7.4, provides pointers about the potential avenues for future research.

7.1 Summary of Findings

To examine the role of imitation in the catch-up of laggard firms, this thesis created and utilised a database of car models launched by different car manufacturers in India, from 1999 to 2018. The database utilized multiple sources of information (e.g., Factiva and other car reviewing portals Cardekho, Autocar etc.) and consists of product features, engine specifications, emission technologies, sales and production volumes, launch and discontinuation dates among others of car models. The dataset on car models was supplemented with other firm related data such as R&D expenditure, total sales, market share, firm age etc. from other relevant data sources (e.g., SIAM, Capital IQ etc.).

The study answers the overarching question by showing that firms, with or without suitable innovation capabilities, while exploiting different windows of opportunity, employed imitation as a catch-up strategy at various stages of their catch-up cycle: albeit firms that lack suitable innovation capabilities utilised imitation to catch-up more than those endowed with superior innovation capabilities. However, whether a firm will engage in innovation or imitation is influenced by firm-level technical capabilities and the competitive and regulatory environment (e.g., demand conditions, industry clockspeed, regulations and standards etc.). This thesis argues that changes in the institutional, technological, and demand conditions present a diverse set of opportunities for firms to catch-up, yet, how firms respond to these opportunities, and to what extent they strengthen their existing capabilities or develop new capabilities as a result thereof, then determines the performance benefits of imitation strategy in catch-up endeavours and the possibility of change in successive leadership.

While the extent of usefulness of opportunities related to institutional, technological, and demand windows may vary at different stages of the catch-up cycle, the technological window of opportunity plays the most central role in the catch-up, whereas institutional and demand, as windows of opportunity, enable the catching up firms to exploit technological opportunities. For instance, firms' responses to institutional changes (e.g., regulations), depending on whether "technology-forcing" or "technology-following", lead to the accumulation of technical knowledge that helps firms exploit future technical opportunities, while demand window influences the exploitation of technological opportunities by providing firms outlets for demand-driven innovation and diffusion. However, firms' responses while exploiting these windows of opportunity and strategic processes for capability development may vary from imitation, innovative imitation, to innovation.

Based on the analysis of the use of the emission control technologies in the 549 car models launched in India during 1999-2018, to meet the emission targets of successive changes in the emission control regulations (i.e., BS I to BS IV) during the same period, Research paper 1 argues that firms, when faced with regulatory changes, do employ imitation to catch-up. However, they do not uniformly choose imitation, innovation, or innovative imitation contingent on their innovation abilities but the choice is moderated by firm innovation capabilities and industry clockspeed. Industry clockspeed influences firms' disposition to focus on improving value-adding features of their products in a way that when the clockspeed is low, firms with high innovation capabilities choose innovation when responding to the increase in the stringency of regulations, while firms with low innovation capabilities choose imitation. Whereas, when the clockspeed is high, even firms with high innovation capabilities largely respond to stringent regulations with imitation instead of innovation. The study highlights the fact that, in a business environment characterised by intense competition (i.e., higher industry clockspeed) and increasingly stringent regulations, companies do not always adopt innovation strategy, rather they engage in imitation, to catch-up with the leader firm: higher 'industry clockspeed' required firms to focus their R&D efforts on improving other value-adding dimensions of the product (i.e., design, new features, performance and safety aspects such as fuel efficiency, power, comfort etc.) as opposed to engaging in the innovative activities to improve the environmental performance of the product.

Using the empirical analysis of 630 car models for competitive imitation, Research Paper 2 found that, in an industry with a large dominant firm, the competitive fringe (including both domestic and foreign firms) showed a greater tendency to imitate dominant firm's competitive actions within the key product segments they operate. Moreover, their propensity to imitate the dominant firm's actions is greatly influenced by their relative

competitive positioning in the market as a whole. Also, the findings showed that foreign fringe firms used innovation (by launching innovative products) to catch-up with the dominant firm, while the domestic fringe firms used imitation (by launching imitative products) as a competitive strategy to catch-up with the dominant firm. However, contrary to our assumption, domestic firms not only imitated the dominant firm's product innovations but also showed a tendency to imitate other innovative foreign rivals. Research Paper 2 also showed that the opportunities for catch-up created by technological changes played a significant role as firms with lower technical capabilities showed a higher propensity to imitate less complex product innovations.

The thesis also examined the role of imitation in catch-up of fringe firms while the leader firm engaged in the product proliferation strategy, as an imitation barrier, to prevent rivals' catch-up. Based on the analysis of the imitative product launches of 316 car models and their corresponding sales volume in the period 2009-2019, Research Paper 3 showed that the impact of product proliferation as an imitation barrier, as theorized in the extant research, may not always be the same. In a competitive action-reaction context, the use of product proliferation strategy by dominant market leaders to saturate product space in order to deter rivals from introducing close substitutes instead results in the increased propensity of imitation by follower firms: market followers will not desist from imitation, but instead imitate the market leaders in order to avoid falling behind in an evolving market. The study also showed that the imitative product proliferation by rivals, as a response to the dominant firm's product proliferation in a given product submarket, results in performance gains for the imitating firms. Rivals' ability to successfully imitate the dominant firm's product innovations and improve their performance not only indicated the improvement of technical capabilities in imitating firms over time but also proved imitation as an effective catch-up strategy for firms with limited innovation capabilities.

7.2 Implications for Research

This thesis, in addition to making a significant empirical contribution through a longitudinal study, makes several theoretical contributions to the extant literature on imitation and firm catch-up and industry evolution: an area that is largely under-researched. When firms think of competitive imitation as a strategy they are required to carefully evaluate, amongst the other aspects such as the object and the scope and speed of imitation, the primary motivation (i.e., *why imitate?*) and a potential target (i.e., *which firm to imitate?*) for imitation. The extant literature highlights several motives concerning interfirm imitation that include imitation to avoid the risks and costs associated with innovation and to neutralize the threat of competition from rivals trying to catch-up (i.e., rivalry-based imitation), imitation of leader firm by rivals as it is perceived to possess superior market knowledge (i.e., information-based imitation), imitation to maintain the competitive status quo (i.e., competitive dynamics theory), imitation to gain legitimacy and avoid uncertainty (i.e., institutional theory), imitation to neutralise competitive advantages of rivals built on distinctive resources (i.e., RBV Theory), and imitation to derive organisational learning and new knowledge among others (Lieberman & Asaba, 2006; Smith et al., 2001; Ferrier et al., 1999; DiMaggio & Powell, 1983; Barney, 1991; Levinthal & March, 1993). This study finds that the motivations of the dominant firm and the competitive fringe vary based on their competitive positioning. While the primary motive behind the competitive imitation of the dominant firm and foreign fringe firms that are endowed with comparable resources and capabilities is to maintain the competitive status quo, for firms that are focused on catch-up, and especially firms with limited resources and capabilities (e.g., firms from developing countries), the motivation to acquire new knowledge and building innovation capabilities takes precedence over other motivations such as defending market share and seeking legitimacy or competitive parity. This is because these firms mostly operate in niche submarkets, in which the dominant firm

shows little interest, so the question before them is not so much to defend their existing market, unless there is a potential threat of entry of the dominant firm in their territory, but to build superior capabilities and then challenge the dominant firm in its territory. Thus, in the context of catch-up, the primary motive of the firm should be to use competitive imitation as a means to acquire valuable knowledge and further build on it.

The different motivations of the firms while engaging in competitive imitation also reflected in their selection of the target firm for imitation. It is well recognised in the literature that rival firms tend to imitate industry leaders whereas the leader firm tends to imitate the nearest rival (Lieberman & Asaba, 2006; Sharapov & Ross, 2019; Posen, Lee, & Yi, 2013; Smith et al., 2001; Ferrier et al., 1999). The findings of this thesis challenge this assumption of competitive imitation. The findings indicate that in a dynamic competitive environment rivals do not always imitate the leader firm (rivalry-based imitation theory view), and some firms may continue to utilise imitation as a sustainable strategic choice to obtain a share of innovators' profits, even if the situation demands innovative strategy, either due to their inability to innovate or to avoid the huge risks involved in innovation. For instance, this study found that rivals, particularly domestic fringe firms operating in niche markets, preferred to imitate the dominant firm's product innovations in the large market and the foreign fringe firms' product innovations in the fringe market. Certainly, the objective behind imitating foreign fringe firms' product innovations is to develop innovation capability by attempting to imitate complex innovations as foreign fringe firms mostly challenged the dominant firm, in its territory, by launching segment-leading innovations. In addition, a wider imitation scope allows the domestic fringe firms to stay abreast of new technologies thereby providing the firm greater avenues for catch-up and performance gains (Narasimhan & Turut, 2013). Similarly, in the price-sensitive large market, the dominant firm not necessarily imitated the innovations of the nearest rival but imitated innovations of the rival(s) that

gained traction with customers. Similarly, foreign fringe firms did not always imitate the dominant firm's product innovations but imitated only those product innovations that were launched in the product submarkets they controlled, to maintain the status-quo. In other words, this thesis enhanced our understanding about competitive situations during which the leader and the rival firms deviate from their usual imitative behaviour and prefer other firms as a potential target for imitation.

The findings of the thesis also build on recent research (Markides & Geroski, 2005; Shenkar, 2010) that proposed that, like innovation, firms can develop competitive advantage through imitation by showing that firms employ imitative strategies during catch-up and beyond – for example, to sustain their leadership once they achieve it. Moreover, the findings also support the research that highlights Red Queen competitive imitation among rivals by showing that all firms, the dominant and the competitive fringe, showed a tendency to engage in competitive imitation and more so when the clockspeed of the industry increased. This highlights that in a fast-changing competitive environment it is not always necessary to win the competition but rather it is important for firms' survival to constantly adapt and evolve themselves vis-a-vis their rivals and therefore imitating one another makes strategic sense (Giachetti et al., 2017). This study also highlights the role of imitation as an enabler for innovation (Levinthal & March, 1993, Zander & Kogut, 1995; Kim, 1997; Haunschild & Miner, 1997; Massini et al., 2002; Massini et al., 2005). Scholars argue that firms while engaging in competitive imitation employ various strategies such as reverse-engineering, benchmarking, and competitor intelligence among others and those efforts either result in the fine-tuning of the existing capabilities or acquisition of new knowledge and capabilities available externally (Lane & Lubatkin, 1998; Waterings & Boschma, 2009; Dobson & Safarian, 2008). The domestic fringe firms primarily focused on acquiring new knowledge and enhancing their innovation capabilities through competitive imitation which was evident

in their behaviour of engaging in innovative imitation over time that prerequisite significant level of technical expertise and further substantiate the role of imitation as an enabler for innovation.

The extant research on the firm catch-up emphasises the critical role of new knowledge and learnings in the catch-up process, it suggests that the acquisition of such knowledge is valuable in firm catch-up if that can lead to innovations (Mowery & Nelson, 1999; Malerba & Nelson, 2011; Lee & Malerba, 2017; Bell & Figueiredo, 2012). This thesis argues that while the importance of innovation is undisputed in the context of firm catch-up, it fails to appreciate the catch-up of firms that lack innovation capability or their catch-up endeavours until they develop superior innovation capabilities. It contributes to the firm catch-up literature by highlighting that these firms utilise imitation as a catch-up strategy. The study showed that, although the learnings and knowledge accumulated through competitive imitation will not necessarily, in the short-term, help firms innovate, imitation can be a better conduit to acquire external knowledge that may eventually lead to the development of strong innovation capabilities. Moreover, competitive imitation allows firms avenues to exploit the institutional, technological and demand windows of opportunity for catch-up while they are still in the process of developing superior innovation capabilities. For instance, firms can utilise imitation to catch-up while exploiting windows of opportunity presented to them due to discontinuities in the institutional and demand conditions. Firms with limited innovation capabilities can utilise imitation to manage technological change forced on them due to changes in the regulatory environment as imitation can help them avoid the risks of undertaking innovation and, at the same time, allows them to cater to the change in consumers' demand by keeping up with the rate of introduction of new products in the market.

Prior research provides evidence that firms can utilise imitation to acquire external knowledge (Lane & Lubatkin, 1998; Waterings & Boschma, 2009; Dobson & Safarian, 2008). However, acquiring this knowledge will not be without challenges because the target firm will employ strategies to prevent this learning from taking place. In this aspect, this thesis further extends the contribution by analysing the firm catch-up in the context of imitation from both the imitating firm's and leader firm's perspectives in which the follower firms will use competitive imitation to create opportunities for catch-up while the leader firm will create preventive imitation barriers to halt the followers' catch-up through imitation. The thesis looked at the phenomenon of product proliferation which is used by the dominant firm to prevent rival imitation. It analysed the product proliferation decisions of the rival firms, as a competitive response to the product proliferation actions of the dominant firm and finds that, in a dominant firm market conditions, the strategy of product proliferation by the dominant firm induced imitation from the rivals, instead of deterring it. Moreover, rivals' imitation of the dominant firm's product proliferation actions improved their performance. The findings have implications for both the firm catch-up and product proliferation and firm performance literatures. The thesis makes a novel contribution to the extant research on product proliferation and imitation; and product proliferation and firm performance: a) by analysing product proliferation decision of a firm as a competitive response to another firm's product proliferation action as opposed to following the logic of pre-emption; (b) by highlighting the contingencies in which product proliferation action of a firm will induce imitation from rivals, as opposed to earlier research that suggests product proliferation prevents imitation (Piazzai & Wijnberg, 2019; Caves & Porter, 1977; Salop, 1979; Mainkar et al., 2006). Thus, the product proliferation strategy, in a dominant firm industry, unlike oligopolistic market conditions (Piazzai & Wijnberg, 2019), will facilitate firm catch-up through imitation. In other words, imitation is likely to be more useful in firm catch-up in a

developing country context (given the high possibility of the presence of dominant firm industries) than in the developed country context and firms need to appraise the market dynamics before using imitation to catch-up. This further highlights the importance of internal and external contingencies in competitive interaction (Ross & Sharapov, 2015).

In the end, besides contributing to the growing literature examining the link between the regulations and innovation (Ambec et al., 2013; Naimoli et al., 2017; Aversa & Guillotin, 2018; Blind et al., 2017; Dechezlepretre et al., 2015; Im & Shon, 2019), this thesis opens up a new line of enquiry by examining a multilevel interaction between regulations (with their degree of stringency), innovation capabilities, and clockspeed and by highlighting the critical yet under-researched role of cross-level moderators that influence the firm reaction to regulations, namely: innovation capabilities supporting the ability of firms to pursue technological change (and their lack constraining such ability), and clockspeed influencing whether firms will innovate or imitate in response to regulations. This indicated a critical reason behind the division in the extant research concerning the impact of regulations on innovation: some scholars contended regulations have a positive impact on innovations (Lee et al., 2004 & 2010; De Vries & Withagen, 2005; Zapata & Nieuwenhuis, 2010), while the others argued for a negative influence (Palmer et al., 1995; Ambec et al., 2013; Naimoli et al., 2017).

7.3 Implications for Practice

Firms' persistent struggle to catch-up with rivals is not only critical for their survival but also, in consequence, leads to the technological advancement and evolution of the industry, which in turn contributes to the economic growth of the country: a higher level of innovative activity translates into higher economic growth (Fagerberg, 1987; Freeman, 1987; Bell & Pavitt, 1993; Fagerberg, Srholec, & Knell, 2007; Mewes & Broekel, 2020). Catch-up, at the

country level, relates to minimizing the productivity gap between the developed and developing countries, while at the firm level, denotes the narrowing of technological capability between the leader and latecomer firms that translates into increased firm performance (Bell & Figueiredo, 2012). In the modern economy, wherein the economic growth and the competitive advantage of nations are directly linked to their ability to utilise and develop complex technologies, catch-up becomes equally important from the public policy perspective (Mewes & Broekel, 2020). Consequently, countries, whether developed or developing, put great emphasis on devising policies and developing the supporting infrastructure necessary to stimulate R&D and innovation, and to facilitate the development of world-class firms and industry.

Catch-up at the firm-level and country-level is interrelated, as the former leads to the latter, and therefore this thesis has important implications for policy development that are aimed at improving the competitiveness of both the industry and the country. The findings of this thesis contribute to the policy research by highlighting that, when drafting regulations, policymakers appear to be too narrowly focused on increasing the stringency of regulations to control the environmental degradation and induce socially beneficial innovation, and overlook the important industry dynamics (i.e., industry clockspeed) that affect the outcome, in terms of innovation, of regulatory change. Similarly, as imitation can play important role in firm catch-up, imitation and adaption (to the local environment) of the institutions and policies of economically developed countries by economically backward countries may facilitate country-level catch-up. Countries that wish to develop their local industries may carefully assess the catch-up cycle of such industries in other countries that have recently achieved industry leadership and emulate their success by devising similar policies and creating linkages and supporting infrastructure to facilitate, at first, imitation and innovative imitation (i.e., capability development through learning from competitors' product and

process innovations, and other competitive actions) and then innovation (i.e., generation of new knowledge, products, processes, and competences). In addition, government policies that foster capability development through imitation may allow latecomer countries to avoid the middle-income trap as constant upgrading of capabilities help latecomer countries to better exploit 'windows of opportunity' for catch-up and increase their chances to move up the value chain by improving their ability to produce high value-added products.

From the perspective of the catching-up firms, this thesis contributes to management practice by highlighting imitation as an efficient strategy for laggard firms, particularly for firms that lack significant innovation capability. In a highly uncertain competitive environment, imitation not only results in significant performance gains for laggard firms but at the same time, in the process, helps them accumulate critical knowledge that may be fruitful in their evolution as innovators. This points towards the need for managers to explore the potential of competitive strategy built around the interplay of innovation and imitation i.e., innovative imitation, as opposed to, either being too innovation or imitation focused: a new innovation that fails to adapt to imitative responses of rivals will have limited performance benefits (e.g., the benefits of innovation are likely to be short-lived) just as the imitation that adds no new value to the original innovation will have (Jenkins, 2014). However, what managers must ensure while exploring the imitation or innovative imitation strategy, is that they fully understand the basis of successful imitation as choosing imitation just because it is an easier and less costly option, as it may appear when compared to innovation, may lead to sub-optimal strategies that will have significant opportunity costs, because in reality imitation is far more challenging to accomplish. Similarly, from the perspective of the leader firms, the study showed that relying on product proliferation related benefits (e.g., achieving product diversification, creation of entry barriers, and harnessing synergies of one-stop shopping) can be detrimental to firm performance because product

proliferation benefits are contingent on the competitive dynamics and a firm's standing in a given market: product proliferation strategy can create credible imitation barrier against rivals in oligopolistic market conditions, yet it induces rivals' imitation in a dominant firm market conditions.

7.4 Future Research Directions

This thesis examined the role of imitation from the firm catch-up viewpoint, especially of firms from developing countries, which often lack innovation capabilities. The current research examined the Indian automobile industry, future research may explore the role of imitation in firm catch-up and industry evolution in other industries and countries. The catch-up through imitation leads to convergence among firms and industries as the focus is mostly on accessing and adapting the existing products, processes or technologies of the leader firm or other competing firms (Nelson & Winter, 1982; Fagerberg &Verspagen, 2002). Although, this thesis highlighted that successful competitive imitation leads to the development of innovation capabilities in imitating firms, a potential future extension of this research may be a comprehensive examination as to how continuous imitation of complex product and technology in an industry eventually results in the development of a new set of capabilities in the imitating firms; and how the combination of this new and existing capabilities further give rise to radical innovation that leads to divergence, as opposed to convergence, among competing firms in an evolving industry.

While investigating the imitation behaviour of catching-up firms, this thesis followed the extant literature on the sectoral system and utilised 'window of opportunity' – i.e., institutional, and competitive dynamics (technological, and demand) – as the context and used changes in emission control regulations in the Indian automobile industry during the past two decades as an institutional window of opportunity. Future research may explore the

role of imitation in firm catch-up in the context of other individual or a mix of institutional and policy changes such as IPR rules, financial regulations, and safety regulations among others. The thesis also incorporated industry level factor – industry clockspeed i.e., the rate of changes in product, process, and organization – in the analysis of imitative behaviour of firms, however, we only measured the industry's rate of introduction of new generations of products, future research may also enrich our understanding by incorporating in the study other aspects of clockspeed (i.e., process and organizational) and by devising and utilizing proxy measures for process and organizational aspects, or a composite measure for clockspeed that accounts for the rate of change in product, process, and organizational aspects of the phenomenon.

The thesis explored the role of imitation in firm catch-up in an industry dominated by a single firm, and in an industry that requires a significant amount of time and resources to develop and introduce new products in the market. For example, introducing a new car model or a variant with additional features (even for the imitative products), requires manufacturing firms to develop and test the prototype in local driving conditions and obtain necessary regulatory approvals (e.g., certifications with regards to emissions, safety etc.) which takes a considerable amount of time. Consequently, it produces different action-reaction dynamics *vis-a-vis* imitation among the leader and the catching-up firms. Future research can extend our findings to other industries, for example, computers and electronics, telecommunication etc., where new product introduction is relatively fast and thus produce different action-reaction dynamics.

Similarly, in the context of competitive dynamics as a window of opportunity for catch-up, this thesis also examined the behaviour of the leader firm in preventing firm catch-up of rivals through imitation by utilising product proliferation strategy in saturating the potential consumer demand for a similar product. Future research may explore other imitation

barriers that a leader firm employs to prevent rivals' catch-up through imitation (e.g., IPRs and patenting, complex product design with a higher degree of interdependencies among components that is hard to decipher etc.). Firms over time, in a bid to take a lead, tend to venture into developing new product submarkets or niches (Klepper & Thompson, 2006) and so an interesting future avenue for our research could be examining how the interfirm imitation of product proliferation plays out in a completely new or nascent product submarket as that will entail more uncertainty for the imitating rivals while committing to follow the leader. Moreover, the global automobile firms are organized in such a way that the parent company or firm alliances operate several brands in different geographies (e.g., Volkswagen Group with Audi, Bentley, Bugatti, Lamborghini, Porsche etc.; Renault-Nissan-Mitsubishi alliance with Renault, Nissan, Dacia, Datsun etc.). Research suggests that in highly complex and heterogeneous product markets customers screen available products based on either brand (e.g., brand loyalists: Honda, VW, Ford, Toyota etc.) or product submarkets (e.g., submarket loyalists: Compact cars, Sedans, SUVs, sports car, vans etc.) (Barroso & Giarratana, 2013). The thesis focused on product submarkets examining the interfirm product proliferation imitation and its effect on imitating firm performance. Future research may examine how product proliferation under different brands may affect proliferating and imitating firms' behaviour.

Finally, interfirm product proliferation imitation also has an important learning dimension for the imitating firms. While the variety of learning (e.g., mimetic, experiential or vicarious learning) (Lieberman & Asaba, 2006) is determined by imitating firm's resource endowment, imitation scope, and imitation speed (Giachetti *et al*., 2017), the learning accumulated by the imitating firm over time will impact the extent and effectiveness of its imitative actions. This could represent a starting point for future research examining interfirm product proliferation imitation and organizational learning.

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