



Economic
Research
Working Paper
No. 83/2024

The Evolution of the Two-Wheeler Industry A Comparative Study of Italy, Japan and India

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March 2024

ABSTRACT

This study leverages secondary data to provide a comprehensive outlook on the origin and evolution of the two-wheeler industry in Italy, Japan, and India. The study reveals how different technological, design, and manufacturing capabilities, combined with specific economic and social features in the historical contexts, have contributed to determine different trajectories in the evolution of these national industries. Recent trends towards digital transformation, electric mobility, connected driving are discussed. Three main takeaways emerge from our analysis. Firstly, the local capabilities play a crucial role in shaping both the origin and progression of the technology and the industry. Secondly, the two-wheeler industry displays patterns and trajectories that mimic the automotive industry, which can thus be used to interpret and forecast past, present, and future of motorcycles. Thirdly, the two-wheeler industry has been uniquely influenced by other industries, which has enhanced the complexity and effectiveness of its products and introduced novel elements which are reshaping the international demand for two-wheelers.

Keywords: industry evolution; technology; capabilities; comparative study; motorcycle; economic history,

JEL Code: N70 Economic History - Transport, Trade, Energy, Technology, and Other Services: General, International, or Comparative

Acknowledgements

I would like to acknowledge the contribution of Neha Chauhan, Sajid Esmail, Luigi Mosca, and Aayush Varma for their support and contribution is the creation of this study. I am also indebted for the insightful conversations with WIPO members in particular Maryam Zehtabchi and Julio Raffo, as well other members of the WIPR 2024 research working group, that were instrumental in the development of the core ideas in the manuscript. Errors and omissions are my own.

INTRODUCTION

Motorcycles have always been more than just a means of transportation; they are symbols of human advancement, creativity, and capability; they incorporate various human needs and lifestyles. They are the result of a complex fusion of codified and tacit knowledge, much of which is ingrained in the communities where they are created. This study presents a comprehensive investigation of the global two-wheeler industry and draws insights from the historical development of this dynamic sector in three key nations - Japan, Italy, and India - and their comparative analysis. The study presents the current state of the industry, taking into account the broader trends towards new transportation practices, technologies and the imperative for sustainability. The aim is to unveil the industry's complexities and highlight the central role of intellectual property, the interplay of capabilities and the broader context of global innovation and competition. This study uncovers the relationship between the complexity of the capabilities used, their development through knowledge relationship pathways (which may span different sectors), and their co-evolution with the welfare of the focal countries we study. The two-wheeler industry has changed dramatically over the years, much like many other industries. This industry has borrowed capabilities from other, closer-knit industries, adapted to customer demands, and developed technological solutions to comply with regulations. We disentangle the complexities of the two-wheeler industry across different sectors, encompassing both traditional two-wheelers, electric vehicles, and emerging mobility solutions.

The conceptual framework adopted for this study is taken from the economic complexity theory developed by Hausmann, Hidalgo, Bustos, Coscia, Simoes and Yildirim (2014), which aims to explain industrial evolution (and related policy implications) through the

mobilization of technological capabilities. Assuming that GDP and income per capita are positively correlated to economic complexity, as shown in the economic complexity index (ECI) (Hidalgo and Hausmann, 2009; Hausmann et al. 2014), one can argue that a nation's progress in terms of welfare will inevitably lead to an improvement in the fundamental capabilities and knowledge at the core of its industries, enabling more rapid technological advancements and better technology repurposing that will impact other industries via spillovers. Hence, this study uncovers the distinctive capabilities that have played a crucial role in driving innovation and success within the two-wheeler industry. Such capabilities include technological and design innovation, as well as marketing strategies, with the objective of highlighting the actions that can be implemented to promote a more effective dissemination of knowledge among other industrial networks. These capabilities should not be viewed as fixed attributes, but rather as dynamic forces catalyzed by intellectual property which helps protecting ideas, designs, and technological breakthroughs and advancements, and capturing value from them. We also explore how skilled labor, research and development centers, and manufacturing facilities have propelled the growth of the two-wheeler sector in various geographical locations, each with distinct types of knowledge and capabilities.

The comparative analysis of the inception, evolution, and current state of the Italian, Indian, and Japanese two-wheeler industries present three key insights that have significant implications for academics, practitioners, and policymakers:

Firstly, the development of national two-wheeler industries is influenced by their technological history in various sectors and the ways in which these technologies are utilized. The capabilities embedded in the region play a crucial role in shaping both the origin and

progression of the technology. Furthermore, this development tends to align with the country's consumption patterns, which are associated with different levels of GDP per capita.

Secondly, the two-wheeler industry, while drawing inspiration from a range of industries and fields such as material science, aerospace, electronics, energy, and chemicals, has a closer relationship with the automotive sector, which can be observed in its patterns and trajectories as a way to understand causes and effects, threats and opportunities of the two-wheeler industry.

Thirdly, the two-wheeler industry, although following its own distinct path, has derived significant advantages from technological collaborations with various other industries. This has not only enhanced the complexity and effectiveness of its products, but it has also impacted the development of novel business models that have transformed the use of the products across diverse consumer segments.

Methodology

This study adopts a longitudinal, qualitative approach to understand how the historical evolution of technological capabilities and demand features drove the development of the two-wheeler industry across three key national industries (Italy, Japan and India) and their relative market. The investigation is based on the collection, selection and aggregation of documents and secondary data from a variety of sources which span between academic publications, industry reports, media pieces, company reports and materials, and policy documents. The original database relies on extensive research conducted primarily via the internet, utilizing various reputable sources (e.g., Mintel, MarketLine, Nielsen, Economist, ANCMA, EICMA, McKinsey and Frost & Sullivan and official figures from the Ministry of Transportation of the three countries). While the decision of leveraging reliable, secondary

sources offers clear advantages of scale and trustworthiness, we acknowledge it also presents limitations. Among others, we notice that the sources present heterogeneity of content across the three different countries. As a result, not all aspects of our analysis are equally represented across each country, forcing us to offer different degree of granularity for different topics across the three countries.

Current State of the Two-Wheeler Industry

To precisely depict the state of the art of the two-wheeler industry and identify the most novel trends we need to consider timely phenomena such as the integration of digital technology in the vehicles, the growing demand of emerging markets, and the emergence of innovative products such as electric two-wheelers, adventure bikes, and touring bikes.

The incorporation of technology into motorcycles advances the vehicle usability and it is often a solution to enhance product distinctiveness. Contemporary motorcycles embody complex technological advancements, featuring functions such as anti-lock braking systems (ABS), traction control, and adaptive cruise control. However, it is the adoption of digital technology, including touchscreen displays, smartphone integration, and advanced navigation systems, that truly revolutionizes their use. These functions extend beyond safety and convenience; they track and enhance the overall user experience, generating value propositions that resonate with millennials and technologically adept consumers (Seredynski, 2022). Collaborations with IT, satellite communication, electronics, ergonomics, and entertainment companies have become an invaluable asset for motorcycle manufacturers, offering products that have a higher degree of safety and a clear experiential component.

However, our report shows how the use of two-wheelers differ significantly across regions. In emerging markets like India, Indonesia, and Vietnam, two-wheelers are a means

of conveyance and a catalyst for economic growth. Their affordability renders them accessible, and their agility in navigating congested urban terrains makes them indispensable means of work and commute. As these nations undergo rapid urbanization, the significance of two-wheelers in addressing transportation challenges cannot be underestimated (Fortune Business Insights website, 2023).

Motorcycles also help address global warming and the sustainability challenge. As businesses and governments are required to reduce their environmental footprints and conserving resources, electric two-wheelers are emerging as a key response to environmental concerns. These vehicles, which replace the conventional internal combustion engine with an electrical, battery-powered engine signify a fundamental shift in transportation strategy. Companies like Kawasaki, Zero Motorcycles, and the renowned Harley-Davidson with its LiveWire model are adapting to this transformation drawing upon capabilities in the automotive and energy industries and utilizing innovation to improve the experience while reducing emissions (Barstow, 2022).

Countries that are economically developed (e.g., Italy, Spain, USA, United Kingdom) are also embracing a use of two-wheelers that is leisurely in nature. Products in such areas respond to this demand for bikes that are enjoyable to drive in non-commuting routes. The allure of unexplored paths and the innate human desire for discovery for example have recently given rise to the distinctive category of adventure and touring bikes. These bikes hold the promise of providing gateways to unique experiences and indulgent consumption - an integral aspect of some modern lifestyles. They cater to a demographic that seeks more than mere transportation—they yearn for excitement, connection, and authenticity.

Future Growth Prospects of the Two-Wheeler Industry

The anticipated growth rate of the global two-wheeler market is forecasted to be approximately 8.0% from 2023 to 2028 (MarkNtel Report, 2023). The primary drivers of this growth are the emergence of novel uses and the increasing demand for electrified vehicles.

While the weight and duration of batteries continue to present a significant challenge for most motorcycle enthusiasts, it is reasonable to envision a future where electric bikes become increasingly feasible for a wider demographic due to technological improvements. This may represent a substantial shift towards sustainable mobility and an opportunity for companies to enter into a previously unexplored market segment that prioritizes innovation for an environmentally conscious market segment.

This trend is in line with the European emission standards introduced in 1992 (EUR-Lex, Council Directive 92/61/EEC of June 30, 1992), which have consistently reduced the limit of pollutant emissions and updated the cycles with which these vehicles must be tested. In a world where governments and consumers are becoming more conscious of their ecological impact, investments in electric vehicle capabilities serve as a crucial differentiating factor for two-wheeler brands and a catalyst for future technological advancements in other markets (e.g., electric bicycles).

The convergence of several trends, including urbanization, digital technology, and the sharing economy, presents intriguing prospects for electric two-wheelers. Market and non-market stakeholders perceive shared mobility as a potential game-changer, as it offers a solution to urban congestion, challenges related to vehicle ownership, and the realm of micro-mobility (CB Insights, 2021). Although semi-autonomous features in two-wheelers may appear to be far to be widely adopted, some studies suggest that they are closer to realization

than one might imagine (Purvis, 2022). In the meantime, different solutions driven by semi-autonomous technological intervention, some adapted by the automobile industry, are in the process of being implemented in motorcycles. Technologies such as lane-keeping and anti-topping assistance possess the potential to redefine the riding experience and significantly enhance safety once deployed on large scale productions.

Another emerging key aspect in two-wheelers is product customization. Today's customers, particularly the younger demographic in developed economies, are in search of products that reflect their unique identities. The provision of customization options, whether in terms of aesthetics or performance, helps cultivate brand loyalty and enhance customer engagement. From the perspective of businesses, this necessitates a clear and effective comprehension of local preferences, the development of tailored, modular solutions, and the construction of strategies that are built from the ground up, taking into account the specialization and diversification of the component and vehicle market (Balland, Broekel, Diodato, Giuliani, Hausmann, O'Clery, and Rigby, 2022).

Geography and Localization of the Industry

The volume of the global two-wheeler market in 2022 amounted to 63 million units. The global market had total revenues of \$95,397.3 million in 2022 (Marketline, 2023). This demonstrates a compound annual growth rate of 2.7% in terms of volume and 6.1% in terms of value from the year 2016 (Marketline, 2018). In terms of unit sales per 10,000 inhabitants, Asia significantly surpassed other nations with a figure of 131, followed by the Americas (49), Africa (30), and Europe (23) (Statista, 2022). The escalating desire for convenient and affordable personal mobility options, is projected to propel the industry volume to 71.5 million

by 2026 (Marketline, 2023). The global market share by value (Exhibit 1) is mainly dominated by Asian nations such as India and China, except for the USA and Brazil (Statista, 2022). The market share categorized by unit sales (Exhibit 2) also predominantly comprises Asian countries, led by China and India, excluding Brazil and Columbia (Ibid.). This phenomenon elucidates the pattern that emerging economies represent expanding two-wheeler markets with substantial demand, whereas developed nations exhibit saturated markets with higher-value products. Asia demonstrates the lowest average price for two-wheelers, amounting to \$2,097, while Australia and Oceania reflect the highest average price at \$10,470 (Ibid.).

****Insert Exhibit 1 and 2 about here****

THE ITALIAN TWO-WHEELER INDUSTRY

The Evolution of the Two-Wheeler Industry in Italy

In Italy, the definition of a motorcycle is provided in Article 53 of Il Codice della Strada (The Highway Code), which was approved by Legislative Decree on April 30, 1992, number 285. According to this article, motorcycles are two-wheeled vehicles designed for the transportation of people, limited to a maximum of two individuals including the driver.

The seeds of the Italian motorcycle industry were planted in the late 19th century, as motorized transportation began to captivate inventors and engineers worldwide and when the country experienced a surge in industrialization. Small workshops and pioneering individuals began experimenting with motorized two-wheelers, laying the groundwork for the emergence of prominent manufacturers. One of the earliest Italian motorcycle manufacturers was Bianchi, which produced its first motorcycle in 1897; two years later, in 1899, Lazzati and Figini in Milan produced the first commercially available two-wheeler. However, it was Moto Guzzi, founded in 1921, that emerged as one of the very first key players in the industry. Moto Guzzi's early success can be attributed to its innovative engineering and emphasis on reliability and performance. Italian pioneers like Enrico Bernardi and Carlo Guzzi experimented with motorized bicycles, laying the groundwork for future developments. Subsequently, in the early 1900s, the industry gained momentum by drawing knowledge and inspiration from neighboring countries, particularly France. The 1930s marked a period of significant growth and innovation for the Italian motorcycle industry. Manufacturers like Moto Guzzi, Gilera, and Ducati began to gain international recognition for their high-performance machines and racing successes.

One of the defining moments of this era was Moto Guzzi's dominance in motorcycle racing. The company's legendary "Gambalunga" bikes, equipped with powerful V-twin

engines, clinched numerous victories in prestigious races such as the Isle of Man TT and the Moto Giro d'Italia. These successes not only showcased Italian engineering prowess but also helped establish the country as a force to be reckoned with in the global motorcycle racing scene. Similarly, Gilera made waves with its innovative designs and technological advancements. The company's racing bikes, powered by supercharged engines, set speed records and earned accolades on racetracks around the world. Ducati also emerged as a formidable competitor, particularly in the realm of single-cylinder racing motorcycles.

Despite many obstacles during both World Wars, the industry continued to grow steadily (Capone and Morrison, 2020). While the WWI period saw production focused on military needs, after World War II Italy underwent a period of substantial reconstruction and growth of its industrial production, aided by the Marshall Plan. The aftermath of World War II presented both striking challenges and opportunities for the Italian motorcycle industry. While the country grappled with rebuilding efforts and economic hardships, the demand for affordable transportation soared. Italian manufacturers seized this opportunity to expand their production and cater to the needs of a growing market.

During the 1950s, companies like Vespa and Lambretta gained prominence for their iconic scooters, which offered practicality, affordability, and style. These compact two-wheelers became synonymous with urban mobility and captured the imagination of millions around the world. In the realm of motorcycles, brands like Moto Guzzi, Ducati (est. in 1926 as radio and electrical product company, and reconverted into a motorcycle company after WWII), and MV Agusta (est. in 1945) continued to innovate and excel. Moto Guzzi introduced the iconic Falcone model, known for its reliability and long-distance touring capabilities. Ducati ventured into the realm of sports bikes with models like the Ducati 125 Grand Prix,

showcasing the company's commitment to performance and racing heritage. MV Agusta, under the leadership of Count Domenico Agusta, emerged as a dominant force in motorcycle racing. The company's racing team, led by legendary riders such as John Surtees and Giacomo Agostini, secured countless victories in Grand Prix racing, earning MV Agusta a reputation for excellence and innovation. The company's production figures reflected its reputation as a premier manufacturer, with a focus on craftsmanship and innovation derived from racing.

In the 1960s, motorcycle and scooter registrations declined due to a shift towards car ownership (Confindustria ANCM, 2023; Gauk Motors, 2024). The 1960s, however, witnessed a burst of technological advancements and design innovations in the Italian motorcycle industry. Companies pushed the boundaries of engineering and design, introducing new features and technologies that would shape the future of motorcycling. One notable development was the emergence of the "café racer" phenomenon, with motorcycles characterized by stripped-down models customized for speed and agility. Italian manufacturers like Ducati and Moto Guzzi embraced this trend, producing lightweight and nimble bikes tailored for spirited riding – e.g., the iconic Ducati Scrambler. In addition to performance-oriented machines, Italian manufacturers also focused on refining the design and comfort of their motorcycles. Companies like Moto Guzzi introduced innovative suspension systems and ergonomic enhancements to improve ride quality and handling. Furthermore, the 1960s saw the rise of iconic models such as the Ducati Mach 1, Moto Guzzi V7, and MV Agusta 750 Sport. These bikes not only pushed the boundaries of performance but also captured the essence of Italian style and craftsmanship.

The 1970s brought both challenges and triumphs for the Italian motorcycle industry. Economic instability, changing consumer preferences, and increased competition posed

significant hurdles for manufacturers, yet the decade also witnessed remarkable achievements and breakthroughs. One of the most significant developments of the 1970s was the rise of Japanese manufacturers in the global motorcycle market. Companies like Honda, Yamaha, and Suzuki introduced a new wave of technologically advanced and competitively priced motorcycles that posed a formidable challenge to their Italian counterparts. In response to this competition, Italian manufacturers embarked on a quest for innovation and diversification. Ducati, under new ownership, revitalized its lineup with models like the Ducati 750SS and the iconic Ducati 900SS, which combined performance, handling, and style in a winning package. Similarly, Moto Guzzi introduced the legendary Le Mans series, characterized by its distinctive styling and powerful V-twin engines. These bikes not only solidified Moto Guzzi's reputation for performance and reliability but also appealed to a new generation of riders. Despite these challenges, Italian manufacturers continued to excel in motorcycle racing, with Ducati achieving success in Superbike racing and MV Agusta securing victories in endurance competitions. These racing triumphs not only showcased the engineering prowess of Italian motorcycles but also bolstered the industry's reputation on the world stage. However, due to various economic challenges, including the 1973 oil crisis, had a negative impact on sales and registrations.

The 1980s were a decade of evolution and adaptation for the Italian motorcycle industry. With the global motorcycle market becoming increasingly competitive and diverse, manufacturers faced pressure to innovate and diversify their product offerings. One of the defining trends of the 1980s was the proliferation of sport bikes, fueled by advancements in technology and a growing demand for high-performance machines. Italian brands like Ducati and Cagiva led the charge, introducing groundbreaking models such as the Ducati 916 and

the Cagiva Mito, which pushed the boundaries of speed, agility, and handling. In addition to sport bikes, Italian manufacturers also expanded into new segments, including adventure touring and off-road motorcycles. Models like the Ducati Multistrada and the Cagiva Elefant showcased the versatility and adaptability of Italian motorcycles, appealing to riders with diverse riding preferences and lifestyles. Furthermore, the 1980s saw the resurgence of iconic brands such as Moto Guzzi and Aprilia, which underwent revitalization efforts and introduced new models to capture the imagination of riders around the world. Moto Guzzi's introduction of the California series and Aprilia's launch of the Tuareg series demonstrated the enduring appeal and innovation of Italian motorcycles.

As the 1990s dawned, Italian scooters experienced a renaissance, propelled by a resurgence in popularity and a wave of innovation that would redefine urban mobility for decades to come (Confindustria ANCM, 2023; Encyclopedia Britannica, 2024a, b). The 1990s saw the iconic Vespa, produced by Piaggio, reclaim its status as the epitome of chic and practical transportation. With its sleek lines, vibrant colors, and unmistakable silhouette, the Vespa captured the hearts of commuters and trendsetters alike. As Italy embraced economic prosperity and cultural revival, the Vespa became a symbol of freedom, fashion, and flair. Piaggio, recognizing the potential of the global market, expanded its reach beyond Italy's borders, exporting Vespas to destinations around the world. But the Vespa was not the only Italian scooter to make waves in the 1990s. Companies like Aprilia, Malaguti, Italjet and Gilera emerged as formidable competitors, introducing their own lineup of sleek and sporty scooters designed for urban adventurers and thrill-seekers. Aprilia, known for its prowess in motorcycle racing, leveraged its racing heritage to create the SR series of high-performance scooters. With cutting-edge technology, agile handling, and eye-catching design, the Aprilia

SR captured the imagination of a new generation of riders. Meanwhile, Gilera made waves with its innovative DNA scooter, featuring a futuristic design and advanced engineering. With its hybrid motorcycle-scooter concept and powerful performance, the Gilera DNA pushed the boundaries of traditional scooter design, paving the way for a new era of urban mobility. In 1991, Malaguti introduced the F12 Phantom, a sleek and sporty scooter that captured the attention of riders seeking performance and style. With its aerodynamic design, powerful engine, and cutting-edge technology, the F12 Phantom became a sensation, winning accolades and setting new standards for scooter innovation.

In the new millennium Italian scooters continued to evolve, embracing technology, and meeting the demands of a changing world. Electric scooters, powered by eco-friendly batteries, emerged as a sustainable alternative to traditional gasoline-powered models. Companies like Vespa and Piaggio led the charge, introducing electric versions of their iconic scooters that combined efficiency, style, and performance. Furthermore, the 2000s saw the rise of maxi-scooters, offering enhanced comfort, storage, and versatility for long-distance travel. Models like the Vespa GTS and the Piaggio X9 appealed to riders seeking the convenience of a scooter without compromising on power or amenities. But perhaps the most significant development of the 2000s was the resurgence of vintage Vespa culture. Enthusiasts around the world embraced the timeless appeal of classic Vespas, restoring and customizing vintage models to reflect their unique personalities and tastes. From custom paint jobs to retro accessories, the vintage Vespa scene thrived, celebrating the nostalgia and romance of a bygone era. In the motorcycle segment, brands like Ducati and Aprilia showcased their engineering prowess with high-performance models like the Ducati Monster

and the Aprilia RSV4. These bikes combined cutting-edge technology with Italian craftsmanship, appealing to enthusiasts and professionals alike.

The 2010s were characterized by a growing emphasis on sustainability and globalization in the Italian motorcycle and scooter industry. With concerns about climate change and air pollution mounting, manufacturers focused on developing eco-friendly vehicles and expanding their presence in international markets. Electric mobility gained traction in the 2010s, with companies like Vespa, Piaggio, and Energica leading the charge. Vespa introduced the Vespa Elettrica, a fully electric scooter that combined classic Italian design with zero-emission technology. Piaggio also expanded its electric scooter lineup, offering models like the Piaggio MP3 Hybrid and the Piaggio Liberty Electric. Meanwhile, Italian motorcycle manufacturers continued to push the boundaries of performance and innovation. Ducati introduced the Panigale V4, a groundbreaking superbike equipped with a four-cylinder engine and advanced electronics. Aprilia unveiled the Tuono V4 1100, a naked sportbike renowned for its agility and power. Globalization played a significant role in shaping the Italian motorcycle industry in the 2010s, with manufacturers expanding their presence in emerging markets like Asia and South America. Companies like Ducati and Piaggio established manufacturing facilities and distribution networks in countries like Thailand, India and Brazil, catering to the growing demand for premium motorcycles and scooters.

As the 2020s unfolded, the Italian motorcycle and scooter industry entered a new era defined by digitalization and electrification. With advances in connectivity and battery technology, manufacturers embraced the opportunities presented by the digital age. Digitalization transformed the riding experience, with manufacturers integrating advanced electronics and connectivity features into their vehicles. Ducati introduced the Panigale V4 S,

equipped with a sophisticated electronics package that included cornering ABS, traction control, and electronic suspension. Electrification continued to gain momentum in the 2020s, with companies like Vespa and Energica leading the way. Vespa expanded its electric scooter lineup with models like the Vespa Elettrica 70 km/h, offering riders enhanced range and performance. Energica introduced the Eva Ribelle, a sporty electric motorcycle equipped with fast-charging capabilities and advanced battery technology. The 2020s also saw the emergence of new trends and technologies in the Italian motorcycle and scooter industry. Companies like Italjet and Lambretta introduced retro-inspired models like the Italjet Dragster and the Lambretta V-Special, capitalizing on the nostalgia for classic designs while incorporating modern features and technology. While the industry experienced a natural halt during the pandemic (2020-2022), traditional bicycles and e-bikes gained popularity during the COVID-19 pandemic (Confindustria ANCM, 2023; Statista, 2024) and some motorbike producers included such vehicles in their portfolio. After COVID-19 period, motorcycles made a comeback while e-bikes continued to grow. Although certain segments of the industry have faced a decline of demand for small-capacity bikes (e.g., Aprilia 50cc and 125cc models) and mopeds - which also corresponded to the exit of some renowned players (e.g., Malaguti) - others new segments like e-bikes, have flourished with new players coming to the market (e.g., Energica). Overall, Italy's two-wheeler industry has shown remarkable resilience in adapting to changing times and shifting consumer demands.

The Structure of the Italian two-wheeler Industry

Scholars highlight that the players in the Italian manufacturers can be classified into three major categories based on their production volumes and product focus: high-volume producers, specialist producers, and niche specialist producers (Muffatto and Panizzolo,

1996). The *high-volume producers*, such as Piaggio, distinguish themselves through substantial production volumes, particularly in the scooter segment. They offer economical urban mobility solutions and primarily focus on low-capacity two-wheelers, typically below 250 cc. Ducati and Aprilia exemplify *specialist producers* that operate at lower production volumes. They concentrate on high-capacity and high-performance two-wheelers, typically exceeding 250 cc. These manufacturers meticulously craft motorcycles with advanced engineering, innovative features, and meticulous attention to detail. Their offerings appeal to enthusiasts seeking powerful and dynamic riding experiences. The *Niche Specialist Producers*, such as Bimota, have a specific focus on medium-low-capacity motorcycles with an emphasis on sports competitions. Despite their lower production volumes, these manufacturers command high prices in the market due to their dedication to performance-oriented vehicles.

In the Italian two-wheeler industry, innovation is a dynamic process that balances engineering advancements and aesthetic appeal. Aesthetics, particularly in the form of fairings, receive significant attention in the design phase, followed by the frame, dashboard, suspension, engine, and transmission. The speed at which innovations are incorporated varies among companies, with volume producers generally adopting a more conservative approach, while specialized producers emphasize faster introductions of new models to keep pace with market changes.

Partnerships play a vital role in fostering growth and competitiveness within the Italian two-wheeler industry. This section reports the role of partnerships as well as how clusters and hubs have been formed by considering both macrolevel factors (networks) and micro

individual- and group-level processes (microlevel activities shaping the localization of economic production, see Aversa, Furnari and Jenkins, 2022).

Three common types of partnerships observed are technological partnerships, the acquisition of new skills and capabilities, and the strategy of internationalization. These partnerships facilitate the expansion of markets, provide access to global customers, and enhance the capabilities of manufacturers (Muffatto and Panizzolo, 1996). Suppliers play a crucial role in the innovation process by providing access to new technologies, skills, and knowledge beyond the capabilities of the client firm. Co-design projects, which involve collaborative efforts from the early stages and are designed by firm approaches, offer different dynamics. These partnerships significantly influence product development by allowing for immediate input on design, improving competitiveness, and enhancing the producer's ability to respond to external changes. In the Italian two-wheeler manufacturing industry, the active involvement of suppliers significantly speeds up the product development process, reduces costs, improves the quality of the end product, and expedites problem-solving. These partnerships facilitate knowledge exchange and coordination, which in turn enhances innovation (Lipparini, Lorenzoni and Ferriani, 2013).

The Italian two-wheeler industry consists of companies of different sizes, each focusing on diverse market segments and performing distinct functions. These companies can be categorized into three main groups, including motorcycle manufacturers, motorcycle component manufacturers, and motorcycle accessories manufacturers.

Motorcycle manufacturers. In 1971, Honda entered the Italian market and established IAP (Industria Automotoagricola Produzione) Industriale in Atessa, Italy. By 1981, Honda had become the market leader in Italy's motorcycle industry with a 24% market share as of 2022.

Italy plays a crucial role in Honda's European operations, accounting for 54% of the company's total production. Honda offers a diverse range of products, including scooters like SH, Forza, and ADV350, as well as motorcycles such as NS125R, Hornet, TransAlp, and Africa Twin. The Atessa factory is involved in precision work, assembly, welding processes, and painting, ensuring strict quality control and fostering innovation (Honda industriale website, 2024)

Piaggio, established in 1884, is the largest manufacturer of scooters and motorcycles in Europe. The Piaggio Group oversees well-known Italian brands such as Vespa, Aprilia, and Moto Guzzi. Piaggio has a history of early ventures into electric mobility, demonstrating a commitment to eco-friendly solutions. The company continues to innovate in the electric vehicle sector, contributing to the development of core components for 2-, 3-, and 4-wheel electric vehicles (Piaggio Group, 2017).

Ducati, established in 1926, initially focused on the production of small Manens capacitors. Following World War II, the company shifted its focus to the manufacturing of two-wheelers, introducing the Cucciolo, which was an internal combustion micro-engine mounted on a bicycle frame. During the 1960s and 1970s, Ducati underwent a significant transformation towards performance motorcycles, with a strong emphasis on technology, style, and design. In the realm of electric vehicles, Ducati is actively exploring electric motorcycles and has secured a contract to supply e-motorcycles to all participating teams in the MotoE racing series starting from 2023. Additionally, the company is also exploring alternative power sources such as hydrogen and biofuels (Ducati, 2023; Phillips, 2023).

Moving on to *motorcycle component manufacturers*, Brembo, founded in 1961, specializes in braking systems. The company attained market leadership in the 1970s for its motorcycle braking systems and subsequently expanded its presence globally. In the 2000s,

Brembo strategically invested in India, China, and Poland. One of the company's innovative approaches includes the launch of a new brand, Bybre, which is dedicated to braking systems for scooters and small- to mid-sized motorcycles in BRIC countries and other Southeast Asian countries (Brembo website, 2020). The Brembo Group also acquired, in 2000, Marchesini (established in 1988), which initially operated as an aluminum and magnesium foundry before transitioning into the manufacturing of high-performance motorcycle wheels. Nowadays, the company collaborates with top teams in MotoGP, SuperBike, and SuperMotard racing, supplying wheels for both racing and road models (Marchesini Wheels website, 2024).

Pirelli, founded in 1872, began its journey with the production of elastic rubber items and subsequently expanded into tire manufacturing. The company's innovative approach in sport tires, radial tires, and motorcycle tires during the 1980s solidified its position in the industry. In the 2000s, Pirelli strategically focused on becoming a pure tire manufacturing company through divestments (Pirelli website, 2024).

One of the *motorcycle accessories manufacturers*, Rizoma, established in 2001, brings a sense of style and modern design to the motorcycle accessories industry. The company has expanded its product range from mirrors to turn signals, light kits, levers, grips, and pegs. Rizoma has established collaborations with Ducati and Lamborghini, and in the electric vehicle segment, it has partnered with EV manufacturer Alpine for the development of an all-new concept car (Rizoma website, 2024).

Alpinestars, founded in 1963, initially focused on providing protective boots for motocross riders. Over time, the company expanded its product range to include footwear, riding suits, helmets, gloves, protection padding, and motorcycle airbags. Alpinestars is

renowned for its innovative approach and introduced TechAir motorcycling airbags in 2001 (Alpinestar website, 2024)

Established in 1972, Dainese specializes in the design and manufacturing of protective gear for motorcycle riders. Its product portfolio encompasses motorcycle trousers, gloves, and D-air racing suits equipped with airbags for motorcyclists. Dainese has also expanded its reach to other sports such as MTB, snowboarding, and skiing through its No Impact business division (Dainese website, 2024).

AGV, founded in 1947, revolutionized helmet design with its fiberglass crash helmet in 1954. Following its acquisition by Dainese in 2007, AGV continued to innovate with its integrated technical design approach known as AGV Extreme Standards. The company's helmets have been embraced not only by motorcycle racers but also by Formula 1 racing drivers (AGV website, 2024).

Geography and Localization of the Italian Industry

The geographical localization of the Italian two-wheeler industry is deeply rooted in the country's historical, cultural, and economic landscape, shaping the development and growth of this sector over the years. Italy's geographical features, coupled with its rich industrial heritage and skilled workforce, have played a crucial role in establishing the country as a global hub for motorcycle and scooter production.

Located in Southern Europe, Italy boasts a diverse terrain that ranges from planes and the snow-capped Alps in the north to the sun-drenched Mediterranean coast in the south. This varied landscape has influenced the design and functionality of Italian motorcycles and scooters, with manufacturers producing models tailored to navigate both urban streets and

rugged countryside roads. Additionally, Italy's favorable climate allows for year-round riding, further fueling the demand for two-wheeled vehicles.

The heart of the Italian two-wheeler industry lies in the Emilia-Romagna region which hosts the so-called "Italian Motor Valley," and it is home to some of the most iconic motorcycle brands, including Ducati, MotoMorini, Italjet, and Malaguti. These companies benefit from the region's robust infrastructure, skilled labor force with specialization in mechanics, and proximity to research and development centers as well as major Universities (e.g., Bologna, Modena, Reggio Emilia, Parma, among others).

Lombardy, the most connected, international and industrialized area of Italy, is also home of some iconic brands such as MV Agusta, Moto Guzzi and Innocenti (maker of Lambretta). Beyond Emilia-Romagna, other regions of Italy also play a significant role in the two-wheeler industry. The Veneto region, home to brands like Aprilia and Benelli, boasts a long tradition of mechanical and motorcycle manufacturing, with a focus on high-performance bikes and racing heritage. Tuscany, known for its picturesque landscapes and cultural heritage, is home to companies like Piaggio (maker of Vespa and many other iconic scooters).

Italy's strategic location within Europe has also contributed to the success of its two-wheeler industry. Situated at the crossroads of major trade routes, Italy has easy access to key markets in Europe, Africa, and the Middle East. This geographic advantage has allowed Italian manufacturers to expand their global footprint and establish a strong presence in international markets.

Furthermore, Italy's commitment to research and development, coupled with government support for the automotive and motorcycle industry, has fostered innovation

and technological advancements in the two-wheeler sector. Companies invest heavily in research facilities and collaborate with universities and research institutions to develop cutting-edge technologies and improve the performance, safety, and sustainability of their vehicles.

In conclusion, the geographical localization of the Italian two-wheeler industry is a testament to the country's rich heritage, skilled workforce, and strategic positioning within Europe. Italy's diverse regions have nurtured a thriving ecosystem of motorcycle and scooter manufacturers, driving innovation, and shaping the future of urban mobility.

Intellectual Property in Italy

The concept of patents, aimed at protecting inventions and encouraging innovation, began to gain traction in Europe during the 18th century. While Italy did not have a unified patent system at this time, individual city-states such as Venice and Florence granted patents for certain inventions. Similarly, trademarks started to emerge as a means of distinguishing goods and services in the marketplace. The early 19th century saw the spread of Napoleonic legal reforms across Europe, including Italy. Napoleon's legal code introduced provisions for intellectual property rights, laying the groundwork for modern IP laws. The Code recognized patents, trademarks, and copyright as legally protected rights, marking a significant step forward in IP legislation. With the unification of Italy in the mid-19th century, efforts were made to establish a unified patent system across the country. The Italian Patent Law of 1860 provided a framework for granting patents, thereby stimulating technological innovation and industrial development. The latter half of the 19th century saw the enactment of copyright laws aimed at protecting literary and artistic works. The Italian Copyright Law of 1882

provided creators with legal protections for their original works, promoting cultural expression and creativity.

The interwar period saw the enactment of the Industrial Property Code, which consolidated various aspects of intellectual property law into a comprehensive legal framework. This code strengthened protections for patents, trademarks, and industrial designs, fostering innovation and economic growth. Italy became a signatory to various international treaties and agreements aimed at harmonizing intellectual property laws on a global scale. Membership in organizations such as the World Intellectual Property Organization (WIPO) and the European Patent Convention (EPC) further integrated Italy into the international IP community. Intellectual property protection, particularly through patents, played a crucial role in fostering innovation within the motorcycle industry. Italian manufacturers filed patents for technological advancements such as engine designs, suspension systems, and safety features, driving continuous improvement and differentiation in the market. Trademarks became instrumental in establishing brand identity and reputation within the Italian motorcycle industry. Iconic logos and insignias, such as Ducati's winged emblem and Moto Guzzi's eagle, not only distinguished these brands but also conveyed a sense of quality, performance, and heritage to consumers. Ducati became known for being one of the first motorcycle companies (together with Harley Davidson) to register its distinctive sound derived by its specific mechanical engineering and the desmodromic engine system (imported from automotive and patented). Despite robust legal frameworks, enforcing intellectual property rights in Italy posed challenges, including issues related to counterfeiting, piracy, and infringement. The motorcycle industry, with its global appeal and lucrative market, faced threats from counterfeit parts, unauthorized replicas, and intellectual

property theft, necessitating concerted efforts by authorities and industry stakeholders to combat such practices.

The evolution of intellectual property in Italy, from the 19th century to the present day, has been intertwined with the growth and development of the motorcycle and two-wheeler industry. Through the protection of patents, trademarks, and copyrights, Italian manufacturers have been able to innovate, differentiate, and compete in the global marketplace. As the motorcycle industry continues to evolve and embrace new technologies, intellectual property will remain a cornerstone of innovation, driving progress and shaping the future of mobility.

THE JAPANESE TWO-WHEELER INDUSTRY

The Evolution of the Two-Wheeler Industry in Japan

According to the Japan Road Traffic Act (Act No. 1505 of 1960), a two-wheeler is officially defined as a "motorized bicycle: a vehicle that has a motor with total emissions or rated output not exceeding that which Cabinet Office Order prescribes, which is operated without recourse to rails or overhead wires, not including a bicycle, wheelchair being used by a person with a physical disability, or a wheeled walking aid or small vehicle." This definition encompasses vehicles equipped with a motor whose total emissions or rated output do not exceed the specifications outlined in the Cabinet Office Order.

The historical progression of Japan's motorcycle industry offers evidence of the nation's recovery and transformation following WWII. After experiencing extensive devastation during the Second World War, Japan faced a severe scarcity of resources needed for manufacturing, including those necessary for motorcycle production (Swim, 1967). The aftermath of the war left Japan significantly behind the Western countries in terms of technology due to its isolation during the conflict (Oshima, 1984). To bridge this technological gap, the Japanese government adopted a strategy of importing foreign technology and promoting domestic production, even if the initial quality was lower than imports. This approach paved the way for gradual improvements and competitiveness in the export market (Herbig and Jacobs, 1997).

In the immediate post-war era in Japan, marked by the urgent need for fast and affordable transportation, Soichiro Honda seized a unique opportunity. Recognizing the demand for quick and convenient mobility solutions, he envisioned an innovative concept in the early post-war years: retrofitting surplus generator motors onto bicycles – a similar idea of what Ducati in Italy had experimented with "Il Cucciolo" engine in 1946. This idea gave rise to the 'Honda motor bicycle' in 1948 and marked the establishment of Honda Motors. In

collaboration with Takeo Fujisawa, Soichiro Honda laid the groundwork for a company synonymous with innovation in the motorcycle industry (Honda website, 2024). As Japan's economy gained momentum, motorcycle production soared. In 1948, approximately 1,000 motorcycles were manufactured, followed by 1,766 in the subsequent year and 2,633 in 1950, with a notable contribution from motor scooters (Swim, 1967).

In the early 1950s, Suzuki entered the motor-vehicle sector, overcoming labor challenges and financial crises within the company (Suzuki website, 2024). Shortly thereafter, in 1955, Yamaha became one of the motorcycle manufacturers in Japan. By the mid-1950s (Yamaha Motor website, 2024), Japan witnessed a surge in motorcycle demand, attracting several new players to the market. Interestingly, Honda emerged as the leading motorcycle manufacturer in the country during this period, despite facing the obstacle of a devastating earthquake in 1955.

By 1959, Honda had firmly established its dominance in Japan, driven by its star product, the "nifty fifty," which captured an impressive three-quarters of the domestic market share. Simultaneously, Honda set its sights on the international arena, initiating plans to develop an export market and participate in the prestigious Isle of Man TT races (Swim, 1967). In 1959, Honda commenced overseas sales for the first time, with the United States being the initial target. The year 1960 marked the birth of Honda R&D, dedicated to the creation of larger, more advanced, and faster motorcycles capable of competing in the expanding global racing circuits (Honda website, 2024).

The subsequent decade witnessed the active participation of Japanese manufacturers, such as Suzuki, Yamaha, and Honda, in events like the Isle of Man TT and F1 Grand Prix, driven by their ambition to cultivate export markets and gain international recognition. This strategic

move stimulated higher demand for exports following the liberalization of international trade and foreign exchange in 1960. By the early 1960s, Japan had emerged as the largest manufacturer of motor vehicles within its borders and surpassed Germany to become the world's leading motor vehicle producer. During the 1960s and 1970s, Japanese motorcycle manufacturers expanded their product lines, catering to diverse consumer preferences. From lightweight commuter bikes to high-performance models, Japanese motorcycles gained popularity across the globe. This period also saw rapid technological advancements, including the introduction of four-stroke engines, disc brakes, and electric starters. Japanese manufacturers led the way in incorporating these innovations into their motorcycles, setting new standards for performance and reliability.

The 1980s brought economic challenges, including fluctuations in currency exchange rates and increased competition from other Asian manufacturers. Japanese companies responded by focusing on efficiency, quality control, and global expansion. Growing concerns about pollution and fuel efficiency led to the development of cleaner, more fuel-efficient motorcycles. Japanese manufacturers embraced these challenges, investing in research and development to produce eco-friendly models. In the 1980s, Yamaha Motor Co. took a pioneering step to address growing environmental concerns by introducing the world's first electrically powered bicycle models in 1993. This innovative move aligned with the global shift towards eco-friendly mobility solutions. Yasuhiro Kashima, the sales manager at Yamaha Motorcycle Sales Japan Co., emphasized the company's commitment to eco-conscious products. Initially, electric bicycles gained popularity among elderly individuals with declining physical capabilities. However, a significant surge in sales occurred in 2009 due to the implementation of new traffic regulations. During the 1990s, Japan faced unique power and

licensing restrictions, resulting in the production of motorcycle models that were not available elsewhere globally. Specifically, the limitations on power output and license acquisition for larger motorcycles led to the creation of miniature replicas of their more powerful counterparts, the 750cc and 900cc bikes, in the form of 250cc and 400cc motorcycles. By the 1990s, the Japanese motorcycle market had become saturated, prompting manufacturers to explore new markets and diversify their offerings. This period saw the emergence of niche segments, such as adventure touring bikes and cruiser motorcycles.

In year 2000s Japanese motorcycle manufacturers continued to expand their global footprint, establishing production facilities and distribution networks in key markets worldwide. This globalization strategy enabled them to remain competitive in an increasingly interconnected world.

The 21st century witnessed a rapid integration of technology into motorcycles, including advanced electronics, ride-by-wire systems, and connectivity features. Japanese manufacturers embraced these advancements, enhancing the performance, safety, and convenience of their motorcycles. With a growing emphasis on sustainability and electric mobility, Japanese manufacturers are today investing in electric motorcycles and alternative propulsion systems. This commitment to innovation ensures that Japan remains at the forefront of the evolving motorcycle industry. Sales of electric bicycles more than doubled from 2008 to 2018, while sales of scooters equipped with engines of 50 cc or less experienced a substantial decline during the same period. These shifts in consumer preferences and market dynamics demonstrate the industry's adaptability to changing environmental concerns and regulations.

Japan is home to one of the largest motorcycle manufacturing industries in the world, characterized by the dominance of four major players: Honda, Suzuki, Yamaha, and Kawasaki. Key export destinations for Japanese motorcycles include Europe and North America. To meet the local demand for motorcycles with lower-capacity engines, Japan imports bikes from other Asian regions, further demonstrating the adaptability of the industry. The post-pandemic Covid-19 era has witnessed a growing demand for bicycles and e-bikes, reflecting the shifting preferences in the local market.

The trajectory of Japan's motorcycle industry portrays a scenario influenced by various factors, which casts doubt on the future performance of the domestic market. The declining popularity of motorcycles for recreational purposes is expected to continue having a ripple effect on sales figures in the domestic market. At the same time, there is an emerging trend in Japan's metropolitan areas, characterized by the increasing adoption of bicycles. In particular, electric power-assist bicycles, known as e-bikes, have experienced a remarkable surge in sales.

Over the years, Japanese manufacturers made substantial investments in research and development. Honda, under the guidance of Soichiro Honda, stood as a trailblazer, consistently pushing the boundaries of technological advancements (Swim, 1967). Pioneering breakthroughs, such as efficient engines and enhanced safety features, were the outcomes of these investments. Environmental consciousness and stringent emissions regulations compelled Japanese manufacturers to pioneer cleaner technologies. The COVID-19 pandemic served as an additional catalyst, hastening the focus on innovations within engine design, fuel injection, and emission control systems (Frost and Sullivan, 2023). Adherence to regulations

demonstrated an unwavering commitment to eco-friendly solutions, thus propelling motorcycle technology forward.

Business Models and Partnerships

The evolving business models in the Japanese motorcycle industry, emphasizing innovation and sustainability, have shaped its enduring success. Partnerships and collaborations further illuminate these shifts, contributing to the industry's dynamic landscape. For example, during the 1960s and 1970s, Suzuki and Kawasaki engaged in a pivotal engine supply agreement, with Kawasaki supplying engines to Suzuki for specific motorcycle models. This symbiotic collaboration allowed both entities to effectively utilize their resources, resulting in an expanded and diversified product portfolio. Furthermore, in the 1980s, Honda made a strategic move by acquiring a controlling interest in Montesa, a Spanish motorcycle manufacturer. This acquisition allowed Honda to expand its range of products and enter the trials and off-road motorcycle segments, demonstrating the impact of acquisitions on diversifying the industry.

Not only individual manufacturers, but the entire motorcycle industry has been affected by these significant partnerships and acquisitions. The level of connectivity within the Japanese motorcycle industry serves as a measure for evaluating cohesion, competitiveness, and the collective shaping of the market. Higher connectivity indicates a closely-knit community potentially working together, which is essential for understanding industry dynamics (Hausmann, et al., 2014).

Geography and Localization of the Japanese Industry

The Japanese Big Four, which consist of Honda, Kawasaki, Yamaha, and Suzuki, represent the dominant forces within the motorcycle industry in Japan. The locations where

the companies are based (Tokyo, Hamamatsu, Kobe and Iwata) of motorcycle production played a pivotal role in shaping the capabilities, complexity, and resources of Japan's motorcycle industry. Accounting for more than a quarter of global motorcycle sales, these four giants have played a crucial role in guiding the industry's evolution and fostering innovation.

Tokyo stands as a bustling center of economic activity and innovation, serving as the capital city of Japan. Within its boundaries lie the headquarters and major facilities of several prominent motorbike manufacturers. Notably, Honda Motor Co., Ltd. has established its headquarters in Minato, Tokyo, where strategic decisions, research, and development efforts shape the company's vision and products (Honda website, 2024). Furthermore, Yamaha Motor Co., Ltd. has also established its headquarters in Japan and maintains a network of group companies and affiliates across the country (Yamaha Official website, 2024), contributing to Tokyo's esteemed status as a hub for motorcycle manufacturing.

Hamamatsu proudly carries the distinguished title of the "Motorcycle City" of Japan and serves as a significant cluster for motorcycle production. It holds a unique place in the history of motorcycling, being the birthplace of industry giants such as Honda, Suzuki, and Yamaha. Notably, Hamamatsu witnessed Honda's creation of Japan's first original motorcycle design, a remarkable achievement that set the tone for the city's enduring association with motorcycles (In Hamamatsu, 2023). In the era following World War II, Hamamatsu played a vital role in supporting and nurturing the culture surrounding motorcycles. Despite the devastation caused by the Pacific War, the city displayed remarkable resilience and determination, which facilitated the establishment of numerous businesses related to motorcycles. Soichiro Honda, a native of Hamamatsu, founded the Honda Technical Research

Institute in the city's wooden barracks, marking the beginning of motorized bicycles and motorcycles in Japan. Hamamatsu saw the emergence of over 30 motorcycle manufacturers, with renowned companies like Suzuki Loom and Yamaha (previously known as Japan Musical Instrument Manufacturing) achieving global recognition. As the birthplace of the motorcycle, Hamamatsu's legacy remains vibrant, symbolizing the spirit of innovation in the face of adversity.

Kobe boasts a rich history of manufacturing and industrial prowess. Kobe's contribution to the motorcycle industry is rooted in its strong manufacturing heritage. Notably, Kawasaki Heavy Industries, which originated in shipbuilding, has its headquarters in this city. The Kobe Maritime Museum, which includes the Kawasaki Good Times World, serves as a testament to Kobe's enduring connection to industry and technology and the transfer of capabilities across different industrial domains.

Located in the Shizuoka prefecture, *Iwata* played a crucial role in Yamaha's entry into the motorcycle market. Here, in 1955, Yamaha Motor Co., Ltd. was established as a distinct company (from the musical instrument production) to oversee the company's motorcycle production. The city of Iwata serves as the headquarters for Yamaha's motorcycle manufacturing operations. Notably, the Iwata South Factory (Bldg. M2) stands as a facility with a well-documented history of producing high-quality motorcycle parts. Iwata's significance lies in its contribution to Yamaha's diverse range of motorcycles and its unwavering commitment to maintaining exceptional production standards.

Despite their Japanese roots, the key players have a reach that extends far beyond their home country. A considerable proportion of their motorcycle production takes place on foreign shores, surpassing domestic manufacturing. The Japanese Big Four exemplify how

capabilities rooted in the national realm can drive not only the evolution of the domestic market but may also have a profound and lasting influence on the global motorcycle landscape.

Intellectual Property in Japan

During the period of post-World War II recovery, spanning from 1945 to the 1960s, a significant milestone was the implementation of Japan's Patent Law in 1959. Although it did not explicitly address inventor's rights or exclusive rights, its main objective was clearly stated as promoting industrial development by fostering the protection and exploitation of inventions.

During this period, Japan's Ministry of International Trade and Industry (now known as METI) assumed a leading role in guiding industrial policy. METI introduced a range of policies aimed at promoting research and development, facilitating the transfer of technology, and fostering growth oriented towards exports. While these policies were not directly aimed at the motorbike manufacturing industry, they indirectly contributed to its advancement by providing access to technological advancements.

In the 2000s, Japan implemented a comprehensive National Intellectual Property Strategy, which played a pivotal role in fostering innovation, driving economic growth, and enhancing global competitiveness. This strategy encompassed a wide range of initiatives, including strengthening intellectual property (IP) protection, promoting research and development, and facilitating the application of IP in various industries, such as motorbike manufacturing. It is worth mentioning that the Intellectual Property Strategy Headquarters,

established within the Cabinet in 2003 and led by the Prime Minister, annually reviews and approves this strategy (Arai, 2007).

The Japanese government's endorsement of the Intellectual Property Promotion Plan 2022 in June 2022 clearly demonstrated its commitment to further enhancing the infrastructure and systems related to intellectual property (Ebata and Hino, 2022). Supporting these efforts were initiatives to encourage businesses to actively protect and leverage their intellectual property, which included facilitating patent filings, enabling licensing arrangements, and implementing effective IP management practices.

Lastly, Japan's active engagement in international IP agreements and initiatives, in line with the global standards outlined in the World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), has strengthened the country's role in shaping the evolving landscape of global IP frameworks (WTO, 2017).

THE INDIAN TWO-WHEELER INDUSTRY

The Evolution of the Two-Wheeler Industry in India

The term "two-wheelers" in India refers to a type of motorized mobility vehicle that can have either two or three wheels and is used for commercial or personal purposes. Legally, these vehicles require registration and a driver's license in order to be operated. They can be powered by either an internal combustion engine (ICE) or an electric battery motor. Motorcycles in India can be broadly categorized into two types. The "Indian design" motorcycles were equipped with two-stroke engines and had an engine capacity of 100-175 cc. Brands such as Escorts and Jawa produced motorcycles of this type. On the other hand, the so-called "British design" motorcycles with four-stroke engines with an engine capacity of 346 cc and a power rating of 13.4 kW. The Royal Enfield is an example of a motorcycle that falls into this category (Royal Enfield website, 2023).

The historical development of the two-wheeler industry in India can be traced back to the period between the 1950s and 1980s. During this time, the market operated as a seller's market, with only a few Indian brands available and limited access for foreign companies. Vehicle options were also limited and targeted different market segments. One of the early players in the scooter market was Bajaj, which began trading imported Vespa scooters in 1948. Later, in 1959, Bajaj started manufacturing these scooters under license from Piaggio. This agreement expired in 1971.

In the period from the mid-1980s to the mid-1990s, the two-wheeler market in India witnessed the introduction of new brands and models. This trend was driven by higher urban incomes following economic liberalization, which brought significant changes in buyer preferences and motorcycle profiles. One notable addition to the market was the gearless scooter produced by Kinetic-Honda, which catered to individuals who faced difficulties operating geared vehicles or mopeds. During this period, scooters enjoyed higher sales compared to motorcycles and mopeds, although motorcycles began gaining popularity in the late 1980s. The demand for motorcycles was primarily for commuter models, with some demand for scramblers that offered more power and the ability to navigate different types of terrain. This era also marked the emergence of four Indo-Japanese joint ventures that produced fuel-efficient and low-powered motorcycles.

The period from 2000 to 2010 was characterized by the prevalence of four-stroke engines, which can be attributed predominantly to shifts in government regulations regarding pollution control standards following the Kyoto Agreement in 1997. This led to the gradual elimination of two-stroke engines from motorcycle production. Consequently, four-stroke engines experienced significant growth while the usage of two-stroke engines

declined. During this time, the market share of mopeds witnessed a decline from 30% in 2000 to 10% in 2003. This can be attributed to the increasing availability of high-quality second-hand motorcycles as well as the introduction of low-powered automatic scooters. Conversely, there was a steady demand for scooters, with the Honda Activa, India's most popular scooter, capturing the top spot since its launch in 1999 and continuing to do so until 2021, with sales exceeding 25 million units. Motorcycles remained the primary drivers of growth in the two-wheeler sector, while scooters and mopeds experienced a progressive decline. The market share of motorcycles grew from 21% in 1994 to 43% in 2000 and eventually reached 77% by the mid-2000s. Hero Honda emerged as the leading seller of motorcycles globally between 2001 and 2007. During this period, the industry's product portfolio expanded with the introduction of entry-level performance motorcycles. The Hero Honda CBZ (156.88 cc) was launched in 1999, followed by the Bajaj Pulsar (150/180 cc) in 2001.

From the 2010s onwards, there has been an increasing demand for high-performance motorcycles. However, the majority of the market share in the country is still dominated by sub-125cc engine motorcycles. In FY2020–21, engines smaller than 125 cc accounted for 85% of two-wheeler sales, with seven out of the ten best-selling models falling into this category. This also included two scooters and one moped.

Electric motorcycles are currently experiencing a decline in battery prices, the localization of parts, the emergence of charging infrastructure, and the availability of battery swapping options, which has resulted in a decrease in operating costs, making them almost as affordable and accessible as traditional motorcycles (Economic Times, 2021). However, the electric motorcycle segment in India is still in its infancy. Its penetration rate increased only minimally from 0.1% in FY2017-18 to 0.2% in FY2019-20, reaching 0.3% in FY2020-21 (Anup,

2021). Currently, electric two-wheelers account for 4% of all two-wheelers sold in 2022, a significant increase from the 1% share in 2021. Additionally, 40% of three-wheelers sold in 2022 were electric. When combined, two-wheelers and three-wheelers accounted for 92% of all electric vehicles registered in 2022 (Economist, 2023).

The composition of the two-wheeler industry's market share in FY2020-21 consisted of 66% motorcycles, 29% scooters, and 4% mopeds. Furthermore, 85% of two-wheeler sales were for engines smaller than 125 cc. These trends indicate a notable growth in sales of higher-performance engines (Anup, 2021). The manufacturing and technological capabilities of major Indian two-wheeler manufacturers evolved from an initial reluctance to innovate prior to economic liberalization, to a dependence on foreign technology, and ultimately to the development of domestic capabilities that could meet domestic demand and cater to global markets. However, the majority of Indian two-wheelers, both domestically and internationally, are relatively less technologically advanced due to the limited specialization of the Indian workforce, which restricts diversification within the industry (Balland et al., 2022).

The Geography and Localization of the Indian Two-wheeler Industry

There are fundamentally three two-wheeler hubs in India. These hubs can be traced back to the mid-1950s when family-owned conglomerates like TVS in Chennai and Escorts in Delhi were dominant. The industry transitioned towards localized industrialization in the early 1960s after the progressive countermeasures against imports which started in 1957. The 1963 the 'Monopolies and Restrictive Trade Practices Act' introduced licensing regimes, fostering the growth of public-sector enterprises. The policies of economic liberalization started in 1991

played a pivotal role in the rapid evolution of the two-wheeler industry, with states like the National Capital Region, Maharashtra, and Tamil Nadu attracting investments and significantly contributing to the industry's growth.

Throughout history, India has witnessed the emergence and evolution of three major hubs for two-wheeler production: Chennai, Pune, and the National Capital Region (NCR) (primarily Delhi). The technological advancements and capabilities of these hubs are closely intertwined with their composition and characteristics, from their inception to their current prominence.

Chennai, the capital of Tamil Nadu, holds significant historical importance as a hub for two-wheeler manufacturing. It was home to the initial manufacturing plants of Royal Enfield and TVS Motor Company, both of which are currently headquartered in the city. Foreign investments, particularly from Japan, have contributed to the attractiveness of Chennai as a hub. The region is also host to various players such as BMW Motorrad and Yamaha, alongside major automobile companies and electronic firms. In recent years, Tamil Nadu has witnessed a surge in manufacturing, accounting for 15.8% of all factories in India in 2020. It has also become a manufacturing base for leading electric scooter companies, and it is recognized for its comprehensive industrial and technological presence, encompassing software, information technology services, and startup ventures.

Pune, a notable center for automobile manufacturing, accommodates the oldest manufacturing facility of Bajaj Auto and its present research and development department. Throughout the years, Pune has enticed major automobile manufacturers and is designated as a key foreign investment zone for German companies. Pune has transformed into a pivotal center for automobiles, durable goods, and information technology services. It holds the

position as the third-largest contributor to information technology exports, hosts numerous startups, and will allure a substantial portion of industrial investment in India in 2020. The Automotive Research Association of India, established in 1966 in Pune, contributes to research, development, testing, and certification services in Pune.

The *NCR hub* encompasses Delhi, Haryana, and sections of Uttar Pradesh. It hosted the initial manufacturing facility of Hero Motocorp, India's largest motorcycle producer. Haryana, within the NCR, has emerged as a major participant in producing passenger cars. Delhi, part of the NCR, has attracted foreign investments from Japan and the Republic of Korea, resulting in a diverse manufacturing sector that includes two-wheeler brands such as Honda, Yamaha, and Suzuki. Noida, a region within Delhi, serves as a hub for manufacturing electronic hardware and information technology, making a significant contribution to India's mobile phone manufacturing.

Changes in demographics have recently influenced consumer preferences in India, with a growing demand for innovative features and enhanced performance in two-wheelers. This shift has caused a surge in demand within the premium two-wheeler segment, accompanied by a decline in the basic segment. The process of urbanization has played a crucial role in this trend, with projections indicating that by 2030, there will be over 500 million urban residents. This, coupled with emergence and expansion of a consumer class, is expected to drive the growth of the two-wheeler market (McKinsey, 2018). The significance of two-wheelers for mobility in India can be inferred from the increase in the proportion of two-wheelers among all vehicles in the country and the rise in the number of registered two-wheelers over the past seven decades.

The national market in India, as of 2020, is made of circa 1.3 billion individuals, which constitute 19% of the global population. 31% of the population resides in urban regions, and India holds the position as the world's 6th largest consumer market. The country's GDP per capita in 2019 amounted to \$2100. In 2019, 49.7% of households possessed at least one two-wheeler, marking an increase from 37.7% in 2018 (Team BHP, 2022). The two-wheeler market has expanded by meeting local demands while constraining imports to locally and foreign-produced vehicles by companies for export purposes. Policies that facilitated economic liberalization, foreign collaborations, and foreign direct investment have contributed to the growth of the market. Furthermore, the standardization of emission and safety policies to align with global norms has reduced the discrepancy between the vehicles and components produced. In 2005–06, India had 11 producers that exported 0.5 million two-wheelers from the country. In 2014–15, 10 manufacturers exported 2.5 million two-wheelers. India became the largest producer of motorcycles during 2016–17 (SIAM website, 2023).

Intellectual Property in India

The development of IP legislation in India began with the adoption of the British Trade Mark Act in 1940 and it has evolved through subsequent acts such as the Trade and Merchandise Act of 1958. The current operational framework is defined by the Trade Marks Act of 1999, which outlines the graphical representation of a trademark and its ability to distinguish goods and services. It typically takes about 18 months for patents application to be published. These applications require a written description and must adhere to criteria such as novelty, non-obviousness, inventiveness, and industrial applicability in order to be approved.

The two-wheeler industry in India has experienced a significant increase in IP activity, particularly after economic liberalization in the early 2000s. This increase in activity has been observed in patent filings related to engines and transportation, reflecting advancements in engine technology to meet stricter emission standards. This shift in perception regarding research and development has transformed intellectual property from being perceived as an additional, sometimes superfluous cost, to being recognized as a strategic investment that is crucial for a company's domestic and global reputation.

Until 2008, major players in the industry had different approaches to IP. Hero Honda, for example, had limited IP holdings and relied heavily on Honda's technology. Bajaj Auto Ltd., on the other hand, exhibited global ambitions with numerous patent filings both domestically and internationally. TVS Motor Company, in contrast, emphasized innovation and had a significant domestic IP portfolio. While IP activities have increased in the country, their primary purpose has been to protect the less complex technologies of specific manufacturers in relatively less advanced products that are demanded by domestic and foreign markets. However, as the nation's economy progresses from a low-income to a middle-income country, it is likely that the less complex technologies will evolve into more complex ones, as theorized by Balland et al. (2022).

COMPARATIVE ANALYSIS: SIMILARITIES AND DIFFERENCES BETWEEN THE ITALIAN, JAPANESE AND INDIAN MARKETS

****Insert Exhibit 3 about here****

Italy, Japan, and India have experienced distinct trajectories of development in their respective two-wheeled industries. Exhibit 3 provides a comparative table of the main differences across the three countries. The Italian industry had its major inception after World War II with the widespread adoption of two-wheelers, and later shifted its focus to performance and style in the 1970s and 1980s. Japan also initiated its motorcycle industry after World War II and continued to expand since then mostly thanks to sales and production in foreign markets. The focus of the Japanese two-wheeler producer has been on research and development, product innovation, and global market expansion. Net of foreign (mostly Japanese) imports, India experienced significant growth of its own motorcycle industry in a later phase, from the mid-1980s to the mid-1990s. This growth was catalyzed by economic liberalization, partnerships with Japanese brands, and rising urban incomes.

The origin and development of motorcycle manufacturing in these countries are rooted in distinct knowledge and capabilities that are the result of their idiosyncratic historical, industrial and economic development. In all three countries the motorcycle industry emerged to respond to a need for convenient and affordable transportation – a solution providing more independence than public transport but inferior costs than cars. Yet, the knowledge base of each country and their economic development led the three industries in different directions. Italian companies primarily came from backgrounds in mechanical equipment manufacturing or bicycle-related accessories and because of this they reapplied their mechanical expertise to excel in motorcycle production. Starting with the 1950s, however,

they embedded capabilities from racing competition to develop high performing bikes, and from the world of industrial and fashion design to produce vehicles that would stand out for their aesthetic qualities, up to becoming, design icons (such as Piaggio's Vespa, or Ducati's Monster). Similarly to Italy, Japan was originally driven by the need for affordable transportation, yet as their capabilities developed, all major Japanese two-wheeler manufacturer diversified into automotive and aerospace. The resulting technological advancements fed back into the motorcycle industry, enabling Japanese production to achieve high levels of performance, efficiency, and functionality, especially with small-sized engines. This led to a production of very versatile motorcycle, which ideally balanced functionality, innovation and affordability. Yet, their design tended to homogenize across the various brands, failing to develop clearly distinctive aesthetics like in the Italian industry. In India, the key companies started from relatively different trajectories: Hero Motocorp started with bicycle components, TVS Motor Company originated from a bus and truck transportation service, while Bajaj Auto began by importing two-wheelers and three-wheelers. These companies leveraged their manufacturing and assembly capabilities to adapt to the growing demands of the motorcycle market. This transition showcases the adaptability of these companies, utilizing their initial capabilities to excel in the production of vehicles that, still today, were mostly geared at responding to a need or convenient transportation. More recently, the country started introducing bikes destined to recreational use with a strong lifestyle component (e.g., Royal Enfield), thus developing models that are more similar to those in the top-segment of the Italian and Japanese industries.

The establishment of motorcycle manufacturing hubs in these countries can be attributed to specific factors. In Italy, the northern regions such as Lombardy and Emilia-

Romagna had well-established industries across various sectors, including a long tradition in mechanical engineering, industrial machines, metal production, rubber, and other materials. These regions also had a highly educated population and early development of technical education facilities, creating favorable conditions for industrial hubs to thrive. In Japan, Tokyo served as a hub for various manufacturing industries, with companies like Honda initially based in Hamamatsu. Other centers developed around other industrial hubs, usually focused on mechanical productions and electronics. In India, Chennai emerged as a hub due to its strategic access to eastern coast ports, which was essential for the automobile industry and its supply network. This region had strong capabilities in mechanics, part production, and assembly. Pune's proximity to Mumbai, India's financial capital, played a pivotal role in its emergence as a manufacturing hub. Delhi also witnessed hub expansion following the establishment of India's largest car producer's manufacturing plant in the region. Delhi developed capabilities in mechanism, part production, metal carpentry, and assembly. These regional hubs highlight the crucial role of infrastructure, accessibility, availability of skilled human capital, and strategic locations in facilitating industrial growth.

Consumer preferences for motorcycles vary among these nations but tended to reconverge with time. In Italy, the market has historically demonstrated a strong inclination towards mopeds and medium-sized motorcycles, ranging from 250cc to 750cc, appreciating models that combine style and performance. In Japan, the market is dominated by mopeds with engines up to 50cc, indicating a preference for compact, efficient, and convenient commuting solutions. In India, motorcycles hold the highest position, with low-powered two-wheelers below 125 cc constituting 85% of total sales. This showcases a focus on practicality, cost-effectiveness, and efficiency in accordance with evolving consumer demands. The

varying preferences underscore the significance of aligning product offerings with consumer needs and market dynamics. Yet, in recent years a common interest for lifestyle and recreational vehicles is increased across all nations (despite with different magnitude) and all countries have displayed an increasing interest for safer and more sustainable vehicles, which has resulted in the development of the electric-powered two-wheelers.

The market share of leading brands is determined by market dynamics and competition. In Italy, Honda, Piaggio, Kymco, and Yamaha hold substantial market shares, with Honda leading the pack in FY 2022. Japan's motorcycle market is predominantly led by the "Big Four" local brands, namely Honda, Kawasaki, Yamaha, and Suzuki, with Honda commanding a the most significant market share. India's top brands include Hero Motocorp, Honda, and TVS, with Hero Motocorp maintaining the highest market share in FY 2023. These statistics on market share reflect the competitive landscape and consumer preferences within each nation's motorcycle industry.

Insights into the scale and strength of the motorcycle markets in these countries can be obtained from domestic sales figures. In Italy, FY 2022 witnessed the sale of 291,799 units domestically, indicating a market of medium size. Japan's FY 2021 sales of 415,890 units demonstrate a comparatively smaller yet significant domestic market, partly due to the country's advanced public transportation infrastructure. India's FY 2023 sales of a staggering 15.9 million units domestically portray the magnitude of its industry, driven by a growing population and increasing urbanization.

Export figures provide evidence of the international competitiveness of these countries' motorcycle industries. Italy, in FY 2022, exported 541,828 motorcycle units, 57,193 mopeds, and a remarkable 27.24 million moped and motorcycle parts, showcasing a thriving global

presence. Japan, in FY 2021, exported 437,042 units, highlighting its substantial contribution to the global motorcycle market. However – differently from their Italian and Indian counterparts – most Japanese brands hold major production sites abroad, which contribute to the performance of their brands despite not being accounted as ‘exports.’ Indian brands in FY 2023 exported 3.65 million units, reflecting the importance of their international presence.

The number of registered motorcycles on the road indicates the enduring popularity of motorcycles in these countries. In Italy, as of 2019, there were 6.89 million registered motorcycles, illustrating a mature and well-established market. Japan, as of March 2021, recorded 10.2 million registered motorcycles, indicative of a country with a strong motorcycle culture in both production and consumption. India, as of 2022, boasted over 210 million registered motorcycles, highlighting the integral and dominant role of motorcycles in the transportation landscape of the nation. The motorcycle industries of these nations manifest distinct market segmentation. Italy and Japan showcase a diverse range of engineering, manufacturing and marketing capabilities that are valuable for catering to a mature and diverse demand with highly diversified. In India, instead, the market is predominantly governed by low-cost volume-focused producers that cater to the high demand for sub-125cc motorcycles. Yet, one can increasingly observe exceptions such as specialist brands like Royal Enfield that cater niche markets or bigger vehicles with a strong lifestyle and leisure component.

Despite originating from a common foundation of capabilities in basic mechanics, metal carpentry, and machine tools, each of these three countries has adopted a distinct approach to innovation within their motorcycle industry. In present-day Italy, there is a significant emphasis on performance and aesthetics, blending style with functionality. Historically,

Japan's strategy involved importing foreign technology and gradually enhancing domestic production through extensive research and development investments, with a focus on performance, utility, and innovation as a combined approach. Indian two-wheeler brands have primarily concentrated on cost-effective and fuel-efficient vehicles, aligning with utilitarian purposes. However, there is an emerging trend towards prioritizing aesthetics and performance.

Partnerships and collaborations play a crucial role in shaping the industry landscape. In Italy, partnerships among local firms are more prevalent than international collaborations. These local partnerships foster technological advancements in the co-development and production of high-tech components for high-performance motorcycles (see Lipparini et al., 2013). Japan's capabilities in fostering knowledge clusters and establishing strong relationships, following the Keiretsu principles, have facilitated partnerships with suppliers and collaborations within both domestic and international markets. In India, particularly from the mid-1980s to the 2000s, strategic partnerships with Japanese brands were dominant, enabling the local production of two-wheelers and access to manufacturing capabilities in production lines and automation, thereby facilitating efficient scaling up. Recent strategic partnerships with foreign brands such as Hero-Harley Davidson, Bajaj-KTM, and TVS-BMW Motorrad highlight the evolving collaboration landscape in India to cater new consumer preferences. The initiation of intellectual property activities varies among these nations. Italy has witnessed pioneers such as Pirelli, Piaggio, and Brembo leading the way in patent filings, indicating a contemporary emphasis on innovation and the protection of intellectual property. Japan adopted a comprehensive approach to IP activity in the 2000s, establishing a National Intellectual Property Strategy, fostering research and development, and facilitating

the application of IP across various industries. India's IP activity gained momentum in the 2000s, coinciding with the termination of joint ventures with Japanese brands, highlighting the country's increasing technological self-sufficiency. This strategic maneuver underscores Japan's dedication to innovation, economic growth, and global competitiveness, coupled with a focus on preserving and safeguarding its competitive edge.

In summary, the motorcycle industry in Italy, Japan, and India exemplifies the enduring influence of adaptability, innovation, and market responsiveness. While each country brings its own distinct strengths and strategies to the forefront, collectively, they enrich the global motorcycle landscape, contributing to an industry that continually progresses, flourishes, and evolves along intricate pathways that enhance and rejuvenate the underlying capabilities rooted within the respective regions. Moreover, these localized capabilities have not only shaped domestic markets but have also left an indelible imprint on the global motorcycle industry, emphasizing that the journey of a thousand miles begins with the initial revolution of a motorcycle's wheel.

Concluding Remarks

Our comprehensive analysis of the three prominent national two-wheeler industries has yielded three primary conclusions.

First, national motorcycle industries evolve along technological trajectories that are shaped by their historical technological background across diverse industries and utilization practices. Consequently, Italy's industry is grounded in connections to aesthetics and racing, which signifies a production focus on distinctive design and performance. Japan's industry is grounded in the redeployment of advanced technologies, which indicates a production focus

on innovation and reliability. India's industry is grounded in fundamental, convenient technologies, which suggests a production focus on efficiency and simplicity.

Second, the motorcycle industry tends to mirror the evolution of the automotive industry across multiple crucial dimensions.

- *Manufacturing Strategies:* Similar to the automotive sector, motorcycle manufacturers often adopt various strategies such as lean manufacturing, automation, and globalization to enhance efficiency and reduce production costs.
- *Innovation and Technology:* Both automotive and motorcycle industries have experienced rapid technological advancements, including the integration of smart features, connectivity, and safety systems in vehicles. For instance, Japanese motorcycle giants such as Honda and Yamaha have been at the forefront of technological innovation by introducing features like anti-lock braking systems (ABS) and advanced rider-assist technologies.
- *Cultural Influences on Design:* Cultural and aesthetic preferences play a significant role in shaping the design and style of vehicles in both car and motorcycle industries. For example, Italian motorcycle design is often associated with elegance and passion, reflecting the iconic and stylish designs seen in Italian automotive brands such as Ferrari, Maserati and Lamborghini.
- *Market Segmentation:* Both industries cater to diverse market segments, offering a range of products from budget-friendly models to luxury and performance-oriented vehicles. For instance, in India, the motorcycle industry has witnessed the emergence of commuter bikes and premium segments, mirroring the segmentation observed in the Indian automotive market, which emphasizes affordability and fuel efficiency.

- *Global Competition and Collaboration:* Intense global competition and strategic collaborations are prevalent in both industries as companies strive to gain a competitive edge and expand their market presence. For instance, joint ventures and collaborations between motorcycle manufacturers in India and international players reflect a strategy akin to that observed in the automotive sector.

Third, international partnerships and the exchange of intellectual property have played a crucial role in shaping the motorcycle industry. Such collaborations have become essential for the evolution of the global motorcycle industry, enabling companies to access new technologies, enhance their competitive positions, and contribute to the overall progress of the industry on a global scale.

In conclusion, the global motorcycle industry is poised for significant evolution in the coming years, driven by technological advancements, shifting consumer preferences, and environmental concerns. With the rise of electric and connected vehicles, the industry is expected to witness a paradigm shift towards sustainability and smart mobility solutions. Moreover, the emergence of new markets, particularly in Asia-Pacific and Africa, presents immense opportunities for growth. However, challenges such as regulatory uncertainties and economic fluctuations may pose hurdles along the way. To thrive in this dynamic landscape, stakeholders must adapt to changing trends, embrace innovation, and foster collaboration across the value chain. By doing so, the motorcycle industry can continue to drive progress and shape the future of transportation worldwide.

EXHIBITS

Exhibit 1: Global market share by revenue (Statista, 2022).

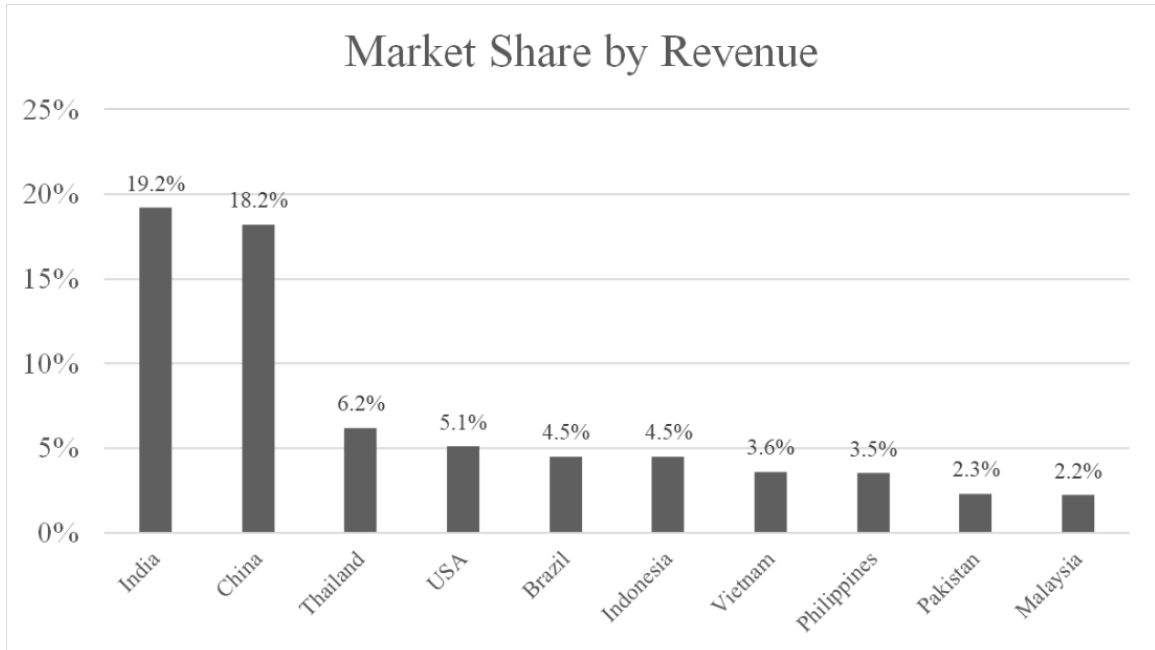


Exhibit 2: Global market share by unit sales (Statista, 2022).

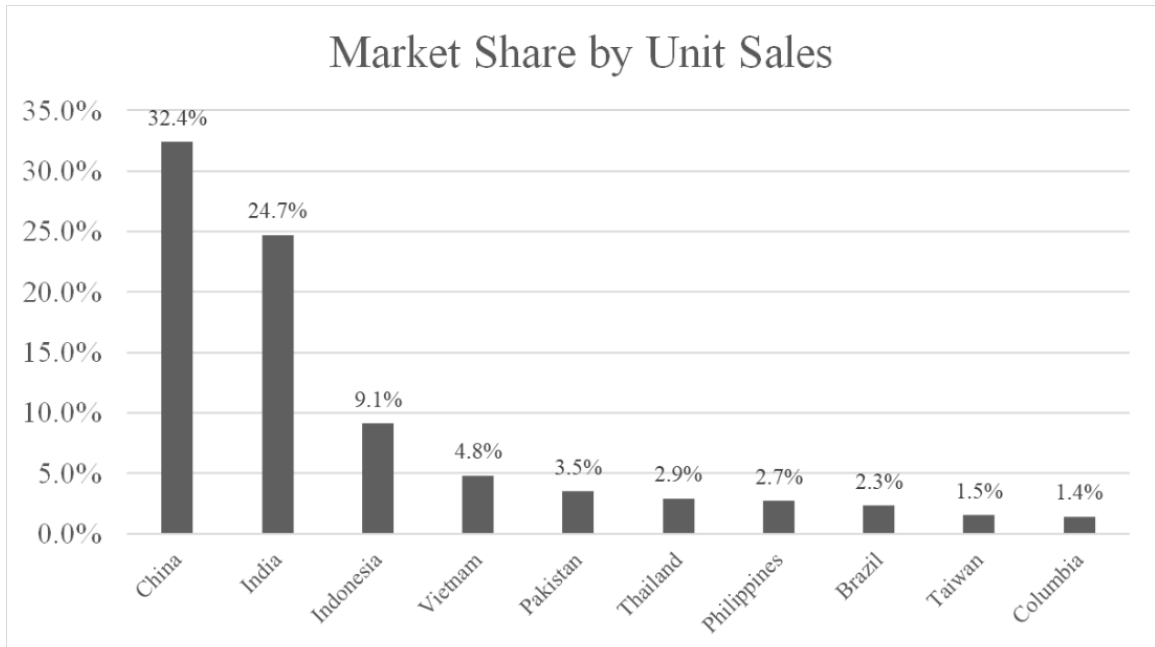


Exhibit 3: Comparative table

Comparative Feature	Italy	Japan	India
Origin and growth period	<ul style="list-style-type: none"> Started post WWII period from 1945 to 1962 was significant in widespread two-wheelers adoption. Second phase took place in 1970s and 1980s, when the focus shifted from utility to performance and style. 	<ul style="list-style-type: none"> Started post WWII and has been remarkably growing ever since. With significant new innovations and technological advancements due to investments in R&D and continues expansion of operations abroad 	<ul style="list-style-type: none"> Mid 1980s to mid 1990s led to significant growth mainly due to the liberalization of Indian economy that let do: Changes in types of vehicles produced by influx of foreign intellect resulting from partnerships with Japanese brands. Spike in demand due to higher urban incomes in the country.
Originating capabilities	<ul style="list-style-type: none"> Mechanical equipment Bicycles Automotive 	<ul style="list-style-type: none"> Mechanical equipment Bicycles Automotive Musical instruments (Yamaha) Electronics 	<ul style="list-style-type: none"> Mechanical equipment Bicycles Automotive
Hub Formation - factors that contributed to formation of hubs	<ul style="list-style-type: none"> Northern Italy was historically more industrialized than the rest of the country implying regions like Lombardy and Emilia-Romagna having existing industries in various sectors, educated populations and 	<ul style="list-style-type: none"> Tokyo is the capital and hub for many manufacturing industries in Japan. While Soichiro Honda was a native of Hamamatsu and founded the Honda Technical Research 	<ul style="list-style-type: none"> Chennai emerged as a hub due to its access to ports on the eastern coast of the country when the automobile industry relied on imports. Pune developed as an important hub due to its

	technical facilities developed early on.	Institute in the Hamamatsu	proximity to the country's financial capital, Mumbai, which also houses the country's largest port.
Most diffused models	<ul style="list-style-type: none"> Mopeds and mid-sized motorcycles (250cc-750cc) 	<ul style="list-style-type: none"> Mopeds up to 50cc engines. 	<ul style="list-style-type: none"> Delhi's automobile hubs expansion followed the setting up of India's largest car producers manufacturing plant in the region. Low powered motorcycles (<125cc)
Market share of 3 largest brands per country	FY 2022: <ol style="list-style-type: none"> Honda (24%), Piaggio (20%), Kymco (12%) Yamaha (12%) 	FY 2022: <ol style="list-style-type: none"> Honda 32.5% Kawasaki 22% Yamaha 10.4%	FY 2023: <ol style="list-style-type: none"> Hero Motocorp (32.2%), Honda (25.2%), TVS (16.2%)
Domestic sales	FY 2022: 291,799 units	FY 2021: 415,890 units.	FY 2023: 15.9m units
Volume of exports	FY 2022: <ul style="list-style-type: none"> Motorcycles: 541,828 units Mopeds: 57,193 units 	FY 2021: 437,042 units	FY 2023: 3.65m units
Volume of two-wheelers in use (registration)	2019: 6.89 million units	2021: 10.29 million units	2022: >210 million units

Market segmentation

Large number of players present in:

- Volume producer's category – Honda, Piaggio
- Specialist producers –Ducati, Benelli, Aprilia
- Niche specialist –
- Bimota
- EV 2-W – Energica
- Components and accessories – Pirelli, Brembo, AGV, Alpinestars, Dainese

Approach to innovation

Approach is heavily focused on performance and aesthetics; implying that two-wheelers must not just perform well, but should also look stylish

- Large producers like Honda, Yamaha, Kawasaki & Suzuki along with other international brands that collectively contribute to 25% of the total sales volume in 2021.

A strategy of importing foreign technology and encouraging domestic production, even if the initial quality was inferior to imports and then gradually improving by rigorous R&D investments to boost the export market.

- Volume producers: largest producers like Hero, Honda, TVS and Bajaj of two-wheelers catering to the most demanded 125cc category type vehicles.
- Specialist brands: producing high-powered/premium two-wheelers catering to a relatively niche market, reflected in the market share, such as Royal Enfield (4.5%).

The approach to innovative technologies has been primarily to meet demand for cost- and fuel-efficient vehicles, leading focus on utilitarian purposes, although personal preferences of consumers towards aesthetics and performance are changing slightly.

Major partnerships

- Partnerships exist among local firms and cross-border partnerships exist too.
- These are in the form of technological collaborations, skills development and utilizing networks of partners for international growth

- Japan's capabilities lie in fostering collaboration and intellect exchange to form knowledge clusters building strong relationships (Keiretsu style) with suppliers and regular partnerships

- From the mid 1980s to the 2000s, large Japanese brands partnered with Indian companies to produce two-wheelers in India.
- More recently, there have been some strategic partnerships for foreign brands operating in India like

within the domestic market & abroad

Hero with Harley Davidson, Bajaj with KTM and TVS with BMW Motorrad.

IP activity

- No data found for history of patent filing in motorcycle industry but in recent years Pirelli (tires), Piaggio (two-wheelers) and Brembo (brakes) have been the players with the greatest number of patents filed.
 - Focus on IP emerged soon after recovery phase post WW2 (1960s).
 - In 2000s, Japan implemented a comprehensive National Intellectual Property Strategy
 - This strategy encompassed a range of initiatives from fortifying intellectual property (IP) protection to stimulating research and development and facilitating IP application across industries, including motorbike manufacturing.
 - IP activities by two-wheeler brands picked up in the 2000s with their respective dissolutions of joint ventures with Japanese brands.
 - Before this, Indian brands were largely dependent on the foreign brands' technological expertise & intellect.
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The Evolution of the Two-Wheeler Industry: A Comparative Study of Italy, Japan, and India

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March 2024

ABSTRACT

This study leverages secondary data to provide a comprehensive outlook on the origin and evolution of the two-wheeler industry in Italy, Japan, and India. The study reveals how different technological, design, and manufacturing capabilities, combined with specific economic and social features in the historical contexts, have contributed to determine different trajectories in the evolution of these national industries. Recent trends towards digital transformation, electric mobility, connected driving are discussed. Three main takeaways emerge from our analysis. Firstly, the local capabilities play a crucial role in shaping both the origin and progression of the technology and the industry. Secondly, the two-wheeler industry displays patterns and trajectories that mimic the automotive industry, which can thus be used to interpret and forecast past, present, and future of motorcycles. Thirdly, the two-wheeler industry has been uniquely influenced by other industries, which has enhanced the complexity and effectiveness of its products and introduced novel elements which are reshaping the international demand for two-wheelers.

Keywords: industry evolution; technology; capabilities; comparative study; motorcycle; economic history,

JEL Code: N70 Economic History - Transport, Trade, Energy, Technology, and Other Services: General, International, or Comparative

Acknowledgements

I would like to acknowledge the contribution of Neha Chauhan, Sajid Esmail, Luigi Mosca, and Aayush Varma for their support and contribution is the creation of this study. I am also indebted for the insightful conversations with WIPO members in particular Maryam Zehtabchi and Julio Raffo, as well other members of the WIPR 2024 research working group, that were instrumental in the development of the core ideas in the manuscript. Errors and omissions are my own.

INTRODUCTION

Motorcycles have always been more than just a means of transportation; they are symbols of human advancement, creativity, and capability; they incorporate various human needs and lifestyles. They are the result of a complex fusion of codified and tacit knowledge, much of which is ingrained in the communities where they are created. This study presents a comprehensive investigation of the global two-wheeler industry and draws insights from the historical development of this dynamic sector in three key nations - Japan, Italy, and India - and their comparative analysis. The study presents the current state of the industry, taking into account the broader trends towards new transportation practices, technologies and the imperative for sustainability. The aim is to unveil the industry's complexities and highlight the central role of intellectual property, the interplay of capabilities and the broader context of global innovation and competition. This study uncovers the relationship between the complexity of the capabilities used, their development through knowledge relationship pathways (which may span different sectors), and their co-evolution with the welfare of the focal countries we study. The two-wheeler industry has changed dramatically over the years, much like many other industries. This industry has borrowed capabilities from other, closer-knit industries, adapted to customer demands, and developed technological solutions to comply with regulations. We disentangle the complexities of the two-wheeler industry across different sectors, encompassing both traditional two-wheelers, electric vehicles, and emerging mobility solutions.

The conceptual framework adopted for this study is taken from the economic complexity theory developed by Hausmann, Hidalgo, Bustos, Coscia, Simoes and Yildirim (2014), which aims to explain industrial evolution (and related policy implications) through the

mobilization of technological capabilities. Assuming that GDP and income per capita are positively correlated to economic complexity, as shown in the economic complexity index (ECI) (Hidalgo and Hausmann, 2009; Hausmann et al. 2014), one can argue that a nation's progress in terms of welfare will inevitably lead to an improvement in the fundamental capabilities and knowledge at the core of its industries, enabling more rapid technological advancements and better technology repurposing that will impact other industries via spillovers. Hence, this study uncovers the distinctive capabilities that have played a crucial role in driving innovation and success within the two-wheeler industry. Such capabilities include technological and design innovation, as well as marketing strategies, with the objective of highlighting the actions that can be implemented to promote a more effective dissemination of knowledge among other industrial networks. These capabilities should not be viewed as fixed attributes, but rather as dynamic forces catalyzed by intellectual property which helps protecting ideas, designs, and technological breakthroughs and advancements, and capturing value from them. We also explore how skilled labor, research and development centers, and manufacturing facilities have propelled the growth of the two-wheeler sector in various geographical locations, each with distinct types of knowledge and capabilities.

The comparative analysis of the inception, evolution, and current state of the Italian, Indian, and Japanese two-wheeler industries present three key insights that have significant implications for academics, practitioners, and policymakers:

Firstly, the development of national two-wheeler industries is influenced by their technological history in various sectors and the ways in which these technologies are utilized. The capabilities embedded in the region play a crucial role in shaping both the origin and

progression of the technology. Furthermore, this development tends to align with the country's consumption patterns, which are associated with different levels of GDP per capita.

Secondly, the two-wheeler industry, while drawing inspiration from a range of industries and fields such as material science, aerospace, electronics, energy, and chemicals, has a closer relationship with the automotive sector, which can be observed in its patterns and trajectories as a way to understand causes and effects, threats and opportunities of the two-wheeler industry.

Thirdly, the two-wheeler industry, although following its own distinct path, has derived significant advantages from technological collaborations with various other industries. This has not only enhanced the complexity and effectiveness of its products, but it has also impacted the development of novel business models that have transformed the use of the products across diverse consumer segments.

Methodology

This study adopts a longitudinal, qualitative approach to understand how the historical evolution of technological capabilities and demand features drove the development of the two-wheeler industry across three key national industries (Italy, Japan and India) and their relative market. The investigation is based on the collection, selection and aggregation of documents and secondary data from a variety of sources which span between academic publications, industry reports, media pieces, company reports and materials, and policy documents. The original database relies on extensive research conducted primarily via the internet, utilizing various reputable sources (e.g., Mintel, MarketLine, Nielsen, Economist, ANCMA, EICMA, McKinsey and Frost & Sullivan and official figures from the Ministry of Transportation of the three countries). While the decision of leveraging reliable, secondary

sources offers clear advantages of scale and trustworthiness, we acknowledge it also presents limitations. Among others, we notice that the sources present heterogeneity of content across the three different countries. As a result, not all aspects of our analysis are equally represented across each country, forcing us to offer different degree of granularity for different topics across the three countries.

Current State of the Two-Wheeler Industry

To precisely depict the state of the art of the two-wheeler industry and identify the most novel trends we need to consider timely phenomena such as the integration of digital technology in the vehicles, the growing demand of emerging markets, and the emergence of innovative products such as electric two-wheelers, adventure bikes, and touring bikes.

The incorporation of technology into motorcycles advances the vehicle usability and it is often a solution to enhance product distinctiveness. Contemporary motorcycles embody complex technological advancements, featuring functions such as anti-lock braking systems (ABS), traction control, and adaptive cruise control. However, it is the adoption of digital technology, including touchscreen displays, smartphone integration, and advanced navigation systems, that truly revolutionizes their use. These functions extend beyond safety and convenience; they track and enhance the overall user experience, generating value propositions that resonate with millennials and technologically adept consumers (Seredynski, 2022). Collaborations with IT, satellite communication, electronics, ergonomics, and entertainment companies have become an invaluable asset for motorcycle manufacturers, offering products that have a higher degree of safety and a clear experiential component.

However, our report shows how the use of two-wheelers differ significantly across regions. In emerging markets like India, Indonesia, and Vietnam, two-wheelers are a means

of conveyance and a catalyst for economic growth. Their affordability renders them accessible, and their agility in navigating congested urban terrains makes them indispensable means of work and commute. As these nations undergo rapid urbanization, the significance of two-wheelers in addressing transportation challenges cannot be underestimated (Fortune Business Insights website, 2023).

Motorcycles also help address global warming and the sustainability challenge. As businesses and governments are required to reduce their environmental footprints and conserving resources, electric two-wheelers are emerging as a key response to environmental concerns. These vehicles, which replace the conventional internal combustion engine with an electrical, battery-powered engine signify a fundamental shift in transportation strategy. Companies like Kawasaki, Zero Motorcycles, and the renowned Harley-Davidson with its LiveWire model are adapting to this transformation drawing upon capabilities in the automotive and energy industries and utilizing innovation to improve the experience while reducing emissions (Barstow, 2022).

Countries that are economically developed (e.g., Italy, Spain, USA, United Kingdom) are also embracing a use of two-wheelers that is leisurely in nature. Products in such areas respond to this demand for bikes that are enjoyable to drive in non-commuting routes. The allure of unexplored paths and the innate human desire for discovery for example have recently given rise to the distinctive category of adventure and touring bikes. These bikes hold the promise of providing gateways to unique experiences and indulgent consumption - an integral aspect of some modern lifestyles. They cater to a demographic that seeks more than mere transportation—they yearn for excitement, connection, and authenticity.

Future Growth Prospects of the Two-Wheeler Industry

The anticipated growth rate of the global two-wheeler market is forecasted to be approximately 8.0% from 2023 to 2028 (MarkNtel Report, 2023). The primary drivers of this growth are the emergence of novel uses and the increasing demand for electrified vehicles.

While the weight and duration of batteries continue to present a significant challenge for most motorcycle enthusiasts, it is reasonable to envision a future where electric bikes become increasingly feasible for a wider demographic due to technological improvements. This may represent a substantial shift towards sustainable mobility and an opportunity for companies to enter into a previously unexplored market segment that prioritizes innovation for an environmentally conscious market segment.

This trend is in line with the European emission standards introduced in 1992 (EUR-Lex, Council Directive 92/61/EEC of June 30, 1992), which have consistently reduced the limit of pollutant emissions and updated the cycles with which these vehicles must be tested. In a world where governments and consumers are becoming more conscious of their ecological impact, investments in electric vehicle capabilities serve as a crucial differentiating factor for two-wheeler brands and a catalyst for future technological advancements in other markets (e.g., electric bicycles).

The convergence of several trends, including urbanization, digital technology, and the sharing economy, presents intriguing prospects for electric two-wheelers. Market and non-market stakeholders perceive shared mobility as a potential game-changer, as it offers a solution to urban congestion, challenges related to vehicle ownership, and the realm of micro-mobility (CB Insights, 2021). Although semi-autonomous features in two-wheelers may appear to be far to be widely adopted, some studies suggest that they are closer to realization

than one might imagine (Purvis, 2022). In the meantime, different solutions driven by semi-autonomous technological intervention, some adapted by the automobile industry, are in the process of being implemented in motorcycles. Technologies such as lane-keeping and anti-topping assistance possess the potential to redefine the riding experience and significantly enhance safety once deployed on large scale productions.

Another emerging key aspect in two-wheelers is product customization. Today's customers, particularly the younger demographic in developed economies, are in search of products that reflect their unique identities. The provision of customization options, whether in terms of aesthetics or performance, helps cultivate brand loyalty and enhance customer engagement. From the perspective of businesses, this necessitates a clear and effective comprehension of local preferences, the development of tailored, modular solutions, and the construction of strategies that are built from the ground up, taking into account the specialization and diversification of the component and vehicle market (Balland, Broekel, Diodato, Giuliani, Hausmann, O'Clery, and Rigby, 2022).

Geography and Localization of the Industry

The volume of the global two-wheeler market in 2022 amounted to 63 million units. The global market had total revenues of \$95,397.3 million in 2022 (Marketline, 2023). This demonstrates a compound annual growth rate of 2.7% in terms of volume and 6.1% in terms of value from the year 2016 (Marketline, 2018). In terms of unit sales per 10,000 inhabitants, Asia significantly surpassed other nations with a figure of 131, followed by the Americas (49), Africa (30), and Europe (23) (Statista, 2022). The escalating desire for convenient and affordable personal mobility options, is projected to propel the industry volume to 71.5 million

by 2026 (Marketline, 2023). The global market share by value (Exhibit 1) is mainly dominated by Asian nations such as India and China, except for the USA and Brazil (Statista, 2022). The market share categorized by unit sales (Exhibit 2) also predominantly comprises Asian countries, led by China and India, excluding Brazil and Columbia (Ibid.). This phenomenon elucidates the pattern that emerging economies represent expanding two-wheeler markets with substantial demand, whereas developed nations exhibit saturated markets with higher-value products. Asia demonstrates the lowest average price for two-wheelers, amounting to \$2,097, while Australia and Oceania reflect the highest average price at \$10,470 (Ibid.).

****Insert Exhibit 1 and 2 about here****

THE ITALIAN TWO-WHEELER INDUSTRY

The Evolution of the Two-Wheeler Industry in Italy

In Italy, the definition of a motorcycle is provided in Article 53 of Il Codice della Strada (The Highway Code), which was approved by Legislative Decree on April 30, 1992, number 285. According to this article, motorcycles are two-wheeled vehicles designed for the transportation of people, limited to a maximum of two individuals including the driver.

The seeds of the Italian motorcycle industry were planted in the late 19th century, as motorized transportation began to captivate inventors and engineers worldwide and when the country experienced a surge in industrialization. Small workshops and pioneering individuals began experimenting with motorized two-wheelers, laying the groundwork for the emergence of prominent manufacturers. One of the earliest Italian motorcycle manufacturers was Bianchi, which produced its first motorcycle in 1897; two years later, in 1899, Lazzati and Figini in Milan produced the first commercially available two-wheeler. However, it was Moto Guzzi, founded in 1921, that emerged as one of the very first key players in the industry. Moto Guzzi's early success can be attributed to its innovative engineering and emphasis on reliability and performance. Italian pioneers like Enrico Bernardi and Carlo Guzzi experimented with motorized bicycles, laying the groundwork for future developments. Subsequently, in the early 1900s, the industry gained momentum by drawing knowledge and inspiration from neighboring countries, particularly France. The 1930s marked a period of significant growth and innovation for the Italian motorcycle industry. Manufacturers like Moto Guzzi, Gilera, and Ducati began to gain international recognition for their high-performance machines and racing successes.

One of the defining moments of this era was Moto Guzzi's dominance in motorcycle racing. The company's legendary "Gambalunga" bikes, equipped with powerful V-twin

engines, clinched numerous victories in prestigious races such as the Isle of Man TT and the Moto Giro d'Italia. These successes not only showcased Italian engineering prowess but also helped establish the country as a force to be reckoned with in the global motorcycle racing scene. Similarly, Gilera made waves with its innovative designs and technological advancements. The company's racing bikes, powered by supercharged engines, set speed records and earned accolades on racetracks around the world. Ducati also emerged as a formidable competitor, particularly in the realm of single-cylinder racing motorcycles.

Despite many obstacles during both World Wars, the industry continued to grow steadily (Capone and Morrison, 2020). While the WWI period saw production focused on military needs, after World War II Italy underwent a period of substantial reconstruction and growth of its industrial production, aided by the Marshall Plan. The aftermath of World War II presented both striking challenges and opportunities for the Italian motorcycle industry. While the country grappled with rebuilding efforts and economic hardships, the demand for affordable transportation soared. Italian manufacturers seized this opportunity to expand their production and cater to the needs of a growing market.

During the 1950s, companies like Vespa and Lambretta gained prominence for their iconic scooters, which offered practicality, affordability, and style. These compact two-wheelers became synonymous with urban mobility and captured the imagination of millions around the world. In the realm of motorcycles, brands like Moto Guzzi, Ducati (est. in 1926 as radio and electrical product company, and reconverted into a motorcycle company after WWII), and MV Agusta (est. in 1945) continued to innovate and excel. Moto Guzzi introduced the iconic Falcone model, known for its reliability and long-distance touring capabilities. Ducati ventured into the realm of sports bikes with models like the Ducati 125 Grand Prix,

showcasing the company's commitment to performance and racing heritage. MV Agusta, under the leadership of Count Domenico Agusta, emerged as a dominant force in motorcycle racing. The company's racing team, led by legendary riders such as John Surtees and Giacomo Agostini, secured countless victories in Grand Prix racing, earning MV Agusta a reputation for excellence and innovation. The company's production figures reflected its reputation as a premier manufacturer, with a focus on craftsmanship and innovation derived from racing.

In the 1960s, motorcycle and scooter registrations declined due to a shift towards car ownership (Confindustria ANCM, 2023; Gask Motors, 2024). The 1960s, however, witnessed a burst of technological advancements and design innovations in the Italian motorcycle industry. Companies pushed the boundaries of engineering and design, introducing new features and technologies that would shape the future of motorcycling. One notable development was the emergence of the "café racer" phenomenon, with motorcycles characterized by stripped-down models customized for speed and agility. Italian manufacturers like Ducati and Moto Guzzi embraced this trend, producing lightweight and nimble bikes tailored for spirited riding – e.g., the iconic Ducati Scrambler. In addition to performance-oriented machines, Italian manufacturers also focused on refining the design and comfort of their motorcycles. Companies like Moto Guzzi introduced innovative suspension systems and ergonomic enhancements to improve ride quality and handling. Furthermore, the 1960s saw the rise of iconic models such as the Ducati Mach 1, Moto Guzzi V7, and MV Agusta 750 Sport. These bikes not only pushed the boundaries of performance but also captured the essence of Italian style and craftsmanship.

The 1970s brought both challenges and triumphs for the Italian motorcycle industry. Economic instability, changing consumer preferences, and increased competition posed

significant hurdles for manufacturers, yet the decade also witnessed remarkable achievements and breakthroughs. One of the most significant developments of the 1970s was the rise of Japanese manufacturers in the global motorcycle market. Companies like Honda, Yamaha, and Suzuki introduced a new wave of technologically advanced and competitively priced motorcycles that posed a formidable challenge to their Italian counterparts. In response to this competition, Italian manufacturers embarked on a quest for innovation and diversification. Ducati, under new ownership, revitalized its lineup with models like the Ducati 750SS and the iconic Ducati 900SS, which combined performance, handling, and style in a winning package. Similarly, Moto Guzzi introduced the legendary Le Mans series, characterized by its distinctive styling and powerful V-twin engines. These bikes not only solidified Moto Guzzi's reputation for performance and reliability but also appealed to a new generation of riders. Despite these challenges, Italian manufacturers continued to excel in motorcycle racing, with Ducati achieving success in Superbike racing and MV Agusta securing victories in endurance competitions. These racing triumphs not only showcased the engineering prowess of Italian motorcycles but also bolstered the industry's reputation on the world stage. However, due to various economic challenges, including the 1973 oil crisis, had a negative impact on sales and registrations.

The 1980s were a decade of evolution and adaptation for the Italian motorcycle industry. With the global motorcycle market becoming increasingly competitive and diverse, manufacturers faced pressure to innovate and diversify their product offerings. One of the defining trends of the 1980s was the proliferation of sport bikes, fueled by advancements in technology and a growing demand for high-performance machines. Italian brands like Ducati and Cagiva led the charge, introducing groundbreaking models such as the Ducati 916 and

the Cagiva Mito, which pushed the boundaries of speed, agility, and handling. In addition to sport bikes, Italian manufacturers also expanded into new segments, including adventure touring and off-road motorcycles. Models like the Ducati Multistrada and the Cagiva Elefant showcased the versatility and adaptability of Italian motorcycles, appealing to riders with diverse riding preferences and lifestyles. Furthermore, the 1980s saw the resurgence of iconic brands such as Moto Guzzi and Aprilia, which underwent revitalization efforts and introduced new models to capture the imagination of riders around the world. Moto Guzzi's introduction of the California series and Aprilia's launch of the Tuareg series demonstrated the enduring appeal and innovation of Italian motorcycles.

As the 1990s dawned, Italian scooters experienced a renaissance, propelled by a resurgence in popularity and a wave of innovation that would redefine urban mobility for decades to come (Confindustria ANCM, 2023; Encyclopedia Britannica, 2024a, b). The 1990s saw the iconic Vespa, produced by Piaggio, reclaim its status as the epitome of chic and practical transportation. With its sleek lines, vibrant colors, and unmistakable silhouette, the Vespa captured the hearts of commuters and trendsetters alike. As Italy embraced economic prosperity and cultural revival, the Vespa became a symbol of freedom, fashion, and flair. Piaggio, recognizing the potential of the global market, expanded its reach beyond Italy's borders, exporting Vespas to destinations around the world. But the Vespa was not the only Italian scooter to make waves in the 1990s. Companies like Aprilia, Malaguti, Italjet and Gilera emerged as formidable competitors, introducing their own lineup of sleek and sporty scooters designed for urban adventurers and thrill-seekers. Aprilia, known for its prowess in motorcycle racing, leveraged its racing heritage to create the SR series of high-performance scooters. With cutting-edge technology, agile handling, and eye-catching design, the Aprilia

SR captured the imagination of a new generation of riders. Meanwhile, Gilera made waves with its innovative DNA scooter, featuring a futuristic design and advanced engineering. With its hybrid motorcycle-scooter concept and powerful performance, the Gilera DNA pushed the boundaries of traditional scooter design, paving the way for a new era of urban mobility. In 1991, Malaguti introduced the F12 Phantom, a sleek and sporty scooter that captured the attention of riders seeking performance and style. With its aerodynamic design, powerful engine, and cutting-edge technology, the F12 Phantom became a sensation, winning accolades and setting new standards for scooter innovation.

In the new millennium Italian scooters continued to evolve, embracing technology, and meeting the demands of a changing world. Electric scooters, powered by eco-friendly batteries, emerged as a sustainable alternative to traditional gasoline-powered models. Companies like Vespa and Piaggio led the charge, introducing electric versions of their iconic scooters that combined efficiency, style, and performance. Furthermore, the 2000s saw the rise of maxi-scooters, offering enhanced comfort, storage, and versatility for long-distance travel. Models like the Vespa GTS and the Piaggio X9 appealed to riders seeking the convenience of a scooter without compromising on power or amenities. But perhaps the most significant development of the 2000s was the resurgence of vintage Vespa culture. Enthusiasts around the world embraced the timeless appeal of classic Vespas, restoring and customizing vintage models to reflect their unique personalities and tastes. From custom paint jobs to retro accessories, the vintage Vespa scene thrived, celebrating the nostalgia and romance of a bygone era. In the motorcycle segment, brands like Ducati and Aprilia showcased their engineering prowess with high-performance models like the Ducati Monster

and the Aprilia RSV4. These bikes combined cutting-edge technology with Italian craftsmanship, appealing to enthusiasts and professionals alike.

The 2010s were characterized by a growing emphasis on sustainability and globalization in the Italian motorcycle and scooter industry. With concerns about climate change and air pollution mounting, manufacturers focused on developing eco-friendly vehicles and expanding their presence in international markets. Electric mobility gained traction in the 2010s, with companies like Vespa, Piaggio, and Energica leading the charge. Vespa introduced the Vespa Elettrica, a fully electric scooter that combined classic Italian design with zero-emission technology. Piaggio also expanded its electric scooter lineup, offering models like the Piaggio MP3 Hybrid and the Piaggio Liberty Electric. Meanwhile, Italian motorcycle manufacturers continued to push the boundaries of performance and innovation. Ducati introduced the Panigale V4, a groundbreaking superbike equipped with a four-cylinder engine and advanced electronics. Aprilia unveiled the Tuono V4 1100, a naked sportbike renowned for its agility and power. Globalization played a significant role in shaping the Italian motorcycle industry in the 2010s, with manufacturers expanding their presence in emerging markets like Asia and South America. Companies like Ducati and Piaggio established manufacturing facilities and distribution networks in countries like Thailand, India and Brazil, catering to the growing demand for premium motorcycles and scooters.

As the 2020s unfolded, the Italian motorcycle and scooter industry entered a new era defined by digitalization and electrification. With advances in connectivity and battery technology, manufacturers embraced the opportunities presented by the digital age. Digitalization transformed the riding experience, with manufacturers integrating advanced electronics and connectivity features into their vehicles. Ducati introduced the Panigale V4 S,

equipped with a sophisticated electronics package that included cornering ABS, traction control, and electronic suspension. Electrification continued to gain momentum in the 2020s, with companies like Vespa and Energica leading the way. Vespa expanded its electric scooter lineup with models like the Vespa Elettrica 70 km/h, offering riders enhanced range and performance. Energica introduced the Eva Ribelle, a sporty electric motorcycle equipped with fast-charging capabilities and advanced battery technology. The 2020s also saw the emergence of new trends and technologies in the Italian motorcycle and scooter industry. Companies like Italjet and Lambretta introduced retro-inspired models like the Italjet Dragster and the Lambretta V-Special, capitalizing on the nostalgia for classic designs while incorporating modern features and technology. While the industry experienced a natural halt during the pandemic (2020-2022), traditional bicycles and e-bikes gained popularity during the COVID-19 pandemic (Confindustria ANCM, 2023; Statista, 2024) and some motorbike producers included such vehicles in their portfolio. After COVID-19 period, motorcycles made a comeback while e-bikes continued to grow. Although certain segments of the industry have faced a decline of demand for small-capacity bikes (e.g., Aprilia 50cc and 125cc models) and mopeds - which also corresponded to the exit of some renowned players (e.g., Malaguti) - others new segments like e-bikes, have flourished with new players coming to the market (e.g., Energica). Overall, Italy's two-wheeler industry has shown remarkable resilience in adapting to changing times and shifting consumer demands.

The Structure of the Italian two-wheeler Industry

Scholars highlight that the players in the Italian manufacturers can be classified into three major categories based on their production volumes and product focus: high-volume producers, specialist producers, and niche specialist producers (Muffatto and Panizzolo,

1996). The *high-volume producers*, such as Piaggio, distinguish themselves through substantial production volumes, particularly in the scooter segment. They offer economical urban mobility solutions and primarily focus on low-capacity two-wheelers, typically below 250 cc. Ducati and Aprilia exemplify *specialist producers* that operate at lower production volumes. They concentrate on high-capacity and high-performance two-wheelers, typically exceeding 250 cc. These manufacturers meticulously craft motorcycles with advanced engineering, innovative features, and meticulous attention to detail. Their offerings appeal to enthusiasts seeking powerful and dynamic riding experiences. The *Niche Specialist Producers*, such as Bimota, have a specific focus on medium-low-capacity motorcycles with an emphasis on sports competitions. Despite their lower production volumes, these manufacturers command high prices in the market due to their dedication to performance-oriented vehicles.

In the Italian two-wheeler industry, innovation is a dynamic process that balances engineering advancements and aesthetic appeal. Aesthetics, particularly in the form of fairings, receive significant attention in the design phase, followed by the frame, dashboard, suspension, engine, and transmission. The speed at which innovations are incorporated varies among companies, with volume producers generally adopting a more conservative approach, while specialized producers emphasize faster introductions of new models to keep pace with market changes.

Partnerships play a vital role in fostering growth and competitiveness within the Italian two-wheeler industry. This section reports the role of partnerships as well as how clusters and hubs have been formed by considering both macrolevel factors (networks) and micro

individual- and group-level processes (microlevel activities shaping the localization of economic production, see Aversa, Furnari and Jenkins, 2022).

Three common types of partnerships observed are technological partnerships, the acquisition of new skills and capabilities, and the strategy of internationalization. These partnerships facilitate the expansion of markets, provide access to global customers, and enhance the capabilities of manufacturers (Muffatto and Panizzolo, 1996). Suppliers play a crucial role in the innovation process by providing access to new technologies, skills, and knowledge beyond the capabilities of the client firm. Co-design projects, which involve collaborative efforts from the early stages and are designed by firm approaches, offer different dynamics. These partnerships significantly influence product development by allowing for immediate input on design, improving competitiveness, and enhancing the producer's ability to respond to external changes. In the Italian two-wheeler manufacturing industry, the active involvement of suppliers significantly speeds up the product development process, reduces costs, improves the quality of the end product, and expedites problem-solving. These partnerships facilitate knowledge exchange and coordination, which in turn enhances innovation (Lipparini, Lorenzoni and Ferriani, 2013).

The Italian two-wheeler industry consists of companies of different sizes, each focusing on diverse market segments and performing distinct functions. These companies can be categorized into three main groups, including motorcycle manufacturers, motorcycle component manufacturers, and motorcycle accessories manufacturers.

Motorcycle manufacturers. In 1971, Honda entered the Italian market and established IAP (Industria Automotoagricola Produzione) Industriale in Atessa, Italy. By 1981, Honda had become the market leader in Italy's motorcycle industry with a 24% market share as of 2022.

Italy plays a crucial role in Honda's European operations, accounting for 54% of the company's total production. Honda offers a diverse range of products, including scooters like SH, Forza, and ADV350, as well as motorcycles such as NS125R, Hornet, TransAlp, and Africa Twin. The Atessa factory is involved in precision work, assembly, welding processes, and painting, ensuring strict quality control and fostering innovation (Honda industriale website, 2024)

Piaggio, established in 1884, is the largest manufacturer of scooters and motorcycles in Europe. The Piaggio Group oversees well-known Italian brands such as Vespa, Aprilia, and Moto Guzzi. Piaggio has a history of early ventures into electric mobility, demonstrating a commitment to eco-friendly solutions. The company continues to innovate in the electric vehicle sector, contributing to the development of core components for 2-, 3-, and 4-wheel electric vehicles (Piaggio Group, 2017).

Ducati, established in 1926, initially focused on the production of small Manens capacitors. Following World War II, the company shifted its focus to the manufacturing of two-wheelers, introducing the Cucciolo, which was an internal combustion micro-engine mounted on a bicycle frame. During the 1960s and 1970s, Ducati underwent a significant transformation towards performance motorcycles, with a strong emphasis on technology, style, and design. In the realm of electric vehicles, Ducati is actively exploring electric motorcycles and has secured a contract to supply e-motorcycles to all participating teams in the MotoE racing series starting from 2023. Additionally, the company is also exploring alternative power sources such as hydrogen and biofuels (Ducati, 2023; Phillips, 2023).

Moving on to *motorcycle component manufacturers*, Brembo, founded in 1961, specializes in braking systems. The company attained market leadership in the 1970s for its motorcycle braking systems and subsequently expanded its presence globally. In the 2000s,

Brembo strategically invested in India, China, and Poland. One of the company's innovative approaches includes the launch of a new brand, Bybre, which is dedicated to braking systems for scooters and small- to mid-sized motorcycles in BRIC countries and other Southeast Asian countries (Brembo website, 2020). The Brembo Group also acquired, in 2000, Marchesini (established in 1988), which initially operated as an aluminum and magnesium foundry before transitioning into the manufacturing of high-performance motorcycle wheels. Nowadays, the company collaborates with top teams in MotoGP, SuperBike, and SuperMotard racing, supplying wheels for both racing and road models (Marchesini Wheels website, 2024).

Pirelli, founded in 1872, began its journey with the production of elastic rubber items and subsequently expanded into tire manufacturing. The company's innovative approach in sport tires, radial tires, and motorcycle tires during the 1980s solidified its position in the industry. In the 2000s, Pirelli strategically focused on becoming a pure tire manufacturing company through divestments (Pirelli website, 2024).

One of the *motorcycle accessories manufacturers*, Rizoma, established in 2001, brings a sense of style and modern design to the motorcycle accessories industry. The company has expanded its product range from mirrors to turn signals, light kits, levers, grips, and pegs. Rizoma has established collaborations with Ducati and Lamborghini, and in the electric vehicle segment, it has partnered with EV manufacturer Alpine for the development of an all-new concept car (Rizoma website, 2024).

Alpinestars, founded in 1963, initially focused on providing protective boots for motocross riders. Over time, the company expanded its product range to include footwear, riding suits, helmets, gloves, protection padding, and motorcycle airbags. Alpinestars is

renowned for its innovative approach and introduced TechAir motorcycling airbags in 2001 (Alpinestar website, 2024)

Established in 1972, Dainese specializes in the design and manufacturing of protective gear for motorcycle riders. Its product portfolio encompasses motorcycle trousers, gloves, and D-air racing suits equipped with airbags for motorcyclists. Dainese has also expanded its reach to other sports such as MTB, snowboarding, and skiing through its No Impact business division (Dainese website, 2024).

AGV, founded in 1947, revolutionized helmet design with its fiberglass crash helmet in 1954. Following its acquisition by Dainese in 2007, AGV continued to innovate with its integrated technical design approach known as AGV Extreme Standards. The company's helmets have been embraced not only by motorcycle racers but also by Formula 1 racing drivers (AGV website, 2024).

Geography and Localization of the Italian Industry

The geographical localization of the Italian two-wheeler industry is deeply rooted in the country's historical, cultural, and economic landscape, shaping the development and growth of this sector over the years. Italy's geographical features, coupled with its rich industrial heritage and skilled workforce, have played a crucial role in establishing the country as a global hub for motorcycle and scooter production.

Located in Southern Europe, Italy boasts a diverse terrain that ranges from planes and the snow-capped Alps in the north to the sun-drenched Mediterranean coast in the south. This varied landscape has influenced the design and functionality of Italian motorcycles and scooters, with manufacturers producing models tailored to navigate both urban streets and

rugged countryside roads. Additionally, Italy's favorable climate allows for year-round riding, further fueling the demand for two-wheeled vehicles.

The heart of the Italian two-wheeler industry lies in the Emilia-Romagna region which hosts the so-called "Italian Motor Valley," and it is home to some of the most iconic motorcycle brands, including Ducati, MotoMorini, Italjet, and Malaguti. These companies benefit from the region's robust infrastructure, skilled labor force with specialization in mechanics, and proximity to research and development centers as well as major Universities (e.g., Bologna, Modena, Reggio Emilia, Parma, among others).

Lombardy, the most connected, international and industrialized area of Italy, is also home of some iconic brands such as MV Agusta, Moto Guzzi and Innocenti (maker of Lambretta). Beyond Emilia-Romagna, other regions of Italy also play a significant role in the two-wheeler industry. The Veneto region, home to brands like Aprilia and Benelli, boasts a long tradition of mechanical and motorcycle manufacturing, with a focus on high-performance bikes and racing heritage. Tuscany, known for its picturesque landscapes and cultural heritage, is home to companies like Piaggio (maker of Vespa and many other iconic scooters).

Italy's strategic location within Europe has also contributed to the success of its two-wheeler industry. Situated at the crossroads of major trade routes, Italy has easy access to key markets in Europe, Africa, and the Middle East. This geographic advantage has allowed Italian manufacturers to expand their global footprint and establish a strong presence in international markets.

Furthermore, Italy's commitment to research and development, coupled with government support for the automotive and motorcycle industry, has fostered innovation

and technological advancements in the two-wheeler sector. Companies invest heavily in research facilities and collaborate with universities and research institutions to develop cutting-edge technologies and improve the performance, safety, and sustainability of their vehicles.

In conclusion, the geographical localization of the Italian two-wheeler industry is a testament to the country's rich heritage, skilled workforce, and strategic positioning within Europe. Italy's diverse regions have nurtured a thriving ecosystem of motorcycle and scooter manufacturers, driving innovation, and shaping the future of urban mobility.

Intellectual Property in Italy

The concept of patents, aimed at protecting inventions and encouraging innovation, began to gain traction in Europe during the 18th century. While Italy did not have a unified patent system at this time, individual city-states such as Venice and Florence granted patents for certain inventions. Similarly, trademarks started to emerge as a means of distinguishing goods and services in the marketplace. The early 19th century saw the spread of Napoleonic legal reforms across Europe, including Italy. Napoleon's legal code introduced provisions for intellectual property rights, laying the groundwork for modern IP laws. The Code recognized patents, trademarks, and copyright as legally protected rights, marking a significant step forward in IP legislation. With the unification of Italy in the mid-19th century, efforts were made to establish a unified patent system across the country. The Italian Patent Law of 1860 provided a framework for granting patents, thereby stimulating technological innovation and industrial development. The latter half of the 19th century saw the enactment of copyright laws aimed at protecting literary and artistic works. The Italian Copyright Law of 1882

provided creators with legal protections for their original works, promoting cultural expression and creativity.

The interwar period saw the enactment of the Industrial Property Code, which consolidated various aspects of intellectual property law into a comprehensive legal framework. This code strengthened protections for patents, trademarks, and industrial designs, fostering innovation and economic growth. Italy became a signatory to various international treaties and agreements aimed at harmonizing intellectual property laws on a global scale. Membership in organizations such as the World Intellectual Property Organization (WIPO) and the European Patent Convention (EPC) further integrated Italy into the international IP community. Intellectual property protection, particularly through patents, played a crucial role in fostering innovation within the motorcycle industry. Italian manufacturers filed patents for technological advancements such as engine designs, suspension systems, and safety features, driving continuous improvement and differentiation in the market. Trademarks became instrumental in establishing brand identity and reputation within the Italian motorcycle industry. Iconic logos and insignias, such as Ducati's winged emblem and Moto Guzzi's eagle, not only distinguished these brands but also conveyed a sense of quality, performance, and heritage to consumers. Ducati became known for being one of the first motorcycle companies (together with Harley Davidson) to register its distinctive sound derived by its specific mechanical engineering and the desmodromic engine system (imported from automotive and patented). Despite robust legal frameworks, enforcing intellectual property rights in Italy posed challenges, including issues related to counterfeiting, piracy, and infringement. The motorcycle industry, with its global appeal and lucrative market, faced threats from counterfeit parts, unauthorized replicas, and intellectual

property theft, necessitating concerted efforts by authorities and industry stakeholders to combat such practices.

The evolution of intellectual property in Italy, from the 19th century to the present day, has been intertwined with the growth and development of the motorcycle and two-wheeler industry. Through the protection of patents, trademarks, and copyrights, Italian manufacturers have been able to innovate, differentiate, and compete in the global marketplace. As the motorcycle industry continues to evolve and embrace new technologies, intellectual property will remain a cornerstone of innovation, driving progress and shaping the future of mobility.

THE JAPANESE TWO-WHEELER INDUSTRY

The Evolution of the Two-Wheeler Industry in Japan

According to the Japan Road Traffic Act (Act No. 1505 of 1960), a two-wheeler is officially defined as a "motorized bicycle: a vehicle that has a motor with total emissions or rated output not exceeding that which Cabinet Office Order prescribes, which is operated without recourse to rails or overhead wires, not including a bicycle, wheelchair being used by a person with a physical disability, or a wheeled walking aid or small vehicle." This definition encompasses vehicles equipped with a motor whose total emissions or rated output do not exceed the specifications outlined in the Cabinet Office Order.

The historical progression of Japan's motorcycle industry offers evidence of the nation's recovery and transformation following WWII. After experiencing extensive devastation during the Second World War, Japan faced a severe scarcity of resources needed for manufacturing, including those necessary for motorcycle production (Swim, 1967). The aftermath of the war left Japan significantly behind the Western countries in terms of technology due to its isolation during the conflict (Oshima, 1984). To bridge this technological gap, the Japanese government adopted a strategy of importing foreign technology and promoting domestic production, even if the initial quality was lower than imports. This approach paved the way for gradual improvements and competitiveness in the export market (Herbig and Jacobs, 1997).

In the immediate post-war era in Japan, marked by the urgent need for fast and affordable transportation, Soichiro Honda seized a unique opportunity. Recognizing the demand for quick and convenient mobility solutions, he envisioned an innovative concept in the early post-war years: retrofitting surplus generator motors onto bicycles – a similar idea of what Ducati in Italy had experimented with "Il Cucciolo" engine in 1946. This idea gave rise to the 'Honda motor bicycle' in 1948 and marked the establishment of Honda Motors. In

collaboration with Takeo Fujisawa, Soichiro Honda laid the groundwork for a company synonymous with innovation in the motorcycle industry (Honda website, 2024). As Japan's economy gained momentum, motorcycle production soared. In 1948, approximately 1,000 motorcycles were manufactured, followed by 1,766 in the subsequent year and 2,633 in 1950, with a notable contribution from motor scooters (Swim, 1967).

In the early 1950s, Suzuki entered the motor-vehicle sector, overcoming labor challenges and financial crises within the company (Suzuki website, 2024). Shortly thereafter, in 1955, Yamaha became one of the motorcycle manufacturers in Japan. By the mid-1950s (Yamaha Motor website, 2024), Japan witnessed a surge in motorcycle demand, attracting several new players to the market. Interestingly, Honda emerged as the leading motorcycle manufacturer in the country during this period, despite facing the obstacle of a devastating earthquake in 1955.

By 1959, Honda had firmly established its dominance in Japan, driven by its star product, the "nifty fifty," which captured an impressive three-quarters of the domestic market share. Simultaneously, Honda set its sights on the international arena, initiating plans to develop an export market and participate in the prestigious Isle of Man TT races (Swim, 1967). In 1959, Honda commenced overseas sales for the first time, with the United States being the initial target. The year 1960 marked the birth of Honda R&D, dedicated to the creation of larger, more advanced, and faster motorcycles capable of competing in the expanding global racing circuits (Honda website, 2024).

The subsequent decade witnessed the active participation of Japanese manufacturers, such as Suzuki, Yamaha, and Honda, in events like the Isle of Man TT and F1 Grand Prix, driven by their ambition to cultivate export markets and gain international recognition. This strategic

move stimulated higher demand for exports following the liberalization of international trade and foreign exchange in 1960. By the early 1960s, Japan had emerged as the largest manufacturer of motor vehicles within its borders and surpassed Germany to become the world's leading motor vehicle producer. During the 1960s and 1970s, Japanese motorcycle manufacturers expanded their product lines, catering to diverse consumer preferences. From lightweight commuter bikes to high-performance models, Japanese motorcycles gained popularity across the globe. This period also saw rapid technological advancements, including the introduction of four-stroke engines, disc brakes, and electric starters. Japanese manufacturers led the way in incorporating these innovations into their motorcycles, setting new standards for performance and reliability.

The 1980s brought economic challenges, including fluctuations in currency exchange rates and increased competition from other Asian manufacturers. Japanese companies responded by focusing on efficiency, quality control, and global expansion. Growing concerns about pollution and fuel efficiency led to the development of cleaner, more fuel-efficient motorcycles. Japanese manufacturers embraced these challenges, investing in research and development to produce eco-friendly models. In the 1980s, Yamaha Motor Co. took a pioneering step to address growing environmental concerns by introducing the world's first electrically powered bicycle models in 1993. This innovative move aligned with the global shift towards eco-friendly mobility solutions. Yasuhiro Kashima, the sales manager at Yamaha Motorcycle Sales Japan Co., emphasized the company's commitment to eco-conscious products. Initially, electric bicycles gained popularity among elderly individuals with declining physical capabilities. However, a significant surge in sales occurred in 2009 due to the implementation of new traffic regulations. During the 1990s, Japan faced unique power and

licensing restrictions, resulting in the production of motorcycle models that were not available elsewhere globally. Specifically, the limitations on power output and license acquisition for larger motorcycles led to the creation of miniature replicas of their more powerful counterparts, the 750cc and 900cc bikes, in the form of 250cc and 400cc motorcycles. By the 1990s, the Japanese motorcycle market had become saturated, prompting manufacturers to explore new markets and diversify their offerings. This period saw the emergence of niche segments, such as adventure touring bikes and cruiser motorcycles.

In year 2000s Japanese motorcycle manufacturers continued to expand their global footprint, establishing production facilities and distribution networks in key markets worldwide. This globalization strategy enabled them to remain competitive in an increasingly interconnected world.

The 21st century witnessed a rapid integration of technology into motorcycles, including advanced electronics, ride-by-wire systems, and connectivity features. Japanese manufacturers embraced these advancements, enhancing the performance, safety, and convenience of their motorcycles. With a growing emphasis on sustainability and electric mobility, Japanese manufacturers are today investing in electric motorcycles and alternative propulsion systems. This commitment to innovation ensures that Japan remains at the forefront of the evolving motorcycle industry. Sales of electric bicycles more than doubled from 2008 to 2018, while sales of scooters equipped with engines of 50 cc or less experienced a substantial decline during the same period. These shifts in consumer preferences and market dynamics demonstrate the industry's adaptability to changing environmental concerns and regulations.

Japan is home to one of the largest motorcycle manufacturing industries in the world, characterized by the dominance of four major players: Honda, Suzuki, Yamaha, and Kawasaki. Key export destinations for Japanese motorcycles include Europe and North America. To meet the local demand for motorcycles with lower-capacity engines, Japan imports bikes from other Asian regions, further demonstrating the adaptability of the industry. The post-pandemic Covid-19 era has witnessed a growing demand for bicycles and e-bikes, reflecting the shifting preferences in the local market.

The trajectory of Japan's motorcycle industry portrays a scenario influenced by various factors, which casts doubt on the future performance of the domestic market. The declining popularity of motorcycles for recreational purposes is expected to continue having a ripple effect on sales figures in the domestic market. At the same time, there is an emerging trend in Japan's metropolitan areas, characterized by the increasing adoption of bicycles. In particular, electric power-assist bicycles, known as e-bikes, have experienced a remarkable surge in sales.

Over the years, Japanese manufacturers made substantial investments in research and development. Honda, under the guidance of Soichiro Honda, stood as a trailblazer, consistently pushing the boundaries of technological advancements (Swim, 1967). Pioneering breakthroughs, such as efficient engines and enhanced safety features, were the outcomes of these investments. Environmental consciousness and stringent emissions regulations compelled Japanese manufacturers to pioneer cleaner technologies. The COVID-19 pandemic served as an additional catalyst, hastening the focus on innovations within engine design, fuel injection, and emission control systems (Frost and Sullivan, 2023). Adherence to regulations

demonstrated an unwavering commitment to eco-friendly solutions, thus propelling motorcycle technology forward.

Business Models and Partnerships

The evolving business models in the Japanese motorcycle industry, emphasizing innovation and sustainability, have shaped its enduring success. Partnerships and collaborations further illuminate these shifts, contributing to the industry's dynamic landscape. For example, during the 1960s and 1970s, Suzuki and Kawasaki engaged in a pivotal engine supply agreement, with Kawasaki supplying engines to Suzuki for specific motorcycle models. This symbiotic collaboration allowed both entities to effectively utilize their resources, resulting in an expanded and diversified product portfolio. Furthermore, in the 1980s, Honda made a strategic move by acquiring a controlling interest in Montesa, a Spanish motorcycle manufacturer. This acquisition allowed Honda to expand its range of products and enter the trials and off-road motorcycle segments, demonstrating the impact of acquisitions on diversifying the industry.

Not only individual manufacturers, but the entire motorcycle industry has been affected by these significant partnerships and acquisitions. The level of connectivity within the Japanese motorcycle industry serves as a measure for evaluating cohesion, competitiveness, and the collective shaping of the market. Higher connectivity indicates a closely-knit community potentially working together, which is essential for understanding industry dynamics (Hausmann, et al., 2014).

Geography and Localization of the Japanese Industry

The Japanese Big Four, which consist of Honda, Kawasaki, Yamaha, and Suzuki, represent the dominant forces within the motorcycle industry in Japan. The locations where

the companies are based (Tokyo, Hamamatsu, Kobe and Iwata) of motorcycle production played a pivotal role in shaping the capabilities, complexity, and resources of Japan's motorcycle industry. Accounting for more than a quarter of global motorcycle sales, these four giants have played a crucial role in guiding the industry's evolution and fostering innovation.

Tokyo stands as a bustling center of economic activity and innovation, serving as the capital city of Japan. Within its boundaries lie the headquarters and major facilities of several prominent motorbike manufacturers. Notably, Honda Motor Co., Ltd. has established its headquarters in Minato, Tokyo, where strategic decisions, research, and development efforts shape the company's vision and products (Honda website, 2024). Furthermore, Yamaha Motor Co., Ltd. has also established its headquarters in Japan and maintains a network of group companies and affiliates across the country (Yamaha Official website, 2024), contributing to Tokyo's esteemed status as a hub for motorcycle manufacturing.

Hamamatsu proudly carries the distinguished title of the "Motorcycle City" of Japan and serves as a significant cluster for motorcycle production. It holds a unique place in the history of motorcycling, being the birthplace of industry giants such as Honda, Suzuki, and Yamaha. Notably, Hamamatsu witnessed Honda's creation of Japan's first original motorcycle design, a remarkable achievement that set the tone for the city's enduring association with motorcycles (In Hamamatsu, 2023). In the era following World War II, Hamamatsu played a vital role in supporting and nurturing the culture surrounding motorcycles. Despite the devastation caused by the Pacific War, the city displayed remarkable resilience and determination, which facilitated the establishment of numerous businesses related to motorcycles. Soichiro Honda, a native of Hamamatsu, founded the Honda Technical Research

Institute in the city's wooden barracks, marking the beginning of motorized bicycles and motorcycles in Japan. Hamamatsu saw the emergence of over 30 motorcycle manufacturers, with renowned companies like Suzuki Loom and Yamaha (previously known as Japan Musical Instrument Manufacturing) achieving global recognition. As the birthplace of the motorcycle, Hamamatsu's legacy remains vibrant, symbolizing the spirit of innovation in the face of adversity.

Kobe boasts a rich history of manufacturing and industrial prowess. Kobe's contribution to the motorcycle industry is rooted in its strong manufacturing heritage. Notably, Kawasaki Heavy Industries, which originated in shipbuilding, has its headquarters in this city. The Kobe Maritime Museum, which includes the Kawasaki Good Times World, serves as a testament to Kobe's enduring connection to industry and technology and the transfer of capabilities across different industrial domains.

Located in the Shizuoka prefecture, *Iwata* played a crucial role in Yamaha's entry into the motorcycle market. Here, in 1955, Yamaha Motor Co., Ltd. was established as a distinct company (from the musical instrument production) to oversee the company's motorcycle production. The city of Iwata serves as the headquarters for Yamaha's motorcycle manufacturing operations. Notably, the Iwata South Factory (Bldg. M2) stands as a facility with a well-documented history of producing high-quality motorcycle parts. Iwata's significance lies in its contribution to Yamaha's diverse range of motorcycles and its unwavering commitment to maintaining exceptional production standards.

Despite their Japanese roots, the key players have a reach that extends far beyond their home country. A considerable proportion of their motorcycle production takes place on foreign shores, surpassing domestic manufacturing. The Japanese Big Four exemplify how

capabilities rooted in the national realm can drive not only the evolution of the domestic market but may also have a profound and lasting influence on the global motorcycle landscape.

Intellectual Property in Japan

During the period of post-World War II recovery, spanning from 1945 to the 1960s, a significant milestone was the implementation of Japan's Patent Law in 1959. Although it did not explicitly address inventor's rights or exclusive rights, its main objective was clearly stated as promoting industrial development by fostering the protection and exploitation of inventions.

During this period, Japan's Ministry of International Trade and Industry (now known as METI) assumed a leading role in guiding industrial policy. METI introduced a range of policies aimed at promoting research and development, facilitating the transfer of technology, and fostering growth oriented towards exports. While these policies were not directly aimed at the motorbike manufacturing industry, they indirectly contributed to its advancement by providing access to technological advancements.

In the 2000s, Japan implemented a comprehensive National Intellectual Property Strategy, which played a pivotal role in fostering innovation, driving economic growth, and enhancing global competitiveness. This strategy encompassed a wide range of initiatives, including strengthening intellectual property (IP) protection, promoting research and development, and facilitating the application of IP in various industries, such as motorbike manufacturing. It is worth mentioning that the Intellectual Property Strategy Headquarters,

established within the Cabinet in 2003 and led by the Prime Minister, annually reviews and approves this strategy (Arai, 2007).

The Japanese government's endorsement of the Intellectual Property Promotion Plan 2022 in June 2022 clearly demonstrated its commitment to further enhancing the infrastructure and systems related to intellectual property (Ebata and Hino, 2022). Supporting these efforts were initiatives to encourage businesses to actively protect and leverage their intellectual property, which included facilitating patent filings, enabling licensing arrangements, and implementing effective IP management practices.

Lastly, Japan's active engagement in international IP agreements and initiatives, in line with the global standards outlined in the World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), has strengthened the country's role in shaping the evolving landscape of global IP frameworks (WTO, 2017).

THE INDIAN TWO-WHEELER INDUSTRY

The Evolution of the Two-Wheeler Industry in India

The term "two-wheelers" in India refers to a type of motorized mobility vehicle that can have either two or three wheels and is used for commercial or personal purposes. Legally, these vehicles require registration and a driver's license in order to be operated. They can be powered by either an internal combustion engine (ICE) or an electric battery motor. Motorcycles in India can be broadly categorized into two types. The "Indian design" motorcycles were equipped with two-stroke engines and had an engine capacity of 100-175 cc. Brands such as Escorts and Jawa produced motorcycles of this type. On the other hand, the so-called "British design" motorcycles with four-stroke engines with an engine capacity of 346 cc and a power rating of 13.4 kW. The Royal Enfield is an example of a motorcycle that falls into this category (Royal Enfield website, 2023).

The historical development of the two-wheeler industry in India can be traced back to the period between the 1950s and 1980s. During this time, the market operated as a seller's market, with only a few Indian brands available and limited access for foreign companies. Vehicle options were also limited and targeted different market segments. One of the early players in the scooter market was Bajaj, which began trading imported Vespa scooters in 1948. Later, in 1959, Bajaj started manufacturing these scooters under license from Piaggio. This agreement expired in 1971.

In the period from the mid-1980s to the mid-1990s, the two-wheeler market in India witnessed the introduction of new brands and models. This trend was driven by higher urban incomes following economic liberalization, which brought significant changes in buyer preferences and motorcycle profiles. One notable addition to the market was the gearless scooter produced by Kinetic-Honda, which catered to individuals who faced difficulties operating geared vehicles or mopeds. During this period, scooters enjoyed higher sales compared to motorcycles and mopeds, although motorcycles began gaining popularity in the late 1980s. The demand for motorcycles was primarily for commuter models, with some demand for scramblers that offered more power and the ability to navigate different types of terrain. This era also marked the emergence of four Indo-Japanese joint ventures that produced fuel-efficient and low-powered motorcycles.

The period from 2000 to 2010 was characterized by the prevalence of four-stroke engines, which can be attributed predominantly to shifts in government regulations regarding pollution control standards following the Kyoto Agreement in 1997. This led to the gradual elimination of two-stroke engines from motorcycle production. Consequently, four-stroke engines experienced significant growth while the usage of two-stroke engines

declined. During this time, the market share of mopeds witnessed a decline from 30% in 2000 to 10% in 2003. This can be attributed to the increasing availability of high-quality second-hand motorcycles as well as the introduction of low-powered automatic scooters. Conversely, there was a steady demand for scooters, with the Honda Activa, India's most popular scooter, capturing the top spot since its launch in 1999 and continuing to do so until 2021, with sales exceeding 25 million units. Motorcycles remained the primary drivers of growth in the two-wheeler sector, while scooters and mopeds experienced a progressive decline. The market share of motorcycles grew from 21% in 1994 to 43% in 2000 and eventually reached 77% by the mid-2000s. Hero Honda emerged as the leading seller of motorcycles globally between 2001 and 2007. During this period, the industry's product portfolio expanded with the introduction of entry-level performance motorcycles. The Hero Honda CBZ (156.88 cc) was launched in 1999, followed by the Bajaj Pulsar (150/180 cc) in 2001.

From the 2010s onwards, there has been an increasing demand for high-performance motorcycles. However, the majority of the market share in the country is still dominated by sub-125cc engine motorcycles. In FY2020–21, engines smaller than 125 cc accounted for 85% of two-wheeler sales, with seven out of the ten best-selling models falling into this category. This also included two scooters and one moped.

Electric motorcycles are currently experiencing a decline in battery prices, the localization of parts, the emergence of charging infrastructure, and the availability of battery swapping options, which has resulted in a decrease in operating costs, making them almost as affordable and accessible as traditional motorcycles (Economic Times, 2021). However, the electric motorcycle segment in India is still in its infancy. Its penetration rate increased only minimally from 0.1% in FY2017-18 to 0.2% in FY2019-20, reaching 0.3% in FY2020-21 (Anup,

2021). Currently, electric two-wheelers account for 4% of all two-wheelers sold in 2022, a significant increase from the 1% share in 2021. Additionally, 40% of three-wheelers sold in 2022 were electric. When combined, two-wheelers and three-wheelers accounted for 92% of all electric vehicles registered in 2022 (Economist, 2023).

The composition of the two-wheeler industry's market share in FY2020-21 consisted of 66% motorcycles, 29% scooters, and 4% mopeds. Furthermore, 85% of two-wheeler sales were for engines smaller than 125 cc. These trends indicate a notable growth in sales of higher-performance engines (Anup, 2021). The manufacturing and technological capabilities of major Indian two-wheeler manufacturers evolved from an initial reluctance to innovate prior to economic liberalization, to a dependence on foreign technology, and ultimately to the development of domestic capabilities that could meet domestic demand and cater to global markets. However, the majority of Indian two-wheelers, both domestically and internationally, are relatively less technologically advanced due to the limited specialization of the Indian workforce, which restricts diversification within the industry (Balland et al., 2022).

The Geography and Localization of the Indian Two-wheeler Industry

There are fundamentally three two-wheeler hubs in India. These hubs can be traced back to the mid-1950s when family-owned conglomerates like TVS in Chennai and Escorts in Delhi were dominant. The industry transitioned towards localized industrialization in the early 1960s after the progressive countermeasures against imports which started in 1957. The 1963 the 'Monopolies and Restrictive Trade Practices Act' introduced licensing regimes, fostering the growth of public-sector enterprises. The policies of economic liberalization started in 1991

played a pivotal role in the rapid evolution of the two-wheeler industry, with states like the National Capital Region, Maharashtra, and Tamil Nadu attracting investments and significantly contributing to the industry's growth.

Throughout history, India has witnessed the emergence and evolution of three major hubs for two-wheeler production: Chennai, Pune, and the National Capital Region (NCR) (primarily Delhi). The technological advancements and capabilities of these hubs are closely intertwined with their composition and characteristics, from their inception to their current prominence.

Chennai, the capital of Tamil Nadu, holds significant historical importance as a hub for two-wheeler manufacturing. It was home to the initial manufacturing plants of Royal Enfield and TVS Motor Company, both of which are currently headquartered in the city. Foreign investments, particularly from Japan, have contributed to the attractiveness of Chennai as a hub. The region is also host to various players such as BMW Motorrad and Yamaha, alongside major automobile companies and electronic firms. In recent years, Tamil Nadu has witnessed a surge in manufacturing, accounting for 15.8% of all factories in India in 2020. It has also become a manufacturing base for leading electric scooter companies, and it is recognized for its comprehensive industrial and technological presence, encompassing software, information technology services, and startup ventures.

Pune, a notable center for automobile manufacturing, accommodates the oldest manufacturing facility of Bajaj Auto and its present research and development department. Throughout the years, Pune has enticed major automobile manufacturers and is designated as a key foreign investment zone for German companies. Pune has transformed into a pivotal center for automobiles, durable goods, and information technology services. It holds the

position as the third-largest contributor to information technology exports, hosts numerous startups, and will allure a substantial portion of industrial investment in India in 2020. The Automotive Research Association of India, established in 1966 in Pune, contributes to research, development, testing, and certification services in Pune.

The *NCR hub* encompasses Delhi, Haryana, and sections of Uttar Pradesh. It hosted the initial manufacturing facility of Hero Motocorp, India's largest motorcycle producer. Haryana, within the NCR, has emerged as a major participant in producing passenger cars. Delhi, part of the NCR, has attracted foreign investments from Japan and the Republic of Korea, resulting in a diverse manufacturing sector that includes two-wheeler brands such as Honda, Yamaha, and Suzuki. Noida, a region within Delhi, serves as a hub for manufacturing electronic hardware and information technology, making a significant contribution to India's mobile phone manufacturing.

Changes in demographics have recently influenced consumer preferences in India, with a growing demand for innovative features and enhanced performance in two-wheelers. This shift has caused a surge in demand within the premium two-wheeler segment, accompanied by a decline in the basic segment. The process of urbanization has played a crucial role in this trend, with projections indicating that by 2030, there will be over 500 million urban residents. This, coupled with emergence and expansion of a consumer class, is expected to drive the growth of the two-wheeler market (McKinsey, 2018). The significance of two-wheelers for mobility in India can be inferred from the increase in the proportion of two-wheelers among all vehicles in the country and the rise in the number of registered two-wheelers over the past seven decades.

The national market in India, as of 2020, is made of circa 1.3 billion individuals, which constitute 19% of the global population. 31% of the population resides in urban regions, and India holds the position as the world's 6th largest consumer market. The country's GDP per capita in 2019 amounted to \$2100. In 2019, 49.7% of households possessed at least one two-wheeler, marking an increase from 37.7% in 2018 (Team BHP, 2022). The two-wheeler market has expanded by meeting local demands while constraining imports to locally and foreign-produced vehicles by companies for export purposes. Policies that facilitated economic liberalization, foreign collaborations, and foreign direct investment have contributed to the growth of the market. Furthermore, the standardization of emission and safety policies to align with global norms has reduced the discrepancy between the vehicles and components produced. In 2005–06, India had 11 producers that exported 0.5 million two-wheelers from the country. In 2014–15, 10 manufacturers exported 2.5 million two-wheelers. India became the largest producer of motorcycles during 2016–17 (SIAM website, 2023).

Intellectual Property in India

The development of IP legislation in India began with the adoption of the British Trade Mark Act in 1940 and it has evolved through subsequent acts such as the Trade and Merchandise Act of 1958. The current operational framework is defined by the Trade Marks Act of 1999, which outlines the graphical representation of a trademark and its ability to distinguish goods and services. It typically takes about 18 months for patents application to be published. These applications require a written description and must adhere to criteria such as novelty, non-obviousness, inventiveness, and industrial applicability in order to be approved.

The two-wheeler industry in India has experienced a significant increase in IP activity, particularly after economic liberalization in the early 2000s. This increase in activity has been observed in patent filings related to engines and transportation, reflecting advancements in engine technology to meet stricter emission standards. This shift in perception regarding research and development has transformed intellectual property from being perceived as an additional, sometimes superfluous cost, to being recognized as a strategic investment that is crucial for a company's domestic and global reputation.

Until 2008, major players in the industry had different approaches to IP. Hero Honda, for example, had limited IP holdings and relied heavily on Honda's technology. Bajaj Auto Ltd., on the other hand, exhibited global ambitions with numerous patent filings both domestically and internationally. TVS Motor Company, in contrast, emphasized innovation and had a significant domestic IP portfolio. While IP activities have increased in the country, their primary purpose has been to protect the less complex technologies of specific manufacturers in relatively less advanced products that are demanded by domestic and foreign markets. However, as the nation's economy progresses from a low-income to a middle-income country, it is likely that the less complex technologies will evolve into more complex ones, as theorized by Balland et al. (2022).

COMPARATIVE ANALYSIS: SIMILARITIES AND DIFFERENCES BETWEEN THE ITALIAN, JAPANESE AND INDIAN MARKETS

****Insert Exhibit 3 about here****

Italy, Japan, and India have experienced distinct trajectories of development in their respective two-wheeled industries. Exhibit 3 provides a comparative table of the main differences across the three countries. The Italian industry had its major inception after World War II with the widespread adoption of two-wheelers, and later shifted its focus to performance and style in the 1970s and 1980s. Japan also initiated its motorcycle industry after World War II and continued to expand since then mostly thanks to sales and production in foreign markets. The focus of the Japanese two-wheeler producer has been on research and development, product innovation, and global market expansion. Net of foreign (mostly Japanese) imports, India experienced significant growth of its own motorcycle industry in a later phase, from the mid-1980s to the mid-1990s. This growth was catalyzed by economic liberalization, partnerships with Japanese brands, and rising urban incomes.

The origin and development of motorcycle manufacturing in these countries are rooted in distinct knowledge and capabilities that are the result of their idiosyncratic historical, industrial and economic development. In all three countries the motorcycle industry emerged to respond to a need for convenient and affordable transportation – a solution providing more independence than public transport but inferior costs than cars. Yet, the knowledge base of each country and their economic development led the three industries in different directions. Italian companies primarily came from backgrounds in mechanical equipment manufacturing or bicycle-related accessories and because of this they reapplied their mechanical expertise to excel in motorcycle production. Starting with the 1950s, however,

they embedded capabilities from racing competition to develop high performing bikes, and from the world of industrial and fashion design to produce vehicles that would stand out for their aesthetic qualities, up to becoming, design icons (such as Piaggio's Vespa, or Ducati's Monster). Similarly to Italy, Japan was originally driven by the need for affordable transportation, yet as their capabilities developed, all major Japanese two-wheeler manufacturer diversified into automotive and aerospace. The resulting technological advancements fed back into the motorcycle industry, enabling Japanese production to achieve high levels of performance, efficiency, and functionality, especially with small-sized engines. This led to a production of very versatile motorcycle, which ideally balanced functionality, innovation and affordability. Yet, their design tended to homogenize across the various brands, failing to develop clearly distinctive aesthetics like in the Italian industry. In India, the key companies started from relatively different trajectories: Hero Motocorp started with bicycle components, TVS Motor Company originated from a bus and truck transportation service, while Bajaj Auto began by importing two-wheelers and three-wheelers. These companies leveraged their manufacturing and assembly capabilities to adapt to the growing demands of the motorcycle market. This transition showcases the adaptability of these companies, utilizing their initial capabilities to excel in the production of vehicles that, still today, were mostly geared at responding to a need or convenient transportation. More recently, the country started introducing bikes destined to recreational use with a strong lifestyle component (e.g., Royal Enfield), thus developing models that are more similar to those in the top-segment of the Italian and Japanese industries.

The establishment of motorcycle manufacturing hubs in these countries can be attributed to specific factors. In Italy, the northern regions such as Lombardy and Emilia-

Romagna had well-established industries across various sectors, including a long tradition in mechanical engineering, industrial machines, metal production, rubber, and other materials. These regions also had a highly educated population and early development of technical education facilities, creating favorable conditions for industrial hubs to thrive. In Japan, Tokyo served as a hub for various manufacturing industries, with companies like Honda initially based in Hamamatsu. Other centers developed around other industrial hubs, usually focused on mechanical productions and electronics. In India, Chennai emerged as a hub due to its strategic access to eastern coast ports, which was essential for the automobile industry and its supply network. This region had strong capabilities in mechanics, part production, and assembly. Pune's proximity to Mumbai, India's financial capital, played a pivotal role in its emergence as a manufacturing hub. Delhi also witnessed hub expansion following the establishment of India's largest car producer's manufacturing plant in the region. Delhi developed capabilities in mechanism, part production, metal carpentry, and assembly. These regional hubs highlight the crucial role of infrastructure, accessibility, availability of skilled human capital, and strategic locations in facilitating industrial growth.

Consumer preferences for motorcycles vary among these nations but tended to reconverge with time. In Italy, the market has historically demonstrated a strong inclination towards mopeds and medium-sized motorcycles, ranging from 250cc to 750cc, appreciating models that combine style and performance. In Japan, the market is dominated by mopeds with engines up to 50cc, indicating a preference for compact, efficient, and convenient commuting solutions. In India, motorcycles hold the highest position, with low-powered two-wheelers below 125 cc constituting 85% of total sales. This showcases a focus on practicality, cost-effectiveness, and efficiency in accordance with evolving consumer demands. The

varying preferences underscore the significance of aligning product offerings with consumer needs and market dynamics. Yet, in recent years a common interest for lifestyle and recreational vehicles is increased across all nations (despite with different magnitude) and all countries have displayed an increasing interest for safer and more sustainable vehicles, which has resulted in the development of the electric-powered two-wheelers.

The market share of leading brands is determined by market dynamics and competition. In Italy, Honda, Piaggio, Kymco, and Yamaha hold substantial market shares, with Honda leading the pack in FY 2022. Japan's motorcycle market is predominantly led by the "Big Four" local brands, namely Honda, Kawasaki, Yamaha, and Suzuki, with Honda commanding a the most significant market share. India's top brands include Hero Motocorp, Honda, and TVS, with Hero Motocorp maintaining the highest market share in FY 2023. These statistics on market share reflect the competitive landscape and consumer preferences within each nation's motorcycle industry.

Insights into the scale and strength of the motorcycle markets in these countries can be obtained from domestic sales figures. In Italy, FY 2022 witnessed the sale of 291,799 units domestically, indicating a market of medium size. Japan's FY 2021 sales of 415,890 units demonstrate a comparatively smaller yet significant domestic market, partly due to the country's advanced public transportation infrastructure. India's FY 2023 sales of a staggering 15.9 million units domestically portray the magnitude of its industry, driven by a growing population and increasing urbanization.

Export figures provide evidence of the international competitiveness of these countries' motorcycle industries. Italy, in FY 2022, exported 541,828 motorcycle units, 57,193 mopeds, and a remarkable 27.24 million moped and motorcycle parts, showcasing a thriving global

presence. Japan, in FY 2021, exported 437,042 units, highlighting its substantial contribution to the global motorcycle market. However – differently from their Italian and Indian counterparts – most Japanese brands hold major production sites abroad, which contribute to the performance of their brands despite not being accounted as ‘exports.’ Indian brands in FY 2023 exported 3.65 million units, reflecting the importance of their international presence.

The number of registered motorcycles on the road indicates the enduring popularity of motorcycles in these countries. In Italy, as of 2019, there were 6.89 million registered motorcycles, illustrating a mature and well-established market. Japan, as of March 2021, recorded 10.2 million registered motorcycles, indicative of a country with a strong motorcycle culture in both production and consumption. India, as of 2022, boasted over 210 million registered motorcycles, highlighting the integral and dominant role of motorcycles in the transportation landscape of the nation. The motorcycle industries of these nations manifest distinct market segmentation. Italy and Japan showcase a diverse range of engineering, manufacturing and marketing capabilities that are valuable for catering to a mature and diverse demand with highly diversified. In India, instead, the market is predominantly governed by low-cost volume-focused producers that cater to the high demand for sub-125cc motorcycles. Yet, one can increasingly observe exceptions such as specialist brands like Royal Enfield that cater niche markets or bigger vehicles with a strong lifestyle and leisure component.

Despite originating from a common foundation of capabilities in basic mechanics, metal carpentry, and machine tools, each of these three countries has adopted a distinct approach to innovation within their motorcycle industry. In present-day Italy, there is a significant emphasis on performance and aesthetics, blending style with functionality. Historically,

Japan's strategy involved importing foreign technology and gradually enhancing domestic production through extensive research and development investments, with a focus on performance, utility, and innovation as a combined approach. Indian two-wheeler brands have primarily concentrated on cost-effective and fuel-efficient vehicles, aligning with utilitarian purposes. However, there is an emerging trend towards prioritizing aesthetics and performance.

Partnerships and collaborations play a crucial role in shaping the industry landscape. In Italy, partnerships among local firms are more prevalent than international collaborations. These local partnerships foster technological advancements in the co-development and production of high-tech components for high-performance motorcycles (see Lipparini et al., 2013). Japan's capabilities in fostering knowledge clusters and establishing strong relationships, following the Keiretsu principles, have facilitated partnerships with suppliers and collaborations within both domestic and international markets. In India, particularly from the mid-1980s to the 2000s, strategic partnerships with Japanese brands were dominant, enabling the local production of two-wheelers and access to manufacturing capabilities in production lines and automation, thereby facilitating efficient scaling up. Recent strategic partnerships with foreign brands such as Hero-Harley Davidson, Bajaj-KTM, and TVS-BMW Motorrad highlight the evolving collaboration landscape in India to cater new consumer preferences. The initiation of intellectual property activities varies among these nations. Italy has witnessed pioneers such as Pirelli, Piaggio, and Brembo leading the way in patent filings, indicating a contemporary emphasis on innovation and the protection of intellectual property. Japan adopted a comprehensive approach to IP activity in the 2000s, establishing a National Intellectual Property Strategy, fostering research and development, and facilitating

the application of IP across various industries. India's IP activity gained momentum in the 2000s, coinciding with the termination of joint ventures with Japanese brands, highlighting the country's increasing technological self-sufficiency. This strategic maneuver underscores Japan's dedication to innovation, economic growth, and global competitiveness, coupled with a focus on preserving and safeguarding its competitive edge.

In summary, the motorcycle industry in Italy, Japan, and India exemplifies the enduring influence of adaptability, innovation, and market responsiveness. While each country brings its own distinct strengths and strategies to the forefront, collectively, they enrich the global motorcycle landscape, contributing to an industry that continually progresses, flourishes, and evolves along intricate pathways that enhance and rejuvenate the underlying capabilities rooted within the respective regions. Moreover, these localized capabilities have not only shaped domestic markets but have also left an indelible imprint on the global motorcycle industry, emphasizing that the journey of a thousand miles begins with the initial revolution of a motorcycle's wheel.

Concluding Remarks

Our comprehensive analysis of the three prominent national two-wheeler industries has yielded three primary conclusions.

First, national motorcycle industries evolve along technological trajectories that are shaped by their historical technological background across diverse industries and utilization practices. Consequently, Italy's industry is grounded in connections to aesthetics and racing, which signifies a production focus on distinctive design and performance. Japan's industry is grounded in the redeployment of advanced technologies, which indicates a production focus

on innovation and reliability. India's industry is grounded in fundamental, convenient technologies, which suggests a production focus on efficiency and simplicity.

Second, the motorcycle industry tends to mirror the evolution of the automotive industry across multiple crucial dimensions.

- *Manufacturing Strategies:* Similar to the automotive sector, motorcycle manufacturers often adopt various strategies such as lean manufacturing, automation, and globalization to enhance efficiency and reduce production costs.
- *Innovation and Technology:* Both automotive and motorcycle industries have experienced rapid technological advancements, including the integration of smart features, connectivity, and safety systems in vehicles. For instance, Japanese motorcycle giants such as Honda and Yamaha have been at the forefront of technological innovation by introducing features like anti-lock braking systems (ABS) and advanced rider-assist technologies.
- *Cultural Influences on Design:* Cultural and aesthetic preferences play a significant role in shaping the design and style of vehicles in both car and motorcycle industries. For example, Italian motorcycle design is often associated with elegance and passion, reflecting the iconic and stylish designs seen in Italian automotive brands such as Ferrari, Maserati and Lamborghini.
- *Market Segmentation:* Both industries cater to diverse market segments, offering a range of products from budget-friendly models to luxury and performance-oriented vehicles. For instance, in India, the motorcycle industry has witnessed the emergence of commuter bikes and premium segments, mirroring the segmentation observed in the Indian automotive market, which emphasizes affordability and fuel efficiency.

- *Global Competition and Collaboration:* Intense global competition and strategic collaborations are prevalent in both industries as companies strive to gain a competitive edge and expand their market presence. For instance, joint ventures and collaborations between motorcycle manufacturers in India and international players reflect a strategy akin to that observed in the automotive sector.

Third, international partnerships and the exchange of intellectual property have played a crucial role in shaping the motorcycle industry. Such collaborations have become essential for the evolution of the global motorcycle industry, enabling companies to access new technologies, enhance their competitive positions, and contribute to the overall progress of the industry on a global scale.

In conclusion, the global motorcycle industry is poised for significant evolution in the coming years, driven by technological advancements, shifting consumer preferences, and environmental concerns. With the rise of electric and connected vehicles, the industry is expected to witness a paradigm shift towards sustainability and smart mobility solutions. Moreover, the emergence of new markets, particularly in Asia-Pacific and Africa, presents immense opportunities for growth. However, challenges such as regulatory uncertainties and economic fluctuations may pose hurdles along the way. To thrive in this dynamic landscape, stakeholders must adapt to changing trends, embrace innovation, and foster collaboration across the value chain. By doing so, the motorcycle industry can continue to drive progress and shape the future of transportation worldwide.

EXHIBITS

Exhibit 1: Global market share by revenue (Statista, 2022).

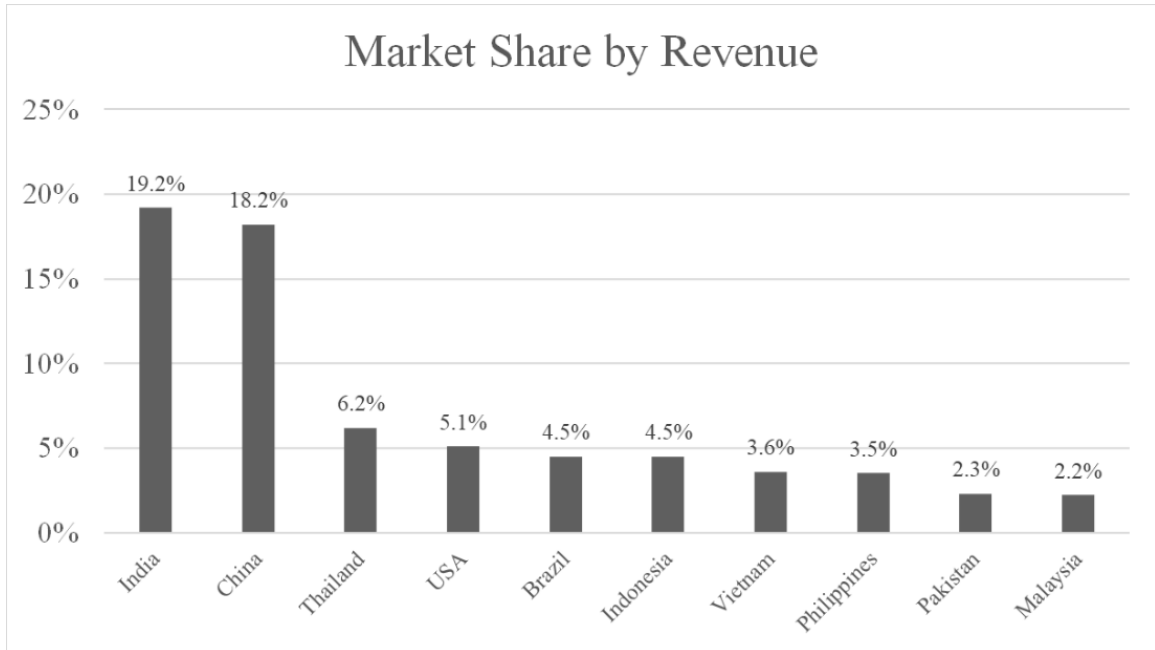


Exhibit 2: Global market share by unit sales (Statista, 2022).

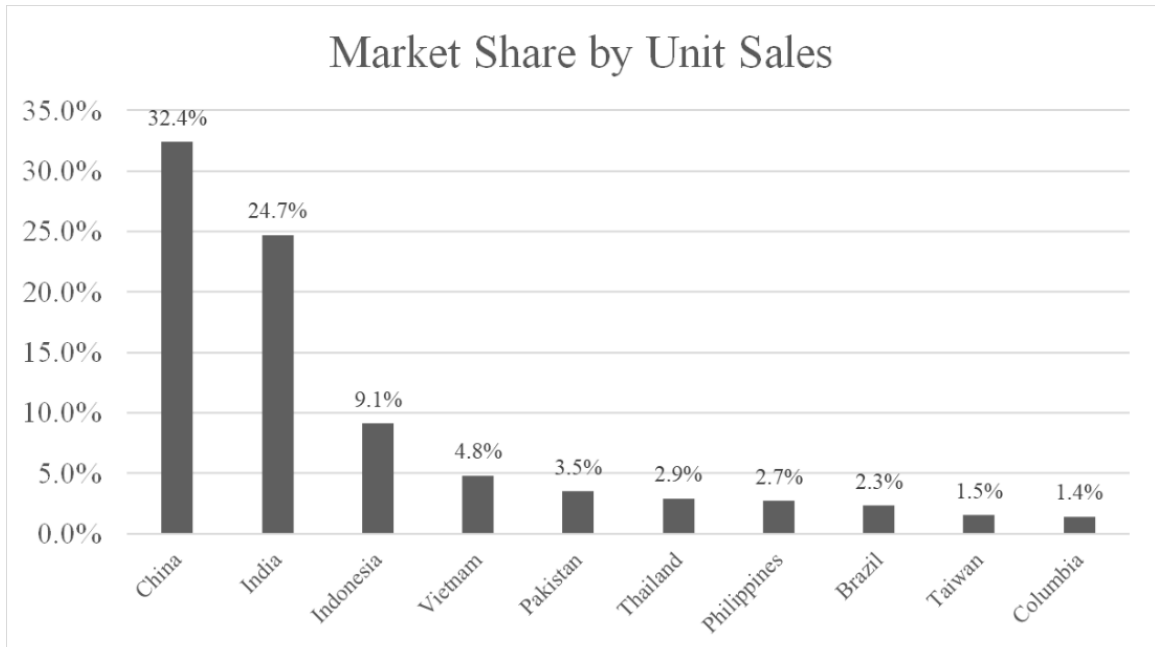


Exhibit 3: Comparative table

Comparative Feature	Italy	Japan	India
Origin and growth period	<ul style="list-style-type: none"> Started post WWII period from 1945 to 1962 was significant in widespread two-wheelers adoption. Second phase took place in 1970s and 1980s, when the focus shifted from utility to performance and style. 	<ul style="list-style-type: none"> Started post WWII and has been remarkably growing ever since. With significant new innovations and technological advancements due to investments in R&D and continues expansion of operations abroad 	<ul style="list-style-type: none"> Mid 1980s to mid 1990s led to significant growth mainly due to the liberalization of Indian economy that let do: Changes in types of vehicles produced by influx of foreign intellect resulting from partnerships with Japanese brands. Spike in demand due to higher urban incomes in the country.
Originating capabilities	<ul style="list-style-type: none"> Mechanical equipment Bicycles Automotive 	<ul style="list-style-type: none"> Mechanical equipment Bicycles Automotive Musical instruments (Yamaha) Electronics 	<ul style="list-style-type: none"> Mechanical equipment Bicycles Automotive
Hub Formation - factors that contributed to formation of hubs	<ul style="list-style-type: none"> Northern Italy was historically more industrialized than the rest of the country implying regions like Lombardy and Emilia-Romagna having existing industries in various sectors, educated populations and 	<ul style="list-style-type: none"> Tokyo is the capital and hub for many manufacturing industries in Japan. While Soichiro Honda was a native of Hamamatsu and founded the Honda Technical Research 	<ul style="list-style-type: none"> Chennai emerged as a hub due to its access to ports on the eastern coast of the country when the automobile industry relied on imports. Pune developed as an important hub due to its

	technical facilities developed early on.	Institute in the Hamamatsu	proximity to the country's financial capital, Mumbai, which also houses the country's largest port.
Most diffused models	<ul style="list-style-type: none"> Mopeds and mid-sized motorcycles (250cc-750cc) 	<ul style="list-style-type: none"> Mopeds up to 50cc engines. 	<ul style="list-style-type: none"> Delhi's automobile hubs expansion followed the setting up of India's largest car producers manufacturing plant in the region. Low powered motorcycles (<125cc)
Market share of 3 largest brands per country	FY 2022: <ol style="list-style-type: none"> Honda (24%), Piaggio (20%), Kymco (12%) Yamaha (12%) 	FY 2022: <ol style="list-style-type: none"> Honda 32.5% Kawasaki 22% Yamaha 10.4%	FY 2023: <ol style="list-style-type: none"> Hero Motocorp (32.2%), Honda (25.2%), TVS (16.2%)
Domestic sales	FY 2022: 291,799 units	FY 2021: 415,890 units.	FY 2023: 15.9m units
Volume of exports	FY 2022: <ul style="list-style-type: none"> Motorcycles: 541,828 units Mopeds: 57,193 units 	FY 2021: 437,042 units	FY 2023: 3.65m units
Volume of two-wheelers in use (registration)	2019: 6.89 million units	2021: 10.29 million units	2022: >210 million units

Market segmentation

Large number of players present in:

- Volume producer's category – Honda, Piaggio
- Specialist producers –Ducati, Benelli, Aprilia
- Niche specialist –
- Bimota
- EV 2-W – Energica
- Components and accessories – Pirelli, Brembo, AGV, Alpinestars, Dainese

Approach to innovation

Approach is heavily focused on performance and aesthetics; implying that two-wheelers must not just perform well, but should also look stylish

- Large producers like Honda, Yamaha, Kawasaki & Suzuki along with other international brands that collectively contribute to 25% of the total sales volume in 2021.

A strategy of importing foreign technology and encouraging domestic production, even if the initial quality was inferior to imports and then gradually improving by rigorous R&D investments to boost the export market.

- Volume producers: largest producers like Hero, Honda, TVS and Bajaj of two-wheelers catering to the most demanded 125cc category type vehicles.
- Specialist brands: producing high-powered/premium two-wheelers catering to a relatively niche market, reflected in the market share, such as Royal Enfield (4.5%).

The approach to innovative technologies has been primarily to meet demand for cost- and fuel-efficient vehicles, leading focus on utilitarian purposes, although personal preferences of consumers towards aesthetics and performance are changing slightly.

Major partnerships

- Partnerships exist among local firms and cross-border partnerships exist too.
- These are in the form of technological collaborations, skills development and utilizing networks of partners for international growth

- Japan's capabilities lie in fostering collaboration and intellect exchange to form knowledge clusters building strong relationships (Keiretsu style) with suppliers and regular partnerships

- From the mid 1980s to the 2000s, large Japanese brands partnered with Indian companies to produce two-wheelers in India.
- More recently, there have been some strategic partnerships for foreign brands operating in India like

within the domestic market & abroad

Hero with Harley Davidson, Bajaj with KTM and TVS with BMW Motorrad.

IP activity

- No data found for history of patent filing in motorcycle industry but in recent years Pirelli (tires), Piaggio (two-wheelers) and Brembo (brakes) have been the players with the greatest number of patents filed.
 - Focus on IP emerged soon after recovery phase post WW2 (1960s).
 - In 2000s, Japan implemented a comprehensive National Intellectual Property Strategy
 - This strategy encompassed a range of initiatives from fortifying intellectual property (IP) protection to stimulating research and development and facilitating IP application across industries, including motorbike manufacturing.
 - IP activities by two-wheeler brands picked up in the 2000s with their respective dissolutions of joint ventures with Japanese brands.
 - Before this, Indian brands were largely dependent on the foreign brands' technological expertise & intellect.
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Suggested citation: Aversa, P. (2024). The Evolution of the Two-Wheeler Industry: A Comparative Study of Italy, Japan, and India. WIPO Economics Working Paper Series no. 83. World Intellectual Property Organization.

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