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Final Thesis

The Bicycle Industry in the new Global Value Chain

The role of Innovation in
the Bicycle Industry Architecture

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Abstract

The aim of the dissertation is to describe how the Bicycle Industry can be an evolved representation of the Global Value Chain, explaining and analyzing the Industry Architecture and investigating Italian companies' reaction to the evolution of the Industry. Whether and how Italian firms, born as craft companies, deal with and how they could keep the leadership, in a sector which has reached a dimension increasingly global. The dissertation presents the relevant literature on Global Value Chain (GVC) and Industry Architecture, Product architecture and the role of innovation in the bicycle value chain and additive manufacturing in a sector where the human job can still be a game-changing factor; it describes the state of the art of the research on this field through quantitative analysis and qualitative description of its evolutions. The thesis of an industry globally oriented is supported by global, European and Italian sales and production figures of the last decade, and furthermore by the results of the companies we looked at. We looked at different cases of Italian companies to identify common features of leading companies and key elements driving to market success. The aim is to understand reasons of changes in bicycle Industry Architecture: where the actions of the Value Chain primarily take place, who has the critical knowledge and how Italian leading firms are competing in a sector which is more and more global. The study is conducted through the qualitative analysis of case studies, show how the geography and organization of different stages, not only production but also pre-production phases such as design marketing or after-sales in Global Value Chain, contribute to lead firms' innovation development. Evidence from the bicycle manufacturing industry suggests that lead firms' innovation capabilities and product innovation cycle are shaped by a particular structure of the GVC wherein they operate influenced also by the nature of the product architecture.

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Introduction

Two wheels, a frame, a handlebar, a pair of pedals and a chain that transmits its movement: for two centuries the bicycle has made humanity move, thanks to a simple, economical and clean mechanism: essential and at the same time perfect. Today materials and technologies, starting from the assisted pedalling, make bicycle comfortable, agile and usable by all. The bicycle thus evolves into a solution for the mobility of the future, which intersects with the new economy of sharing, the logistics of home deliveries and a renewed philosophy of well-being and slow movement.

The bicycle is the perfect synthesis between technology and tradition, enabling to move without any constraints. It is an ancient but modern machine, whose industry, like its final product itself, has been renewed and reinvented, adapting to new demands and new game's rules. Today, the bicycle is still proposed as the symbol of a modern industry that manifests itself as a platform, and the bike is capable of becoming the fulcrum of various economies, between innovation and craftsmanship.

I. VALUE CHAIN CONCEPT AND ITS EVOLUTION IN LITERATURE

1.1 Global Value Chain: an introduction

The research proposal of this dissertation rises from the study of the Global Value Chain, thus at first, we have to clarify what Value Chain is about and how is defined according to the literature.

From an economic point of view, globalization can be defined as: « (…) the increasing interdependence of world economies as a result of the growing scale of cross-border trade of commodities and services, the flow of international capital and the wide and rapid spread of technologies. It reflects the continuing expansion and mutual integration of market frontiers (…) and the rapid growing significance of information in all types of productive activities and marketization are the two major driving forces for economic globalization» (Shangquan, 2000)[1]

Globalization implies the functional integration and coordination of geographically dispersed international activities, enabling evolution on a global scale of the industrial organization. This international expansion and geography fragmentation are made Value Chain, which studies the different ways in which global manufacturing and distribution systems are integrated into a common chain that creates value.

The global economy is to an increasing extend structured around the Global Value Chain (GVC), which has significant implications with regard to production, global trade and employment. The GVC link-up business, workers and consumers from around the world. The framework of the Global Value Chain allows us to understand how an industry is organized by analysing the structure and dynamics of all those different actors who are involved in a given industry.

«The value chain describes the full range of activities that firms and workers perform to bring a product from its conception to end use and beyond. This includes activities such as design, production, marketing, distribution and support to the final consumer. The activities that comprise a value chain can be contained within a single firm or divided among different firms». (globalvaluechains.org, 2011)

Therefore, the term Global refer to the phenomenon where production is broken into activities and tasks realized in different countries, a sharing of the production chain internationally. This can be seen also as a large-scale implementation of Adam Smith' s division of labour. We can use the famed example with which Smith begins *The wealth of Nations*[2]*,* where he describes a pin factory: the production of the pin was divided into numbers of distinct operations, each performed by a dedicated worker. In our modern contest the operation is instead spread across national borders, we have witnessed a huge change in the international model of trade, which has gone from trade-in-goods to trade-in-tasks. The result has been a new layout of the international division of labour, whereby goods become the result of long Global Supply Chains, to which companies from different countries add pieces of value.

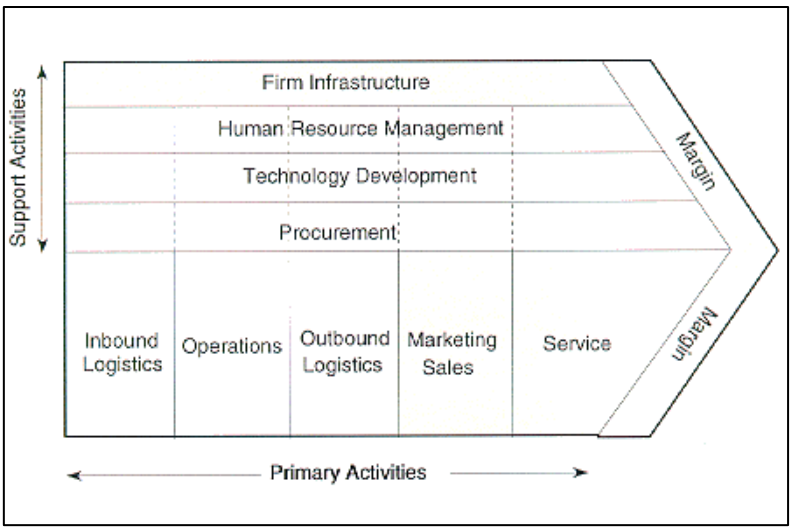
1.2 An historical perspective

Value Chain is a concept in in transformation, developed into a more global framework that reflects the complexity of nowadays economy, indeed, moving back to *globalvaluechains.org* definition of value chain quoted above, we can now see the step forward from Porter's approach on the field: it is no more a matter of an analysis based on the single company, but it aims to look at a broader phenomenon.

1.2.1 Michael Porter's Value Chain

To understand the base of the concept of value chain we have to go back to Michael Porter, who was the first that introduced that concept in his book *Competitive Advantage: Creating and Sustaining Superior Performance* (Free Press, 1985).
«Competitive advantage cannot be understood by looking at a firm as a whole», Porter wrote. «It stems from the many discrete activities a firm performs in designing, producing, marketing, delivering and supporting its product. Each of these activities can contribute to a firm's relative cost position and create a basis for differentiation».[3]

Figure 1. Micheal Porter Value Chain



Source: Porter, Micheal E., Competitive strategy: Creating and sustaining superior performance

The value chains analysis proposed by Porter focus on activities inside the organization, and links them to the competitive strength of an organization, evaluating which value a particular activity add to the final product or service.

This approach considers the firm as an independent element, and it is still meaningful to understand the dynamic within the company that generates comparative advantage and can lead to succeed in the market, how value chain activities are performed affect costs and profits, so this tool can help you understand the sources of value for your organization, indeed, since value chain is a set of activities that an organization carries out to create value for its customers, Porter's value chain that companies can be used by companies to examine all of their activities, and see how they're connected.

The importance of starting from Porter our analysis of the GVC is given by his still contemporary general purpose: his perspective on firms as value chains made up by transformation and support activities can be seen also in more recent studies.

1.2.2 The evolution of the concept into global

We have witnessed a revolutionary advance in information technologies and in communication, especially in the last twenty years, which has made possible an exceptional change in production processes and in the international trade model. According to *Ministero degli Affari Esteri*, the GVC focus is no longer on industrial sectors but on business functions that compose the supply chain, for example R&D, procurement, marketing, after sales service, since countries are aiming to a specialization on specific function rather than on industries.

If then globalization in the productive sphere implies a functional integration between activities dispersed internationally, and to better understand the forms this integration takes, the study of value chains is an essential reading key and, it is not a coincidence that from the early 2000s the Global Value Chain arose as a real line of study. According to Global Value Chains Center (Duke University of Durham), research focus on issues related to development and sources of competitiveness within the chains, to try to identify points on which to leverage within these processes and elaborate therefore appropriate industrial policies and strategic plans for companies and states.

GVC-based studies typically follow a research approach that develops in two main phases: the mapping of the chains and their analysis:

- The **mapping of value chains** is the process of identifying the location and activities carried out by the various subjects involved in the chain, from the procurement of raw materials to sale to the final consumer.
- The **analysis of the chains** instead tries to determine the role that factors such as the internal governance and relationships between companies participating in the chain in influencing the location, the development or competitiveness of a product or service

Activities which make up the value chain can be contained within the single firm or not, as well can be contained within a single geographical location or not. Also in the literature we can see this new attention on networks and firm's boundaries, focusing in the understanding of the construction of the value which is divided among multiple firms and spread across geography. The increasingly complexity of the network is the reason

why we have to move forward from the single perspective of a firm as a whole, made up of activities, to a network of economic activities and connections, where companies are hub of different importance. The growing spatial dispersion of the activities included in the chain of value leads to one of the main distinctions between *domestic value chain* and *international value chain*. In the latter case we are talking about the Global Value Chain and the first references to this concept date back to the first half of the 1990s.

In essence, the birth of the GVC is due to the fact that production has become fragmented, divided among several companies, geographically dispersed, which have specialized tasks for the addition of value, considered almost as an activity of the GVC itself. Arndt and Kierzkowski (2001) used the term *Fragmentation*[4] to describe the physical separation of different parts of the production process, that it is organized among different companies and in different countries (Gereffi, Humphrey, Sturgeon, 2005)[5].

Global Value Chain Analysis represents only one of several firm-level research approaches on the structure and dynamics followed by industries global. In fact, over time and with the progress of studies, a great variety of terms and concepts, sometimes redundant, in order to describe the complex network of relationships it gives shape the world economy: from the notions already mentioned of the supply and value chain (*Global Value Chain*), to the *International production networks*, that focus on international production networks in which multinational companies act as protagonists), passing through the French *filière,* and Womack and Jones's *Value Stream*[6], up to the *Global Commodity Chain*, certainly the most significant before the appearance of the *Global Value Chains.*

1.2.3 The French filière approach

The *filière*[7] framework is particularly intriguing because allow us to say that we can use different words to relate to similar concept and also because can be seen as an example of the evolution that the value chain concept as met during last decades: *filière* is used by French Scholars for describing the physical flow of inputs to get outputs and, like the *value chain,* the *filière* notion has significantly evolved over time to include an increasing number of aspects, i.e. transformations of the economic environment, changes in

industrial strategies, and government choices. Initially proposed in the 1950s to study the industrialization of the food industry, the idea of filière began to include cross sectoral cooperation, synergies, coopetition approaches, etc. in order to take into account the complexity of the production network of our era. (la-fabrique.fr)

1.2.4 The Global Commodity Chain

The Global Commodity Chain's emphasis is on the role two different types of leading companies plays in creating and leading global networks of production and procurement and in shaping the internal structure of supply chains: the *buyers* and the *producers*. The quality and the weight of a specific firm is related to its role and its power within the network, that is the Value Chain indeed. Gereffi (1994)[8] therefore identifies two kind of industry's organization: Producer driven commodity chain and buyer driven commodity chain. The term *buyer-driven* is used here to highlight how large global buyers, thanks to their bargaining power, manage to create a good supply base, to then be able to build a world-scale production and distribution system without however hold the property. Buyer-driven commodity chains definition refers to industries in which the central role is played by the large retailers, or where the leading company is in the final phase of the chain. On the other hand, *producer-driven commodity* chain are characterised by firms which are large manufacturers, such as IBM, vertically integrated, or who otherwise have established more strong relationships with their affiliates, creating strong links and points of contact with them. Moreover, the buyer driven chain are more easily found in product with relatively simpler manufacturing, such as household appliances or toys. In this type of industries, in fact, innovations are mainly located in phases such as design and marketing rather than manufacturing skills. On the contrary, *producer-driven* chains are more common in sectors such as automobiles or more generally in industries that produce goods that require a high intensity of capital and technological innovations. Those sectors require important skills in production, skills that must be developed and used internally or, at most, shared with companies subjected to the leader.

In the past thirty years, however, we have seen what the globally operating giants have changed its organization a lot. The intensification of trade and investment on world scale have radically changed the structure of the trans-national giants: they have in fact

become less and less vertically integrated and increasingly network-oriented, as a result of the greater possibilities of coordination and communication offered by information technologies, and above all by large companies improvements made in the business environment, such as greater protection international of copyright and patent rights, and all this has contributed in making almost the intuition underlying this model, which does not adequately describe the various ones, is obsolete recently discovered forms of connection between businesses.

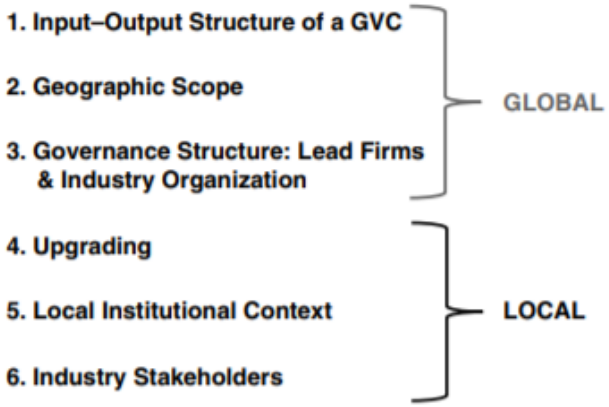
1.3 The importance of global value chain

«The global economy is increasingly structured around global value chains (GVCs) that account for a rising share of international trade, global GDP and employment. The evolution of GVCs in diverse sectors, such as commodities, apparel, electronics, tourism and business service outsourcing have significant implications in terms of global trade, production and employment and how developing country firms, producers and workers integrate into the global economy. GVCs link firms, workers and consumers around the world and often provide a stepping-stone for firms and workers in developing countries to participate into the global economy»[9].

The GVC framework allows to understand how global industries are organized by examining the structure and dynamics of different actors involved in a given industry. In today's globalized economy with very complex industry interactions, the GVC methodology is a useful tool to trace the shifting patterns of global production, link geographically dispersed activities and actors within a single industry and determine the roles they play in developed and developing countries alike. The GVC framework focuses on the sequences of value added within an industry, from conception to production and end use.

According to Gereffi (2016)[9], there are six basic dimension that the GVC analysis explores, those dimension can be divided into global and local elements.

Figure 2. Six dimensions of GVC analysis



Source: Fernandez-Stark, Bamber and Gereffi (2013)[9]

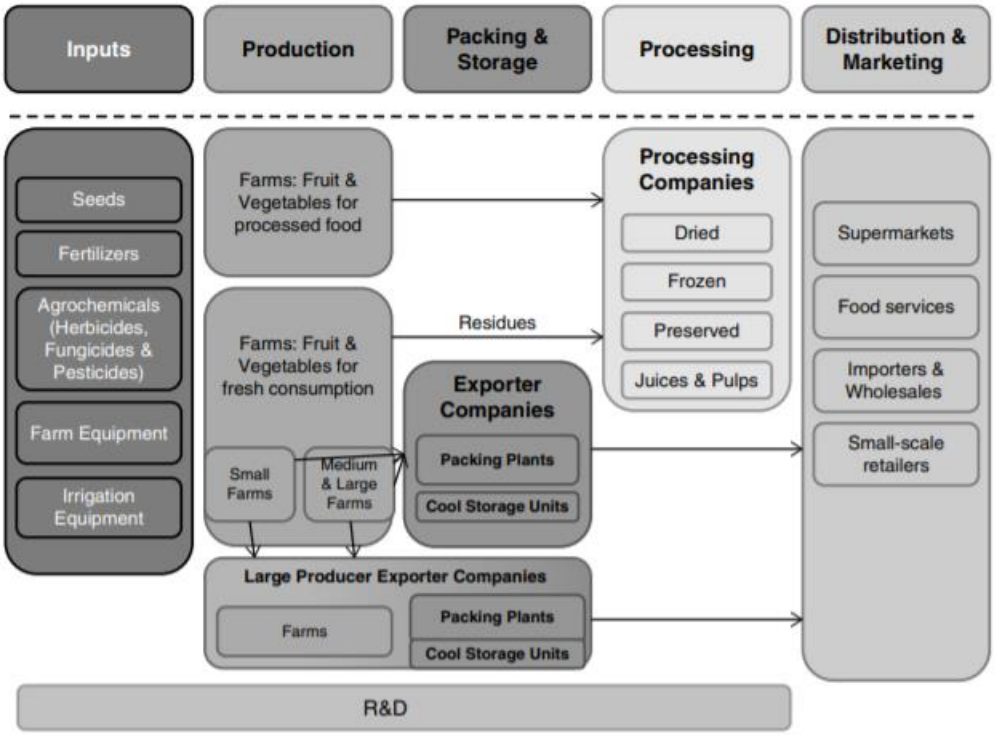
As we can see, the first three elements refer to international elements, determined by the dynamics of the industry at a global level. The second set of three dimensions explains how individual countries participate in GVCs. The Gereffi's approach on global value chain studies the global economy from two opposite point of view: global or top-down and local or bottom up.

1.3.1 Input – output structure of a GVC.

A chain represents the entire process of transformation and production from input to output of products and services, and this first dimension focus on the identification of the main segments or activities in a global value chain and in the detection of the dynamics and the structure of companies under each segment of the value chain. The core of the chain vary by industry, but typically include: R&D, design, procurement, marketing, distribution and sales. Usually, all stages of pure production are outsourced to developing countries or in emerging ones, taking advantage of the enormous wage differential that characterizes these territories compared to those already developed. On the other hand, the pre-manufacturing steps (such as research and development, design) and post-manufacturing phases (such as customer service and marketing) they remain within the parent company and are not outsourced as they are the activities closer to the consumer and the ones that create most of the added value.

Gereffi and Fernandez-Stark (2011)[9], use the fruits and vegetables value chain as example, as we can see in the diagram below:

Figure 3. Fruit and vegetables global value chain



Source: Fernandez-Stark et al. (2011c)[9]

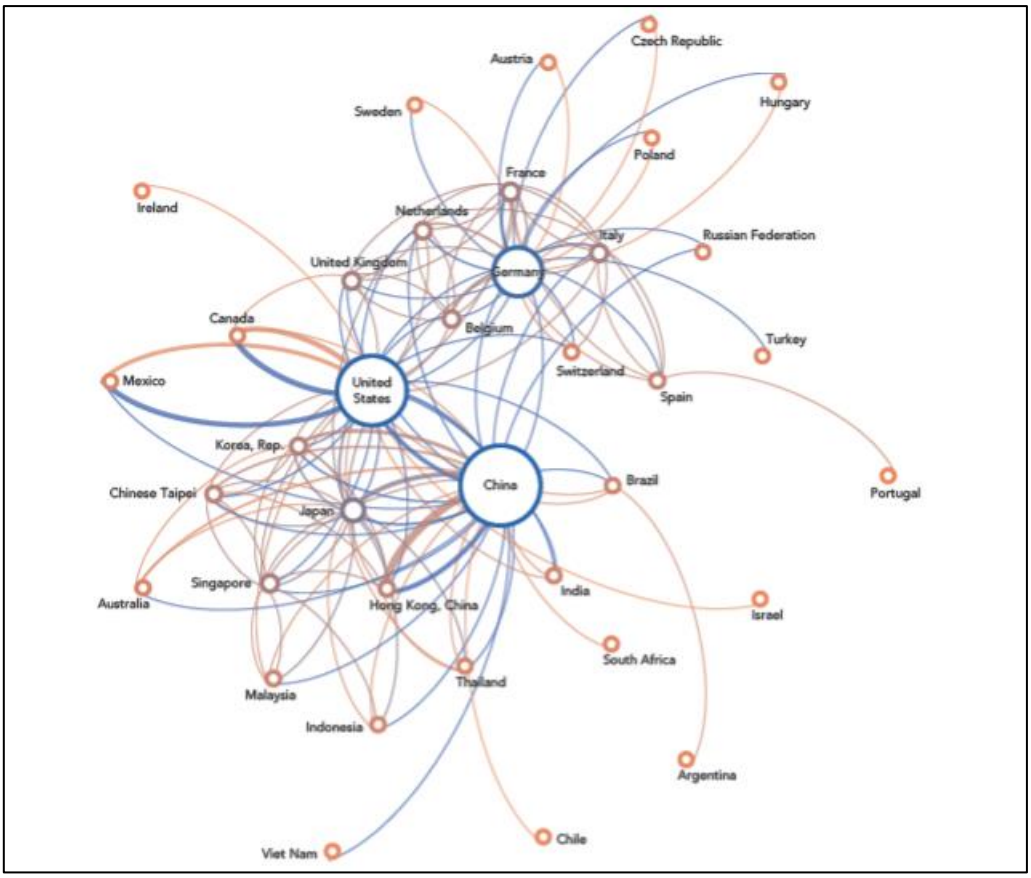
According to the authors, it take relevance to identify the type of companies engaged in the industry and their key characteristic: «*global or domestic; state-owned or private; large, medium or small; and so on*»[9]. Identifying the firms that have a role in the chain will help in the understanding of the industry's governance structure.

1.3.2 Geographic scope

«*Geographical analysis is based first on the identification of the lead firms in each segment of the value chain*. (…) *One of the main contributions of GVC analysis has been to map the shifts in the geographic scope of global industries. However, GVCs operate at different geographic scales (local, national, regional, and global) and they continue to evolve*»[9]

Today, due to the opportunities to integrate into specific parts of the value chain, many developing countries are mainly exporting manufactured goods. For what concern involvement of developing countries in the GVC, the geographical aspect suggests that the world appears to have three hubs of production interconnected by extensive trade in parts and components: United States, Asia (China, Japan, Republic of Korea) and Europe (especially Germany).

Figure 4: The trade of components show us three interconnected production hubs



Sources: World Bank Group, IDE-Jetro, OECD, World Trade Organization (2017).

The figure shows the most important flows of parts and components and the countries most involved are highlighted in red. In developing countries, large companies tend to be involved in global production's networks.

1.3.3 Governance

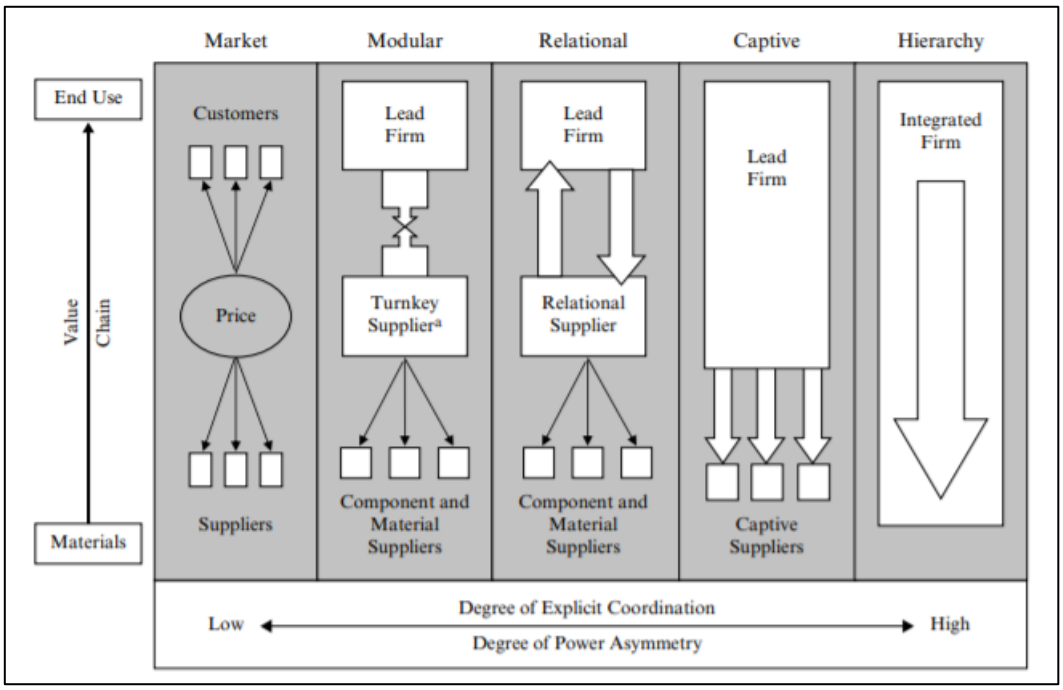
Governance analysis represent the focus of the GVC study, since «it allows you *to understand how a value chain is controlled and coordinated when certain actors have more power of others in the distribution of risks and profits of an industry»*[9]*.*

Gereffi (1994)[9], defined governance as «authority and power relationship that determine how financial, material and human resources are allocated, and flow within a chain».

Gereffi, Humphrey and Sturgeon (2005)[5] used the term *Global Value Chain* within a scheme called *Commodity Chains*, which connects the concept of value chain added to the global organization of industries. With that term, it is emphasised the importance of coordination between various companies and the growing presence of global buyers as key guides in the formation of manufacturing and distribution networks globally dispersed and organizationally fragmented. Gereffi (1994)[10] made a distinction between the "producer-driver" chain and the *buyer driven* chain to describe how governance is structured within the *global commodity chain*, as we have already seen.

But the *Global commodity chain* scheme has proved inadequate since it does not adequately specify the various forms of collaboration between companies that instead they have recently been discovered in the field. Consequently in 2005, Gereffi, Humphery and Sturgeon[5] have proposed a more complete typology of governance of the value chain, including five types of classification that highlight various degrees of power exercised from the leading company: markets, modular, relational, captive and hierarchy.

Figure 5. Five global value chain governance types



Source: Gereffi et al. (2005, p. 89).[9]

These structures are measured according to three factors:

- Complexity of the shared information
- how that information can be encoded
- the level of competence needed by the supplier to meet production specification.

- Market: «market governance involves transaction that are relatively simple … the central governance mechanism is price rather than a powerful lead firm»[9]. As this is a generic good, suppliers can create products receiving no input and coordination from buyers, establishing specific characteristics and price of the products themselves. The cost of switching to new partners is low for both producer and buyers.
- Modular: «modular governance occurs when complex transactions are relatively easy to codify. (…) Relationships are more substantial than in simple markets because of the high volume of information flowing across the interfirm link»[9]. the supplier assumes all responsibility for the technological skills required by the

process, using generic machines that limit the investments of specific transactions.

- Relational: «*relational governance occurs when buyers and sellers rely on complex information that is not easily codified and transmitted or learned»*[9]*.* These creates a mutual trust and a social bond between the parties necessary especially when there is an absence of spatial proximity; links between buyers and suppliers, in this governance, take time to build, therefore we can find high cost and difficulties to switch to new partners.
- Captive: «*in these chains, small suppliers are dependent on one or few buyers that often wield a great deal of power»*[9]*.* This structure is characterized by a group of small suppliers waiting to follow instructions from customers and they are subject to strict monitoring on product quality and on delivery time. In captive governance it is important that suppliers do not violate the main skills of leading companies, which mainly deal with areas beyond out of production, but they benefit the lead firm by increasing the efficiency of their supply chain.
- Hierarchy: «*hierarchical governance describes chains characterized by vertical integration and managerial control within lead lead firms that develop and manufacture product in-house»*[9]*.* Product specifications cannot be coded as they are complex, as a result, highly competent suppliers cannot be found, forcing the firm to procure all the means necessary to organize efficient production.

What emerges from the study of the different types of governance is that the relationship between leading companies and suppliers is characterized by asymmetries of power, on whose exploitation depends the ability of the firm to capture revenues within the GVCs. Magnani, Zucchella and Strange (2019)[11] argue that power asymmetries change in over time, expanding or shrinking, making the relationship between buyer-supplier of dynamic nature. Additionally Gereffi, Lee and Christensen (2009)[12] has shown that many GVCs are characterized by multiple and interacting governance structures ì, and these affect opportunities and challenges for economic and social Upgrading.

1.3.4 Upgranding

Upgrading is defined as the movement of companies within the global supply chain, towards higher value assets, in order to increase benefits of participation in global production (Gereffi, 2005)[9]. A successful upgrade is composed of a set of government policies, institutions, business strategies, technologies and workers' skills. The dynamics of the value chain can lead to an improvement in both the economic and social spheres.

1.3.5 Local institutional context

Global value chains are inserted within local dynamics: economic, social and institutional, that can determine their probabilities of success, or failure, in an industry and are linked to those strategies required for companies' better performance within the chain itself. Economic conditions include the availability of key inputs such as labour costs, infrastructure availability and access to other resources such as finance.

1.3.6 Industry stakeholder

The analysis of the value chain requires the study of all the agents involved in an industry, the most common in this are represented by companies, industry associations, workers. Each of them plays an important role in contributing to the development of a sector: stakeholder behaviours are important indicators of the growth of GVCs.
The GVC includes two types of companies: leading companies and supply companies: the former are typically *transnational corporations* (TNCs) whose headquarters are located in economically advanced industrial countries and they control and define the main activities in terms of price, supply and performance in producer-driven and buyer-driven GVCs.

1.4 Unbundling moments

Emerging economies, following the revolution brought about since the emergence of the Global Value Chains, have found their own path towards economic development by

inserting itself inside these *global supply chains* and specializing only in some stages of production, as it is no longer necessary to build a complete industrial base by oneself. However, the relocation operated by the *Headquarters Economy* to the *Factory Economy* it generally involves only some phases of the chain, which are not particularly profitable[13]. To better understand this concept, It is useful first of all to see how value chains have changed with the develop of the globalization process, and above all how they have changed the way it is integrated the global economy.

There are two main moments, the *First* and the *Second Unbundling*, referring with *Unbundling*[14] to the operational possibility of implementing the delocalization, not of an entire production, but of only some phases of its process, such as example the design phase alone. In the pre-globalization world, production and consumption were closely related, due of the backwardness of transport and communication technologies.

1.4.1 First Unbundling

Things started to change when the cost of moving goods fell, transport technologies improved in a process that fostered and was fostered by the Industrial Revolution (Baldwin 2016)[14]. In particular, five factors characterized this first unbundling:

- The industrialization of the *North* of the world (Europe, North America and Japan) a detriment of the *South* of the world (in particular China and India).
- The strong impact of steam energy on costs commercial.
- Strong divergence in income comparing *North* to the *South*
- The populations of poorer areas migrated in search of better living conditions.
- Although production was dispersing globally, it clustered locally in factories and industrial districts.

1.4.2 Second Unbundling

Globalization accelerated again from around 1990, when the information and communication technology (ICT) revolution radically lowered the cost of moving ideas (Baldwin, 2016)[14], characterized by the international separation of factories. Specifically,

radically better communications made it possible to coordinate complex activities at distance. Once this sort of offshoring was feasible, the North-South wage gap that had arisen during the first unbundling made it profitable.

This phase, which has transformed and continues to reshape the global economy equally pace with technological progress, is what we call Second Unbundling, and it is also this is characterized by five macro-factors:

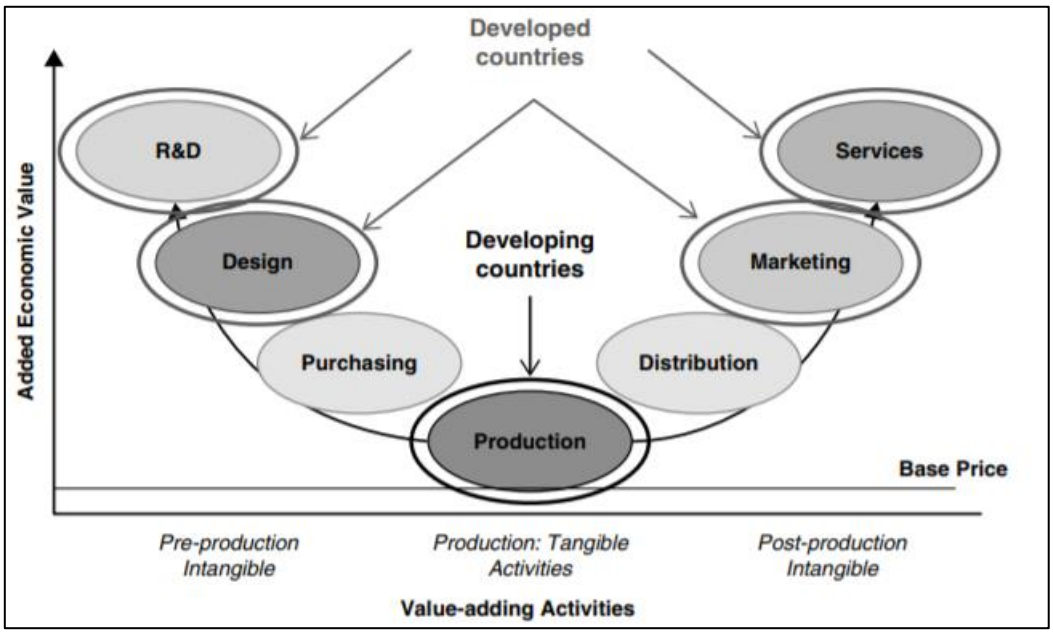
- Inversion of the global income gap
- The industrialization of the South of the world to the detriment of the economies of North
- The growth of trade and investments
- *Emerging market economies* industrialize simply by hooking up to certain phases of the GVC.
- New style of industrial competitiveness that combined G7 know-how with developing-nation labour.

This last characteristic in particular admits the possibility of a *third Unbundling* , which is likely to involve workers in one nation providing services in another nation, including services that today require physical presence. Or to allow labour services to be physically unbundled from laborers (Baldwin 2016)[14].

1.5 SMILE curve

The GVC's structure focuses on the sequences of added value in an industry, from conception, through production, to final use, examining technologies, standards, regulations, products, processes and markets in specific industries and locations, and providing a comprehensive view of global industries. The path of added value along the value chain can be represented graphically from the *smile curve.* The concept was first proposed by Stan Shih in 1992, the founder of Acer Inc., an IT company based in Taiwan. According to his observation, the two extremes of the value chain - product conception and business marketing- give a higher added value to the product than the included activities in the central part of the chain – production.

Figure 6: Smile curve of high-value activities in global value chains

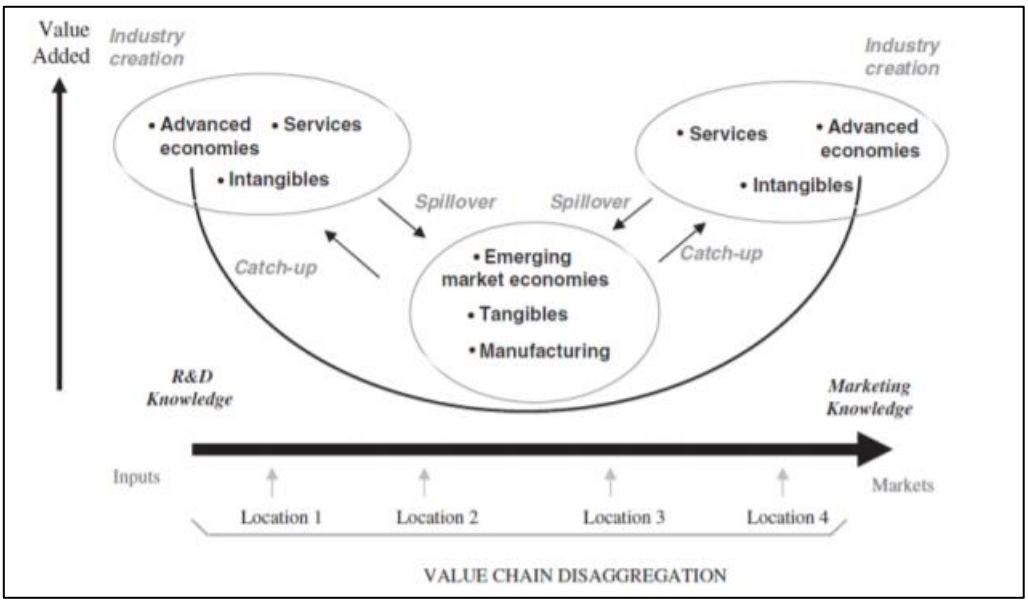


Source: Authors based on Baldwin, Ito and Sato (2014); Shih (n.d.).[9]

The smile curve was then extensively quoted to describe the potential distribution of added value in other types of industries and to justify business strategies aimed at a higher added value. Mudambi (2008)[15] has took the concept, emphasizing how businesses tend to focus at the beginning and end of value chain to obtain a higher added value. The areas of most profitable value are concentrated on both ends of the chain, including the activities with the most intense level of knowledge and creativity, located in economic markets advanced, as highlighted by Gereffi in 1999 (Mudambi, 2008)[15]. All the phases that are in the middle part of the "smile" imply a lower creation of added value, such as those of assembly final or manufacturing, and are typically carried out by emerging market economies.

The heterogeneity among firms stimulates some incentives to control certain activities and this generates three processes that constantly change the economic design: "catch-up", "spillover" and "industry creation".

Figure 7: Dynamics of the Smile Curve



Source: Mudambi (2008)[15]

The high value-added activities of multinational companies create a "*spillover*" effect of knowledge in emerging market economies. companies from emerging countries who control assets in the middle of the value chain, such as those located in China, India, Brazil and Mexico have tried to raise the smile curve to get a bigger one value added, we call that activity *catch up.* Finally, the concept of "*industry creation*" is linked to the concept of *creative destruction* by Schumpeter: this process accelerates obsolescence in the advanced economies' markets and pushes some industries to move to emerging economies' markets.

1.6 The Upgrading process

Upgrading is a very broad concept, which does not find a common definition in the literature on Global Value Chains. In general, however, by it we mean « a way to make better products, make them more efficiently, or move into more skilled activities »[16], in the particular context of the Global Value Chains, it has typically been associated with improvement in the profitability of a company through its repositioning along the value chain (Gereffi and Korzeniewicz, 1994)[10].

Upgrading involves organizational learning to improve the position of firms in international trade chain, the participation in global chains is therefore a necessary step

for industrial upgrading because it puts firms and economies on potentially dynamic learning curves (Gereffi, 1999)[17].

Humphrey and Schmiz (2002)[16] identify four possible strategies to make an upgrading, providing the most basic template for classifying upgrading within GVCs:

1. *Product upgrading:* companies can improve their position by moving towards more sophisticated production lines.
2. *Process upgrading*: companies can improve their production processes by working inputs more efficiently, for example following a reorganization of the entire production system, leading to a change in the production of new product.
3. *Intra-chain upgrading*: Firms could acquire new functions within the chain, for example by moving from the production stages and assembly to those of design and marketing. It is also known as functional upgrading.
4. *Inter-chain upgrading*: these strategies are found when companies apply the knowledge gained in certain functions of production into new sectors.

Taiwan bicycle industry is a clear example of upgrading process: the industry is an export-oriented industry, which is part of the global bicycle production from the 70s, exporting the 90% of the local production and reaching 10 million bicycle exported in the 1998. Despite an increasing movement of production offshore, losing advantage to cheaper labour abroad, the bicycle industry continue to produce in Taiwan, competing in the high-end of bicycle trade (Gomez et al., 2014)[18]. The industry as shown an upgrading process, moving from Third World producer to becoming a key actor in the bicycle industry scenario. This upgrade is shown also by the fact that an exported bike is risen from and average of $ 95 to $ 300 between 1998 and 2000. The functional upgrade can be seen in the 1970s, when Taiwan's bicycle firms went to Japan to learn about standardization of bicycle components, leading to a transfer of knowledge, after that, in the 1980s, the government helped bicycle firms to deal with the issue of low-quality products through the development of more advanced manufacturing processes and skills within the whole business system (Mari, 2021)[19].

1.7 How to measure value

A fundamental aspect of the studies on the Global Value Chains regards the *Value* that is created along the chain. So far we have highlighted the importance, for a company or a country, of the position in those phases of the chain responsible of the greater creation of value, and above all that of trying to implement strategic behaviours that allow to "climb" the chain towards those functions that allow it to carve out a greater share of wealth. It is now necessary to understand what is referred to the concept of value, and in this regard, we highlight the three main measures (Banga, 2013)[20](Sturgeon et al.)[21] proposed so far:

Profits: the distribution of profits is used very often, in the context of the *global value chain analysis*, as a primary indicator of global income shares. The most appropriate measure is typically the Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA), which measure of profitability, looking at company's overall financial performance. it is a more precise measure of corporate performance since it can show earnings before the influence of accounting and financial deductions. However, it has some weak points: it expresses the profitability but can be misleading because it strips out the cost of capital investments like property, plant, and equipment, and it does not show the value produced in the different phases and places involved in GVCS.

Value-added: Value-added is defined as value of output minus value of external inputs (raw materials, intermediate inputs, outsource services, etc.) (Banga, 2013), the distribution of added value along the various stages of the chain constitutes is another indicator used to measure the various shares of income. It can be used both by disaggregating the chain and trying to identify the value brought to the final product by each phase, and by looking at its distribution among states or macro-regions, using international data on imports and exports to attribute the shares of added value to the various nations.

Higher participation in GVCs may not ensure higher gains. A break-up of forward linkages and backward linkages in GVCs can provide a useful insight into the gains that go to a country from its participation in GVCs. If gains are measured in terms of 'net value-

added' by participation in GVCs, then higher the forward linkages as compared to backward linkages, higher are the gains. This would imply that by its participation in GVCs, a country is creating and exporting more domestic value-added than the foreign value added which it is importing. (Banga, 2013)[20].

II. INDUSTRY ARCHITECTURE AND THE ROLE OF INNOVATION

The last few years, literature started to focus on "ecosystems", "platforms", and "industry architectures", namely on the whole structure of industry. This new interest is motivated by all those changes in the nature of the competitive environment, that can be for instance regulatory or technological change. Therefore researcher have sought to find new ways to describe the structure of the "aggregate" level that firms compete in, shifting away from traditional conception of "industries", and focusing on the dynamics of managing complementarities, links, and networks.

At first, we need to start from defining *industry architecture*: The concept of industry architecture takes its origin from two question: *who does what?* and *who takes what?*. It describes how labour is typically organized and structured within an industry and which firms capture value and profit as a result. While Industry Architecture reflects the conditions under which firms operate, it is influenced at the same time by firms' attempts to reshape those conditions to their own advantage. (Jacobides, 2016)[22]

2.1 Platforms architecture

A deeper notion corelated to the previous concept is the one referring to *industry platform*, which is present in various industries, especially in business driven by information technology. The bicycle industry can be taken as a clear example: Treck, Cannondale, Bianchi, Campagnolo, Shimano, Selle Royal, LOOK, Specialized, Santini and hundreds if not thousands of other firms, small and large, make all the parts necessary to build a bicycle, and provide a variety of services and accessories for cyclist of any level, that in one form or another serve as industry platforms. All these firms and their partners participate in what we can call platform-based "ecosystem" innovation (Iansiti and Levien, 2004)[23]. The term platform has been used in a wide array of fields, appearing in the new product development and operations management field, in technology strategy and in industrial economics, but there are two predominant forms of platforms: internal or company-specific platforms, and external or industry-wide platforms (Gawer and Consumano, 2012)[24]. The first popular usage of the term platform seems to have

been in the context of new product development and incremental innovation around reusable components or technologies (Gawer and Cusumano, 2012).

Internal (company or product) platforms is defined as a set of assets organized in a common structure from which a company can efficiently develop and produce a stream of derivative products (Meyer and Lehnerd, 1997). Industry platforms, on the other hand is defined as products, services or technologies that are similar to the former but provide the foundation upon which outside firms (organized as a 'business ecosystem') can develop their own complementary products, technologies, or services.

2.1.1 Internal platforms

We refer to these as internal platforms in that a firm, either working by itself or with suppliers, can build a family of related products or sets of new features by deploying these components, *product platforms* (Wheelwright and Clark, 1992) can meet the needs of different customers simply by modifying, adding, or subtracting different features. Platforms are also defined as a set of subsystems that form a common structure from which a company can efficiently develop and produce a family product (Muffatto and Roveda, 2002)[25]. There are also broader definition, viewing platforms as the collection of assets (i.e., components, processes, knowledge, people and relationships) that a set of products share (Robertson and Ulrich ,1998).

There are several potential benefits of internal platforms, for example savings in fixed costs; efficiency gains in product development through the reuse of common parts and "modular" designs, in particular, the ability to produce a large number of derivative products with limited resources; and flexibility in product feature design. (Gawer and Cosumano, 2012)[24]

The key objective of platform-based new product development is the ability to increase product variety and meet diverse customer requirements and business needs while maintaining economies of scale and scope within manufacturing processes.

2.1.2 External platforms

We have defined external or industry platform, as products, services or technologies developed by one or more firms, and which serve as foundations upon which a larger

number of firms can build further complementary innovations, in the form of specific products, related services or component technologies. There is a similarity to internal platforms in that industry platforms provide a foundation of common components or technologies, but they differ in that this foundation is "open" to outside firms. The degree of openness can vary on a number of dimensions such as level of access to information on interfaces to link to the platform or utilize its capabilities. (Gawer and Cosumano, 2012)[24]

Industry platforms tend to facilitate and increase the degree of innovation on complementary products and services. The more innovation there is on complements, the more value it creates for the platform and its users via network effects, creating a cumulative advantage for existing platforms: As they grow, they become harder to dislodge by rivals or new entrants, the growing number of complements acting like a barrier to entry. The rise of industry platforms raises complex social welfare questions regarding the trade-offs between the social benefits of platform-compatible innovation, versus the potentially negative effects of preventing competition on overall systems. (Gawer and Cosumano, 2012)

2.2 The link between innovation and GVC

2.1.1 The role of innovation

One characteristic of innovation dynamics in platform industries is that platform leaders and competitors navigate a complex strategic landscape where both competition and collaboration occur, sometimes among the same actors, the challenge is how to stimulate complementary innovations by other firms, including some competitors, while simultaneously taking advantage of owning the platform.

The topic of innovation is crucial in order to understand evolutive dynamics within sectors: firms are unable to return on research, and the reason of that is given by a particular architecture advantage of leading firms that makes impossible for others to receive the value created through innovation. (D.Teece)[26]

Economic globalisation has dramatically increased during the past decades and consequently, economic activities, goods, services, capital, people, technology and

knowledge are easily transferred across national borders. Following the international fragmentation of production, products are nowadays manufactured and traded in international production networks or Global Value Chains (GVCs). More recently, innovation activities have also become increasingly global thereby giving rise to Global innovation Networks (De Backer, 2017)[27]. The nexus between these two types of networks in the global economy has not really been explored, although strong interdependencies between GVCs and GINs are likely, research focusing on innovation in GVC have addressed this matter in recent years: a body of studies have investigate on the relationship between R&D and production phase in Global Value Chain and how their mutual dependence affects firms' innovation.

Two separate streams have emerged (Buciuni and Pisano, 2020)[28]:

1. The geographical distance between pre-production phases (i.e. R&D, Design) and production activities is considered a key element of the GVC strategy of global leaders like for example Apple (designed in USA, produced in China). This separation is viewed as a push to improve multinational enterprises innovation potential. (Dedrick et al. 2010)[29]
2. The second strand of literature is based upon the fact that the geographical concentration of the various stages of the GVC is an essential condition for the developing of innovation (Buciuni and Finotto, 2016)[30]. The separation of *brain and brawn* is counterproductive to firms' innovation process, particularly when innovation is incremental.

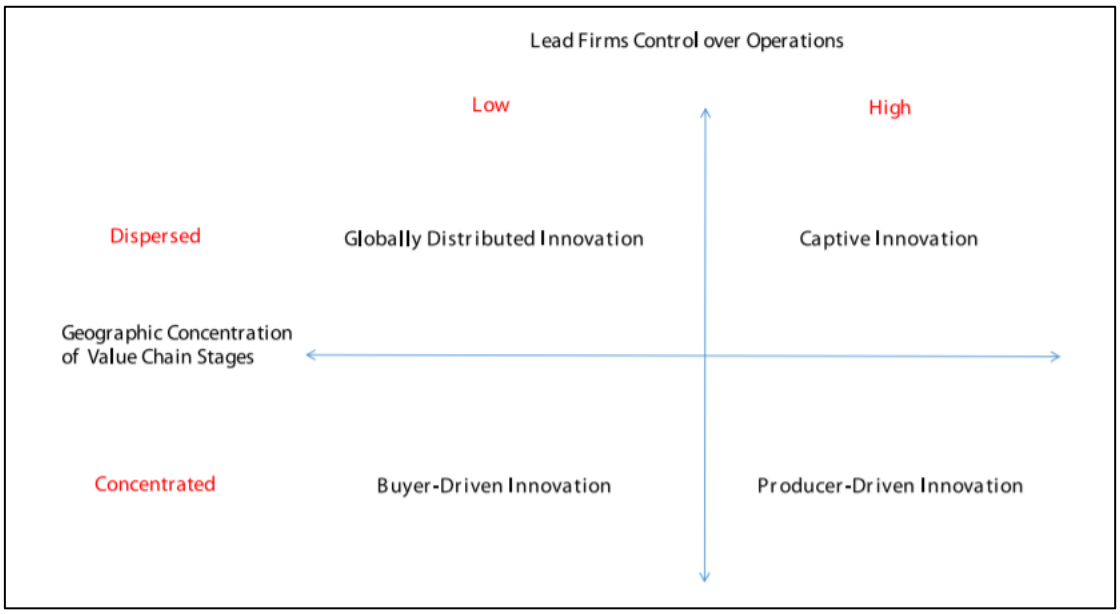
Having in mind that lead firms represents one of the numerous actors involved in GVC, and that innovation is generally the outcome of a process which involves several firms in multiple location (Pisano and Teece, 2007)[31], strategic decisions and performance, taken by global champions, remain a key driver in the formation and evaluation of GVC. Particularly in a time when we assist to a transfer of intangible activities and knowledge, not only production, which is something that is rapidly changing the geography of innovation (Baldwin, 2016)[14], understanding the structure of the chain of value will help us to answer to today's global economic scenario's challenges. Understanding how GVCs

are organized and coordinated represents a starting point for the study of lead firms' innovation development.

2.1.2 Variety of innovation in GVC

Buciuni and Pisano developed and discussed four alternative models of GVC structure, each of which captures a specific lead firm's innovation pattern (Buciuni and Pisano, 2021)[3232]. They used two main theoretical factors to identify the four structures: notably transaction cost economics (Williamson, 1973), already used in assessing the buyer-suppliers transaction (Gereffi et al., 2005)[5] and innovation strategy's Modularity-Maturity framework (Pisano and Shih, 2012)[33], which is useful to underline links between firms' dispersion of value chain stages and their product innovation strategy.
This distinction of two dimension and their interdependence allow Buciuni and Pisano to conceptualize a matrix which is helpful to pinpoint four alternative models of innovation in GVC: *Globally Distributed Innovation, Captive Innovation, Producer-Driven Innovation* and *Buyer-Driven Innovation.* (Buciuni and Pisano, 2021)[32].
Pietrobelli and Belotti (2011) [34] help us understand the connection between national and regional innovation system with GVC, and underline how those linkages affects firms' learning process and innovation capabilities: indeed, companies' innovation potentiality is influenced by the context in which firms operate. The geographical dispersion of value chain stages, in particular of pre-production functions, is especially relevant in GVCs' context, because by definition value stages are distributed.

Figure 8. Variety of Innovation in GVC



Source: Buciuni and Pisano (2020)[28]

Each quadrant represents a specific GVC structure, that is directly correlated to the way a lead firm generate innovation.

For instance, a lead firm with a geographically distance between pre and post-production activities can have a high control over operations when the production process is codifiable but, at the same time, suppliers' capabilities are low and there is an high complexity of the buyer-supplier transaction. Recalling the *captive* governance introduced previously, this specific GVC structure lead to a Captive form of innovation, in which lead firms coordinate innovation through explicit coordination mechanism; the production chain is globally dispersed, since we are speaking of a Global Value Chain, but innovation development tends to be directly performed and controlled by the leading company, through subsidiaries for example (Buciuni and Pisano, 2021)[32]. In this type of model, called *Captive Innovation*, we do not expect a high spread of innovation capabilities, therefore upgrading opportunities are generally limited.

Globally Distributed Innovation occurs when there is a low complexity of buyer-supplier 's transactions and suppliers' capabilities are high; therefore, the lead firm can choose a loose form of coordination. We are in the situation where geographical dispersion of value chain is combined with lead firm' s low control. Since suppliers capabilities are high, we can observe lead firms to delegate to their partners among the GVC some pre-

production activities, leading over time to a fragmentation of the innovation globally: innovation capabilities could shift from lead firm to key suppliers.

A completely different situation comes when pre- and post- production are geographically concentrated. This scenario in characterized by difficulties in separating production stages which is quite common in craft-based productions (Buciuni, Coro' and Micelli, 2013)[35]. In this case, leading firms can decide to execute manufacturing activities inside or out-source these phases to key suppliers. Even if most of craft-based productions are mature, they are difficult to encode, thus lead firms set up their suppliers from the top using explicit forms of governance and therefore, innovation could be concentrated too. *Producer-Driven Innovation* has as key element that innovation is somehow embedded in production activities, sometimes outsorced to specialized partners, but always orchestrated by the lead firm.

The *Buyer-Driven Innovation* (Buciuni and Pisano, 2021)[32] model is referred to the situation where lead firms' control over activities is low, despite activities are geographically concentrate. Value chain's phases are hard to split from a specific location, no matter the modularity of the production process.

Table 1. Summury of Innovatio Model characteristics

Innovation Model	*Product Innovation Pattern*	*Key Actors in Product Innovation*	*Lead Firms' Strategy*
Globally Distributed Innovation	▪ New ideas and product design are developed by lead frms at their HQs ▪ Product development occurs overseas ▪ Innovation and production chains partially overlap	▪ Lead frms' designers and R&D teams (design of new models) ▪ Foreign independent contractors (OEMs) ▪ (product development)	▪ Lead frms initiate the product innovation pattern and own innovation ▪ Lead frms transmit new design to overseas contractors and introduce new products in the market
Captive Innovation	▪ R&D is either developed by lead frms internally or acquired from specialists ▪ Product development occurs internally, although it can be delegated to key suppliers for niche products ▪ Innovation andproduction chains rarely overlap	▪ R&D independent labs (research on new materials, new product features) ▪ Lead frms' R&D teams (product development and product testing)	▪ R&D independent labs (research on new materials, new product features) ▪ Lead frms' R&D teams (product development and product testing)
Producer-Driven	▪ New innovative ideas are generated globally ▪ Product development occurs within the cluster ▪ Innovation and production chains partially overlap	▪ Global designers and architects (new product ideation) ▪ Lead frms' purchasing department (scouting for new production partners) ▪ Cluster specialized producers (prototype development)	▪ Lead frms collectfeedback and new ideas from the market ▪ Lead frms coordinate product development within the cluster
Buyer-Driven	▪ Ideas for new product development are gathered from fnal markets ▪ Product development requires collaboration with producers/suppliers ▪ Innovation and production chains partially overlap	▪ Global wholesalers and distributors (feedback from market) ▪ Lead frms' internal design and R&D team (new product ideation) ▪ Providers or suppliers or the raw materials/products traded (product development)	▪ Lead frms collect feedback and new ideas from the market ▪ Lead frms coordinate product development with providers

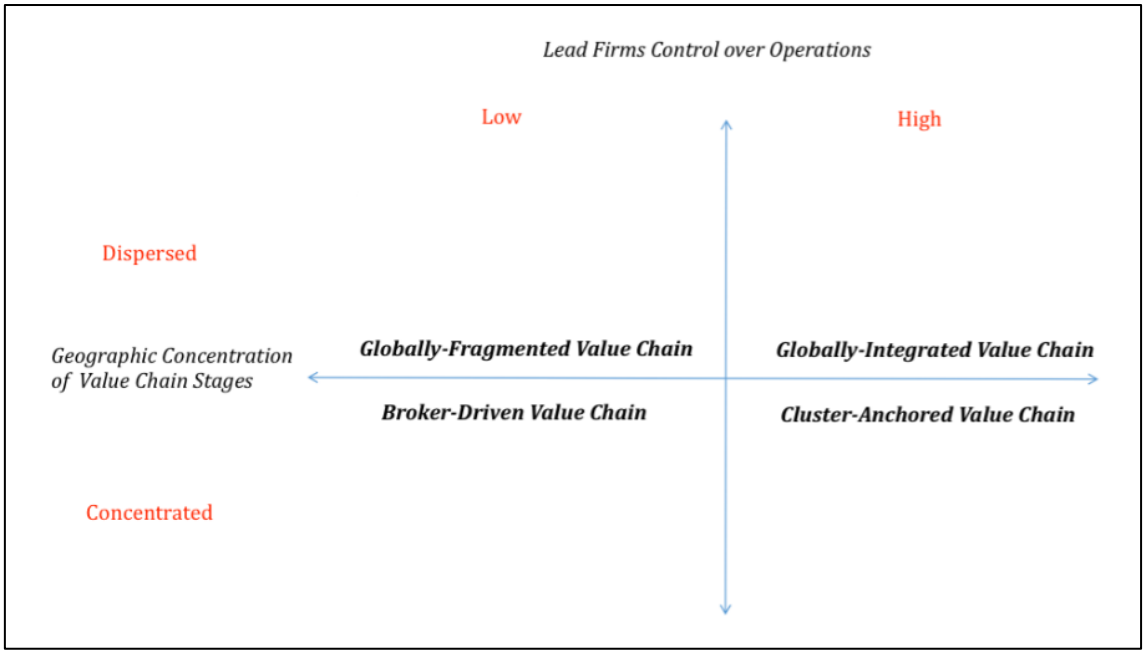
Source: Buciuni and Pisano 2021 [32]

2.1.3 Variety of GVC architectures

The increasing interaction between industrial cluster and globally dispersed production networks shape into forms of industrial organization where the local and the global dimension coexist. (Towards a plurality of global value chain architectures: What implications for firms' innovation?, David Arnold, August 14th, 2018)

Global and local are interconnected, and there is a growing interdependence between cluster and GVC, Buciuni and Pisano (2018) argue that new hybrid forms of industrial organization are rising, with different level of globalization.

Figure 9. Variety of GVC architectures



Source: Buciuni and Pisano (2018)

Globally-Fragmented Value Chain: lead firms have little or no control over global operations because of the low complexity of the production acknowledgment. The professional bicycle sector provides an interesting example of how contractors from developing economies can replace innovation over time. Normally, leading brands competing in this niche market are Italian and American firms like Pinarello or Specialized, but thanks to a *learning by supplying* process, Taiwanese suppliers like Merida or Giant moved from being suppliers to OEMs, ODMs, and eventually OBMs. Indeed, most of occidental firms started outsourcing production offshore in the late 90s

when carbon fibre was introduced, opening the competition to developing countries which firms started to design and market their own bikes competing against Western brands.

Globally-Integrated Value Chain: lead firms' explicitly coordinate global operations. Value chain activities are geographically dispersed and are generally performed in regions where MNEs have access to cheaper labour force, tax incentives or governmental subsidies. When production is outsourced offshore, leading firms are responsible for the specification of the production process and quality control. This is the case pharmaceuticals industry Global Value Chain, a sector where the exploitation of context-specific advantages like cheaper cost of labour (i.e. Puerto Rico) and tax incentives (e.g. Ireland and Singapore) is key in patent holders' business model (Buciuni and Piasano, 2018).

Broker-Driven Value Chain: lead firms are brokers which buy natural resources or commodities from local providers and resell them globally. The buyer-supplier transaction is coordinated through the price mechanism, new product development is controlled and coordinated by brokers while local producers have little or no participation in global innovation. This type of GVC is typical of industries which depend on natural resources like oil, gas and wine. Brokers operate as *knowledge gatekeepers* and control knowledge transfer; they have access to market and control the innovation process. An example of this type of GVC in the production of Prosecco, which has recently witnessed of a rapid increase of the demand leading to an appreciating of the cost of the Glera grapes, the only grape used that can be used, and consequently has increased the final cost of Prosecco. One solution came from the use of different types of grapes in the fermentation process, for instance the Trebbiano variety which is still suitable for sparkling wine production. Nevertheless, the use of this grape doesn't allow brokers to use the label Prosecco in their new wine, this innovation has offered them the opportunity to fulfil the requirements coming from a price-sensitive market segment resulting to a new product development, completely coordinated by brokers, leaving local producers with little or no participation in global innovation.

Cluster-Anchored Value Chain: Lead firms have globalised their pre- and post-production functions while keeping operations locally. Production is controlled through internal operations and/or a network of clustered suppliers. This type of GVC architecture is

widely diffused in the design furniture industry, particularly in the Italian clusters. This strategy is characterized by *short* and *dense* supply chains which prevented leading firms from outsourcing production abroad. While production remained local, champion firms have globalised their R&D and distribution activities and have developed cooperation with international designers and buyers, therefore the development of new products can start outside the cluster. (Buciuni and Piasano, 2018)

III. BICYCLE INDUSTRY

3.1 Introduction

The *bicycle*, also called a bike or cycle, is a vehicle consisting of two wheels held in a frame one behind the other, propelled by pedals and steered with handlebars attached to the front wheel.

Around the 9500 b.C. the first two-wheeled wagons appear, while in the 1796 a vehicle called *celerifero* show-up, which is the first prototype of a two-wheeled vehicle, without handlebars and to be used by pushing. After that, the *draisienne*, with its rudimental handlebars, the *velocipide*, finally with pedals, and the *biciclo* appeared.

The bicycles, as we know nowadays, were first introduced in the 19th century, while its exact origins are uncertain, we know that in June 1817, the German Baron Karl von Drais tested *die Laufmaschine*, also known as the running machine or velocipede, and since then it is an instrument that hardly changed in more than 200 years. They become more comfortable, the components and the materials changed, but the structure at the base has remained more or less the same, it has always been simple: a triangle frame with three tubes, two wheels, two pedals and a handlebar. The bicycle is the perfect synthesis between technology and tradition, it is an ancient but modern machine, which has evolved with the gearbox, new materials, more sophisticated and aerodynamic shapes but which has been able to reinvent itself without distorting itself.

Even today the *two wheels* are proposed again as a symbol of a modernity that manifests itself as a *platform* capable of becoming the vital fulcrum of many different economies: the *economy of the bicycle* is made up of many *economies*, just think of the materials and components up to all the safety devices, related services and infrastructures, and those *economies* have different values and potentiality but all together they compose this *bikeconomy***.**

By Bike Economy we mean all those sectors in which the bicycle is considered an economic value, which therefore can generate growth and development. On the industrial level, for example, the Bike Economy does not only involve the production of these vehicles and their components, but also the whole industrial sector that deals with building cycle paths and all those structures that allow and facilitate the circulation of this vehicle. Across Europe, the bike industry has given new life to various business

sectors. From technology to fashion up to industry and economies based on respect for the environment, a turnover that grows from year to year.

The European Cyclist' Federation (Ecf) has estimated a total value of more than 510 billion per year, this value does not come just from the value of bikes' sales, moreover it comes from EU bike manufacturing and from urban design's interventions. The value proposed by the Ecf represents also, all the benefits related with the healthcare, the improving in social safety and the reduction of $C0^2$ emissions. In this regard, Italy, despite being late compared with others EU states for what concerned infrastructure and bike - oriented 's policy, it is still todays the main producer in Europe of bicycles with an overall turnover of € 1.3 billion, sadly decreasing by more than the 50% compared to 10 years ago. Even if the Chinese competition, whit its lower quality and mass consumption products, affected Italian industry, the *made in Italy* whit an high attention on quality keeps resisting, mostly thanks to an export which is worth more than € 600 million.

Besides, the segment with the greatest potential in Italy, related to the bikeconomy is the *cicloturismo*, which, in Italy, is worth an estimated € 7.6 billion according to the data of *Legambiente.* This figure would lead to a rise of € 12 billion the current value of the Italian *Pib* (*Prodotto interno bici*, the Bicycle Domestic product), which is an index of the overall two-wheeled business, including the production of bicycle and accessories, cycling holidays and all the positive externalities generated by citizens using bicycles. *Cicloturismo* could serve as a *window* to revitalize the Italian bike companies, which even though they are recognized as excellence, they are suffering the competition of bigger companies, which can exploit different competitive advantages, and that are going to serve increasingly niche segment.

3.2 The history of the Industry

3.2.1 Understanding the product

A bicycle is a product made from a complex set of activities based on various technologies and materials, it is made up by a long list of pieces that can be arranged to form a *product architecture*, the organization of a product's functional elements, which helps to understand how a bicycle is fabricated and how the bicycle industry evolved

over time (Ulrich, 1995)[36]. The history of bicycle fabrication is also influenced by automobile industry and can be better understood through the hypothesis of technological convergence. (C. Mari, 2021)[19]

According to bicycle history books, the word bicycle appeared in France in 1828 indicating a light cab drawn by a single horse and having two wheels on a single axle (Hadland and Lessing, 2014)[37]. The transition from the early velocipede to the safety bicycle can be described through the conceptual framework of a social constructivist approach to technology studies introduced by Pinch and Bijker in 1984. (C. Mari, 2021)[19] It means that a relevant social group (i.e. bicycle riders) shares the same set of values, referred to the bicycle, and found out a problem concerning that *arteface* that needs to be solved. A range of solutions can be identified through a process based on an alternation of variation and selection among designs. The relevant social groups select some of the problems for further attention, then a variety of solutions are generated, some of these solutions are then selected, which subsequently generate new artefacts (celerifero, velocipede, biciclo, bicycle). (Bijker, 1995)[38]

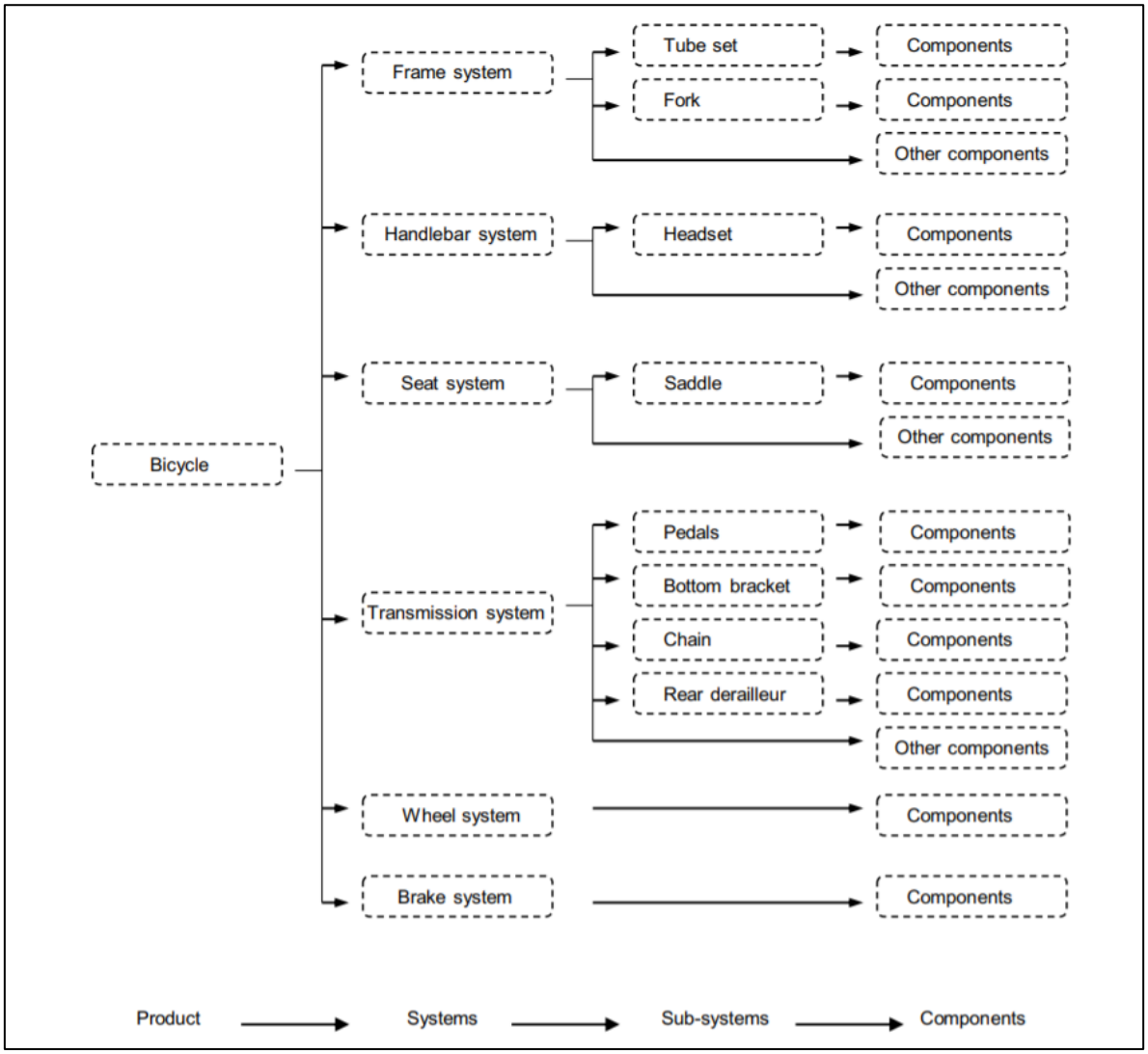
Its embraces five dimensions interconnected with each other (C. Mari, 2021)[19]:

1. A *physical dimension:* a bicycle is a tangible product of technology. The link between a rider's physical characteristics and a bicycle's physical properties influences the performance of the cyclist in pedalling.
2. A *functional dimension:* bicycle performs some specific functions, it can be used for transportation, leisure and racing purposes.
3. An *economic dimension*: it is a manufactured object, a nexus through complex relationships between producers, labourers, and consumers.
4. A *psychological dimension*: a bicycle is an object of cultivated desire. Both bicycle users and potential users might experience a strong longing to a bicycle or a bicycle brand.
5. A *temporal dimension*: a bicycle has a story to tell with a past, present and future.

Bicycle, as a product, is a bundle of components and it has the function, at a most general level of abstraction, of transportation (moving from point A to point B). if we take a step forward, given that it is made up by numerous components, we can distinguish a collection of functions, which are integrated in the product-bicycle: support

rider weight, make cycling comfortable, make cycling safe and make cycling efficient. Each component is a separable physical part and its role is to implement the function of the product-bicycle.

Figure 10. Bicycle decomposition



Source: C.Mari, (2021) [19]

Decomposing a bicycle helps to understand the various components needed to build it and provides some hints on the number of piece parts in a bicycle.

3.2.2 The evolution of the industry

The modern idea of bike was born at the end of 19th century in the United Kingdom and in France. It derives from previous means of transport characterized as a two-wheeled man propelled machine that has been developed since 15th century. For about half a century the industry was characterized by continuous technological improvement, taking advantage new mechanical manufacturing processes. Indeed, the production of a bicycle has its roots in the context of other metal using industries, particularly those already experienced in the production of durable goods requiring small, even intricate, mechanisms and parts (Harrison, 1985)[39]. There is a historical trajectory that links the manufacturing of a bicycle to the production of automobiles. The relationship between these industries can be understood through the hypothesis of technological convergence developed by Rosenberg (1963)[40].

The organization and the evolution of the bicycle industry over time are intertwined with both the develop of the set of components and the evolution of manufacturing. How a bicycle is decomposed and manufactured helps explaining the structure of the bicycle industry. A key feature for understanding the organization of a generic industry is to focus on the boundaries of a firm, in particular the extent to which a firm is vertically integrated and which activities are no longer internally carried out, but instead it purchases from other firms, usually outlined as a make or buy decision, determining what to do internally versus what to outsource in the market (C. Mari, 2021)[19].

Vertical boundaries are usually represented through a sequence of phases or activities, called the vertical chain, therefore a vertical integration occurs when these stages are organized within a single firm. Few companies had both financial resources and capabilities to manufacture a complete bicycle. Most firms did not find advantageous to internalize activities and prefer to focus on frame building or assembling.

Going back to evolution, during the early of the 20th century, the industry was highly integrated in order to reduce costs and provide resistant and comfortable mass-produced bikes at low price, major investment ware in the field of production innovation rather than in product design.

In the late 50's and 60's only road bike segment was pulling the whole industry head and materials used for the aerospace industry, like dura-aluminium, were increasingly used

to achieve weight reduction, this is a clear example of the *convergence* mentioned above. Since its foundation, Schwinn Bicycle Company, an American manufacturer established in 1895, has been the leader of the industry offering standardized bicycles, which could be produced at a low cost. Due to the integration of the bicycle value chain, consumers identified the names of large integrated players such as Schwinn or Peugeot with quality bicycles. Barriers to entry were relatively high, because entrants needed high capital investments in machinery and in distribution channel management.

In the late 60's and 70's, the bicycle industry was characterized by capital intensity and poor attention to innovation and research; frame producers dominated the market, the Supplier Bargaining Power was low and they were not specialized. Among leading firms, the rivalry rate was low due to the oligopoly situation in a market that was growing. The industry evolution was driven by producers rather than consumers, whose bargaining power and influence was small.

Consumer trends changed dramatically in the 1970s, when young Californians Joe Breeze, Otis Guy, Gary Fisher, and Craig Mitchell invented the idea of off road, the prototype of the mountain bikes were first developed in California in 1978. Moreover, during that decade, oil embargo further encouraged bicycling, leading to more bikes than cars were being sold in the USA. Some riders began to assemble and sell some of their bicycles, and this new trend of the market and the following change in consumer demand gave rise to the fragmentation of the bicycle value chain.

Another crucial step in the evolution of the bike industry was when producers started to manufacture frames and parts specifically designed for off-road use. As a consequence, the structure of the bicycle industry started changing dramatically: the market was requiring highly specialized components, and this provided smaller companies the opportunity to come up with innovative designs and specialized parts. This event demonstrates that a mature industry could go modular being already integrated. New structure and that firm strategy could influence and shape Industry Architecture: parts manufacturers were able to ride the innovation trend in the bicycle industry, while original manufacturers downgraded and became assemblers. Suppliers upgraded, becoming specialized, were able to capture an important part of the consumer willingness to pay, while original manufacturers capture only the low end of

the value chain. Industry Rivalry increased at the assembly level of the chain, few components producers took the leadership and they enjoyed the fast growing phase.

In the last 40 years the bicycle industry underwent dramatic changes due to a radical shift in customer preferences. The mature business of the late 70's was revolutionized by change into the industry architecture and the supply chain pattern: Shimano and Merida bear the greatest responsibilities for this development. The latter one turned upside down the frame producer supply chain since was an assembler and it became a market leader, while Shimano took the leadership of the component sector. This revolution led to a change in the bicycle supply chain: vertically integrated manufacturers lost their dominance due to a slow adaptability to new trends, absence of investments in R&D and a short-term strategy.

In the last decade the bicycle business has been under pressure meaning that every firm in the supply chain, from suppliers to bicycle retailers, must be profitable to survive. Multiple business models co-exist, creating plenty of operators and possibility to access and nowadays industry has achieved significant international scale, as shown also by the fact that several Italian companies are acquired by international groups, this is the case for instance of the world's oldest bicycle manufacturing company in existence, Bianchi, which, since May 1997, has been part of Cycleurope Group, which is owned by the Swedish company of Grimaldi Industri AB.

The modern bicycle industry has experienced an undisputed leadership of European brands, at the true beginning dominated by UK's firms then the Italian companies arise, the *Made in Taiwan* era began only in the last decades of the 20th century, indeed import from Taiwan steadily increased inverse to price from the mid1990. At that point, the Italian business model went under crisis due to suddenly fall of prices as consequence of globalization booming. Prices decreased alongside all the value chain as well as the retail prices, Taiwanese supplier were the most ready to react to shrinking margins and they were able to challenge branded company on the final market, and not just being their supplier.

Taiwan began a key location for the bicycle industry, not only for assembling activity, but Bicycle manufacturers also based in Taiwan like Giant and Merida, began OEM and not only subcontractors leveraging patterns of cooperation between producers and distributors which enabled companies to upgrade in the value chain, gaining position on

new markets and consumer recognition. Only few years later, Italian and European firms started marketing their products out of Europe but retail prices for these products were out of the market and the scenario already settled. The reason of this delate is to be attributes to the long supply chain, that was slow and inefficient, even if it was still profitable.

Taiwanese brand to enter the market at lower prices but still very profitable starting to get recognition at consumer level. The 'Made in Taiwan' movement in bicycle manufacturing was viewed differently by the operators. Bicycle brands welcomed the opportunity to focus on research and design, offshoring production to Far East locations due to advantages such as lower labour cost or taxation.

Well-known brands with strong country of origin's image such as Cannondale for the U.S.A. or many Italian firms tried to keep production at home but the market went to another direction. Cannondale moved its plants to Taiwan some years later due to tougher price competition, most of Italian firms on the contrary lost momentum and they did not innovate on their business model.

For instance, Giant, starting from the early 1980's developed its engineering competencies and understood the global market trends, implementing brand operations infrastructure in key locations such as Netherlands, USA, Japan, Australia.

The current situation indicates a split between assemblers and component manufactures, with the latter as the best equipped to survive and gain values within the bicycle industry in the coming years. To endorse this theory, we are witnessing the rise of the so called *mega-suppliers* also in the bicycle sector (Donovan, 1999). Mega-suppliers are big firms manufacturing and assembling entire modular packages such as the transmission system or brake system. Their approach is different from the traditional supplier of bicycle components because:

- they build an integrated system made of many components, rather than providing some single pieces.
- they lead the industry in the technological innovation as their size allows them to invest in R&D.
- they use ingredient-branding as a tool for advertising directly to consumers, which will likely search for a bicycle assembled with a particular brand of components.

Power within the bicycle industry is progressively flowing away from assemblers towards the large component manufacturers.

Looking at the current bicycle industry situation, there are three mega-suppliers: a Japanese firm (Shimano), a US firm (SRAM) and an Italian company (Campagnolo), even though the last one is smaller than its competitors. A further impetus for establishing mega-suppliers is the birth of a large market for both pedal electric cycle, with electric motor that assist riders, and electric bicycles, which can be propelled without pedalling. The bicycle industry in the last 20 years has experienced a slow, steady growth amid a series of disruptions, with year after year, consumers spent more, propelling impressive investment in newly born segments such as gravel, E-bikes, composite bikes, event bikes, and kids' bikes. Then came 2020 and COVID-19 hit also the bicycle industry last March with the economy that contracted for the first time since 2009 while the bicycle industry being an outlier indeed current data trends show the bicycle industry unit sales will grow 28 percent in 2020.

3.2.3 The history of the Italian bicycle

The Italian experience shares similarities with other countries that developed a domestic bicycle industry and, therefore, it can help to shed light on the role played by the different categories of firms participating in the industry, regardless of the peculiarities of any geographical context. (C. Mari, 2021)[19]

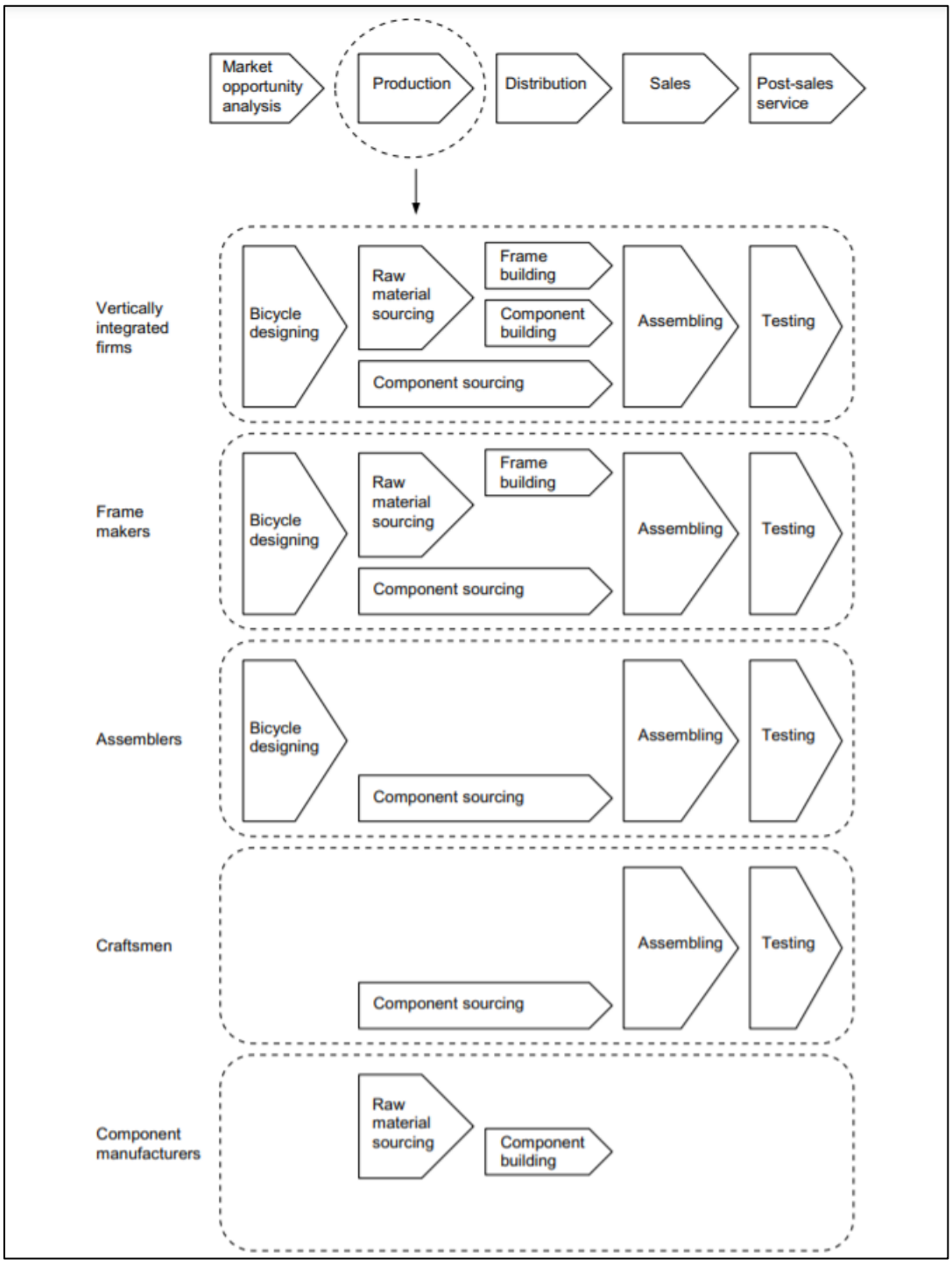
The history of the Italian bicycle industry can be broadly divided into four phases starting from the 1880s to the present time:

- The first phase, from 1880 to 1890, saw an increasing number of small craftsmen, primarily located in the northern part of the country, joining the nascent industry. Their businesses were very small and did not specialize in bicycles but produced or repaired a wide range of mechanical products. A notable exception was Edoardo Bianchi who menaged a small mechanical repair shop in Milan and developed the first safety style bicycle in Italy in 1886, inspired by an imported English bicycle (C. Mari, 2015)[41]. During the first phase, the contribution of Italian bicycle firms to the business system was limited to the repairing activity, infact

all the other stages were carried out by foreign companies exporting bicycles to Italy. (C. Mari, 2021)[19]

- In the second phase, between 1890 and 1900, the industry experienced a significant growth: the Italian market was still dominated by bicycles imported from abroad, but Italian companies expand the number of activities carried out, starting to understanding the market, assembling complete bicycles, distributing, selling and repairing them.
- The third phase began in the 1900s and lasted until the 1970s. Domestic production of complete bicycles began to rise due to the increase in bicycle sales. Although production was still fragmented in numerous small workshops and craftsmen, some firms started to access external financial sources that led to the birth of a few joint-stock. The backbone of the industry was located in three geographical areas, specifically, in order of importance, Lombardy, Veneto and Piedmont (ANCMA, 1953). The capital of the Italian bicycle industry was Milan, since the following firms had their headquarters in the city: Bianchi, Legnano, Borghi (whose brand was Olympia), Focesi (whose brand was Gloria), Viscontea, and Taurus. The geography of Italian bicycle industry also included Varese, where Ganna started his firm; Padua, where Rizzato (whose brand was Atala) and Torresini (whose brand was Torpado) built their bicycles; Vittorio Veneto where Carnielli (whose brand was Bottechia) began his business; Bassano del Grappa, where Willier Triestina was active; and Celle Ligure, where Olmo manufactured his bicycles (C. Mari, 2021)[19] .
- The fourth and last phase is from the 1980s to the present and is characterized by the progressive decrease in the number of both vertically integrated firms and frame manufacturers, due to a strong foreign competition, particularly from Far East. At the present time, the whole industry is composed of assemblers and component manufacturers. This change also affected the long-standing tradition of fabricating high quality steel frames which are, now, almost completely disappeared, except for a few artisanal makers that build a limited number of custom frames. (C. Mari, 2021)[19] .

Figure 11. Business system of Italian bicycle industry 1900–1970s



Source: C. Mari, 2021 [19]

This image sum-up the actors that arise during the third phase, the business system of fourth phase overlaps with the one depicted in Fig. 11, al even though the key difference, not shown in the chart, is that there is just one vertically integrated firm in Italy, Bianchi and which was acquired by a foreign group in 1997. The main category of

firms within the industry in the fourth phase is the assembler, who has become synonymous with a bicycle company.

3.2.4 A brief overview of other major states

The Italian bicycle industry evolved through an import-substitution industrialization model with the goal of replacing imports with domestic production: initially both complete bicycles and components were imported. The former was imported because Italian infant industry was not ready to provide yet, the latter were the easiest way to create a market through the assembly of bicycles. During the import years the transfer of knowledge enabled the industry to expand quickly. In 1908, the domestic production took off, and the import of bicycles from other countries decreased accordingly (Piloni, 1982). The import-substitution model was used by other countries both in Europe and Asia, such as France, the Netherlands, Japan, China and Taiwan.

France is credited with initiating the bicycle industry in the 1860s, but it lost its advantage when UK assumed the major position in bicycle production at the beginning of the 1870s and was to be the main supplier to world markets for the following twenty years (Millward, 1999). One of the earliest large-scale bicycle firm in France was the *Manufacture française des armes et cycles* (MFAC) based in Saint-Etienne, (Dauncey, 2012)[42], was founded in 1885 initially only selling and repairing British imported bicycles, but in 1888 started producing bicycles becoming, the first vertically integrated firm in its country.

The Dutch market imported bicycles from UK, Germany and US since the 1880s until 1925. Afterwards, the local industry began to manufacture complete bicycles through domestic makers and assemblers (Tjong Tjin Tai et al., 2015)[43].

The bicycle industry in Japan has its origin in UK, importing complete bicycles, components, and most importantly the first vertically integrated firm starting in the 1890s and lasted until the 1910s when Japanese entrepreneurs developed a method of bicycle assembly known as set fitting or knock-down system. It meant that Japanese firms imported unassembled components in sets that were put together to form complete bicycles. The turning point occurs when in 1910, Premier Bicycle

Manufacturing Company, a British bicycle firm established a branch factory in the city of Kobe, accelerating the development of the local bicycle industry.

China imported bicycles from UK, Germany and Japan between 1879 and the 1920s. Its native bicycle industry started in 1936 when a Japanese entrepreneur built the Changho Works factory in Tianjin and started to make Anchor bicycles. After the Communists led by Mao Zedong came to power in 1949, the bicycle industry was revived, creating the Flying Pigeon, a Chinese publicly owned bicycle company. Since the 1950s, the Chinese government played a key role in developing the domestic bicycle industry, and more than 500 million Flying Pigeon PA-02 bicycles have been made, and as of 2007, more than any other model of vehicle (Koeppel, 2007)[44]

In Taiwan the bicycle industry started later than in other countries (Chen et al., 2009)[45], Taiwan imported both complete bicycles and components from Japan between 1946 and 1951, afterwards the government adopted policies that limited imports and therefore the industry expanded. The bicycle industry, in Taiwan, consisted primarily of frame makers and component manufacturers, in 1969, Taiwan began to export its bicycles to the United States and until the 1980s the industry experienced significant and continuous growth (Chu and Li, 1997)[46].

3.3 The distribution channel and industry supply chain

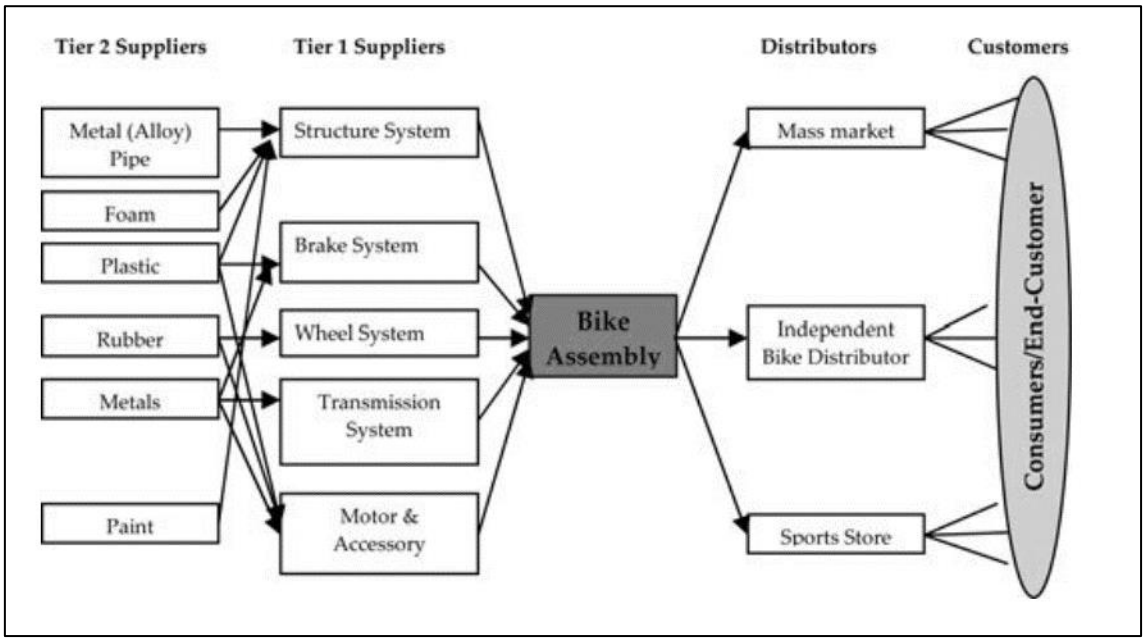
Bicycle supply chain evolved, and as we observed the dominance of new players: *Original Brand Manufacturer* (OBM), bicycle companies took the leadership and shaped the industry thanks to their capacity to play on global scale, the clearest example in this sense is Gian, which own production facilities and brand. Other actors in the market are *Original Design Manufacturer* (ODM): they design and produce original bicycles and accessories, but they do not to brand and market them, instead, the product is rebranded by another firm for sale.

Most bicycle brands today design their own product, and they might create sample, but the serial production is made by third party manufacturer. We refer to them as Original Equipment Manufacturers (OEM) and benefit from employing ODMs firms because of the low labour inputs, proximity to markets and reduced transport cost. This setup allows an OEM to focus more on sales and on the marketing of its products since the

ODM is responsible for the design and manufacturing. Original Equipment Manufacturers (OEM's) are responsible for taking a bicycle brand's unique design and fabricating it into a finished product. Examples of OEM is Cannondale, which is an American division of Canadian conglomerate Dorel Industries, produced and assembled in Taiwan. Cannondale, Cervélo, and Specialized are made by a factory in China or Taiwan belonging to a completely different firm, Scott's bikes are manufactured mainly in Korea by Youngone Corporation, which also own the brand Scott.

The supply chain structure of a bike can be arranged in four layers. (Chiu and Kremer, 2014)[47]

Figure 12. Bicycle supply chain structure



Source: (Chiu and Kremer, 2014)[47]

The upstream layer consists of sub – suppliers (Tier 2) who provide raw materials. The second level (Tier 1) is made up of suppliers who produce the components of the bike. The next layer is the focal company, which focuses on the assembly process and manufacturing key components. Finally, the last layer is the distributors who set up the market channels and provide services to customers. (Chiu and Kremer, 2014)[47]

Original Brand Manufacturer with an OEM function, such as Shimano and Giant, has taken the leadership of the industry comprising the supply chains in order to position

better for market share, they leverage lower manufacturing costs due to purchase raw materials directly from material suppliers. Moreover, by working as a first-tier supplier they improved their manufacturing processes, competencies and knowledge: an OBM, which produce for competitor OEM's frames or components, get full understanding of the client/competitor's costs, product direction, market capitalization and supplier relations.

The industry has had more change in the last year with respect to the way bikes are being bought and sold than the past 100 years. There are three major distributors in the bicycle supply chain: Mass-market distributors which emphasize the mass-market segment while independent bike distributors and sports stores sell specialized bikes in niche market areas. Mass market, independent Bike Distributor and Sports Store are only some of the various way by which bicycle are nowadays sold. Up until recently the independent dealer was heavily relied upon and nearly the sole source of distribution. But things have changed, and it starts with looking at modern consumer behaviour as online shoppers are increasingly becoming more comfortable buying unconventional items over the Internet including bicycles and also Trek, Giant, and Specialized are opening up stores. Retail is changing, but consumers still want to touch and feel products they don't feel comfortable buying online and firms noticed this new field of competition.

The USA situation can be taken as example:

According to National Bicycle Dealers Association (NBDA) 2015 annual report, bicycle are sold through five primary and distinct channels of distribution: specialty bicycle retailers, mass merchants, full-line sporting goods stores, outdoor specialty stores, and "other" (mixture of retailers including Internet sales).

- Department, discount and chain toy stores sell mostly price-oriented products, accounting for approximately 74% of bicycle units sold in 2015, and representing 32% of the dollars with an average selling price of US$ 89.
- 4,000 specialty bicycle retailers commanded around 13% of the bicycle market in terms of unit sales, but accounting for a dominant dollar share, 49% of the dollars moved in the U.S. market.

- Chain sporting goods stores sold approximately 6% of the bicycles in 2015, and 8% of the dollars, at an average price of $266.
- Outdoor specialty retailers sold approximately 3.5% of the bicycles in 2015, representing 8% of dollars and an average retail selling price of $464.
- The “other” category sold 2% of the units, representing 3% of the dollars, with an average price of $247.

Taiwan is becoming more and more expensive, and 6-7 years ago the production started to be transferred to China, but now the new production locations are Cambodia, Vietnam and Bangladesh. The second relocation considered both components and frameworks. The technology developed in Taiwan is generally higher than that of Italy and Europe, especially in the areas of printing carbon and mass production and shortened delivery time. Handicraft culture is at the same time our company's proprietary technology and constraints. High-end frame brands have demands that only Taiwan institutions and technologies can guarantee. These costs and lead times are not sustainable for European companies.

3.4 Market figures and size

Bicycle statistics play a significant role in providing a knowledge base to understand industry evolution and public policy to support the industry, city cycling or new road. Statistics can highlight how the industry performs over time, can help to understand which countries are manufacturing, importing or exporting bicycles and components.

3.4.1 Data collection

To be useful, statistics must be reliable, the degree to which statistics reflect reality, sufficient, statistics must be complete so that data are not affected by any gaps, and comparable, referring to the possibility that a sequence of data over time, or between one place and another, is measuring the same variable.

Bicycle statistics show serious problems with each of the three characteristics, and it is not an exaggeration to state that data and information are plagued by unreliability,

incompleteness and incomparability. Indeed, bicycle statistics have two main problems that make even more difficult to use them for studying purposes: (C. Mari, 2021)

- Bicycle data are not available.
- If they are the access to them is not always guaranteed.

For instance, have access a copy of the company annual report it is nearly impossible, only a very small number of large firms provide a digital version of their most recent annual reports. The Dutch company Accell Group, which owns Atala, Lapierre, KOGA and many other brands, is the only firm releasing the number of bicycles manufactured each year starting from 2004. The Canadian Dorel Industries (Cannondale and Pacific cycle), Fox Factory Holding Corp. (United States) and Shimano Inc. (Japan) also does that.
Bicycle's statistics are usually provided by four primary sources in each country: office for national statistics, customs department, trade organization and bicycle firms, but still very few data are available, and it is difficult to build a long time series to analyse how the bicycle industry evolved over time, also because there is a strong disaggregation in the methodology used by customs departments in recording foreign trade statistics.
Trade organizations comes to help, which were established to collectively represent the manufacturers and protect their interests, and generally publish an annual report, providing some bicycle statistics, particularly those regarding the production of bicycles and components. The data assembled by trade organizations share a common feature: the lack of an in-depth analysis of both industry and competitors in each country and worldwide. (C. Mari, 2021)[19]
The first association was established in England in 1893, the Cycle Manufacturers Trade Protection Association. Later, in 1919, it became the British Cycle & Motor Cycle Manufacturers and Traders Union Ltd. (Millward, 1999). Italy formed its association of bicycle manufacturers in 1920 and called it ANCMA. Looking at the Europe situation, in 2015, the Confederation of the European Bicycle Industry (CONEBI) was formed as a merger between the Association of the European Two-Wheeler Parts' and Accessories' Industry (COLIPED) and the Association of the European Bicycle Industry (COLIBI). CONEBI releases a yearly short report describing the European bicycle industry. The report was released for the first time in 2009 and was accessible free of charge until the 2017 edition referring to 2016's data, a payment is required for more recent report.

The following sections of this chapter offer a panorama of bicycle statistics through cases of data available in different countries. Therefore, it is not to be intended as a thorough description of all the statistics available within the industry.

3.4.2 Global overview

It is a starting point to scratch the surface of the topic, *Bicycles - Global Market Trajectory & Analytics*, published in June 2020 by Global Industry Analysts, Inc, estimated the global bicycle market at US$29.2 Billion in the year 2020, with a projection of US$34.6 Billion by 2027, growing at a Compound annual growth rate (CAGR) of 2.4% over the analysis period 2020-2027. Hybrid Bicycles, one of the segments analysed in the report, is projected to record a 3.1% CAGR and reach US$13.6 Billion by the end of the analysis period. After an early analysis of the business implications of the pandemic and its induced economic crisis, growth in the Road Bicycles segment is readjusted to a revised 1.7% CAGR for the next 7-year period. (ResearchAndMarkets.com)

China and Taiwan produce the majority of the world's bicycles, responsible for 87% of global production. China alone exported 59.1 million bicycles in 2012. Most of these bikes are sold in the US. Between China and Taiwan' s bike sectors are quite distinct, and each has different fields within the bicycle industry. While China exports low-end bikes that usually retail for less than $100 in places like the United States, Taiwan focuses on high-end racing and mountain bikes, which usually sell for over $400. (worldatlas.com, 2017).

3.4.3 USA market

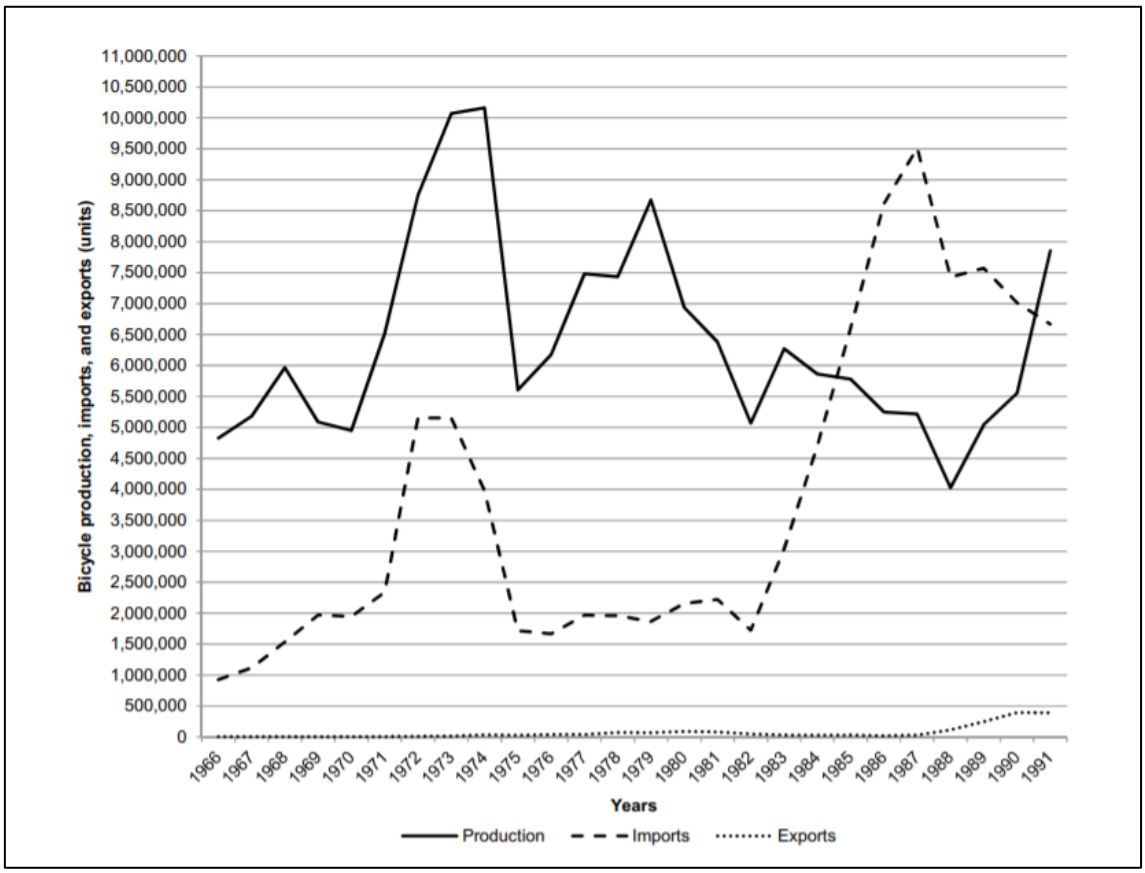
Looking at NBDA 2015 annual report, the last one free of charge, the industry's high point, in terms of unit sales, was the so-called *bike boom* in the 1970s, prior to the arrive of Taiwanese firms. The boom ended suddenly when the industry reached a rapid saturation point and did not have breadth of product choices to sustain sales levels. Today, the industry an estimated 2,000 companies involved in manufacturing and distributing cycling products to retailers, and approximately 150 different bicycle brand names to choose from. The success story of MTB has been the focus of much of the specialty industry in recent years, with mountain bikes representing about 25% of all

bicycles sold in the year 2012 by specialty bicycle stores, followed by hybrid bikes, and road bikes at 20%, according to the annual retail survey published by the NBDA.

According to research made by David Lange and published in December 2020 (Statista.com) around 47.5 million of Americans cycled on a regular basis in 2017. The U.S. bicycle market, which includes the retail sales of bicycles, related parts and accessories through all channels of distribution, has an estimated size of around US$ 6 billion annually. In 2017, MTB with a retail value of almost US$ 580 million were sold in the United States. Sales of electric are forecast to experience strong growth in the coming years, in fact by 2023, global sales of e-bikes are forecast to reach approximately 40 million units. Goldstein Market Intelligence analyst forecast that the size of bicycle industry in US is set to grow at a CAGR of 5.70% over the forecast period (2017-2030), Between 15 and 20 million units of bicycles are sold in the U.S. annually (2019).

Looking at the work of Mari, *A Business History of the Bicycle Industry*, we can get a clear draw for USA bicycle market: that provide an initial understanding of bicycle output in that country. The data, covering the second half of last century US bicycle industry from 1966 to 1991, clearly show the sharp increase during the first half of the 1970s when bicycle output increased to over 10 million units. The average yearly bicycle production during this time frame was approximately 6,400,000 pieces (C. Mari, 2021)

Figure 13 USA Bicycle Productio, Imports and Exports



Source: C. Mari, 2021

3.4.4 Taiwan market

Emerging from the wake of World War II, Taiwan's bicycle industry started out depending on imports, but quickly progressed to manufacturing with domestically made steel and local assembly, before eventually upgrading to automated and even smart manufacturing. Companies shifted from OEM production to ODM, and eventually established or acquired their own brands, and turned their focus from the domestic to the global market.

Taiwan exported 2,125,050 bicycles in 2019 (MOEA), which represented a drop of 3.85% from bikes exported in 2018. Taiwan had a total value US$1,340,966,566, down by 9.23% from the total value of exported from the island in 2018.

Most bikes sold in the USA are produced in Taiwan's manufacturers, with Giant being the largest of them all. Asian factories account for almost 95% of bikes sold in America, generally, low to mid-level bike units are manufactured in continental Asia whereas the

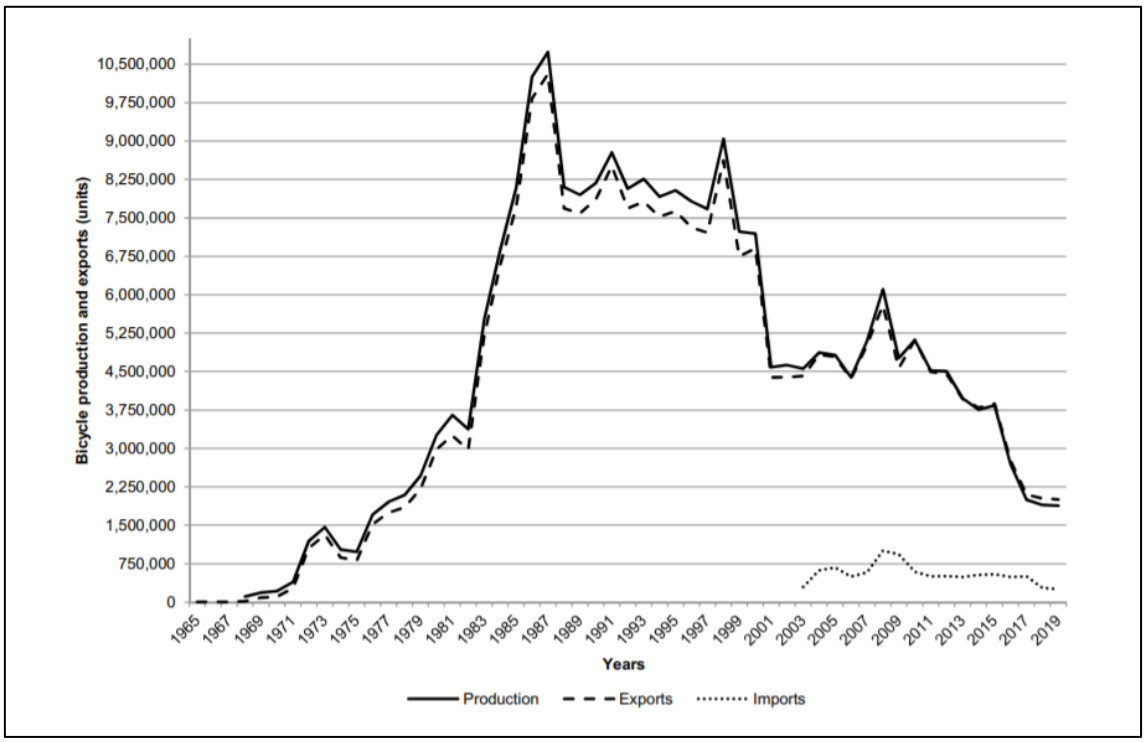
high-end bikes are made in Taiwan, that traditionally has focused its energies on a higher spec level of manufacturing. More than half of Taiwan's bicycle exports were destined for European markets according to Taiwan's Ministry of Economic Affairs 2019 report. European markets represented 50.5% of complete bicycle exports from Taiwan, doubling the turnover of the second largest destination (North America), which is responsible for the23.4% of shipments. Among EU countries, exports to Britain grew by 6.27%, making UK the largest recipient of Taiwan-made bicycles in the EU during 2019 with 232,419 bicycles from Taiwan.

During recent years, Taiwan's bicycle exports have gradually dropped, but the steady growth of its e-bike exports has taken up some of the slack, and more or less made up for the reduction in bicycle exports.

According to the *Ministry of Economic Affairs of Taiwan* (MOEA), Taiwan accounted for 64.7 % of the EU's import market in 2019 of E-bike, incrementing of 32.4 % in respect the previous year. It was followed by Vietnam, 14%, and Switzerland, 12.1%. The reason is primarily given by the anti-dumping duties imposed by the EU on exports from China. E-bikes are becoming a major driver of growth in the Taiwanese bicycle manufacturing industry, increasing from 2.7 % of total sector output in 2015 to 35.5 percent in 2019. MOEA statistics show Taiwan's e-bike exports accounted for US$863 million in 2019, up 128.4% rise referring to the previous year, with The Netherlands, U.S. and Germany among the top destinations. (Taiwan Today, July 07, 2020)

The chart below shows the huge increase during the 1970s and 1980s when the production jumped from 394,000 units (1971) to approximately 10,738,000 units in 1987, after that, bicycle output stabilized around 8 million pieces until 2000. Since the 2000s, the size of bicycle production significantly decreases to reach the lowest level of approximately 1,880,000 units in 2019. The data are provided by The Ministry of Economic Affairs of Taiwan.

Figure 14 Taiwan Bicycle Productio, Imports and Exports



Source: C. Mari 2021

The explanation of such a situation is the choice made by large bicycle firms, such as Giant and Merida, to move in part their production capacity to countries where the cost of labour is lower than Taiwan. (C. Mari, 2021)

Foreign trade data of Taiwanese bicycle industry highlight that bicycle export is a fundamental activity for local firms as their output is almost completely sold to other countries.

3.4.5 European bicycle market

In Europe, in 2019, 20 million bicycles were sold, of which 12,666 million were produced in the Old Continent by a sector that directly and indirectly generates more than 90,000 jobs. (Sole24ore, 2020). The year in which bike sales reached their peak was 2007 (CONEBI data, Confederation of the European Bicycle Industry, 2016). The European Cyclists Federation estimates that the economic impact of the bicycle is 150-155 billion (Il Sole 24 Ore, 2019).

According to Eurostat, in 2019, EU Member States exported almost 1 million bicycles and other cycles, worth a total of €368 million. Representing a 24% increase compared with 2012. Over the same period, EU Member States imported over 5 million bicycles, worth €942 million, a decrease of 12% with 2012. Additionally, EU States exported 191,900 electric bicycles worth €272 million in 2019 (the data include bicycles with pedal assistance and an auxiliary electric motor with a continuous rated power less than 250 W), importing in the meanwhile 703900 electric bicycles, equivalent to €594 million. Compared with 2012, the number of exported electric bicycles was almost twelve times higher in 2019, while imports of electric bicycles doubled.

In 2019, the United Kingdom was the main destination of EU bicycles (36%), followed by Switzerland (18%), both being also the top destination for EU exports of electric bicycles, 33% and 29% respectively.

Imports of bicycles from non-EU countries came mainly from Cambodia (24%), Taiwan (15%) and China (14%), followed by Philippines (9%), Bangladesh and Sri Lanka (both 7%). While imports of electric bicycles into the EU came primarily from Taiwan (52%), followed by Vietnam (21%), China (13%) and Switzerland (6%), which evidence the change of direction taken by Taiwanese manufactures.

In 2019, the EU produced over 11.4 million bicycles. This represents a 5% increase on the previous year and 10% higher than the number produced in 2014. The total production of bicycles peaked at 13.7 million in 2015, 17% higher than the number produced in 2019. (Eurostat, 2020)

Among EU Member States, Portugal was the largest producer of bicycles in 2019, manufacturing 2.7 million bicycles, followed by Italy (2.1 million), Germany (1.5 million), Poland (0.9 million) and the Netherlands (0.7 million). These five countries together accounted for 70% of total EU production of bicycles in 2019.

The following data are taken from 2017 CONEBI annual report, which refers to 2016 data, the last updated free of charge report issued by CONEBI. These figures enable us to drawing an overview of this industry' size, helping us to contextualize the Italian evolution. All the figures presented in the following tables are at net value - excluding VAT.

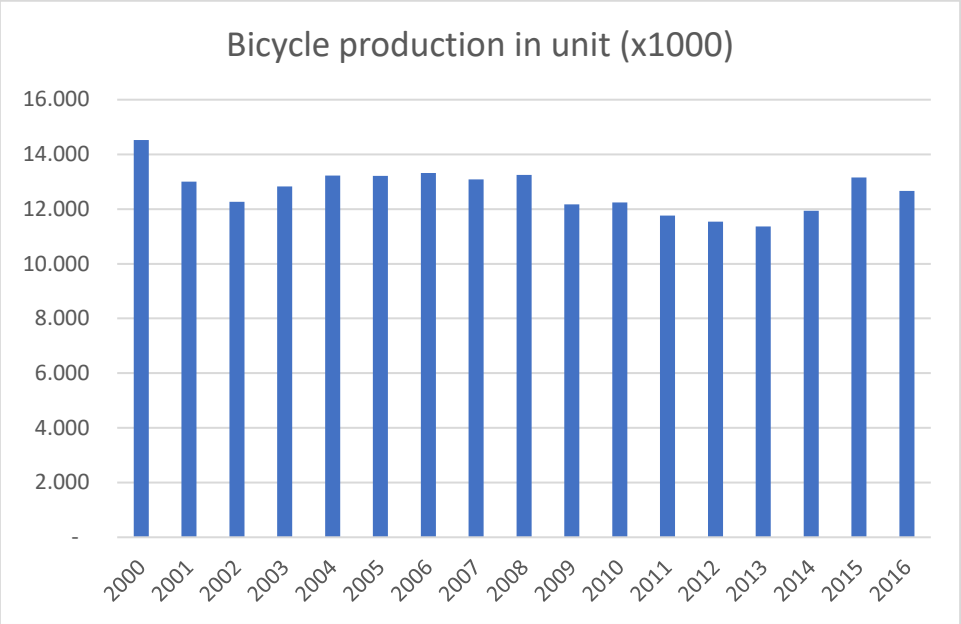
Table 1. European Bicycle Production 2016

Year	Bicycle Production (x 1,000)	Evolution year/year r-1 (%)
2000	14.531	
2001	13.009	-10,47%
2002	12.272	-5,67%
2003	12.828	4,53%
2004	13.232	3,15%
2005	13.218	-0,11%
2006	13.320	0,77%
2007	13.086	-1,76%
2008	13.246	1,22%
2009	12.178	-8,06%
2010	12.241	0,52%
2011	11.758	-3,95%
2012	11.537	-1,88%
2013	11.360	-1,53%
2014	11.939	5,10%
2015	13.152	10,16%
2016	12.666	-3,70%

Source: European Bicycle Market 2017 Edition (CONEBI, 2017)

In a growing market, like the bicycle's one, European Union is losing positions at international level. The Total Production has been decreasing since 2000. This is the consequence of a change of the geography of the industry. As we can se in Europe at the beginning of the new millennium the production was more than 14.531 million of units, while after sixteen years amounted to 12.666 million in bicycle (CONEBI, 2017) and in 2019 is around 11.4 million (Eurostat, 2020)

Figure 15. *European Bicycle Production Historical data 2000-2016*



Source: European Bicycle Market 2017 Edition (CONEBI, 2017)

Nevertheless, we can observe differences within the Union, Italy lost its leadership and Germany gained a dominant position, German factories started to offshoring to East European countries where the cost of labour is more favourable. In the table below we divide and present the European Production in 2016 by country

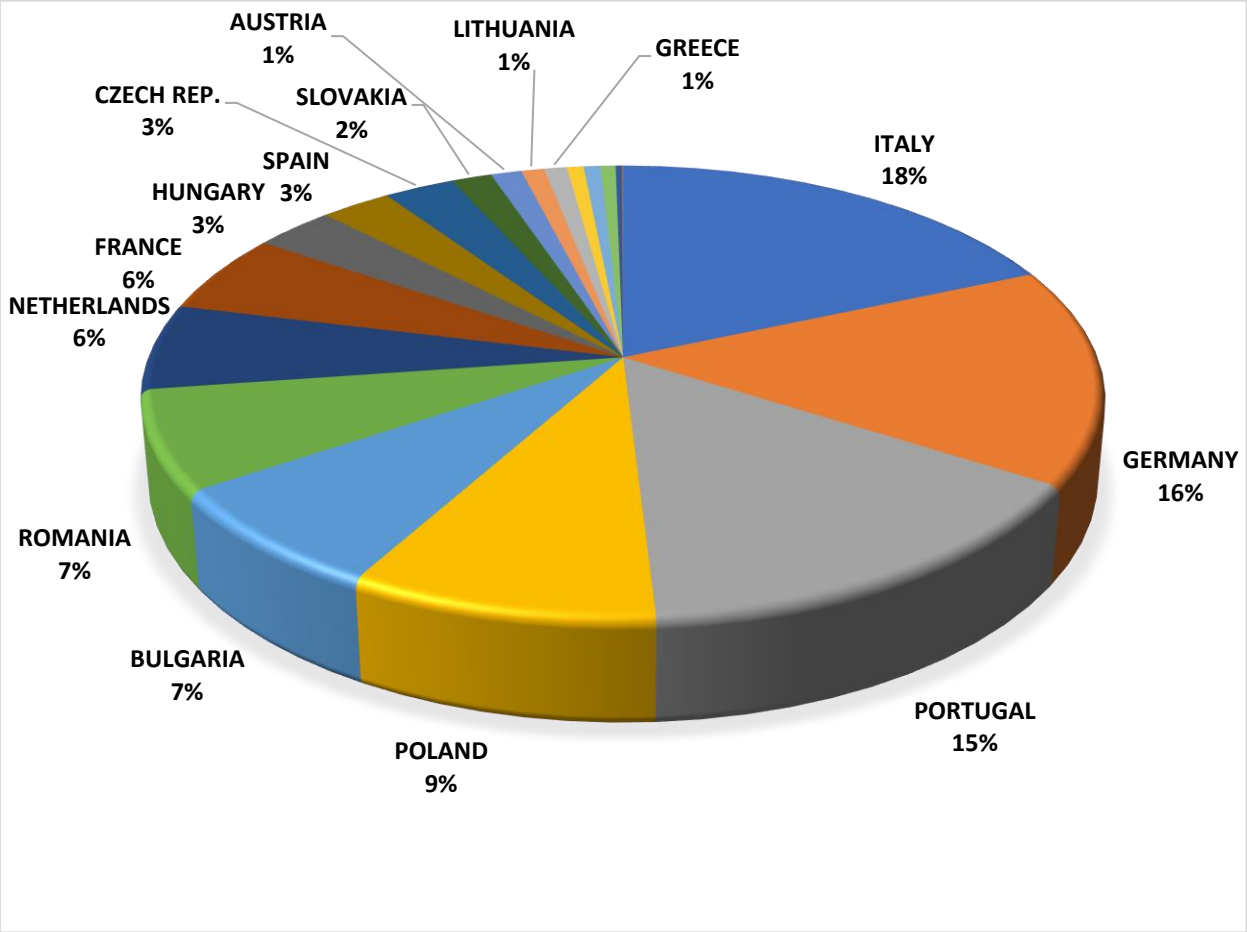
Italy has a strong production of bicycle but has huge gap in production of *EPAC* (Electric Power-Assisted Cycles) if compared with other European countries. Interesting here is to have a look to 2012 data: Germany was leading EU countries with 2,211 million of bike produced, the 19.2% of European total production and Italy was closely following with 2,195 million of units produced (CONEBI, 2013). Todays, things as change, indeed German firms has started focusing more on the production of Electric Power-Assisted bicycle. Thereafter there will be presented European Bicycle and EPAC by country share.

Table 2. 2016 European Production

Country	Bicycle Production (x 1,000)	EPAC Production (x 1,000)
ITALY	2.339	24
GERMANY	1.971	352
PORTUGAL	1.904	20
POLAND	1.150	6
BULGARIA	948	20
ROMANIA	900	60
NETHERLANDS	775	200
FRANCE	720	95
HUNGARY	402	171
SPAIN	351	10
CZECH REP.	350	80
SLOVAKIA	200	5
AUSTRIA	153	90
LITHUANIA	114	4
GREECE	112	1
SWEDEN	83	1
UK	83	0
BELGIUM	75	20
FINLAND	30	5
SLOVENIA	4	0
DENIMARK	3	0
CROATIA	0	0
CYPRUS	0	0
ESTONIA	0	0
IRLAND	0	0
LATVIA	0	0
LUXEMBOURG	0	0
MALTA	0	0
TOTAL	12.667	1.164

Source: European Bicycle Market 2017 Edition (CONEBI, 2017)

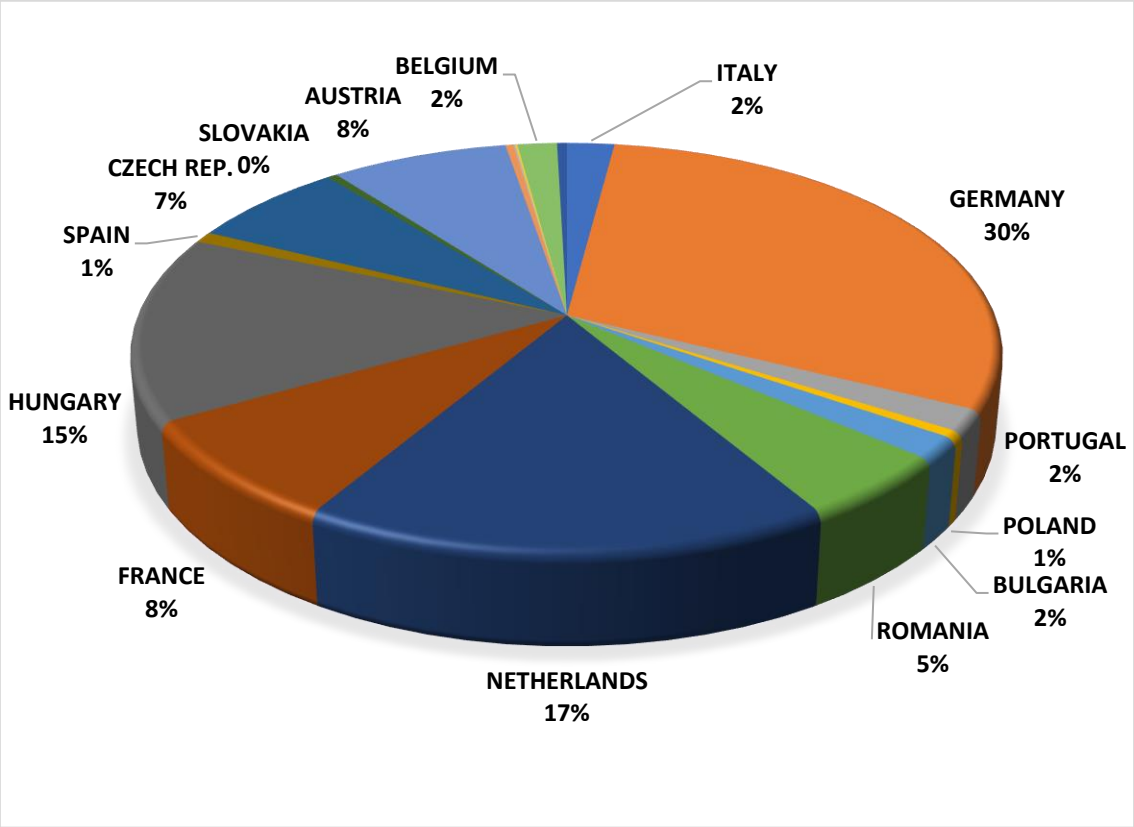
Figure 16. 2016 European Bicycle Production Country Share (%)



Source: European Bicycle Market 2017 Edition (CONEBI, 2017)

Epac situation is completely different, of course units produced in Europe are lesser the than the units of bicycle, but more specialized market have a greater share in combination with the eastern Europe, this time Hungary more than Poland. Portuguese and Italian firms seems not to be interested in the production of those type of bike in 2016. As we are going to se later looking at 2019 data given by ANCMA things in Italy changed in recent years.

Figure 16. 2016 European EPAC Production Country Share (%)



Source: European Bicycle Market 2017 Edition (CONEBI, 2017)

As we described in the previous part of our thesis, the supply chain of this industry is complex. Production does not only refer to assembled bikes, but a really important role is played by components and accessories components, such as saddles, group sets and wheels, have a tremendous importance for consumers. Looking into more details to these elements of the industry, we can observe a different situation: It is much more difficult to engineer a fork or pedals rather than to assembly a bike or to produce an aluminium or carbon frame. Italy in this field can still rely on powerful brands like Campagnolo, Miche, Cinelli, DedaAcciai and Fulcrum Wheels for components, and for shoes and clothes Sidi and Santini. France, for instance is leader for pedals and wheels with LOOK and Mavic respectively. We can see the presence of East European country, such as Romania, gaining share in production of component.

Table 3. 2016 European Parts & Accessories Production

Country	P & A Production (M€)	Country Share (%)
ITALY	482.000	27,5%
ROMANIA	300.000	17,1%
GERMANY	298.000	17,0%
FRANCE	214.000	12,2%
PORTUGAL	100.000	5,7%
CZECH REP.	90.000	5,1%
NETHERLANDS	85.000	4,8%
FINLAND	40.000	2,3%
BELGIUM	35.000	2,0%
UK	32.000	1,8%
POLAND	31.500	1,8%
HUNGARY	10.000	0,6%
SPAIN	10.000	0,6%
BULGARIA	9.612	0,5%
SLOVAKIA	8.500	0,5%
SLOVENIA	8.500	0,5%
LITUANIA	142	0,0%
AUSTRIA	0	0,0%
CROATIA	0	0,0%
CYPRUS	0	0,0%
DENMARK	0	0,0%
ESTONIA	0	0,0%
GREECE	0	0,0%
IRLAND	0	0,0%
LATVIA	0	0,0%
LUXEMBURG	0	0,0%
MALTA	0	0,0%
SWEDEN	0	0,0%
TOTAL	1.754.254	

Source: European Bicycle Market 2017 Edition (CONEBI, 2017)

In 2016, ranked on top of the production of Parts & Accessories (P & A) with € 482 million, with a quite relevant gap compared to main rivals, Romania (€ 300 million) and Germany (€ 298 million), which can be explained with consumer's attention especially when we are looking on components and the knowledge specificity necessary when producing such components.

Some bicycle statistics, particularly those regarding exports and imports of bicycles and components, are measured in value. This can create problems associated with comparing different currencies and their exchange rate over time, therefore analysing sales figure in Europe, we take a look only on units sold.

Looking at sales figure in Europe, we cannot see any growth in comparison to ten years ago, with 20.550 million of bike sold in 2016, a data that compared to the number of bicycle produced in the same year underlines the fact that Europe it is not an exporting economic area for this industry.

Table 4. European Bicycle and EPAC Sales 2000-2016

Year	Bicycle and E-Bike Sales (x 1,000)	Evolution year/year r-1 (%)
2000	18.945	
2001	17.745	-6,33%
2002	17.840	0,54%
2003	20.206	13,26%
2004	20.322	0,57%
2005	20.912	2,90%
2006	21.033	0,58%
2007	21.344	1,48%
2008	20.206	-5,33%
2009	19.582	-3,09%
2010	20.461	4,49%
2011	20.039	-2,06%
2012	19.719	-1,60%
2013	19.780	0,31%
2014	20.340	2,83%
2015	20.633	1,44%
2016	20.550	-0,40%

Source: European Bicycle Market 2017 Edition (CONEBI, 2017)

In the chart below we can see as the figures of sales for each country, and we can note again that the trade balance is negative. Culture plays a double role: Germany, driven especially by EPAC seals got leadership not only because of strategic approach and engineering capabilities, which are mainly focused on EPAC sector, but also because of

a growing domestic demand. On the contrary, Italy is still a net producer country, indeed it produces more than what it sells on is internal market.

Table 5. 2016 European Countries Bicycle and EPAC Sales

Country	Bicycle and E-Bike Sales (x 1,000)	Average price (€)
GERMANY	4.050	643,00 €
FRANCE	3.035	337,00 €
UK	3.050	521,00 €
ITALY	1.679	390,00 €
POLAND	1.200	350,00 €
SPAIN	1.115	533,00 €
NETHERLANDS	931	1.010,00 €
SWEDEN	576	575,00 €
BELGIUM	540	628,00 €
ROMANIA	510	200,00 €
DENMARK	510	700,00 €
CZECH REP.	490	250,00 €
AUSTRIA	397	660,00 €
PORTUGAL	350	250,00 €
CROATIA	350	318,00 €
FINLAND	320	350,00 €
SLOVENIA	310	250,00 €
IRLAND	225	250,00 €
HUNGARY	221	265,00 €
GREECE	166	195,00 €
SLOVAKIA	140	220,00 €
LITUANIA	113	298,00 €
BULGARIA	79	125,00 €
ESTONIA	75	250,00 €
LATVIA	70	250,00 €
CYPRUS	22	264,00 €
MALTA	14	250,00 €
LUXEMBOURG	11	550,00 €
EU 28	20.549	388,64 €

Source: European Bicycle Market 2017 Edition (CONEBI, 2017)

Germany topped the ranking with 4.050 million of bicycle sold in 2016, with an average price of €643,00. Note, that the sale figures for associated country are taken directly from CONEBI's member associations, in the other countries we used estimates from industry experts. (CONEBI, 2017)

Europe is a key market especially for the kind of products requested by consumers and relative prices the average price for a bike in EU is estimated at € 388,64, with ten countries with an average price higher than EU's average price, which enables firms to return investments and to deliver product and service at high level. Therefore, the industry can rely on high margins and can invest in innovation and marketing activities and in sponsorships.

Cycling industry still requires specialised manual labour but, from table below, we can see that satellite activities employ relevant number of people, even though production has been moved out from countries, a clear example can be seen with The Netherlands. We could say that pure production and assembling are not the only elements that can foster employment, but research and development activities, headquarters staff, commercial branches and so on require medium and high-level profiles. Germany is a paradigmatic example: it produces half quantity of components and less units of bicycle than Italy, but it employs 166.1% people more than Italian firms.

Table 6 . 2016 Employment in European Bicycle And Bicycle Parts & Accessories Industries

Country	Bicycle Employment	P&A Employment	Total
GERMANY	3905	5573	9478
ITALY	3287	2417	5704
POLAND	4873	420	5293
PORTUGAL	1137	4024	5161
NETHERLANDS	2280	1071	3351
FRANCE	780	1751	2531
CZECH REP.	597	1890	2487
ROMANIA	1350	1100	2450
BULGARIA	1860	65	1925
HUNGARY	1034	530	1564
SPAIN	609	322	931
GREECE	202	640	842
UK	447	220	667
SLOVAKIA	443	189	632
LIYUANIA	600	0	600
BELGIUM	285	202	487
FINLAND	128	300	428
AUSTRIA	300	0	300
SWEDEN	147	40	187
DENMARK	106	30	136
SLOVENIA	15	70	85
LATVIA	29	0	29
IRELAND	14	0	14
ESTONIA	5	0	5
CROTIA	0	0	0
CYPROUS	0	0	0
LUXEMBOURG	0	0	0
MALTA	0	0	0
EU 28	24.433	20.854	45.287

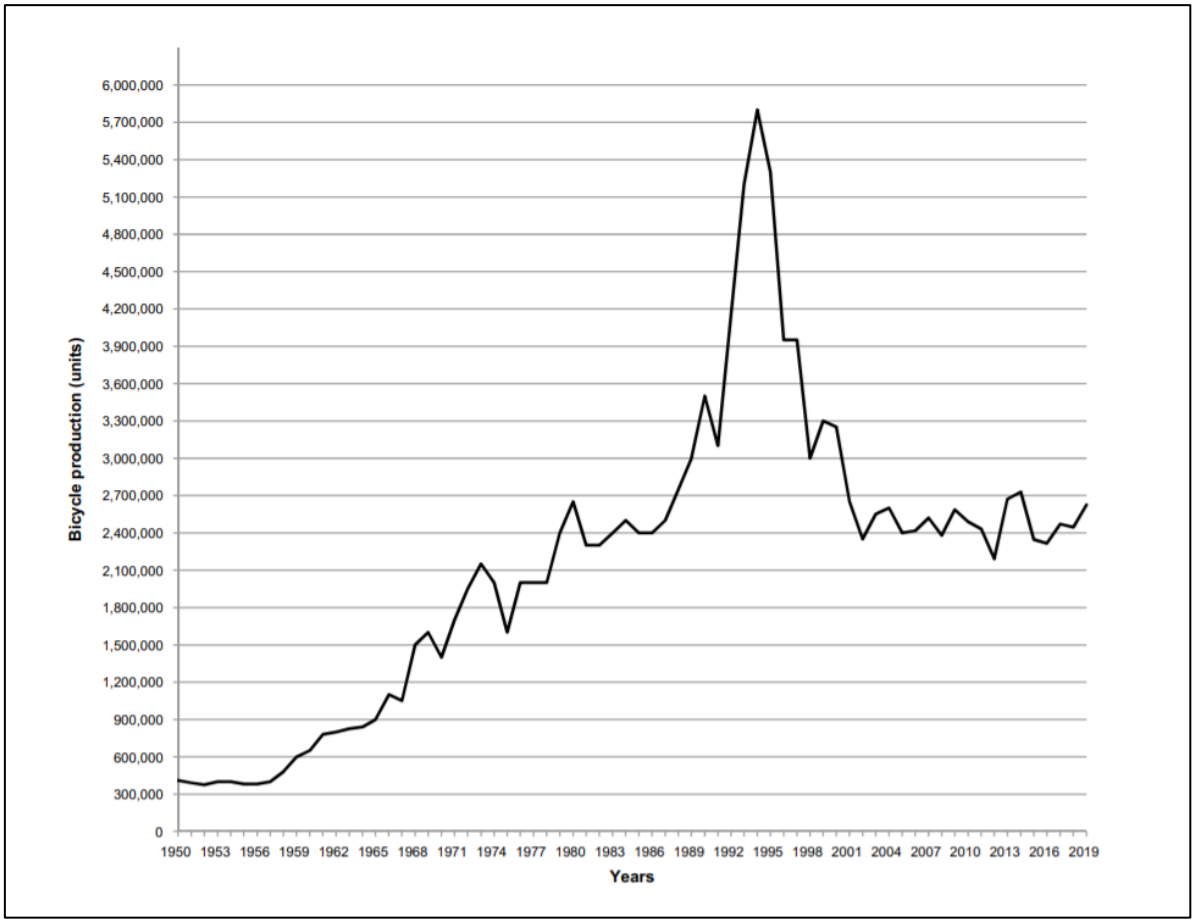
Source: European Bicycle Market 2017 Edition (CONEBI, 2017)

3.4.6 Italian market

The bike sector in Italy generated an estimated turnover of between 7 and 12 billion, approximately 0.7% of the national wealth (Il Sole 24 Ore, Bike Economy 2019 dossier) considering the production of bikes and accessories, cycling holidays and the set of positive effects resulting from the use of bicycles such as savings on health care, welfare and fuel costs.

Bicycle production statistics in Italy cover the 1950–2019 time span. Before that year we have very few reliable from scattered sources. An estimate of bicycle output between 1907 and 1914 shows that Italian industry manufactured an average of 146,000 finished bicycles, ranging from 98,062 in 1907 to 221,612 in 1910 (Piloni, 1982). The time series provided by the trade organization ANCMA (2019, 2020) reveals a first period, from 1950 to 1958, characterized by steady bicycle production of approximately 400,000 pieces. From 1966 to 1978 and from 1979 to 1989, bicycle production showed a further growth reaching 2,000,000 pieces and 3,000,000 pieces, respectively, in 1994 the production peaked with of 5,800,000 units. A significant decline whereby bicycle production is reduced approximately by 60% begins in 1995 and lasts until 2002. Bicycle production fluctuates from 2002 to 2019 reaching approximately 2,600,000 pieces. (C. Mari, 2021)

Figure 17. Italian bicycle production 1950–2019



Source: C, Mari (2021); ANCMA (2020)

The statistics from ANCMA show two main limitations. Firstly, the data represent an estimate of the domestic production of bicycles, not actual production. Secondly, the process of estimation is based on the assumption that one bicycle frame is equivalent to one bicycle. ANCMA makes an estimate of the number of frames, both manufactured in Italy and imported, that becomes a proxy for the number of bicycles produced every year as explained in 2018 by Nigrelli, ANCMA's director of bicycle industry. (C.Mari, 2021)[19]. According to ANCMA, the bicycle production estimate has a margin of error of plus or minus 50,000 bicycles, moreover, it is not clear how the number of bicycle frames is estimated, particularly the domestic production of frames also, the process of estimation is that estimation methods might have been changed over time. The number of imported bicycle frames is not an estimate, as such data are available through the official statistics provided ex post by the Italian Customs Agency. (C. Mari, 2021)[19]

Table 7 . Italian Bicycle Production 2009-2019

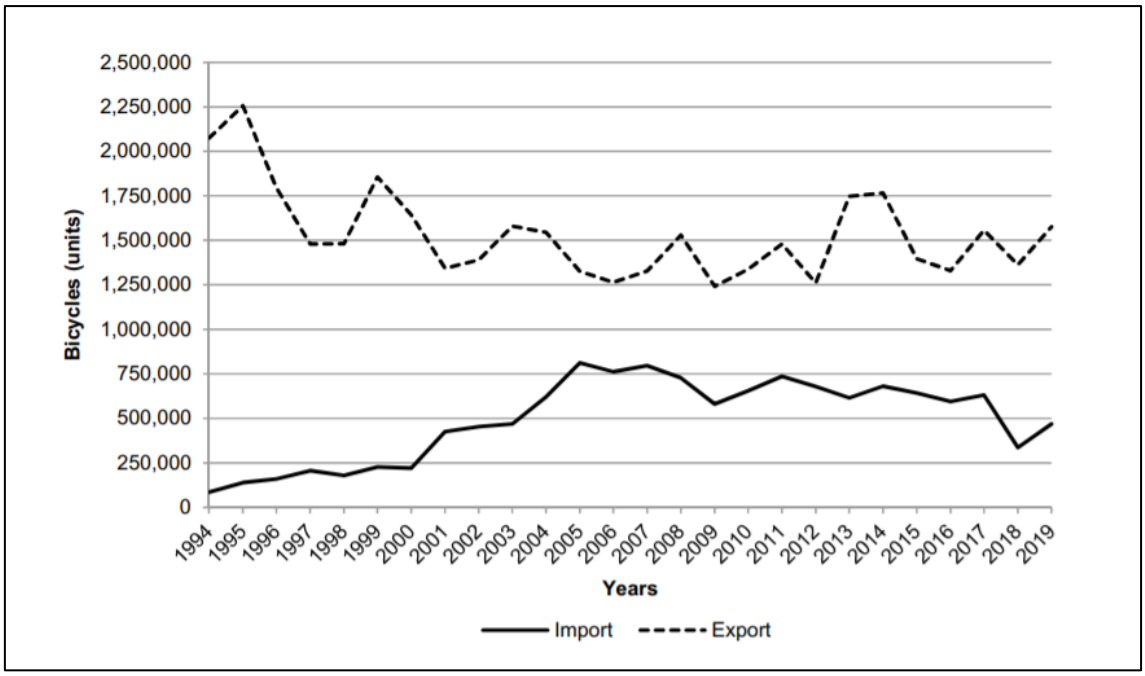
Year	Producion in units
2009	2.585.000
2010	2.489.000
2011	2.430.000
2012	2.190.075
2013	2.671.200
2014	2.782.700
2015	2.346.173
2016	2.315.000
2017	2.470.000
2018	2.445.000
2019	2.625.000

Source: ANCMA 2020

As for the circulating bike fleet, it is estimated that Italy counted 440 bicycles per thousand inhabitants. In Germany and the Netherlands, the ratio is almost 1 to 1 (Il Sole 24 Ore, 2019). Italy, like many other countries, adopted an import-substitution industrialization model as discussed previously and foreign trade statistics support this argument. Istituto Nazionale di Statistica (ISTAT) published in 2020 a data set includes a time series from 1994 to 2019 for finished bicycles and from 1991 to 2019 for bicycle frames (C. Mari, 2021). Before the 1990s it is not possible to identify both bicycles and

bicycle frames. The Figure 18., focused on more contemporary data, shows a declining trend in bicycle exports since 1994 and a stabilization around to a yearly average of 1,536,000 units. The import of bicycles is characterized by a growth trend between 1994 and 2005, reaching approximately 811,000 units in 2005. From 2006 to 2017, the import of bicycles fluctuated upward and downward around approximately 675,000 pieces. Later, imports decreased significantly in 2018.

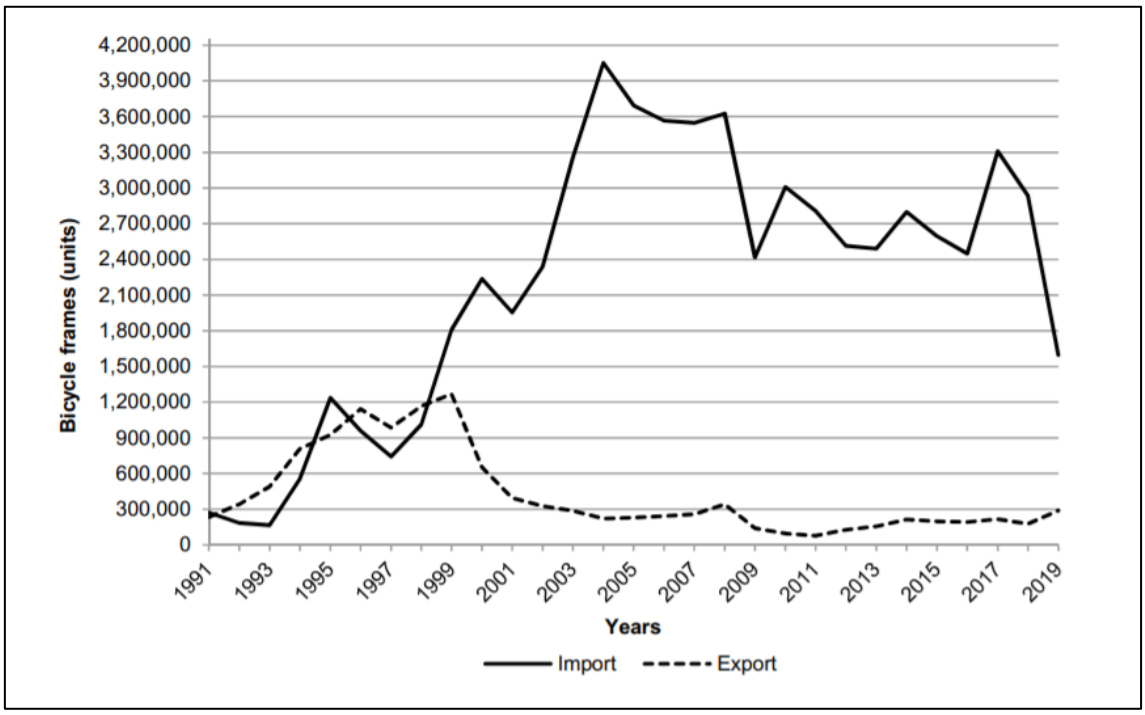
Figure 18. Italian bicycle import-export 1994–2019



Source: C. Mari (2021); ANCMA (2020)

Italian bicycle firms have almost completely set frame fabrication aside and this change is clearly visible through foreign trade statistics in Figure 19.

Figure 19. Italian frame import-export 1991–2019



Source: C. Mari (2021); ANCMA (2020)

The export of Italian bicycle frames was significant between 1991 and 1999 nearly reaching 1.268.000 pieces. From 2000 to 2004, however, there was a dramatic decrease that reduced frame exports by approximately 83%. The number of imported frames rose sharply from 2003 to 2004 and peaking 4.051.000 pieces imported. From 2005, there was a decrease characterized by upward and downward fluctuations, and the yearly average number of bicycle frames was approximately 2.890.000 units. The figures about bicycle frames indicate that Italian bicycle companies are progressively replacing the manufacturing of frames with the import of products, presumably from Asia (C. Mari, 2021)[19].

According to ANCMA, Italian bicycle production in 2019 is increased of the 7% with the respect of the previous year, with more the half of the units produced going abroad. An encouragement figure is given by the increase of production of E-bikes and the drop of import of this typology. With some years of late, Italian firms followed the market trend of EPAC bikes and started to produce this special type of know-how, but still figuring a lower production than German firms in 2016.

A stable market for Italian firms is given by components, statistics of parts & accessories are growing steadily.

Table 8. 2019 Italian Bicycle and Bicycle Parts & Accessories Industries

	2019	+/-	2018
Bicycle production	2.625.000	7%	2.445.000
Bicycle export	1.576.000	16%	1.363.555
Bicycle import	469.000	39%	336.406
P&A export			16.543.370
P&A import			31.686.493

	2019	+/-	2018
E-Bike production	213.000	209%	102.000
E-Bike export	90.000	1%	89.000
E-Bike import	72.000	-55%	160.000

in € million	2019	+/-	2018
P&A export	358	3%	346
P&A import	381	18%	323
Bicycle export	217	19%	183
Bicycle import	135	23%	110
E-Bike export	58	38%	42
E-Bike import	81	-11%	91
Commercial balance	36	-23%	47

Source: ANCMA 2020

Italy has historically been the country of high-end road bike. This statement is based on common opinion but, when we take a look into data, we can easily understand that we are talking about a small niche of market. We can always say that is the most profitable one, but it does not weight enough to pay off investments and to support business growth. Road bike represents the 6% of the whole bicycle market in Italy, Italy lost momentum to enter into Mtb market during the 80's and afterward a slow decline began. Nevertheless, we can see from our charts that Mtb is the second most popular product sold by Italian companies, and there is not an overflow of products from Chinese firms, also thanks to the approval of European regulation establishing a definitive anti-dumping duty on bicycle imports originating in the People's Republic of China extended to imports of bicycles shipped from Indonesia, Malaysia, Sri Lanka, Tunisia, Cambodia, Pakistan and Philippines, regardless of whether or not they are declared as originating in those countries. This led to the protection of excellence and to the recognition of

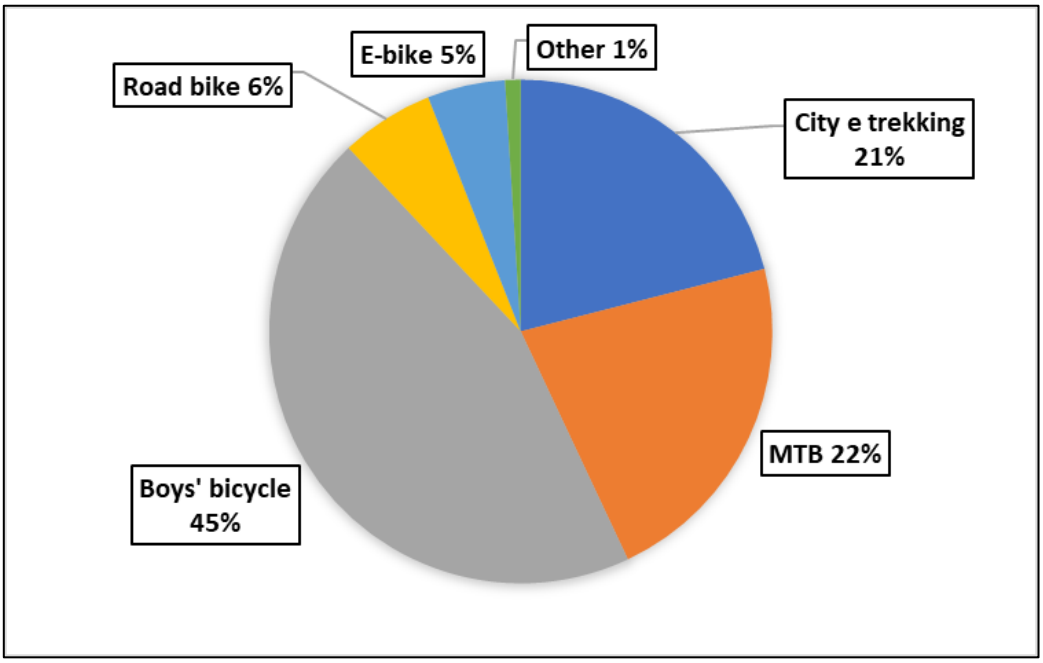
Italian know-how, made up of unique skills, beauty, innovation and know-how (ANCMA, 2020). It is clear evidence that the issue for our companies is on export and international competition rather than domestic market.

Table 9. 2019 Italian Bicycle Production by Type

Type	%
City e trekking	21%
MTB	22%
Boys' bicycle	45%
Road bike	6%
E-bike	5%
Other	1%

Source: ANCMA 2020

Figure 20. 2020 Italian Bicycle Production by Type



Source: ANCMA 2020

IV. Bicycle Industry Case Studies

In this chapter we present some case studies focusing our attention on firms position within the value chain, the role of innovation in the value chain and in the history of the brand, comparing firms with different attitude we describe company profiles and management opinions. We have followed the stream of production along the value chain: from frame producers to distributors. The North of Italy is the geographical area of our research, this area has been a cluster for bicycle industry since the beginning of the last century but is not broadly know. Today's global configuration of the bicycle industry clash with the historic tradition of Italian family owned firms, therefore some structured companies still located in this area are competing at international level being successful but at the same time other firms with the same background are struggling due to their size, lack of internationalization and short period strategy.

At the end of 2017, there were 3,098 companies registered in the bicycle supply chain, of which 59.7% carried out repairs, with an artisanal component of 66.6% (Artibici Confartigianato Report 2018). 250 companies in the sector, often small and family-friendly, which invoice a total of 1.35 billion, delivering the country the supremacy of production (frequently assembled) and exports to Europe

Overall, the Italian bicycle industry counts 250 companies, often small and family-owned, more than 5000 employees, 2.5 million bikes produced and a turnover of 1.35 billion Euros. Of these 250 firms, 150 deal with components and accessories which export worth 358 million in 2019 (ANCMA, 2020). The macro sector is divided into city bikes, mountain bikes and racing bikes, that is the most important segment for our country and that represents excellence. The bike industry exports worth over 217 million euro, mainly maid of high-end bikes. The Italian market has an annual production capacity of 2.5 million traditional bikes and 215 thousand e-bikes. (Il Soe 24ore, 2020)

In order to provide evidence of the fitting of the theories presents above with the real business, we are going to describe different approaches to industry architecture and governance of global supply chain.

4.1 The power of industry architecture and impact on innovation

When it comes to choosing which group to mount on our dream bike, the discussion has a unique direction: cycling component market, from group sets to breaks, is dominated by three major firms: Shimano, SRAM, Campagnolo. On one side Shimano and SRAM with its global and wide rage product strategy, on the other, there is Campagnolo and its niche segment. The former have production distributed across several countries, Taiwan, Portugal, China, Cech Republic and the U.S just to name a few, the latter focused his efforts in order to produce exclusively within Campagnolo-owned factories, being recognised as a well named brand made in Italy until 2017, when the company ushered two factory in Romania and renamed itself *Made in Europe.* While SRAM has a relatively young history since it was founded in 1984, Shimano and Campagnolo have battled for the leadership in the components market since the late 70s, pursuing different strategic management path. In fact, the two most important components company during the 80's made opposite decision, resulting dramatic changes in the industry's architecture.
At first we present the two companies taken into consideration because relevant to our research proposal, showing their opposite approaches to GVC and industry architecture. Shimano has been proactive while Campagnolo had a reactive approach, with a passive strategy which brought the company to defend a profitable position but did not take into consideration further evolutions, both inside and outside the firm.

4.1.1 Campagnolo, a presentation

The history of Campagnolo started in one precise day: November 11, 1927; that day, *Gentullio "Tullio" Camapgnolo,* an Italian rider born in Vicenza, was leading a stage of the Giro d'Italia in a freezing day. At that time, the bicycles were not equipped with the most modern electronic gearboxes but with rear wheels with only two gears. Tullio Campagnolo was prepared to climb the first steep slopes of the Croce d'Aune pass but his hands were so numb from the cold that he couldn't loosen up the hub wing nuts to unlock the wheel and shift to an easier gear. Consequently to that event, Tullio Campagnolo had a stroke of genius: he would redesign the nut's lever to make the release more straightforward. (Campagnolo Milestones)
The Quick Release system was patented on February 8, 1930 and in 1933 the Campagnolo Company was founded, headquartered in the backroom of his father's

hardware store in the city of Vicenza, focusing on the production of the famous *cambio a bacchetta*. Campagnolo spent much time following races and speaking with cyclists, taking notes of every input, suggestion, and recommendation. All those inputs collected on the field was then elaborated, translated through pencil and paper into sketches and perspective drawings. The *rod gear* made its debut on May 4, 1940, presenting two levers controlling wheel disengagement and chain position. Campagnolo's slogan of the 1930s became "*Senza attriti e senza rumore*" (i.e., friction-free and noise-free). But the revolution occurred in 1949, when Campagnolo at Paris exposition introduced a rear derailleur prototype equipped with an articulated parallelogram and a double pulley tensioner, the so-called *Gran Sport*. In 1951 he introduced the gearbox *Gran Sport* with single cable, whose operation is now retraced on all bicycle gearboxes. Campagnolo became a leader and global reality of its sector. The 60's were an amazing stepping-stone for Campagnolo, which soon became the benchmark in the field of bicycle parts manufacturing. 110 out of 130 cyclists participating in the 1963 Tour were equipped with a Campagnolo rear derailleur. The company started exporting worldwide and opened a plant near the city of Bologna to start experimenting in new sectors: motorcycle and car racing wheels, as well as lightweight magnesium parts for the aerospace industry (NASA). In the 70s Eddy Merckx and many other riders used the legendary *Super Record*: Campagnolo offers materials never used before, unbeatable reliability and quality, and marks an indelible turning point in the history of mechanics applied to bicycles. Campagnolo's Super Record was a milestone, it remained in production from 1973 to 1987, it was updated to the black and silver version in 1979. The rear derailleur was made in ergal and titanium, proving to be successful in terms of lightness, precision, and aesthetics (Campagnolo.com)

Professional races are Campagnolo's all-time research and development laboratory. Tullio Campagnolo and his team were always present at every stop-over and at every race collecting data and feedbacks. His mission was to listen, and to learn what to improve directly from cyclists. In 1983, the company crosses the half-century line. The use of titanium made the Super Record extra light, taking the weight down of 200 grams. Tullio Campagnolo died in Vicenza on February 1st, 1983 and his son, Valentino, took over the running of the family-owned company. (Campagnolo Milestones)

Bicycles were undergoing transformation, in fact aerodynamics and lightness became common terms. Steel became lighter and aluminium alloys were introduced in the production of frame tubes. Valentino Campagnolo followed the thoughts of his father as man and as entrepreneur concerning how to manage the company and how to innovate.

The early 80's represents a critical step for the Vicenza based company: competition brought by the Japanese Shimano started to grow, Shimano entered in the mountain bike market with major investments and sponsorships. Afterward Campagnolo did the same, but the delay and the Campagnolo image, which was trapped in racing bike, were obstacles too big to face, forcing the Italian company to abandon the off-road market early in 1995. In the late '80s Campagnolo decided to follow precise path, choosing to focus on a more profitable niche market, that had always dominated: the high range. The Japanese competitors, however, engaged a long battle for supremacy in the market; Shimano won definitely on low-end product market and holds the leadership in that segments and sport city bike with a turnover of more than one billion Dollars: ten times Campagnolo's one. Campagnolo consolidates its presence in the top of the range in the components of the world road, in cohabitation and constant challenge with Shimano, creating a real market niche for customers called *campagnolisti*.

Although the market is constantly evolving and changing, Campagnolo still chooses to be faithful to its history, customers, and mythical image that has never changed or distorted. Although hosting this bicycle market segment has high consumption potential and high fidelity, it has caused the company to gradually reduce its market share, especially in the OEM market, where manufacturers choose cheaper products.

The Campagnolo group also includes the Fulcrum wheel brand, born about ten years ago to allow the use of Campagnolo wheel technology also with Shimano and Sram components. As is well known, Shimano and SRAM have one *system*, Campagnolo has another and the two systems do not talk to each other, as happens for example with Canon and Nikon lenses. The total turnover of the Vicenza group is approximately 120 million per year, divided as follows: 80 million Campagnolo (wheels and groups) and 40 million Fulcrum. Overall, the two Campagnolo wheel brands account for 65% of turnover, 35% from groups. The company is profitable and operates with its own means, in the old way. The market is very competitive. But the winning weapon is still that of

quality and innovation. The company's Research and Development sector is in Vicenza. And 7-8% of the total turnover is allocated to R&D every year. A huge percentage compared to the Italian average (2-3%) which is the best way to prepare for the future. (ilSole24ore, 2016)

Campagnolo exports more than 70% of its turnover and sells and distributes its products everywhere world. It supports partners throughout its locally managed distribution branches. Campagnolo coordinates all global activities and operates on five continents Through a structured network consisting of 5 commercial branches (North America, Spain, France, Germany, Japan) and Taiwan's logistics centers. In the UK and The Benelux relies on independent import companies, while Campagnolo in the rest of the world Cooperate with more than 70 distributors in 32 countries/regions.

Campagnolo has never produced components in Taiwan. It has only brought low-end products to Romania since 2009, opening two factories in 2017 and used them only in the production process. Campagnolo's strategy is to maintain and continue production in Europe, just like the German company Cube, which is Europe's leading company in assembling bicycles. The second wave of relocation transferred the production of components as well of frames to Cambodia, Vietnam and Bangladesh, as result of the technology improvement of Taiwanese firms, which was even higher than in the Italian and European companies, not matching the demand of the mass production. In this case, Campagnolo has been withdrawn from mass production; it has always regarded its niche market as the top Italian brand. The disadvantage of this strategy is that it is only sold in the aftermarket. At the same time, it does not have strong functions in marketing activities and does not invest in selected distribution channels that may help build a product's exclusive image. For example, Canyon is an example. Canyon is a frame manufacturer who only sells online, but manages to increase its profit margin by 25%. B2C is a new field for these brands. The best way to get into the top specifications is sponsorship, but for company policy, Campagnolo does manage to cooperate with well-known high-end brands such as Trek or Specilized. The reason for this is that after the sponsorship of the professional team, they do not accept the contractual obligation to purchase programming quantities. In addition, in order to cooperate with these companies, they need to increase the workload in terms of quality and delivery time.

Unfortunately, in terms of the size of Campagnolo, only the first of the two elements is impeccable and it is difficult to guarantee on-time delivery, especially for new products. From the perspective of the global value chain, the Campagnolo case is very interesting and understands the importance of scale and industry architecture. Campagnolo keeps the production in Italy, but this decision does not conform to the industry structure. Only the strength of the brand and the company's mid-size can defend its position in the market. Innovating the industrial structure is possible, and it is very difficult to defend the old-outdated strategy. Therefore, Campagnolo transferred some production to Romania to supply the German market and established a parts logistics center and a wheel manufacturing company in Taiwan.

4.1.2 Innovation and EPS: Campagnolo case

For Campagnolo, innovation is a key feature of the corporate vision. Campagnolo base his designs by observing cyclists and the types of bicycles they like to buy. Today, technological developments in the bicycle market and materials are driving the company's research and new product launches. Campagnolo is the first manufacturer to use an 11-speed, and the second to introduce an electronic transmission system. For Campagnolo vision, strategy follows innovation; this means that the company´s aims are determined by the technological progress and innovations made by the R&D department. The launch of new products is scheduled according to the season: the clients' preview (B2B sales) is planned for September and the product presentation for the public is in March.

The R&D departments of mechanical and aerospace engineers and materials experts are at the core of new product development. The contribution of the School of Materials Development of the University of Padua, which has cooperated with the company for more than 20 years, is particularly important. The Composites Department is the most important production department, applying technological innovations in product manufacturing, moreover the Carbon fibre processing requires a lot experience and complex manufacturing procedures, even if the market requires the product, it is not launched if the technology is not fully developed and tested. The product manager has a crucial role in the Campagnolo system, since is the nexus between the product

development and the marketing department, the sales office and the production area in order to offer the best possible results to the customer.

Our analysis of Campagnolo has to deal with the world of racing because it is from here that technology comes and then delivered to private bikes, we can find similarity with the case of F1 and mass-produced cars. In order to understand the process and results of innovation, we need to start by assuming the importance of people and different social groups, there is not a fixed and stable path to invent, but is a mix of inspiration and intuition. Particularly in our case, innovation is developed by different social groups: riders, engineers, and mechanics.

Since these actors came from different technological frameworks, there are therefore different degrees of inclusion in their technological frameworks: in fact, the point of view of a mechanic will be very different than that of a rider, but could have a similar approach to that of the engineer who designed one of the components. We can distinguish incremental innovation and disruptive innovation (Christensen et al., 2002)[48]: the former comes with the interaction of these three different experiences, while the latter are always start from an intuition, such as quick release by Tullio Campagnolo. Sharing of technology with a wider audience with different needs further develops the initial knowledge used for racing components, in Campagnolo new technical applications are resulting of flexibility in interpretation of know-how derived from research on road bikes. This is very important for understanding how the innovation of complex artifacts produced by combining different technical experiences and combining specific environmental factors can produce useful innovations: it is a composite path with different sources of pressures: private firms, market demand, public investment and adjacent sectors. In the field cycle there are different points of view and for each there is someone who cares to trace a path of innovation. An example of source of innovation is the minimum weight rule established by UCI, Union Cycliste International, for racing bike. Since that, companies are focusing on aerodynamics, and therefore great importance is attached to the transmission and wheels.

Campagnolo has innovative shifting systems, the *Campagnolo EPS*, is a shifting system that use electrical circuits managed by an electronic control unit, *Digital Tech Intelligence*, meaning that there are no more steel cables that connect the control levers to the front and rear derailleurs. It is not a simple application to the mechanical system,

but it is a completely electronic system to all effects. This innovation lead to further changes in the world of racing and cycling in general, allowing to control the performance in a scientific way, knowing the pedalling frequency in real time, based on mathematical data and not on feelings. We can imagine that in the future the change becomes more automatic, with the electronics that suggests when to shift the rider. EPS allows to face challenging climbs and treacherous terrain like the pavé with less risk of mechanical problems because you always have the right gear-cog in relation to push on the pedals, in order to get the maximum performance from the propulsive effort as in sprints in order to have more speed and reactivity.

The DTI (Digital Tech Intelligence) receives impulses from the controls through the interface that communicates with the sensor placed inside the derailleurs: depending on the sprocket that has been selected with the controls, the EPS re-positions the derailleur to optimize its position with respect to the chain. Thanks to the electronic evolution of the Multi-shifting technology which is already used in the mechanical units, it is possible to obtain multi shifting with 11 gear-cogs. The EPS system is capable of automatically detecting a whole range of malfunctions. If a malfunction is detected, the EPS system turns on an RGB led located on the power unit. Depending on the area where the malfunction has been detected the led takes on different colours. If this happens, there is a procedure called *Ride Back Home* that allows you to manually «uncouple» the rear derailleur to position it on the required sprocket.

For Campagnolo, this has been a significant achievement and an extremely important project, while for riders it represents the zenith of cycling technology today. Campagnolo Super Record EPS is considered by pros and amateur the best drivetrain in the World, representing a revolution in the cycling world, moving from mechanic group set to electronic one.

4.1.3 Shimano, a presentation

Shimano is a Japanese firm founded in the 1912, the company has 32 consolidated subsidiaries and 11 unconsolidated subsidiaries, with primary manufacturing plants in Kunshan, China, Malaysia and Singapore. It established its position as a bicycle parts manufacturer throughout the 1960s, and consolidated that in the 1970s through

constant attention to customer needs, a culture of product and technological innovation, and a strong focus on improving manufacturing processes. They were able to move forward from core competences to competitive advantage into this industry and to take the leadership of it. Shimano is well known for being incredibly in spotting trends and early market such as off-road bike, developing a company culture of attention to customers' emerging needs, and thanks to that and thanks to the development of new products, Shimano over the years outperformed others component producers like Campagnolo.

A culture of innovation through strong focus on research is one of the key factors of its success: in fact Shimano always invested massively in R&D and its technology had been protected by almost 500 US patents since 1976, Campagnolo had less than 50 in same years. The turning point was in 1982, when Shimano introduced for the first time a complete group-set of components specially designed for off-road us. Furthermore, Shimano has been having a strong tradition of quality excellence at costs controlling, at first by manufacturing its parts in South-East Asia, achieving labour cost advantages. A second key element of Shimano's cost management is the focus on process improvement: faster production at lower costs has been a mantra since the 1950s (Shimano). This mix of competences mentioned above, combined with the first mover advantage, have been rapidly translated into a competitive advantage that allowed Shimano to be perfectly positioned for the mountain-bike craze of the 1990s.

In 2017, Shimano had net sales of US $3.2 billion, 38% in Europe, 35% in Asia, and 11% in North America. Bicycle components represented 80%, fishing tackle 19%, and other products 0.1%. The company is publicly traded, with 93 million shares of common stock outstanding. Shimano sales constitute an estimated 70–80% of the global bicycle component market by value. Its products include drivetrain, brake, wheel and pedal components for road, mountain, track and hybrid bikes. The components include crank set comprising cranks and chainrings; bottom bracket; chain; rear chain sprockets or cassette; front and rear wheel hubs; gear shift levers; brakes; brake levers; cables; front and rear gear mechanisms or derailleurs. Shimano Total Integration (STI) is Shimano's integrated shifter and brake lever combination for road bicycles. (Time to ride Shimano, 2017)

Key elements of Shimano's are:

- bundling of products: offering its products in bundles in order to capture more consumers' surplus.
- integration of systems and components: companies that wanted to use Shimano's thumb shift had to buy the freewheel at the same time as the gearshift.
- continuous change of products' specifications: keeping competitors far from developing components compatible with Shimano.
- exclusivity discounts to dealers.
- high investments in advertisement: building brand image and creating awareness among customers regarding components they were using.

Looking at the costs side we can highlight how they did reduce costs through a combination of the marketing measures mentioned above and a set of cost reduction policies focused primarily on logistics, economy of scale and advanced cost controlling procedures. The key advantage in this sense is the reduction of transportation costs thanks to production location close to frame producers, i.e. Taiwan, but also they have been able to enjoy cost driver thanks to an expansive marketing strategy that increased the market share influenced by Japanese culture of lean production. Shimano's strategy was characterized by lowering cost trough a permanent attention over years to quality and innovation of production processes. For instance, they were disadvantaged by the strength of their currency, the Yen, therefore they sorted this problem out by off shoring production to China for the Asian market and to Czech Republic for the European one

During last decades, competitors and other firms of the industry managed to react to the changing business environment lead by Shimano behaviour, and therefore we can observe different reaction strategies at different stages of the value chain.

An interesting insight is regarding Cannondale, an American frame producer leader in aluminium technology. Cannondale strategy is based on a strong brand name, a selective distribution and Made in USA products. Against the spreading of Shimano's components and its contracting power, the American firm reacted by sourcing their gears from SRAM and by manufacturing their own components, through Coda and HeadShok brands. Although Cannondale's experience with its own brands cannot be regarded as a failure, the company still relies on Shimano that remains the main supplier of components for Cannondale (Shimano). This is the result of Shimano's strong brand

awareness, thanks to end users that keep asking for Shimano's products for higher-end bikes, which are seen as added value.

4.1.4 From being modular to integration: Shimano

Many products are becoming more modular over time, and that this development is often associated with a change in industry structure towards higher degrees of specialization: there are strong connection between a new product introduced in the market and industry structure's changes. A fine analysis of the product architecture could prove the existence of multiple linkages between product architecture and industry structure, these considerations involve the firm boundaries decision and the investments on technology, research and development (Fixson, Park, 2008)[49]. The case of bicycle drivetrain component industry during the 80's is characterized by increasing vertical specialization in the associated industry resulting from increasing modularity.

In the first part of the 80's, the industry was fairly competitive and included both small and large firms, with over 50 firms active in the market, and over half of those developed and manufactured only three or fewer of the components of a group set, but by the end of the decade, the industry structure had drastically changed. The tipping point was the split of the total bicycle market into two major categories: road bicycles and mountain bicycles. Shimano had become by far the dominating firm for bicycle drivetrain components in both categories, with slightly less than 60% market share in the road bike category, and almost 80% market share in the MTB category (Shimano). The rest of the market as occupied by Campagnolo and some minor niche firms. Since each firm have a completely integrated component sets, between 1980 and 1990, the industry migrated higher level of integration, both within and across the individual component segments. This relatively is an unusual case of decreasing product modularity that is linked to substantial changes in industry structure.

Shimano' case is a result of the linkages between product architecture, innovation, and industry architecture. In order to understand this industry architecture, we have to analyse the product itself, at the end we can say that industry architecture has been shaped accordingly product architecture. Product architecture is the scheme by which the function of a product is allocated to physical components (Ulrich, 1995)[36]. If we map

functional elements and we link them to physical, we can divide the architecture in two big archetypes: modular or integral. Of course, reality is more complex and we cannot set a straight border between these two different possibilities. In the bicycle sector we have a clear evidence of industry shaping with the business case of Shimano. In 1989, the Japanese company took its product architecture integration one step further (Fixson and Park, 2007)[49]. In the MTB market Shimano introduced its HyperGlide (HG) freewheel, which allowed bike riders to change gears under load while pedalling, even when shifting from a smaller to a larger sprocket (Bicycling magazine, Sep 1988, Dec 1989). Shimano brought an additional component, *the hub*, into its already integral drivetrain system in order to introduce a new technical standard of interface. This strategy enables the company to reduce component compatibility with other products of other companies. Thanks to this innovation, Shimano enjoys a more standardized product range. Instead, competitors must introduce more variants of their components to make them compatible. We cannot assert that there is a right path to follow to move from modularity to integration or one perfect model. For instance, systems can migrate towards and away from modularity (Schilling, 2000)[50], product architectures can oscillate between integral and modular states as in the double-helix model (Fine, 2008)[51]. Looking at company level, we find evidence of this phenomenon on Jacobides research activity on potential gain from specialization and gains from trade as underlying forces that ultimately cause an industry's disintegration (Jacobides, 2005)[52].

It is important to have in mind that Shimano started to produce all the components since the beginning, but, more importantly, it introduced an integrated design before it began its expansion in the market (Fixson and Park, 2007)[49]. According to many scholars, we can state that an industry could go through an industry architecture change towards higher degrees of integration (Christensen et al., 2002)[48]. This strategy finds its reasons on the transaction costs reduction and on the value for a firm of maintaining an integrated knowledge perspective (Brusconi et al., 2001)[53].

The components' industry was used to be modular, and Shimano introduced a modular product to its offers; with modular product we are speaking of products which accept or provide upgrades to existing systems. It was the outcome of changes in both customer demand and technological necessity to lower transaction costs. The final result of this shift in Shimano offer, is the dominant position reached in this industry by Shimano.

Competitors were forced to adapt their offer to Shimano's one and to play as followers: a more integrated product strategy gained the market leadership. Due to the elimination of inter firm component compatibility, other firms lost the possibility to engage with Shimano's ecosystem, that was not co-specialized with *outside* components anymore, and started to sustain itself.

This fact provides evidence of linkages between individual product architecture and strategic performance dimensions of a firm, help us in the understanding the industry-changing power of product architecture innovation. Moreover, Industry Architecture can help us to understand Global Value Chain evolutions and geo-localization: industry architecture has implication not only on product performance or firm operational functionalities, but it has strategic impact on the industry as a whole. Shimano from that moment on started to intensify its production and completing its offer. But the change of architecture leaded also to a need of knowledge and know-how, in fact, modular sectors required a deep knowledge base to compete effectively, while a broader range of knowledge is necessary in order to change the architecture of the industry. It is easy to understand that a change in the product architecture is possible if there is the possibility of a higher number of resources and investments. Starting from the product dimension is important to understand and design the paths through which changes in individual product architecture dimensions propagate through the industry. In bicycle sector decreasing modularity in a mature and modular industry has driven to an overwhelming dominance of the attacking firm. (Fixson and Park, 2007)[49]

The bicycle drivetrain industry, as a consequence of Shimano's strategy was triggered by a more integral function-component allocation, consequently forcing the competitors who offered all of the six drivetrain components, *i.e., systems firms into a system competition*. At the same time, by contrast, the reduction in interface standardization, drastically reduced the available market size of complementary components to which component firms could attach their own components. Through this elimination of interfirm component compatibility, the small firms essentially lost the population of components that were *co-specialized* with their own components. Moreover, the systemic form of competition difficult for all firms still standing because the origin of performance differentials was very difficult to detect, and it took the

remaining competitors several years to close the performance gap. (Fixson and Park, 2007)[49]

4.1.5 Differences in the two case studies

The first direct evidence in these two cases is Innovation in two corporate cultures. Shimano uses its innovations to change markets and industries. Campagnolo is only committed to product innovation, so it cannot change this development trend at the industry level. Shimano relies on distributors and other companies to implement its strategy, and has played a central role in the industry with its standards and business strategies. On the contrary, EPS Campagnolo products are the best powertrains on the market, but marketing, distribution and strategies are only effective for high-end product niche markets. There is no effort to expand the potential market and ensure alliances and partnerships in the downstream stages of the global value chain. This narrow industry structure approach stopped Campagnolo from expanding its bargaining power and impact on other companies.

Decreasing modularity in a mature and modular industry led to an overwhelming dominance of the attacking firm. The introduction of an integral architecture by a then non-dominating firm resulted in a near-monopoly position of the innovating firm within a few years (Fixson and Park, 2007)[49]. Changes in the product architecture effects in two different propagation paths, one hitting small component firms, the other larger systems firms. Although some auxiliary activities (such as dealer training and free tools) are essential to the set the process in motion, the analysis shows that there is a clear connection between technological changes and the industrial structure, from the former to the latter, from the product innovation, via product architecture changes, to industry architecture and value chain composition.

4.2 Innovation in bicycle frame's Global Value Chain

The frame is the core component of any bicycle and the essence of the product. Bicycle frames have different variables: design, material, weight, etc. Since the advent of bicycles, consumer expectations and market concepts have changed product

development, what trends can be seen in the current frame production? What is the impact on the supply chain? t has only been a few years since the restart of frame production became a topic in the European bicycle industry. Investing and setting up framework production in Europe are seen by frame's company as a major move to add flexibility to the industry's supply chain. Producing enough aluminium frames to meet demand has long been considered a problem. Due to the anti-dumping measures imposed on electric bicycles imported from China, the surge in demand also shows greater challenges, forcing the production relocation of a big part of the over 750 thousand of e-bikes that ware imported into the EU from China in 2018. (BIKE Europe).

Portugal and Poland were the first European alternative to Asian's frame, establishing their own frame production facilities, followed in January 2020 with the newly founded Cycle Gets, a Bulgarian start-up specializing in the production of aluminium bicycle frames, with a maximum capacity of 250,000 frames per annum. To complete the geo-picture of the current frame production in the Old continent, closely outside the European continent, Turkey is the major exporter of bikes across Europe, making strides in frame production through Korel Elektronik, with a alloy bike frames making capacity of millions units yearly and recently started a new investment in Eskişehir to produce complete finished bicycles under *Corelli* brand, a clear reference to Italian know-how All the aluminium parts including frames, forks, handle bars, seat tubes are produced locally by Korel. (Korel Electronik web site)

Poland e Portugal, in particular, specialize on robotized frame production, in order to respond to the rising mass production demand. The Industry 4.0 focus on quicker and more efficient production processes, based on the use of modern IT technologies which combine high-tech research centres and robotized production lines. Automated frame production can increase production capacity, reduce delivery time and reduce the speed to market for bicycle frames. The shift to robotized frame production has been reported also in Vietnam with *Astro Engineering* and in Belgium with *Rein4ced.* Polish company *AG Motors* claims to have the capability to manufacture a complete aluminium frame in one uninterrupted welding process. (BIKE Europe)

Besides the added interest in aluminium production and the possible return to steel frame alternatives, the high-end industry is seeing a new impulse in carbon frame production research technology: the Italian company *Atala* launched in 2019 the first

production ready carbon frame made by printing in one piece. This technology is set to change the market for both carbon and alloy frames. Atala is owned by *Accell Group* for the 50 percent, a bicycle company based in Heerenveen, Netherlands which owns also other historical European brand as *KOGA* and *Lapierre*. Moreover, last year, the German bike frame company *Velosione* launched its first *injection-model open-mold carbon city e-bike frame*, an important step to have a more flexible supply chain and to brought closer the frame production to the market demand.

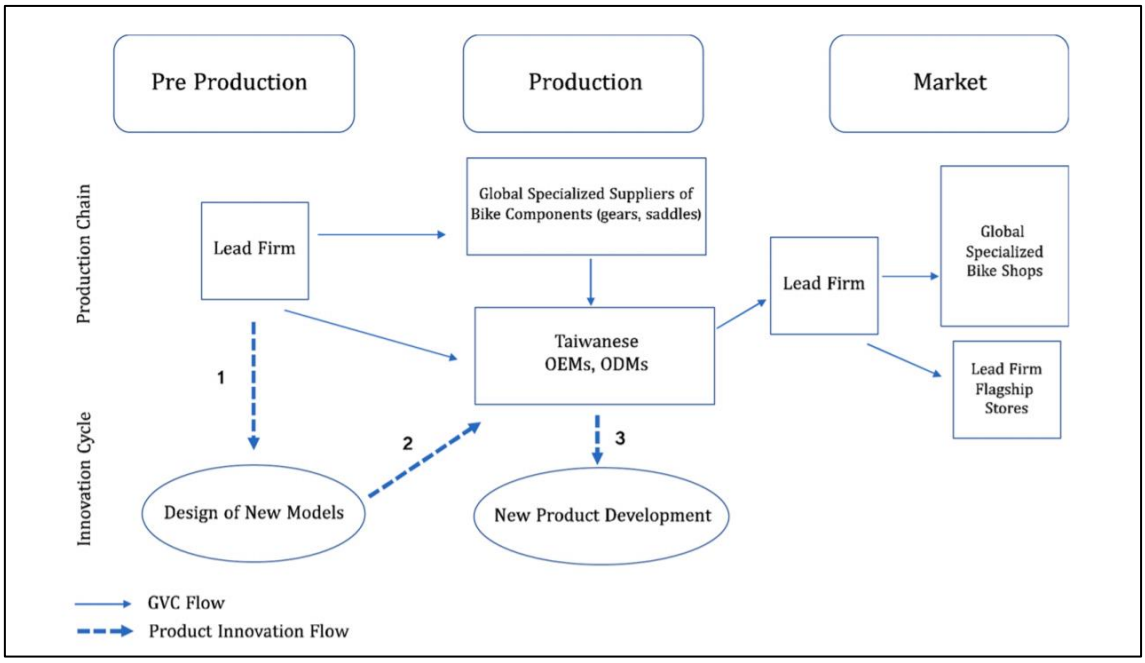
But, what historical lead firms in bicycle industry can do in the field of innovation? Generally identified by brand-name firms like Italian Pinarello and Bianchi or American Cannondale and Specialized, lead company of the sector have little or limited involvement in global operations because production modularity and suppliers' capabilities are high. Independent contractors are typically large producers located in Asia (above all, Taiwan) that can operate as private label producers and Original Equipment Manufacturers (OEMs) for numerous Western brands. (Buciuni and Pisano, 2021)[32]

The geographic dispersion of value chain stages is a relatively recent phenomenon, which was initiated in the 1990s by the introduction of carbon-fibre in the production of bicycle frames. Due to the labour-intensive nature of carbon-fibre production, Taiwanese contractors started specializing in this specific value chain stage, and then, became the providers of all the frames assembled by professional bicycle brands. In recent years, the upgrading of Taiwanese suppliers culminated with their evolution into OEMs and, in some cases, into Original Design (ODMs) or even Original Brand Manufacturers (OBMs).

Italians firms were among the last who outsourced the entire production of bike frames to Asia. At the beginning there were problems in meeting the production standards, but now Italian company simply send to suppliers the new product specifications and wait for the new frames to be delivered to their headquarters. As a result of this process, historical Western, coordinating suppliers through a *modular governance model*, have limited control over global operations. The high codificability of bicycle production processes and the fast-growing capabilities of foreign suppliers created the premises for the use of two coordination mechanisms that are marked by a low level of explicit coordination. (Buciuni and Pisano, 2021)[32]

The shaping of the new bicycle Global Value Chain structure was coupled by a change in the innovation strategy of Western leader firms, which in the end lead the way for the development of a new product innovation pattern. Traditionally, Western firms generate innovation inside the company or through tight cooperation with local suppliers due to the co-location of pre-production, *design*, and manufacturing activities. However, because innovation in this type of production is process-embedded, changes in the geography of production triggered the shift of innovation capabilities from lead firms to their suppliers.

Figure 21. GVC Structure and Innovation Cycle in the Globally Distributed Innovation Model.



Source: Buciuni and Pisano, 2021

As shown in Figure 21, by off shoring the production of carbon-fibre bicycle frames to Taiwanese dealers, Western brands also ended up delegating most of the product development offshore. Buciuni and Pisano argue that this new innovation strategy seems to be the result of the new GVC structure, rather than its cause: what is produced at the firm's headquarters in Europe or in USA is a mere 3D prototype of the new frame. From that moment of the chain on, the entire process of product development is undertaken by suppliers, for example if western brands want to change the shape of a

frame, they need to talk to their contractors because they really know the process inside out. As far as lead firms' innovation capabilities are concerned, we can observe that they keep performing the very first phases of product innovation and post-production activities, especially design, marketing and distribution, while they depend entirely on foreign producers for the product development and the production.

Like production, also innovation is divided into distinct blocks, which are distributed globally and delegated to independent actors. Lead firms orchestrate both production and the innovation cycle through loose relationships, which not often imply explicit forms of coordination. Over time, this specific GVC structure has allowed Taiwanese producers to initiate a learning by supplying process (Alcacer & Oxley, 2014)[54], which led firms like the Taiwanese Merida to improve their production and innovation skills, eventually establishing their brand in the final market, Merida is now a well now brand being also a technical sponsor for UCI World Tour teams. Since innovation capabilities seem to be shifting to Asia, a key source of competitive advantage for Western lead firms lies in their brand reputation and design skills.

4.2.1 The Pinarello's case

Pinarello is among the world leaders and recognized innovator in the development of professional and racing cycle technology. The reference market is represented by final consumers and the main world retailers of road and racing bicycles Thanks to constant attention to innovation and technological and process development, factors that have always been the basis of the Pinarello group philosophy, the brand enjoys a consolidated international recognition in the study, design and production of high performance racing cycles, with a complete range of products (racing, time trial, triathlon, track, cross, electric, city and kids), with a high degree of customization of the models.

The strengths of Cicli Pinarello, according to consolidated financial statements, are represented by:

- a diversified client base, both Italian and foreign, who offer good guarantees of solvency and punctuality in payments;
- a good financial and asset balance;

- a good operating margin, achieved thanks to the experience and knowledge of the business by the management;
- innovative capacity and constant development of the product range;
- a high communication process, also thanks to the support and sponsorship of the main professional teams.

If we look at the first half-yearly balance sheet 2019 of Cicli Pinarello srl, the Italian market covers 20.6% of the company's turnover, while on the foreign front, 34.4% is destined for the European Union and 46% for extra markets EU. The percentage remained more or less the same also in the first semester of the 2020, but the total revenues went from € 61.993.990 at 30.06.2019 to € 46.440.109 in the same period of the 2020.

The story of Pinarello's firm is linked, as many Italian successful companies, with the history of its founder Giovanni Pinarello, born in Catena di Villorba in 1922 during a difficult post-war period in Italy. His love for two wheels led him to pursue a career in cycling during the era of *ciclismo Eroico* (Heroic cycling), when Coppi, Bartali, Bobet competed on white roads. The young Nani attracted attention, winning over 60 races in the Dilettanti circuit becoming a pro in 1946. Nani gained popularity in 1951 thanks to its *Maglia Nera*, which at that time was reserved to the last rider of the general ranking of the *Giro d'Italia,* and that is the beginning of the story of Pianarello. Giving up racing in 1952 leaving his place to another rider, his team compensated him with 100.000 lire, an significant amount of money for that time, allowing him to fulfill his dream and opening in 1953 a small workshop: It is the beginning of Cicli Pinarello.

In 1961 started a full artisanal production in a warehouse near Villorba and the first victories began to arrive culminated with the consecration in 1975: the first victory of the Giro d'Italia definitively launched the brand. In 1988 comes the first victory at the Tour de France and Cicli Pinarello begins to become an important brand. It is no longer the small workshop: the great turning point coincides with the coupled Pianarello-Hidurain that will dictate the law in cycling for years.

Giovanni slowly leaves his place to his son Fausto, who, in 90s, forges alliances with apparently secondary teams, Telekom and Fassa Baortolo, which then gradually turn out to be extraordinary, thanks to champions who would bring the Pinarello brand into the firmament of cycling. Particularly from the alliance with the Fassa Bortolo comes the

Dogma, a bike in magnesium which becomes a reference point for the excellence of the time. From now on the story of Pianarello is full of success and perfect and technologically advanced but also beautiful models: 15 Tour de France, 4 Giro d'Italia, Goad Olympic medals and World Championships both on road races and trak, moreover Pianerello's bikes are awarded several times with *Best Bike of the World* and with *London Design Award (Dogma F10),* and they are known as synonymous with innovation and design: Dogma 60.1 was the first asymmetric bicycle and DogmaK10S Disk is the first road bicycle with intelligent suspensions.

The professional bicycle according to Buciuni and Pisano classification has a Globally Distributed Innovation which reflects the modular architecture of the GVC. The GVC wherein lead firms generate this type of innovation is organized in dispersed globally modules and performed by independent subcontractors; moreover, due to mature product architectures and suppliers' high production capabilities, lead firms competing in the final market have in general a low degree of control over operations, even if Pianarello's managers fly every 20 days in order to control the production. As we pointed out before, pre-production activities like R&D and design are performed directly by Pinarello, in its headquarter, as also the production of first prototypes, while the production of mock-ups and frames final prototypes are delegated to the same Asian producers which are responsible for global manufacturing too, then the frames arrive in the Treviso area and are checked, bored, milled, painted. All by hand, one by one. Pinarello, as a lead firm, coordinate both GVC operations and innovation activities through loose relationships, a typical characteristic of the modular type of governance (Gereffi et al., 2005)[5].

Generally speaking, both the GVC structure and innovation development in bicycle industry are fragmented and geographically dispersed, with lead firms focusing on pre and post-production activities and originating new product development through the generation of novel design and thanks to investment in R&D. Today Pinarello produces in the East, in Taiwan, and it could not be otherwise, as said Fausto Pinarello in a interview for BDG-MAG.com, because certain technology and quality on certain volumes are possible only there. An example can be the use of *Toray carbon*, the best on the market, which only some Taiwanese specialized factories are authorized by *Toray* to process it. In 2017, was finalized the agreement between Pinarello and L Catterton, the

largest global consumer-focused private equity fund, which enters the capital of Pinarello Holding in an operation aimed at the international development of the Treviso-based company.

When innovation is *process-embedded* (Pisano and Shih, 2012b)[33], then we can expect innovation capabilities to follow the geography of value chain stages and to move over time from lead firms to their global suppliers. This specific mechanism has supported the transfer of knowledge from developed to developing economies, hence supporting the upgrading trajectories of global suppliers. (Buciuni and Pisano, 2021)[32]

4.3 The Veneto's saddle district: Italian brands successfully leading the market

The saddle is a component that is often considered second-rate, chosen based on mere aesthetic and taste considerations. Being one of the five points of contact that the cyclist has with his vehicle, it goes without saying that on the contrary it is an aspect that deserves attention, since finding the right saddle is not easy for us and it is a process that requires experience, hours on the bike and a minimum of anatomical knowledge. Contrary to what is commonly believed, the saddle does not support the entire weight of the cyclist but only a part, unlike what happens on a motorcycle. In fact, the cyclist's weight is partly unloaded on the saddle while the rest, based on the position assumed, is supported by the legs and arms: the position of the saddle relative to the rest of the bike, its height and its setback, affect the cyclist's posture, pedalling efficiency and general fatigue.

Bicycles have not always had saddles. The first prototypes, such as the *draisine*, the *celeriferous* or the *velocipede*, were moved by the muscular strength of the driver who acted directly on the ground with his feet. The upright posture, to ensure maximum thrust, did not require supports for the pelvis, as it would only have been an obstacle to the stride. In the second half of the 19th century a French metalworker modified the structure of the velocipede, inserting the pedal transmission. The support of the feet on the pedals therefore forced the bicycles to be equipped with a support for the driver's pelvis and thus the saddle was added, whose structure and function was exactly borrowed from those for horses. A saddle has the characteristic tapered shape. The central part is responsible for the support of the pelvis and ischial tuberosities of the

cyclist, while the beak must allow the cyclist's legs to move freely while pedalling. If we were making the exploded view of a saddle, we would be faced with three main groups: Lower guides, saddle body and coating.
In Italy there are three company which lead del global saddle sector: Selle Italia and Selle Royal. But, we can say that the global market for bicycle saddles speaks *Veneto*: Selle Italia is based in Casella d'Asolo (Treviso) while Selle Royal is located in Pozzoleone (Vicenza). Components follows in the wake the bicycle market with a massive growth that does not stop even in the face of a Covid emergency.

4.3.1 Selle Italia

The Italian market was supported in year 2020 by the so-called *bicycle bonus*, but the bicycle boom is a global phenomenon. In this scenario, Europe plays an important role: if Italy could have exceeded the threshold of two million vehicles sold in 2020, the European Confederation of the cycling industry estimates the bicycles sold last year in the Union to be over 20 million. European, with a forecast that aims to reach 25 million pieces in 2025. An exponential growth in consumption that goes hand in hand with that of production, where Italy has always played a leading role regarding components, in particular for a specific sector such as that of saddles where the national industry has a world leader. In the wake of the market explosion, Selle Italia has announced to increase its business with a 40% increase in turnover corresponding to a 50% increase in production volumes: "And in light of the difficulties that some bicycle manufacturers will have during the of 2021 in the procurement of accessories from Eastern markets, returning to an entirely Italian supply chain will be the key to success in the coming years" comments Giuseppe Bigolin, president and patron of the historic company from Asolo, in a interview for IlSole24ore. The success of the Italian brand also passes through continuous innovation such as that of Green-Tech, a highly sustainable production process that allows for products with a low environmental impact that are combined with a reduction in processing times and with competitive costs. Green-Tech technology allows Selle Italia to optimize the production process, bringing it closer to those of an industrial scale, and to develop products capable of responding to the demands of both the OEM market. The Asolo-based company is a supplier of numerous brands such as

Canyon, Ktm, Wilier-Triestina, as well as of the *After Market* network which allows passionate cyclists to purchase a 100% Made in Italy and environmentally sustainable quality product for their bike. A saddle made entirely of recyclable materials and built entirely in Italy through a new production process with revolutionary characteristics for the cycling sector, which will allow the production of a range of products by means of an automated, robotic and technologically very advanced production system, but above all eco-friendly and sustainable.

In 2016, Selle Italia has acquired the majority of Selle San Marco, a well-known company based in Rossano Veneto (Vicenza) and the new the group is worth half of the world market for high-end saddles for cycling professionals, with a tour of business of 30 million euros in 2016. Two historic brands of the Veneto bicycle district, which make *Italian know-how* the distinctive feature for an overall export that exceeds 85%. The partnership announced between Selle Italia and Selle San Marco aims to support the strengths of both: design, research, the introduction of elements of science in the study of products. The two companies operate on the same market, but with specificities that give rise to widely complementary production.

Selle Italia, 120 years of history behind it, founded at the end of the nineteenth century in Corsico, just outside Milan, when the car was a luxury for the few, and then successfully taken over by the Venetian family in the seventies. It is the leading company in the production of top-of-the-range saddles reserved for professionals; in fact, it produces innovative,and *Made in Italy* saddles capable of guaranteeing the highest level of performance on the market. The agreement brought two of the most long-lived and well-known brands in the history of Italian cycling to exploit important industrial synergies. The strategic plan of the new management consolidated the Selle San Marco brand and, consequently, its progressive growth on all global markets. The two brands continued to operate autonomously, but the collaboration opened advantage in particular to R&D and the Supply Chain.

Selle Italia, however, also means a company well rooted in the Veneto area in which it has resided since the 1970s, originally, in 1897, the headquarters were in Corsico, just outside Milan, and still firmly in the hands of the Bigolin family, unlike many other realities of Italian cycling that have ended up yielding to the sirens of investment funds and private equity. however, there are no foreclosures on the entry of any external

capital, according to the ownership (IlSole24ore, October 2020), provided, however, that these give adequate development plans and that allow Selle Italia to make a further leap in quality on international markets.

4.3.2 Selle Royal

Selle Royal Spa was founded in 1956 by Riccardo Bigolin in Pozzoleone (Vicenza) and during 80's and 90's has become a leading firm in the OEM market and AM as well. The saddles produced by the Italian brand have won many design awards and are exanimated in bioengineering research laboratories in many European universities. Present in over 70 countries around the world, Selle Royal is one of the world's largest manufacturer of bicycle saddles. Selle Royal Group holds a premium position in the marketplace with brands for each of market segment. They control 25% of the world production of bicycle saddles.

Today the group is led by Riccardo Bigolin's daughter, Barbara, who is CEO and chairman, but also a shareholder together with her two sisters. In sixty years Selle Royal has become a global company by acquiring a company in England, where it produces Brooks England leather saddles, one in the United States, one in Brazil. Finally, in 2010 it took over Justek, Chinese number one in the sector, covering the 5 continents. Among the iconic brands there are the Italian *Fi'zi:k*, created in-house, a world leader for saddles, shoes and accessories, which supplies the products to many world tour teams. The portfolio also includes the American brands *Crankbrothers*, the English *Brooks* and the Japanese *Pedal Ed*. The Selle Royal group generates 130 million euros in revenues and 14.6 million EBITDA, exports are 90% in 2029.

Acquisitions are important to company strategy in order to get global, moreover, to be competitive firms have to scale globally and rely on strong brands. As example: Brooks was the biggest producer during the 60's and 70's, but then they focalized on high quality hand-crafted saddles, which guaranteed high margins, but not enough to cover all the overheads. Selle Royal had a big attention to OEM market and a tight relationship with frame producers, delivering high quality products, in competitive lead time and in massive quantities. In order to do that, SR set up two distribution sites: one in Europe and one in Asia. The 70% of production is made in Italy, with some line like *Fi'zi:k* , which

is the high end of the company's catalogue, which are 100% made in Italy. The 80% of production is branded, while the remaining is private label. Each level of products requires technologies and staff dedicated; therefore, a global market and different locations are needed. Key factor working with OEM is the ability of SR to develop its own brand. R&D plays a pivotal role in this scheme as well as important investments in plants and machinery. An example is the joint-venture with *Bayer* forming *Technogel Srl*, to develop a gel technology which is now used in the production of anti-decubitus cushions and then imported into the saddle industry.

V. Findings and conclusions

We now present findings of our research summing up principal characteristics of the bicycle industry and the role of innovation in its architecture noticed by analysing data. Focusing on Italian established firm we discovered differences in company size and governance, as well in market targets and awareness of the dynamics of their Global Value Chains: these divergences have implications in companies' growth and innovation capabilities. Looking at North of Italy firms, we identified two opposite approaches to Global Value Chain challenge: a more proactive approach opens to adjust strategy to new scenarios; a defensive approach, directed to defend position on one market niche. Consequently, companies which utilize this second approach are less global oriented and they operate on crowded market niches where is getting hard to operate due to some firm's high marketing investments and innovation in IoT.

The bicycle industry, with a history of over a century undertook epochal changes, specifically with a turning point during the 80's: the bike evolved as something which is closer to the one that we see nowadays, in the shapes and in the mechanical features, and additionally the Mtb appeared. Italian firms did not get the importance of that revolution, in the Italian perspective, the bicycle was the road bike and none of our leading firms take up the challenge given by the Mtb understanding the demand of the market. Campagnolo's case is very significant in this sense: drivetrain was a high-end product itself, but it became required on cheaper bikes such as mountain bikes. The Italian company did not see space in the market, declined to enter this segment considering it as a passing trend and Shimano took over the leadership. The same happened for other Italian companies in different segments: such as Selle San Marco in saddles industry and frame producer like Pinarello, De Rosa and Colnago. All these big names of cycling did not realize that the market was growing, changing and opening to new customer targets. Avoiding cheaper targets and big production, remaining focused on elite targets, did not push them out of the market and cut them off from the growing segment. At that point for Italian companies became very hard to face the competition of market's big operators even if they had a strong brand recognition, also because the importance of financial possibilities was becoming a key factor for supporting the business. Only a few forward-looking firms, one example is *Selle Royal*, were able to

assess the change and to act accordingly being competitive at international scale. The competitive advantage of the Italian bicycle industry was on artisan knowhow but there were weaknesses on industrialization process and those companies, that did not move their attention internationally and are now producing only small quantities for passionate customers willing to pay a premium price for heritage and brand, struggling to compete in the market. Italian industry lost the middle market production, being unable to offer competitive prices. This is not as result just of relocation of plants, but on the contrary, probably because we were not able to source from abroad at more competitive conditions, not only in terms of price, we lost many jobs and we did not create big companies with their headquarters in Italy and a global sourcing and distribution strategy.

5.1 Elements redesigning the Bicycle Industry Architecture

Our research started from the GVC framework in order to understand dynamics, peculiarities and the complexity of the bicycle industry. While *internationalization* refers to the geographic spread of economic activities across national boundaries, *globalization* implies the functional integration and coordination of these internationally dispersed activities (Dicken, P. 2003)[55]. Bicycle industry fit the Global Value Chain Model but Italian companies during 80's did not understand the shifting and development of the market. They kept the same strategy even if the quantity requested and the features have changed. Generically, Italian firms focus on the value created internally with few or no attention to external condition. We can say that nowadays we experience a buyer-driven market (Gereffi, 1999)[17] dominated by OEMs with strong brands and by Component manufacturers that impose their standards, i.e. Shimano, thanks to the ability of understanding market progress and customer need and supplying the demand preferences. Bicycle is one of the few industries that went more modular from being integrated and a key element to succeed in the new pattern was the management of the modular production network (Sturgeon, 2002)[5]. For instance, Shimano became leader working close to first Mtb developers from USA and Taiwanese frame producers. Shimano listened to new trends and gained a first moving advantage on these segments that became dominant.

The aim of the dissertation is to highlight reasons why and how the Bicycle Industry' s GVC explaining and analysing the Industry Architecture and investigating Italian companies' reaction to the evolution of the Industry. The second intention is to describe the pattern of the industry architecture and the key elements that shape it. There were identified two main industry architectures:

- A structure which is highlighted by large production and broad product catalogue, with production in the Far East and headquarters worldwide located investing especially on innovative technology and marketing activities.
- The second structure is typical of the Italian bicycle cluster located in the Northeast and is characterized by assembling parts locally, hand-made production of high-end models, limited range of products, and family-owned companies.

Findings show that the first architecture structure is leading the market and that the other one is competitive in the high-end model. To understand if Italian approach to GVC shifting in Bicycle Industry is still competitive and which are the possible perspective we have to understand the context where company strategic decisions are taken. A company management look at the business following precise ideas and values and the Corporate Culture is identified as the values which support growth and vitality of the firm. The corporate culture plays a key role in shaping the style of business the management wants to run and the strategy is affected by those values: it is difficult to strive big production numbers if the corporate culture has as central point high quality and artisanal manufacture. Additionally, the size of the company and financial possibilities affect some decisions rather than others as well. The industry shifted from integrated to modular and many firms did not understand this change and its consequences. Jacobides and Kudina in 2013 highlight the importance of the *fit* between the industry and the company organization: industry architectures' shape success going internationally, Industry Architectures differ are not necessarily technologically determined. (Jacobides and Kudina, 2013)[56]. Italian firms did not adjust their architecture as soon as the market moved forward. Furthermore, increasing fixed costs like sponsorships and R&D investments required bigger quantities to be spread on. In this research we found out that all the big OEMs have similar Global Value Chain and have similar history, i.e. Merida and Giant both started as manufactures in OEM and

created their own brand even if they still produce components for other well-named label. OEM brand have design and engineering phases in their home countries, limited local production and large supplier or owned plants in Taiwan or China, even for high-end products. In Italy small businesses resist with local outlook but they are struggling in the mass market. Taiwan for instance is the best place for assembling, financially competitive, and over years it has proven to be reliable for high quality standards and lead time for big commissions. Components could be produced almost everywhere, but low-value added activities have to be cheap to be competitive in the market.

Nowadays costs are increasing and therefore part of production is moving again from Taiwan to Vietnam, Cambodia, Laos or Thailand. The point here is that strategic decision does not concerns only cost of production but are more general and involve the mission of the company. Here it is really important to understand the role of technology and research & development: assembling and easy manufacture can be moved quickly to place that can ensure costa advantage, the important element for a business is the quality of the strategy at the HQ. This involves not only phases such as design and engineering of the product, but also the lead time and reliability of the production in terms of time and quality, the choice of the production site and the key markets to target.

Looking at the distribution, the American model is proven to be the most successful: Flag-Stores of big brands and massive specialised retailers, where being there can be seen as a *status quo* presence, are the most profitable and they support brand growth and awareness. Brand like Trek and Specialized understood this that importance and during the last decade made heavy investments in marketing and especially in range of product very wide broad. Industrials, which are more focus on product manufacture and not on products narrative, were not able to understand new customer wishes and moreover the market was changing while the strategy was remaining the same. Italians are now no longer the only ones to do very high-end customized bicycle: Trek, a brand made in Wisconsin, is considered by operators the *best bicycle*, and it produces one million bikes per year, serving with good results both top customer and medium-low end. Similarly, Cannondale, produced in USA, continues to represent the American excellence for aluminium with the series CAAD, one of the world's most advanced aluminium road bike.

Italians are still the leaders on tube-to-tube knowhow both using steel and carbon, but with high costs and the impracticality to strive for massive productions: ironically large orders are a problem for most of Italian high-end brands. Tube-to-tube technology allow to create frame with pinpoint accuracy, in order to perfectly fit the customer's body measurements. It is a technique which generically welding tubes manually in order to produce the frame, even if nowadays 3D modelling help in simulating road performance, aerodynamic penetration and resistance to impact. To give an example concerning the lead time and reliability of the production in terms of time and quality, a De Rosa titanium bike has a lead time of 11 months. The Germans had never had strong cycling tradition, but, thanks to massive investments, and their excellence in mechanical engineering, they have been the first European manufacturer of bicycle frames for years. Italian bicycle industry lost middle production due to the lack of scale economies proving that competitive advantage, i.e. Italian knowhow, is not stable if there is not innovation and awareness of business.

Of course, there are exception, for example, for example Campagnolo: which has always been in the bicycle industry at global level, but with Italian mentality. They still have important market share in the United States and Japan, state were SRAM and Shimano are local brands, since the 60's but always thinking as an Italian company. The location in Vicenza was important in the past, when the cluster in Veneto was really crowded, but today, thanks to globalization and the global size of the markets, it is not anymore in order to support the business. Campagnolo does not collaborate a lot with universities or frame manufacturers from its region, like did in the past. Nowadays the "*Italian brand*" is exploited in marketing and heritage and not for the cluster network. This means also a delay in understanding market trends: for instance, Campagnolo has launched lately, i.e. in 2016, components and wheels for disc-brake, when were standard required by consumers, while disk brakes were firstly induced ate the Eurobike 2012 by the Italian Colnago with the C59. Similarly happens in the off-road world with Fulcrum Wheels brand: the market has moved from 26'' to 29'' in early 2000 and in 2014 it is moving again towards the 27.5'' standard.

Todays it is clear that it is necessary to locate a important part of the production in East Asia for logistics reasons - for example shipment needs 45 days from Taiwan to Italy- and obviously for costs and technologies. Nevertheless, it is worth keeping the

headquarters in Italy because of the culture regarding the bicycle and the engineering technology. The first to understand this was Pinarello, as we mentioned, that went to produce in Taiwan 15 years ago, managing to make the leap from being a local manufacturer to compete in global high-end niche thanks to a revolutionary product lines such as Dogma. This proves that they were able to evolve their strategy even though they were already successful locally. Pinarello, to support its growth, is part of the Catterton Partners, highlighting the global size of the bicycle sector. The other Italian bicycle firms that has managed to become a global company is Bianchi thanks to an international management: the ownership is Swedish with the group Cycleurope AB and the mass production has been moved to Taiwan while in Italy in Treviglio remains only the very high range assembling.

5.2 The global size of the industry

The bicycle industry as we know today is the result of a internationalization process, which is occurred in several levels, from raw material procurement to distribution. The relocation of production is not a negative thing especially if Italy is no longer a country of pure manufacturing due to poor policy makers' industrial vision. Italy missed the right time to invest on industrial upgrade, and the Italian frame manufacturers were and still are dimensionally too small and disaggregated in order to be global players: they are not big enough to compete by themselves in the market and move back the production from Taiwan or China. Taiwanese production has always been technologically ahead of Italians as well as in production capacity. Taiwanese manufactures have been able to guarantee quality production of sizable quantities.

Most Important brands strategy is to keep their HQ in home-countries, investing in R&D, designing, prototyping and testing locally but running large amounts of outsourced manufacturing in east Asia. The key point comes with marketing and advertising investments, which are becoming over years decisive factors.

Instead of looking at the progressing of the market and look at who are the new entrants, their evolution and growth, Italians brands have always thought they were untouchable, *too good to change*. They have not been able to understand that for a global market a global product was needed: designed and studied in Italy, prototyped,

tested and then produced in Taiwan. The Made in Italy does not add great value also looking at the medium-hight market. A good example of successful company strategy in Italy is Selle Royal with its acquisitions and its large production strategy: It is one of the few companies that produces for private labelling, enabling Selle Royal to increase their production, to reduce fixed costs increasing economies of scale and therefore they have the financial assets to buy plants and brands, to sponsor Pro Tour team and expand the company. In saddle production there is not particular difference for road and off-road products but there is big difference between low products and high-end ones: there is more technology in comparison to other bike components and when assembling high-end products there is still an high percentage of manual labour.

Also, distribution, like we have seen for down-stream stages of the *Value Chain*, presented different change over years but, similarly to production, it seeks the need of more specialization. Sales assistants must provide service and experience to add value to clients, not just offer technical support. Evolution in consumer preferences is moving sales from small family-owned stores to bigger retailers, which can offer wide catalogue of products and more competitive prices. Digital revolution is not seen as a threat even if this is a sensitive topic for independent retailers, thanks to the high importance that the seller as a person has on the seller perspective of the product, nowadays sales experience is more important than the product itself, the challenge for retailers should be to raise the quality of service and management.

The Italian concept of bicycle is far from the North European one: it is seen as sport and leisure gear rather than a means of transport. Additionally, in 2019 Italy has one of the highest ratio car/inhabitants in Europe with 655 passenger cars per 1.000 inhabitants, and the lowest for bicycle, while the European average is 569/1.000 (*Acea Vehicles In Use Report – January 2021*). Italian distribution channel should change its approach, as already some Italian sector already did, examples are furniture, fashion and clothing. The artisan knowhow and customer's experience are no longer enough, something more is required because the competition got tougher and hand-crafted products are only a niche market. In the distribution system, the independent retailer is the weak point of the chain. The idea is to involve all the operators: producers and retailers, where pricing policy is transparent in a way that ensures a return for the entire channel. In this way the added value is not only on the product but also on the distribution and the dded

value should be understandable easily by the customer. The Italian heritage and brand name are not enough characteristics to stay competitively in markets. Numerous firms are looking for partners, investors, funds of private equity. US firms have implemented massive investments years ago and they are paying off. For example, we can look at cases of Dorel for Cannondale and Merida for Specialized

5.3 The role of Innovation in Bicycle Industry Architecture

The topic of innovation is crucial in order to understand evolutive dynamics within sectors, economic globalisation has increased during the past years and consequently, economic activities, technology and knowledge are transferred across national borders. Following the international fragmentation of production, products are nowadays manufactured and traded in international production networks. Having in mind that lead firms represents one of the numerous actors involved in GVC, and that innovation is generally the outcome of a process which involves several firms in multiple location (Pisano and Teece, 2007)[31], strategic decisions and performance, taken by global champions, remain a key driver in the formation and evaluation of GVC. Nowadays, we assist to a transfer of intangible activities and knowledge, not only production, which is something that is rapidly changing the geography of innovation (Baldwin, 2016)[14], understanding the structure of the chain of value will help us to answer to today's global economic scenario's challenges.

The bicycle sector is an example of how contractors from developing economies can replace innovation over time. *Globally Fragmented Value Chain* occurs when lead firms have little or no control over global operations because of the low complexity of the production acknowledgment. Normally, leading brands competing in this niche market are Italian and American firms like Pinarello or Specialized, but thanks to a *learning by supplying* process, Taiwanese suppliers like Merida or Giant moved from being suppliers to OEMs, ODMs, and eventually OBMs. Indeed, most of occidental firms started outsourcing production offshore in the late 90s when carbon fibre was introduced, opening the competition to developing countries which firms started to design and market their own bikes competing against Western brands.

As we seen, innovation can occur also inside some leading firms, and Campagnolo, Pinarello and Selle Royal are clear example of successful Italian brand, leading their market sector, and innovating inside the company. Campagnolo has innovative shifting systems, the *Campagnolo EPS*, is a shifting system that use electrical circuits managed by an electronic control unit, *Digital Tech Intelligence*, meaning that there are no more steel cables that connect the control levers to the front and rear derailleurs. In Pianerello's case we have seen that pre-production activities like R&D and design are performed directly by Pinarello, in its headquarter, as also the production of first prototypes, while the production of mock-ups and frames final prototypes are delegated to the same Asian producers which are responsible for global manufacturing too, then the frames arrive in the Treviso area and are checked, bored, milled, painted. Pinarello, as a lead firm, coordinate both GVC operations and innovation activities through loose relationships. Selle Royal prove that acquisition or join venture an add value inside the company, through the acquisition of knowhow and technology, and consequently being innovating while continuing to produce and create in Italy. The joint venture with *Bayer*, which established *Technogel Srl*, developed a gel technology which is firstly used in the production of anti-decubitus cushions and then imported into the saddle industry.

5.4 Technological frontiers and product innovation

The modular product architecture of the bicycle helped facilitate the co-opting of technical knowledge prevalent in other industries by allowing entrepreneurs to focus their product development and subsequent commercialisation activities at the component level of the product artefact. (Galvin, 2020)[57]. The industry in the last decades received many trend both from inside and outside the sector. Additive manufacturing, new materials, IoT data driven and the use of artificial Intelligence are some of them.

5.4.1 Additive manufacturing and 3-D technologies

Additive manufacturing is starting to play an important role in sports equipment, especially if it allows to design custom-made equipment, adapting products to the

structure of each athlete, offering better performance as well of increasing comfort. In cycling industry the aim is to imagine a bike that is lighter, faster, more comfortable, while reducing manufacturing time and costs. At the moment, there is no such thing as a bike 3D printed in its whole, but there are certain components, such as the saddle, frame or pedals, which are made using 3-D technology.

Specialized, in a recent collaboration with Carbon, a 3D printer manufacturer, redesigned the saddle, which it considers one of the most important parts of a bike's architecture: the challenge is designing a saddle which maximize rider performance and at the same time offer comfort and stability. Using Carbon's knowledge, called *Carbon Digital Light Synthesis technology*, the company substituted the traditional foam with an intricate elastomeric lattice structure, which allows riders to rebound quickly, disperse pressure and improve breathability.

Kinazo, a Slovak company, prototyped in 2017 the *Kinazo e1* in aluminium, a 3D printed electric bike, thanks to a partnership with the automotive manufacturer Volkswagen. Kinazo e1 has a battery integrated in the frame and the electronics are controlled through a mobile application, 3D printing allowed the customization and also that the frame is shaped in one piece. Urwahn Bikes, a German bike manufacturer, developed a 3D printed frame for racing bike in partnership with Schmolke Carbon, which is specialized in the fabrication of carbon fiber bike parts.

The use of additive manufacture, 3-D technologies is being used more and more in bicycle industry, even if slowly, especially to overcome design and time constraint as well as high costs, particularly in research and development phases: Through a series of techniques, 3D scanning, developing detailed CAD models and after over additive manufacturing processes, a virtual and physical prototype can be developed. Additionally, an endemic challenge of the industry is the constant geometrical revolution of components: bike cranks are becoming narrower due to biomechanical influences and tyres are becoming wider, i.e. the gravel phenomena. The solution can be the addition of additive manufactured part, which has the advantage of being replaced into the process without disrupting the conventional process.

Customisation is not a new concept to the bicycle industry: it refers to the adjustment of a bicycle's geometry to fit the anthropometry and biomechanics of the rider, in the three contact points between rider and bicycle: hands-handlebar, feet-pedal and seat-

saddle. As mentioned above, also with example, thanks to additive manufacturing, customisation can be a process that no longer occurs after manufacture. Indeed, customization can be integrated in early phase, i.e. design, without negatively affecting manufacturing times or cost. Moreover, the use of additive manufacture and big data help designers to select dimensions of the frame and adjusting it using CAD and Solidworks, and the software re-design the frame automatically, updating it due to parametric capabilities. This is a game changer in a sector where, traditionally, if something change, all the other elements should be manually re-modelled.

Customization, data-driven design and complexity are signal of a move from a standardize mass production towards a new era, driven by end-users, which are more and more part of the decision-making process. Customer's preference and desire of personalized products are opportunities, especially for Italian brand, if they prove to be able to develop *IoT* within their craft-making know how.

5.4.2 Augmented Reality in Marketing phase

By definition, *Augmented Reality* is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, thanks to a multiple sensory modality: visual, auditory, haptic, somatosensory and olfactory. (Schueffel Patrick, The Concise Fintech Compendium, Fribourg, Switzerland, 2017). The system should have these three basic characteristics: a blend of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects.

Today's bicycle industry is very competitive, with the big companies dominating the market by leveraging the newest materials and knowledges in order to produce products that meet the ever-changing customer demands. As these innovations come to market, the competition becomes harder and therefore the need for differentiator becomes pressing. Cannondale decided to use Augmented Reality solution for a triple reason: drive the marketing needs of the company; provide critical product design and technical guidance to shop and seller, in order to improve the customer experience; and deepen engagement with end-users. Usually, bicycle are sold through independent retailers, few brand has shops, and are generally near the factory or HQ and not spread

around the world. Consequently, local shops must have a certain industry knowledge and a relevant knowledge of how a particular bike is manufactured and which replacement is needed, therefore, shop's owner are not interested to push a particular brand. Cannondale realized that can create a bad perception on the brand and a uncomfortable customer experience.

The American company began to research innovative solutions so fill this space and diversified the Cannondale' customer experience from buying other brands. The solution found AR as the tool that could drive the marketing challenges of the company. The Cannondale designer was already using PTC's Creo CAD to project their bikes and developed it in order to animate instructions using Vuforia Studio. The AR application, which is availed also for products owner that already purchased the bicycle, is a unique tool in the market, allowing consumers to streamline the repair process. Independent retailer can have more insights on the product and can be more prepared on the repairing phase, with quick access to relevant information, while end users can be more educated at the time of the purchase: the shop can scan the *VuMark* of a Cannondale bike and show to the customer what will be the final result of a bike as well as the feature the bike offer.

5.4.3 Leveraging inter-industry spillovers

The modularity of the bicycle as a product and of the bicycle industry architecture make easy the exchange of technical knowledge widespread in other industries by allowing brands to focus their product development and subsequent commercialisation activities. An example previously presented in this research is the case of Technogel: mixed-knowhow between a pharmaceutical company, i.e. Bayer, and a Saddle firms, i.e. Selle Royal, resulting in a technology primarily used in anti-decubitus cushions and then imported into the saddle industry.

The global bicycle industry presents very high levels of innovation, performance-related driven, at the product level and in respect of many of the processes used in the development of components (Galvin, 2020) [57] . As an industry that services a competitive sport in which small improvements can represent the difference between winning and losing, there is a constant demand from the very high end of the market for innovative

components that drive performance outcomes. Over time, many of these innovations diffuse through the industry to the mass-market (H.D. Yan, M.C. Hu, 2008)[58].

Historically, the industry has grown based on smaller specialised firms, which started to develop, during the '60s and '70s, a range of components to sell to frame-makers. These components mast be able to *mix and match* with as many frame as possible and so the industry started to shift towards a range of industry standards to connect components together (Dowell, 2006)[59]. Today the bicycle has a modular architecture with components linked together via a limited number of widely-dispersed industry standards (Galvin, 2020)[57]. Since single firm are not able to manufacture an entire bicycle, the sector is populated by specialised firms located around the world.

Many innovations relating to hubs and wheels are developed by incumbent firms: the use of new materials, i.e. titanium and carbon fibre, in the hubs often emerged from firms with significant experience and competencies in this field, also small size but really high specialized, using a traditional R&D process with incremental innovation. Zipp is an American company founded by Leight Saergent, a former employee for Williams F1 team. during the F1 experience he specialized and worked with fibreglass and started to experiment with carbon fibre. He use its technical knowledge relating to carbon fibre construction to design a carbon fibre disc wheel. Commercialising the product under the name of Zipp, today the company is one of the largest firms producing carbon fibre discs and other aerodynamic wheels (Galvin, 2020)[57]

5.4.4 Two-wheeled Artificial Intelligence

Many bicycle innovations originate from the automotive world, and so it was also for the idea of applying abs brakes to two wheels. The idea take is birth because of the spread of e-bikes, which going at 25 km / h, and safety problems related. Blubrake, a company founded in Italy by Fabio Todeschini, had the intuition to adapt at the bicycle a control system which can prevent the locking in conditions of low grip and overturning in sudden panic braking. the problem is rather complex for the bicycle, the braking system is smaller and is therefore subjected to very high pressures. the ABS system for bicycles is able to control the pressure in the brake system. the system consists of a

hydraulic actuator, advanced sensors and an electronic control unit, all integrated within the frame.

HiRide, founded in 2017, focus on the suspension compartment. The road bike is not always equipped with suspensions, which improve its stability. HiRide proposes an AI-based solution. The intelligent electronic system makes it possible to balance the stiffness of the suspension to maximize the propulsion of energy, minimizing its dispersion, through a control unit integrated into the frame. Pinarello adopted it in his K10S model, also using it in the cobblestones of the Paris-Roubaix 2019.

5.5 Italian industry perspective

Italian brands are frequently seen as the ultimate representation of bicycle aspirations, an Italian bike is commonly seen as the dream's bike for riders worldwide. In contrast, products from Taiwan are suggested as affordable step to something better. But despite powerful brand narratives, all famous Italian brands have turned to Taiwan or east Asia for production purposes. The premium attention and premium prices of Italian brands can be justified based on three pillars: craftmanship, pro cycle custodianship and *Italianess*.

Italy's proud tradition in manufacturing is a powerful, tangible, asset. To be *Made In Italy*, according to Italy's official Tourism office, is to *symbolize the excellence of Italian artisanship and manufacturing. Italian products bearing the prestigious Made in Italy title are highly-coveted the world over – for their integrity and durability, design originality and creativity*. A sense of exclusiveness also boosts the appeal of Italian road bikes, which usually has the Italian flag, the "*Tricolore",* and the words *Prodotto Italiano*. It is more appealing a road bike bearing *Made in Italy* mark than one made in Asia, to be precise, legally both elements only mean products have undergone *substantial transformation* in Italy for instance, but usually elements are designed and assembled in Italy, while produced in east Asia countries.

Names like Bianchi, Bottecchia, Colnago, De Rosa, Moser, Pinarello and Wilier have all attention to sports marketing., enjoying visibility of World Tour races. Visibility of Italian brands in pro cycling topped in 2002 at the 89th Tour de France, the most seen event around the World; of the 21 teams that participated, nine were supplied by Italian firms:

Pinarello sponsored three teams, Colnago and De Rosa two teams while Fondriest and Carrera one; all off the teams have HQ in the North-East district, between Lombardia and Veneto.

Italian firms can enjoy the *Italian brand,* meaning the knowhow of the country, which influence the perception of customers on products: indeed, they are prepared or even they expect to pay more for a given product particularly in a luxury segment like high-end road bikes. History, style, passion and creativity are some of the values associated with Italy that have been successfully translated into highly desirable objects for centuries. History, style, passion and creativity are examples of values associated with Italy and then translated into highly desirable objects for centuries.

Until the final decade of the 20th century the premium road bike segment was owned by Italian brand, but things started to appear vulnerable when Taiwanese companies started investing in sports marketing: Giant entered in the Euro-centric pro cycling bubble in 1997 with its sponsorship of the Spanish team ONCE, while the previous year the American brand Cannondale and Italy's Saeco team agreed for a deal worth half-million dollar.

The process started when American brands offshoring production of *entry-level* road bikes to Taiwanese manufacturers. Giant, Hodaka, which is partially owned by Giant, Ideal and Merida were the main beneficiaries of this transfer of production, thanks to their experience in aluminium. To capitalise that situation, Taiwan's two biggest bicycle manufacturers, Giant and Merida, along with 11 other parts suppliers established the *A-Team* in 2002, to ensure Taiwan would maintain its status as the preferred destination for *innovation value.*

Italian brand tried to survive to the Asian wave, leveraging their prestige and resisting to offshore the production, even if the products were expensive and the Italian economy had been stagnant. Colnago was the first to move, at least publicly. On 25 February 2005, Colnago issued a press release announcing that Colnago choose dual sourcing strategy to serve global markets: all high-end Colnago bicycles continued to be Made in Italy while mid-range bicycles started to be produced in Taiwan from. In Italy, and in Europe it was no longer feasible to cost-effectively manufacture mid and low-end bicycles and being competitive in the market. Colnago was the first Italian brand who has officially decided to move part of the production to Taiwan.

In less than two decades, two of the three important pillars of Italian bicycle manufacturing had had surrendered at the Asian's *avance*: Bianchi, is a long-time client of Giant and Hodaka, and so did Pinarello. For those brands, it seems only Italianness remains, and as Merida's VP William Jeng stated: "*It is just a perception, a romantic nostalgia"*, the reality is that the brands may be Italian, the vast majority of product is Far Eastern.

For now, only success stories are coming from Taiwan. Recent market reports from ANCMA 2020 showed that road bikes still accounted for 6% of the totality of bicycles sold in Italy in 2019, but imports from Taiwan have risen: Italy had become a major potential market for the Taiwan bicycle industry. Keith Bontrager coined the phrase "Strong, light, cheap. Pick two" in the early 1990's – ironically, when over-engineered (heavy) Italian bicycles were still apex products.

The road bike market has changed significantly in the past three decades and most of the growth now it is accountable to Taiwanese producers. Although, opportunities still remain for legacy Italian road bike brands, it seems this depends on how far they have drifted from their heritage and whether or not they can regain an authentic original narrative. It might not be easy for the once-dominant Italians to take on Taiwanese manufacturers, but perhaps they can start by revisiting the three pillars, craftmanship made in Italy, pro cycle custodianship and *Italianess*, and pick two.

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