Lisbon School of Economics & Management
Universidade de Lisboa

MASTER

MANAGEMENT AND INDUSTRIAL STRATEGY

MASTER´S FINAL WORK

DISSERTATION

UNDERSTANDING KNOWLEDGE ABSORPTION AND APPLICATION IN THE INTERNATIONALIZATION OF CHINESE COMPANIES: MULTIPLE CASE STUDIES IN THE BICYCLE INDUSTRY

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SUPERVISION: NUNO FERNANDES CRESPO

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Abstract

The global bicycle industry is undergoing a rapid transformation, marked by intense international competition, cost pressures, and a growing demand for differentiated products. Thus, Chinese manufacturers shift from traditional OEM roles toward more value-added functions within Global value chains (GVCs).

This study examines how Chinese bicycle companies enhance their roles in Global Value Chains (GVCs) by developing and utilizing Absorptive Capacity (ACAP). Based on the multi-case study method, this paper provides a deep analysis of the evolution paths of three Chinese bicycle enterprises: Elitewheels, Tavelo, and Boostor, which have transitioned from OEM suppliers to more innovative and autonomous manufacturers. Based on GVCs governance structure theory and the ACAP framework proposed by Zahra & George (2002), this paper systematically analyzes how enterprises acquire, assimilate, transform, and apply external knowledge to achieve capability upgrading and value enhancement.

This study enriches the understanding of the growth mechanism of developing manufacturing firms in GVCs and reveals the interaction between GVCs governance structure and absorptive capacity. It also provides a strategic reference for other enterprises in labor-intensive industries, emphasizing that participation in the global market is not only a manufacturing opportunity but also a starting point for capacity building and knowledge innovation.

Keywords: Absorptive Capacity, Global Value Chains, Functional Upgrading, Chinese Bicycle Industry, OEM to OBM Transition

Resumo

A indústria global de bicicletas está passando por uma rápida transformação, marcada por intensa competição internacional, pressões de custos e uma crescente demanda por produtos diferenciados. Assim, os fabricantes chineses estão migrando de papéis tradicionais de OEM para funções de maior valor agregado dentro das cadeias de valor globais (GVCs).

Este estudo examina como empresas chinesas de bicicletas aprimoram seus papéis nas Cadeias de Valor Globais (GVCs) por meio do desenvolvimento e utilização da Capacidade Absorptiva (ACAP). Baseado no método de estudo de múltiplos casos, este artigo apresenta uma análise aprofundada dos percursos evolutivos de três empresas chinesas de bicicletas: Elitewheels, Tavelo e Boostor, que fizeram a transição de fornecedores OEM para fabricantes mais inovadores e autônomos. Com base na teoria da estrutura de governança da GVCs e no framework de ACAP proposto por Zahra & George (2002), este artigo analisa sistematicamente como as empresas adquirem, assimilam, transformam e aplicam conhecimento externo para alcançar a atualização de capacidades e o aumento de valor.

Este estudo enriquece a compreensão do mecanismo de crescimento de empresas manufatureiras em desenvolvimento em GVCs e revela a interação entre a estrutura de governança da GVCs e a capacidade de absorção. Também fornece uma referência estratégica para outras empresas em indústrias intensivas em mão de obra, enfatizando que a participação no mercado global não é apenas uma oportunidade de manufatura, mas também um ponto de partida para a construção de capacidades e inovação do conhecimento.

Palavras-chave: Capacidade de Absorção, Cadeias Globais de Valor, Upgrading Funcional, Indústria Chinesa de Bicicletas, Transição de OEM para OBM

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1 Introduction

High-end, technologically advanced bikes are lighter and stiffer, but this premium experience often comes at a steep price. Even entry-level carbon bikes may start at around 2,000 euros. However, for the past two decades, nearly two-thirds of these products have been made in Chinese factories, including luxury high-end models (Norcliffe & Gao, 2022). These manufacturers produce the bike frames, assemble the complete bikes, apply the brand labels, and prepare them for export. After the bikes travel around the world, the finished products finally reach consumers' hands.

Historically, Chinese bicycle companies have played an active role on the global stage through original equipment manufacturing (OEM). According to the China Bicycle Association's research (2021), from January to June, China exported 35.536 million bicycles, representing a 51.5% annual increase. The export value was US$2.426 billion, an annual increase of 81.9%. Following the global pandemic, these companies have gained greater international visibility and begun developing their own brands. Many have established their own bicycle brands, leveraging improved manufacturing capacity and access to the supply chain. The report by China Insight and Info (2024) suggested that, as of May 7, 2024, the number of registered enterprises in the Chinese bicycle industry exceeded 4 million. And 10.999 million bikes were exported in the first quarter of 2024. China's bicycle sector has demonstrated remarkable growth, making it a compelling subject for study.

The massive export volumes of Chinese bicycle companies reflect the outstanding internationalization of Chinese brands over the past few decades, which has contributed significantly to the country's tremendous economic growth and positioning China as one of the key phenomena in the global economy (Casanova et al., 2024). Gaining from low labor cost and a highly efficient local value chain, lower price has once become the label of made-in-China products, and Chinese companies are also willing to maintain

this strategy in their internationalization. Nowadays, Chinese firms also emphasize the importance of R&D, pursuing the change from Made-in-China to Design-in-China (Casanova & Miroux, 2024). As a matter of fact, Chinese companies have led a new reality of internationalization. According to its nominal Gross Domestic Product ranking, China has become the second-largest economy in the world, which has a strong relationship with its defining economic and political context (Casanova et al., 2024).

Although enterprise internal R&D plays a vital role in an enterprise's development, the external knowledge also makes a tremendous contribution to an enterprise's innovation process (Escribano, Fosfuri and Tribó, 2009). Due to the increasingly crucial importance of external knowledge flows over the last two decades, absorptive capacity (ACAP) has gradually become one of the key drivers of a firm's competitive advantage (Bierly III et al., 2009). In particular, its two components, potential absorptive capacity (PACAP) and realized absorptive capacity (RACAP), offer a theoretical framework for analyzing how firms acquire, absorb, transform, and utilize external knowledge (Zahra & George, 2002). Meanwhile, global value chain theory helps understand how knowledge is transferred through inter-firm relationships, power asymmetries, and structural configurations (Gereffi, Humphrey, & Sturgeon, 2005). Together, these frameworks help us better understand how Chinese bicycle companies upgrade from the role of OEM to a more complex, more value-added position in the global market, such as original brand manufacturers (OBM).

Based on these conceptual foundations, this study addresses two main research questions: (1) How has participation in global value chains impacted Chinese bicycle companies? (2) How does absorptive capacity function in the context of Chinese bicycle firms within global value chains?

To answer these questions, this research aims to investigate how Chinese bicycle manufacturers are influenced by their participation in global value chains. It also examines the role of absorptive capacity in facilitating this transformation, focusing on how firms acquire, assimilate, and exploit external knowledge to transition from OEM roles to higher-value-added positions. Overall, these investigations aim to reveal the

mechanisms by which external knowledge and participation in global value chains drive innovation and strategic upgrading in China's bicycle industry.

The paper is structured into more five chapters after this introductory one. It starts with a theoretical review concerning the knowledge absorption and transmission (chapter 2), followed by the description of method and data collection (chapter 3) . The fourth chapter will present the cases of different bike companies in China and give detailed analysis with the theories. Finally, the discussion of results will be done in chapter 5 and comprehensive conclusions will be presented in chapter 6.

2 Literature Review

In an increasingly globalized business environment, the ability of firms to absorb and transform external knowledge has become a key determinant of competitiveness and sustainable growth (García-Villaverde et al., 2018; Zahra & George, 2002).

This chapter will present a comprehensive overview of knowledge absorption and transmission literature, which is a critical part of firms' internationalization, shaping their ability to recognize, assimilate, and apply in practice (Cohen & Levinthal, 1990). This process is complex and can be understood through a combination of theoretical frameworks. Based on the seminal contributions of Zarah and George (2002), it starts off with varying conceptualization of what is absorptive capability theory, antecedents, and consequences. Meanwhile, after knowing why and how to absorb and assimilate external knowledge, the background should also be considered since knowledge absorption does not occur in a vacuum. Global value chains theory (Gereffi, 1999) analyzes this process within the external environment, introducing how firms execute several processes within international supply chains.

2.1 The relevance of knowledge absorption in companies

Innovation originated from the internal context of a firm, such as in the R&D department, which is important; however, sources of knowledge from outside are often crucial. Furthermore, most innovations are developed from borrowing existing knowledge instead of inventing something totally new (Kostopoulos et al., 2011a; Cohen & Levinthal, 1990). Therefore, the ability of firms to apply knowledge to the innovation process is highly required (Escribano et al., 2009). The types of expertise are diverse, and not all of them can be generated effectively or applied to empirical activities. Thus, external knowledge transfer and application become so crucial for

expanding a firm's knowledge base and getting access to new ideas (García-Villaverde et al., 2018).

The concept of absorptive capability has become a fundamental theme in the study of organizational learning and innovation. It mainly emphasizes the ability to exploit and recognize external knowledge. External sources of knowledge are essential, but finding them and finding useful and suitable expertise for the needs of the firm is more important (Camisón & Forés, 2010; Cohen & Levinthal, 1990). It requires a high level of prior related knowledge, including not only basic skills but also the most recent scientific or technological developments. Thus, the value of new information can be discovered, assimilated, and applied to practice. All these abilities constitute knowledge absorptive capacity. Todorova and Durisin (2007) pointed out that the absorptive process is complex, involving information recognition, interpretation, and acting on external information. Furthermore, absorptive capability is a dynamic capability that enables firms to leverage external knowledge for a consistent competitive advantage, as expanded by Zahra and George (2002). Back to absorptive capability itself, a firm's absorptive capability is composed of four distinct but complementary capabilities: acquisition, assimilation, transformation, and exploitation (Cohen & Levinthal, 1990; García-Villaverde et al., 2018; Zahra & George, 2002).

Acquisition can be seen as a capability to identify and acquire externally generated knowledge (Camisón & Forés, 2010). Recognizing the value is seen as the first component of absorptive capability (Zahra & George, 2002). It has three key factors that influence acquisition efforts: intensity, speed, and direction. Research suggests that the higher efforts the organization puts in, the faster it develops the necessary capabilities; however, there are still limitations caused by learning cycles and resource constraints. Furthermore, firms' pathways for gaining external knowledge are also determined by the direction of knowledge accumulation, which requires diverse expertise across the organization to recognize the potential value of the new knowledge (Todorova & Durisin, 2007). Effective acquisition activities lay the foundation for subsequent assimilation, transformation, and exploitation processes, which ensure

valuable external knowledge is captured and integrated into organizational learning and innovation (Zahra & George, 2002). In addition, according to Lane, Koka and Pathak's (2006) research, organizational cognitive structures and cross-functional communication channels are crucial factors for strengthening a firm's ability to detect the external environment and valuable knowledge opportunities.

Assimilation involves the firm's routine and process, serving as a bridge between knowledge acquisition and its transformation into competitive advantage. This capability enables organizations to translate acquired information into understandable and valuable insights by integrating it into existing frameworks, routines, and knowledge structures (García-Villaverde et al., 2018; Zahra & George, 2002). One of the limitations of this process is the existing conflicts between externally acquired information and the firm's existing cognitive structures (Zahra & George, 2002; Cohen & Levinthal, 1990). External knowledge is often embedded within specific contextual backgrounds, which may prevent organizations from fully understanding and utilizing it (Cohen & Levinthal, 1990). Furthermore, the effectiveness of assimilation may be influenced by the organization's prior knowledge base, as it shapes the cognitive framework and absorptive pathways needed to make sense of new information (Cohen & Levinthal, 1990). The breadth and depth of the organization's prior knowledge base have an effect on its ability to assimilate new knowledge effectively. Firms must invest in developing robust routines and fostering a culture that supports knowledge sharing and learning to enhance their assimilation capabilities, as such efforts significantly facilitate the integration of external knowledge (Lane et al., 2006).

Suppose assimilation serves as the bridge between knowledge acquisition and internalization. In that case, transformation can be understood as a dynamic process, where organizations can develop the ability to combine existing knowledge and newly acquired knowledge (García-Villaverde et al., 2018). This process involves not only the addition or removal of knowledge but also the interpretation of existing knowledge from different perspectives. It involves interpreting, restructuring, and recombining knowledge (Zahra & George, 2002). This process extends beyond simple knowledge

addition or subtraction; it involves transforming the context and meaning of knowledge by integrating it across domains and perspectives. Bisociation (Koestler, 1964) is a key mechanism in this process, providing changes in the character of knowledge when firms perceive a situation or idea through two seemingly incompatible frames of reference. Therefore, the ability that firms are able to recognize, at first sight, two unrelated information and then integrate them into a new schema suggests a transmission capability (Duan et al., 2021). Through bisociation, organizations can generate new patterns of understanding by merging disparate knowledge domains. The ability to integrate unrelated information into a coherent knowledge model demonstrates what Zahra and George (2002) describe as transformation capability, which is a firm's capacity to reshape its knowledge base to meet new challenges. Moreover, this capability is often supported by organizational practices such as cross-functional collaboration, boundary-spanning roles, and flexible knowledge systems that promote the reinterpretation of existing practices in light of new inputs (Shahzad et al., 2020). Furthermore, transformation is more likely to occur in firms that maintain a high level of knowledge diversity and openness to alternative viewpoints, which fosters a context conducive to creative recombination.

According to Zahra and George's (2002) research, exploitation, known as the application or implementation, is especially emphasized. In the context of absorptive capability, exploitation refers to the ability to apply, leverage, and transform absorbed external knowledge into valuable operational and commercial value. It involves the use of systematic routines that enable firms to integrate new knowledge with existing competencies, fostering innovation, improving processes, and organizational mechanisms that integrate new knowledge with existing competencies, leading to process improvements, product innovation, and the development of new business models (Cohen & Levinthal, 1990; Camisón & Forés, 2010). Exploitation facilitates knowledge reuse, allowing firms to continuously adapt and enhance their competitive advantage by embedding learned insights into strategic initiatives. As the "realized" dimension of absorptive capacity, exploitation bridges the gap between knowledge

acquisition and tangible organizational performance (Zahra & George, 2002). It is not only about the initial use of knowledge, but also about embedding learned knowledge into daily practices, strategic decision making, and institutional structures (Escribano et al., 2009). This ongoing embedding process supports organizational learning loops that drive continuous improvement and adaptability.

2.2 The reconceptualization of knowledge absorption

ACAP theory suggests that firms with strong absorptive capacity are better equipped to process external knowledge, resulting in more effective decision-making and faster adaptation to market changes (Cohen & Levinthal, 1990). Building on this foundation, Zahra and George (2002) reconceptualized absorptive capacity as a dynamic capability, rather than a static one. They emphasized its critical role in enabling firms not only to acquire and assimilate external knowledge but also to transform and exploit it for sustained competitive advantage. As part of this reconceptualization, they proposed a two-dimensional structure of ACAP: Potential Absorptive Capacity (PACAP), which encompasses acquisition and assimilation, and Realized Absorptive Capacity (RACAP), which involves transformation and exploitation. Together, these components form a dynamic capability that supports continuous organizational learning, innovation, and adaptation in rapidly changing environments (Zahra & George, 2002; Lane et al., 2006).

The PACAP and RACAP framework provides a more nuanced understanding of how firms convert external knowledge into strategic value (Zahra & George, 2002). PACAP refers to a firm's ability to identify, acquire, and assimilate valuable external knowledge. It reflects the firm's connection to its external environment through channels such as industry networks, supply chains, foreign competitors, licensing agreements, and other formal and informal knowledge sources. While PACAP focuses on recognizing and internalizing external knowledge, it does not involve its direct commercial application.

Assimilation, as a component of PACAP, involves the internal processing, interpretation, and integration of acquired knowledge into the firm's existing knowledge base and routines. This process often depends on prior knowledge, organizational routines, and cognitive structures (Lane et al., 2006; Zahra & George, 2002). In contrast, RACAP captures a firm's ability to transform and apply assimilated knowledge for commercial and strategic benefit. It involves converting internalized knowledge into new products, processes, services, or business models that enhance a firm'sg internalized knowledge into new products, processes, services, or business models that enhance a firm's competitiveness. RACAP thus bridges the gap between learning and performance by leveraging knowledge through innovation, operational improvements, and strategic renewal (Camisón & Forés, 2010; Lane et al., 2006).

In the context of global production networks, PACAP is particularly relevant for firms engaged in OEM, where the ability to learn from multinational clients, suppliers, and market trends is essential for survival and incremental improvement. However, firms seeking to upgrade to OBM must develop strong RACAP to internalize external knowledge and translate it into proprietary technologies, product innovation, and independent brand strategies (Flatten et al., 2011). This transformation highlights the strategic importance of leveraging accumulated knowledge for competitive advantage, rather than merely acquiring it. Prior research on global value chain upgrading emphasizes that transitions from OEM to OBM require not only the technical ability to innovate, but also the organizational capacity to apply and commercialize knowledge in a strategic and sustainable manner (Gereffi et al., 2005).

2.3 Absorptive capacity in technological innovation

ACAP has been widely recognized as a critical factor of technological innovation (Duan et al., 2021). It facilitates a company's ability to acquire, assimilate, transform, and exploit external knowledge, which is critical for developing and creating new products and improving internal processes. Building on Cohen and Levintal's research, new research further explored the relationship between an organizational unit's

absorptive capacity and its innovation (Duan et al., 2021). In the research, Tsai (2017) provides empirical evidence that absorptive capacity has significant impacts on a business unit's innovation as well as its performance. He finds that a unit's network centrality enhances its access to knowledge, but it is the unit's absorptive capacity that determines whether this knowledge is effectively replicated and applied s to knowledge, but it is the unit's absorptive capacity that determines whether this knowledge is effectively replicated and applied to innovation outcomes. This highlights the importance of investing in ACAP as a core capability.

In addition to internal mechanisms, without sufficient ACAP, external knowledge does not lead to effective innovation performance (Escribano et al., 2009). Escribano et al. (2009) examined external knowledge flows and concluded that the benefits of knowledge from suppliers, customers, and research institutions are highly related to the firm's level of absorptive capacity. Firms with more absorptive capacity are better able to identify the existence of external knowledge flows and, more importantly, exploit them effectively, which indicates absorptive capacity is indeed a source of competitive advantage (Kostopoulos et al., 2011).

Moreover, in the context of a knowledge-based economy, absorptive capacity assumes a more crucial role in developing a sustainable competitive advantage (Escribano et al., 2009), as knowledge sectors become increasingly turbulent and intellectual property rights become more stringent(Lichtenthaler, 2009). Besides, the degree of environmental turbulence has an effect on learning (Jansen et al., 2006). Especially in highly dynamic contexts, internal exploitative learning has negative effects. Thus, firms with stronger absorptive capacity are better able to respond to market and technological certainties through sustainable learning and innovation.

In terms of performance and value outcomes, Kostopoulos et al. (2011) suggest that absorptive capacity makes a significant contribution directly to product development and indirectly to the innovation process and financial performance. Only if the firms are able to recognize the value of new external knowledge, assimilate, and apply it (Cohen and Levinthal, 1990; Zahra and George, 2002) will they gain innovation

benefits. Otherwise, enterprises will get into trouble with competence (Kostopoulos et al., 2011). Moreover, their study supports the view that innovation acts as a channel through which knowledge absorption enhances firm-level outcomes. Thus, the relationship between ACAP and financial performance becomes tight (Kostopoulos et al., 2011).

These studies suggest the significance of ACAP in developing and facilitating technological innovation. From acquiring knowledge via external sources (Escribano, Fosfuri and Tribó, 2009; Tsai, 2001), to integrating it effectively in turbulent envirionments (Lichtenthaler, 2009), and finally making contribution to business performance through innovation (Kostopoulos et al., 2011), ACAP emerges as a crucial capability in sustaining techonological advancement in business.

2.4 The relevance of knowledge in internationalization

In the process of internationalization, firms not only acquire external knowledge but also transform and integrate it into their internal operations to sustain competitive advantage (Zahra & George, 2002; Kostopoulos et al., 2011). The concept of absorptive capacity explains how firms identify, acquire, assimilate, and exploit external knowledge (Camisón & Forés, 2010). However, in globalized contexts, knowledge flows are not only shaped by firm level capabilities but are also influenced by the structural characteristics of global production and governance systems (Gereffi et al., 2005). Particularly in developing countries, involvement in a Global Value Chains (GVCs) will not only contribute to exploring new markets for their products, but also provide access to external knowledge and facilitate learning and innovation (Pietrobelli & Rabellotti, 2011).

GVCs represent international networks of firms involved in designing, producing, marketing, and distributing products and services across global markets (Antràs, 2020). A central aspect of GVCs theory is the concept of governance, which defines how lead firms control and coordinate the activities of suppliers, including the processes of knowledge transfer, learning, and upgrading. Gereffi et al. (2005) first classify

governance into five modes: Markets, Modular value chains, Relational value chains, Captive value chains, and Hierarchical Value Chains, which are characterized by different degrees of power asymmetry and knowledge transfer mechanisms. Within these five governance structures, three critical variables play determining roles: the complexity of transactions, the ability to codify information, and the competence of suppliers (Gereffi et al., 2005; Pietrobelli & Rabellotti, 2011) (Antràs, 2020).

Transaction complexity refers to the degree of difficulty in specifying, communicating, and fulfilling requirements in exchanges between firms in each stage. The more complex transactions are, the greater the coordination and the closer interaction are demanded (Antràs, 2020). As for codification, it is the extent to which product and process information can be standardized and transmitted through formal, codified documents such as blueprints, technical specifications, or quality standards (Hernández & Pedersen, 2017). For high codification, it means lower need for intensive interactions, while low codification requires relational coordination for effective knowledge transfer (Antràs, 2020; Pietrobelli & Rabellotti, 2011). Compared with transaction complexity and codification, competence is more related to suppliers' capabilities in production, design, R&D, marketing, and branding, which have great influences on the governance mode, their autonomy, and the depth of learning opportunities (Gereffi et al., 2005; Humphrey & and Schmitz, 2002; Pietrobelli & Rabellotti, 2011). These variables determine the ease and mechanism through which knowledge is transferred within each governance type.

In Market value chains, transactions are simple, price based, and arm's-length, which only accept the value chain suppliers with the required capabilities, with little explicit coordination or knowledge sharing between firms (Antràs, 2020). The competence of suppliers is high. This mode provides firms a window to get related information about the global market's requirements, including products, processes, technology, and standard (Pietrobelli & Rabellotti, 2011). In this case, firms are allowed to gain knowledge and innovation due to the spillover and imitation of knowledge in the value chain. However, suppliers are gained with minimal coordination and limited

knowledge exchange, and have little exposure to advanced knowledge or learning opportunities (Antràs, 2020; Pietrobelli & Rabellotti, 2011).

Typically, in Modular value chains, suppliers are required to manufacture products to meet customers' detailed specifications, which demands some standardized and easily codified knowledge exchange (Antràs, 2020). Therefore, the competence of suppliers must be at a high level. In this context, where the complexity of transaction, codification of knowledge, and suppliers' competence are all at a high level, suppliers are learning and making innovation through the competence are all at a high level, suppliers are learning and making innovation through the high pressure of lead firms to meet their needs (Pietrobelli & Rabellotti, 2011). Although modular structures provide access to technical standards, the scope for deeper learning or innovation is limited as suppliers remain dependent on lead firms for design and customer knowledge, and receive limited assistance from leading firms(Antràs, 2020; Pietrobelli & Rabellotti, 2011).

In Relational value chains, the complexity of transactions is also high, while the codification of transactions is low, which means it is based on complex interactions and trust-based relationships. This value chain allows intensive and tacit knowledge exchange, requiring solving problems jointly and a high proportion of face to face interaction and mutual learning (Pietrobelli & Rabellotti, 2011). Thus, firms in this kind of value chain have highly complementary competencies, and suppliers are offered richer learning opportunities, allowing them to develop higher competencies and engage in functional upgrade (Antràs, 2020; Pietrobelli & Rabellotti, 2011). Given the example of the computer industry in Taiwan, local suppliers built up a tight relationship with multinational corporations and interacted with them, gaining external knowledge through the blueprints and face-to-face interactions. It finally made the functional upgrade from contract manufacturing according to buyers' specifications to independently designing and producing their own products.

However, there are also two types of value chains with low competencies, Captive value chains and Hierarchical value chains (Pietrobelli & Rabellotti, 2011). Captive

value chains occur when small suppliers highly rely on lead firms, with narrow transition of knowledge and tight control over process and information. Thus, suppliers' independent capability development and innovation are greatly constrained, and suppliers' position will get locked in a high risk (Antràs, 2020; Pietrobelli & Rabellotti, 2011). According to Jansen's (2006) research, the shoe industry in Brazil's Sinos Valley illustrates how integration into a GVCs can support product and process upgrading, while preventing functional upgrading, keeping local firms dependent on a few dominant U.S. buyers. Local suppliers were discouraged from engaging in design, marketing, and sales, as these remained core competencies tightly controlled by lead firms (Schmitz, 2006).

In contrast to relational and modular forms, Hierarchical value chains refer to vertically integrated firms that internalize knowledge and control knowledge flow (Antràs, 2020). Pietrobelli and Rabellotti (2011) highlight that key functions such as R&D, marketing, and production are managed internally, which means lead firms take some of the direct ownership in the process, leaving few avenues, access to knowledge, and opportunities to upgrade for external firms. This type is similar to the relationship between a transnational company and its subsidiaries.

Within these types of value chains, Relational and Modular value chains, in particular, facilitate deeper knowledge exchanges through close interactions and standardized processes, enabling firms to upgrade capabilities efficiently (Ponte & Sturgeon, 2014). Within GVCs, the notion of upgrading is highly related to knowledge management, which enables firms to gain higher value activities by effectively absorbing and applying external knowledge (Antràs, 2020; Pietrobelli & Rabellotti, 2011). According to Humphrey and Schmitz (2002), four types of upgrading are defined: product, process, functional, and inter-chain upgrading, each requiring strategic knowledge absorption and innovation.

First, process upgrading involves transforming inputs into outputs more efficiently by reorganizing production lines or systems or introducing advanced technology (Antràs, 2020; Pietrobelli & Rabellotti, 2011). This type of upgrading focuses on

improving operational efficiency and reducing production costs. Furthermore, product upgrading refers to moving into the production of more complicated and higher-value product lines, often reflected in increased unit values and enhanced quality (Antràs, 2020; Pietrobelli & Rabellotti, 2011). Then the functional upgrading requires acquiring new, higher value-added functions within the value chain, such as design and marketing, instead of existing lower-value-added functions (Antràs & Chor, 2022). Finally, inter-chain upgrading describes the process by which firms leverage competencies acquired in a particular function to enter a new, more technologically advanced or profitable sector (Antràs & Chor, 2022).

Similarly, Mudambi (2008) emphasizes that intensive activities, such as R&D, marketing, and branding, are critical for firms to transit from Original Equipment Manufacturer to Original Brand Manufacturer roles. Despite GVCs offering exposure to global standards, firms still often face significant challenges, including cultural barriers, technological gaps, intellectual property protection, and pattern issues (Mudambi, 2008).

This conceptual understanding of governance in different value chains and upgrading provides a foundation for analyzing how Chinese firms navigate GVCs and develop knowledge capabilities, which will be discussed in the next section.

2.5 The practice of absorptive capacity in China

In the context of emerging economies, the role of ACAP in developing innovation has gained increasing attention, especially in China, where ACAP is being recognized as a core of technological innovation and crucial competence (Petti & Zhang, 2016). China, one of the key phenomena in the global economy (Casanova et al., 2024), will contribute more empirical evidence that ACAP mediates the relationship between R&D investments and innovative outcomes, helping to convert expenditures into tangible performance gains (Petti & Zhang, 2016).

Emerging economies, including China and Brazil, are pursuing technological upgrading by integrating foreign technologies with their indigenous innovation

capabilities (Fu et al., 2011). However, research emphasizes that technology diffusion and acquisition are neither costly nor unconditional (Shahzad et al., 2020). The process of technological catching-up requires not only access to external knowledge, but also the absorptive capacity to assimilate and internalize to fit into local contexts (Fu et al., 2011). Fu, Pietrobelli, and Soete (2011) examine foreign direct investment (FDI) in certain industries in China and Brazil, showing that both countries made agreements with FDI on creating connections between foreign and local firms, and imposing training requirements for gaining external knowledge. Within this framework, ACAP is viewed as the missing link between external knowledge exposure and the internal innovation process.

This is highly relevant for firms seeking to transform from OEM to OBM, in which the value creation depends increasingly on branding, design, and innovation instead of low cost production alone (Antràs, 2020; Pietrobelli & Rabellotti, 2011). As Pietrobelli and Rabellotti (2011) argue, such functional upgrading is contingent not only on access to foreign knowledge but also on a firm's ability to absorb and assimilate that knowledge within its own innovation system.

Furthermore, from a broader empirical context, absorptive capacity plays a significant mediating role in the relationship between market knowledge acquisition and radical innovation performance (Zhou & Li, 2012). In particular, it enables firms to transform externally acquired knowledge into internally coherent strategies that facilitate innovations. Zhou and Li (2012) demonstrate that Chinese high-tech manufacturing firms, particularly those in the electronics, telecommunications, and biomedical industries, have effectively applied absorptive capacity to transform market knowledge into innovative product development. In their study, some firms with external knowledge alone show insufficiency, while other firms that possess the internal capability to assimilate, transform, and apply that knowledge in practice show great performance and outcomes. This capacity becomes especially critical when pursuing breakthrough innovations in rapidly changing technological environments.

More recently, Petti and Zhang (2016) conducted a large scale empirical study involving 1,096 Chinese private enterprises and found that realized absorptive capacity (RACAP), which is the ability to transform and exploit knowledge, mediates the relationship between R&D investment and firm performance. Besides, their study also suggests that compensation, such as wages and benefits, is more effective than motivational practice in enhancing a firm's ability to transform and exploit knowledge (Petti & Zhang, 2016). These findings reveal a persistent "transformation gap" in many Chinese firms, where the ability to apply and commercialize knowledge leaves behind the ability to acquire it.

Historically, as one of the most prominent participants in global value chains, China has experienced crucial growth in both industrial output and employment (Lee & Gereffi, 2015). Lee and Gereffi (2015) suggest that China's share of global manufacturing value added within GVCs rose from 4% to 13% between 1995 and 2008, making a great contribution of more than 42 million new manufacturing jobs. However, Chinese manufacturing firms participated in global value chains primarily as OEM suppliers, occupying an exclusive position in a governance structure dominated by lead firms with strong branding power (Gereffi et al., 2005; Lee & Gereffi, 2015; Marcato & Baltar, 2020). In such structures, lead firms control not only product design and branding but also key customer interfaces, leaving suppliers locked into roles characterized by price competition and limited learning opportunities (Pietrobelli & Rabellotti, 2011). For Chinese firms to upgrade their positions in GVCs, transitioning from captive OEMs to relational or even lead firms, developing robust absorptive capacity becomes essential (Petti & Zhang, 2016).

These studies demonstrate that absorptive capacity is not only a mechanism for technological learning but also a stimulation for indigenous innovation in China's manufacturing industry. There is a high need for firms to develop absorptive capacity to turn external knowledge into real innovation. Without strong internal mechanisms to transform and apply knowledge, even high levels of knowledge access will fail to produce lasting innovation or brand competitiveness.

In recent years, the number of registered bicycle enterprises in China has grown significantly (China Insight and Info, 2024), reflecting a broader shift from low-cost OEM production to more value-added activities such as self-designing, branding, and product innovation. The Chinese bicycle industry provides a valuable context for examining how traditional manufacturers absorb and utilize external knowledge to pursue functional upgrading and global expansion.

Despite growing scholarly interest in absorptive capacity and global value chains, empirical gaps remain regarding how this transformation is applied in traditional sectors, especially in emerging economies. Thus, this study examines how Chinese bicycle companies manage their absorptive capacity during internationalization, aiming to contributenese bicycle companies manage their absorptive capacity during internationalization, aiming to contribute to both theoretical development and practical understanding.

3 Methodology

3.1 Introduction

This chapter outlines the methodological framework to explore how Chinese bicycle firms engage with GVCs and develop ACAP in the context of internationalization. As reviewed in the previous chapter, ACAP, particularly PACAP and RACAP, provides an analytical foundation to examine how Chinese bicycle companies identify, assimilate, transform, and exploit external knowledge. Complementarily, GVCs theory contextualizes these processes within international production networks, highlighting how global value chains influence knowledge transfer and opportunities for upgrading.

3.2 Research design

Given the complexity and context-specific nature of knowledge absorption and transformation processes, this research adopts a qualitative research approach.

Qualitative research is suitable for studies aiming to explore meanings, methods, and participant perspectives in complex social contexts (Saunders et al., 2023). As for the qualitative data, they are non-numerical and allow researchers to explore subjective experiences and internal practices.

Additionally, a multiple case study approach is employed to allow an in-depth exploration of knowledge management practices within specific organizational contexts, which is well suited for exploring "how" questions and for analyzing dynamic processes in such contexts (Saunders et al., 2023; Yin, 2009). By comparing multiple cases, the study can identify patterns and differences that contribute to theoretical refinement (Yin, 2009).

3.3 Selection of cases and data collection

Cases were chosen based on the researcher's judgement or criteria, such as unique insights and specific networks within Chinese bicycle companies. This study selects cases that can be considered typical. Based on Saunders et al.' (2012) suggestions , the selection of the cases relies on research questions and concentrates on the identification of information that is highly related to the study. The rationale for choosing these three cases is as follows:

- Each firm has the experience of making the transition from OEM to OBM, enabling the study of functional upgrading.
- All firms have established their own brands and engage in the international market actively.
- Their products are internationally recognized for quality and innovation.
- All chosen interviewees have their unique know-how about the subjects being investigated and their active roles in their companies.

Table 1 illustrates the details of the interview process

Tabela I: Interview Sample of characterization

Company	Interviewee Job Position	Interview Platform	Interview Time

Elitewheels	*Quality Assurance Manager*	Wechat	55mins
Tavelo	*Head of International Marketing*	Wechat	45mins
Boostor	*CEO*	Wechat	48mins

Source: own elaboration

To ensure the collection of information is rich, relevant, and reliable, which are aligned with the research objectives, semi-structured interviews were employed as the primary data collection method. As Saunders et al. (2023) suggest, interviews are particularly effective for generating insights directly related to the research questions, allowing for a deeper exploration of to the research questions, allowing for a deeper exploration of participants' experiences and perspectives. Semi-structured interviews provide a balance between structure and flexibility (Saunders et al. 2023). An interview guide was prepared in advance, outlining key topics and questions to be addressed, while allowing adjustments based on the flow of conversation.

All interviews were conducted with the participants' informed consent, and their anonymity was fully preserved. With participants' permission, interviews were audio recorded to ensure accurate data capture. Due to contextual relevance, all interviewees were Chinese, and interviews were conducted in Chinese. The interviews took place between May and June 2025, scheduled according to the availability of the respondents.

3.4 Interview development

The interview script (please see Appendix) was designed based on the literature review of the study, particularly the concepts of absorptive capacity and global value chains, and is structured into four main sections. The first section focuses on the interviewee's background, including their role, responsibilities, and professional experience. The second section explores the firm's participation in international markets and its position within global value chains. The third section examines the firm's practices related to knowledge acquisition, assimilation, transformation, and exploitation, which are the core elements of ACAP. The final section examines the

firm's upgrading path, particularly the transition from OEM to OBM, as well as the associated challenges, drivers, and capabilities. It is worth noting that while the core structure was consistent, certain questions or topics were adapted during the interview process to better suit each interviewee's specific role and organizational context, in line with a semi-structured approach.

4 Case studies

4.1 Elitewheels

Elitewheels is a vertically integrated carbon wheel manufacturer transitioning from OEM to OBM. Founded in 2015, it is a China-based manufacturer, specializing in high-performance carbon fiber bicycle wheels. In its early years, the company initially started as an OEM, producing wheels for various international bicycle brands. This business model remained in place until 2015, when the company formally launched its own brand, transitioning from OEM to OBM. Currently, only a small portion of Elitewheels' production remains OEM based, with the majority focused on manufacturing and marketing under its brand name. The company emphasizes internal research and development, holding over 30 patents and employing proprietary techniques to control product quality and ensure safety standards. Unlike many competitors, Elitewheels produces its own carbon fiber pre-preg materials, rims, hubs, and wheelsets, maintaining vertical integration across its production chain. Its products are now used by several UCI Continental teams, including those competing in World Championships and ProTour races.

Thus, this case study shows the value of assessing Elitewheel's absorptive capacity in the OBM process and the transition in global value chains. Specifically, it will focus on the practice of absorptive capacity in Elitewheels, exploring how the company acquires, assimilates, transforms, and exploits in depth.

As the quality assurance manager noted, "*During Elitewheel's early period, international brand owners were deeply involved in the company's R&D processes,*

transferring specific technical knowledge and exercising close control over product standards." The relationship between brand owners and factories was extremely tight and closed, which laid the foundation for the firm's later development of internal capabilities.

In 2015, Elitewheels formally launched its own brand, marking a strategic shift from OEM to OBM. The transition was largely knowledge driven. However, due to constraints imposed by intellectual property rights, the company initially focused on producing entry level wheels by modifying existing technologies to avoid patent infringement. These early OBM products were characterized by affordability and acceptable quality, allowing the brand to penetrate price-sensitive international markets.

During its OEM stage, Elitewheels operated within a captive value chain of the GVCs, where foreign lead firms dictated design specifications, production processes, and quality standards (Pietrobelli & Rabellotti, 2011). As the company transitioned to OBM, it began to enhance its own product development capabilities. Elitewheels actively engaged in external knowledge acquisition, particularly through human resources recruitment. One essential example was that they recruited a quality assurance engineer from the international brand Specialized, who had been working there for 5 years. Relying on his prior knowledge, this engineer helped establish a knowledge identification and evaluation system, which is designed to enable Elitewheels to systematically evaluate emerging technologies, assess their feasibility and applicability of advanced technologies for adaptation, and determine whether they can be successfully applied to mass production. This transformation represents a clear case of realized absorptive capacity, where the firm not only acquires knowledge from external sources but also applies it to operational improvements and innovation outcomes. However, this upgrade brought some impacts on its original OEM business. As the company grew its OBM business, it began to lose OEM clients who were concerned about the intellectual property risks and potential competition.

During the interview, the interviewee emphasized that in the bicycle industry, product related technologies have already reached a high level of maturity. As he

mentioned, "*Although product innovation remains important, it only accounts for a limited share of competitive advantage.*" More and more firms are focusing on bike geometry and appearance design to cater to aesthetics. Instead, the key technological focus within the industry lies in achieving high yield rates during mass production. Once a product prototype is developed, the most challenging task or the highly needed is the ability to industrialize the process while maintaining consistent quality standards.

The production of carbon fiber components, such as wheelsets and frames, continues to rely heavily on manual labor, particularly in tasks like carbon fiber layup and finishing, which are all performed manually. As a labor intensive industry, the manufacturing process involves various stages that are difficult to fully automate or precisely control. For instance, during the molding and curing stages, a "black box" phenomenon often occurs, where subtle changes in temperature, humidity, or material alignment can significantly affect product quality. Consequently, most of the external knowledge and technological efforts absorbed by firms like Elitewheels, or most of the firms in this industry, are concentrated on improving production efficiency and process control, rather than on radical product innovation, which is seen as more straightforward and less critical to long term competitiveness.

Currently, Elitewheels, as an international brand, is serving a broad customer base, particularly in Europe and North America. UCI continental teams use its wheelsets and have received positive market feedback for both performance and value. Meanwhile, the company continues to face challenges from emerging OBM players and existing strong players. Sustaining product innovation, protecting intellectual property and knowledge, and establishing a distinctive global brand identity are becoming increasingly essential. The case of Elitewheels illustrates how absorptive capacity plays a crucial role in enabling traditional OEM firms to move up the value chain through external knowledge acquisition, internal transformation, and the strategic utilization of external knowledge.

4.2 Tavelo bikes

Tavelo started as an OEM, evolved through original design manufacturer (ODM), and now builds its premium brand on design-driven differentiation. Tavelo Bikes is a Chinese high-end carbon fiber bicycle manufacturer that has built its reputation through both premium product innovation and OEM expertise. Initially recognized as a trusted supplier and technology partner for famous international cycling brands, Tavelo played a key role behind the scenes, contributing to the design and production of advanced carbon fiber components. By closely collaborating with elite athletes and international frame builders, the company has developed in-depth know-how in carbon layup, structural engineering, and performance optimization. Driven by a strong commitment to innovation, Tavelo collaborates closely with elite athletes, which allows the company to integrate technologies with real world insights, resulting in products that emphasize lightweight construction, stiffness, and durability.

Quality assurance in production was emphasized several times during the interview. With approximately 35 specialists engaged across departments, the company has established a strict, standardized quality control system. From raw material inspection to finished product evaluation, every production step is documented to ensure consistency, eliminate defects early, and uphold performance standards. Detailed standard operating procedures guide each phase, supporting the brand's continuous improvement and high-level craftsmanship.

According to the interview with Tavelo's Head of International Marketing, actually, the company's own brand was officially established only 3 years ago. However, the founder and the core team have extensive experience in the bicycle manufacturing industry, having engaged in OEM production for a long period. During this early background, Tavelo primarily served foreign brands by producing high-end carbon frames, in which they gradually accumulated both technical know-how and operational capabilities.

As their experience grew and capabilities matured, Tavelo did not transition from OEM to OBM directly; instead, they shifted from OEM to ODM first. With the new role, Tavelo did not merely manufacture products to meet client specifications but

actively participated in the product development process. As the interviewee stated, "*Many international cycling brands now outsource not only their manufacturing but also their design work, offering only the initial concepts or market driven ideas.*" Tavelo often served as the invisible force behind these brands, designing and developing complete framesets that would later carry foreign brand labels. According to the strategies of those international cycling brands, once the framesets become bestsellers, they will spend a huge amount of money to purchase the manufacturing mold and obtain the exclusive right to use it. This stage was crucial in building up Tavelo's internal capability of design expertise and engineering knowledge.

Only after accumulating sufficient design proficiency and production experience did Tavelo decide to launch its own brand, integrating its knowledge into its product line. This strategic move marked a significant turning point in the company's upgrading path, representing a transition from receiving knowledge to creating knowledge.

When asked about how Tavelo absorbs and transforms external knowledge, the interviewee emphasized, "*Innovation in the bicycle industry often follows a trend driven pattern, which means once a leading brand introduces a successful design, many others seek to optimize or iterate upon it, creating an integration and upgrading innovation.*" In this situation, staying closely aligned with global trends and being able to adapt quickly is more valuable than isolated, radical breakthroughs. Tavelo's accumulated experience makes it a critical advantage in recognizing valuable external knowledge and assessing its relevance to internal needs.

However, as mentioned before, the true challenge is not only about the design in innovation, but in the ability to mass production innovative designs while maintaining high yield rates. For example, in the development of Tavelo's flagship frame model Arow, the company initially pursued an aggressive design vision. During the process of prototyping and testing, they meet significant difficulties in stabilizing quality during batch production. Ultimately, compromises were made to enhance manufacturability and ensure consistent quality control.

This reflects Tavelo's core philosophy: the real innovation relies on translating design knowledge into scalable, reliable production systems, rather than pursuing radical breakthroughs. As a result, the company's focus during knowledge transformation is primarily on incorporating external insights into manufacturing improvements, ensuring both product performance and repeatability. The commitment to quality positions the company as a brand that prioritizes durability, functionality, and customer trust.

Tavelo's evolution within the global value chain demonstrates a clear shift in governance structure and functional role. In its early years, the company operated primarily as an OEM and later as an ODM for well known international brands. It delivered both manufacturing and design services under the guidance of foreign brand owners. Through these collaborations, Tavelo was exposed to global design standards, technical requirements, and market expectations, which are a critical channel for knowledge spillovers. Over time, the company accumulated significant internal expertise and developed its own design and quality control systems. This knowledge accumulation made Tavelo evolve from a supplier within relational value chains to an OBM role, where it now controls product development, branding, and global market positioning under its own OBM structure (Pietrobelli & Rabellotti, 2011).

This transition represents not only a value chain shift within the GVCs but also a functional upgrading, allowing the company to move up the value chain and capture higher value-added segments. Today, Tavelo is becoming an independent innovator, shaping its own brand and product strategies, with continued emphasis on design adaptability and production quality.

4.3 Boostor

Boostor is a high-end wheel manufacturer based in Xiamen, China, known for combining advanced engineering with craftsmanship. With a production capacity exceeding 20,000 rims per month, the company operates its own fully controlled factory, ensuring consistent product quality and precision across every build. Originally

established to provide OEM and private label solutions for both domestic and international premium cycling brands, Boostor leveraged over a decade of industry experience to transition into developing its own brand identity. They integrate custom-designed manufacturing machines with the expertise of highly trained human builders, achieving consistently accurate and high quality wheelsets. Each product reflects a balance of high technology and handcrafted excellence.

Boostor represents a distinctive case of strategic transformation and technological experimentation within China's high-end carbon fiber bicycle manufacturing sector. It was designed as a digitalization lab within a larger OEM framework to push the carbon bike industry into the data age. The company originates from a large scale carbon fiber manufacturing facility with over a decade of experience in producing a variety of products, including tennis rackets, fishing rods, and badminton rackets. The company's founder, originally from the mining industry, leveraged his engineering background and extensive network to transition into carbon fiber manufacturing. Because of his personal interest in cycling, he and his co-founders eventually led the business to specialize in the carbon fiber bicycle industry.

In its early stages, the factory behind Boostor served mainly as a subcontractor for OEM suppliers, often taking on outsourced manufacturing tasks from other factories. This position enabled the team to accumulate technical know how and experience, especially in Standard Operation Procedures (SOPs) and quality assurance systems. During this period, due to its partnership with the industry's top manufacturers, Boostor established strong and close connections with its workers. They recruited a number of highly skilled employees who had previously worked for the top manufacturers, bringing their transformed and internalized knowledge. This talent inflow laid a strong foundation for identifying and evaluating new technologies and facilitated the development of Boostor's independent capabilities.

As the factory's capacity and reputation grew, it gradually built direct OEM partnerships with international brands. Today, OEM production still remains the company's main business and the source of revenue, while OBM activities represent

only a small portion of operations. According to the CEO, their innovation strategy is not rooted in radical products; instead, it is in learning and absorbing market trends. Boostor closely monitors successful products in the market, analyzing designs and broader industry dynamics before determining the feasibility of production. The main factors that decide whether to develop a product are primarily based on whether it can be efficiently produced with stable quality and at a controlled cost. "*What matters in manufacturing,"* said the CEO*, "is not just the innovation itself, but whether you can make it reliably, efficiently, and at scale."*

Boostor's development within the global value chain illustrates a progressive shift in governance structures. Initially, the company operated under a hierarchical structure, undertaking outsourced manufacturing tasks from sector top factories. At this stage, Boostor had limited autonomy and relied heavily on technical instructions and specifications from upstream clients, with little innovation. As the company developed core manufacturing competencies and established a reputation for quality and reliability, it moved to captive value chains, working directly with international brands as an OEM supplier. This transition reflected an increase in capacity and competence in executing more complex and standardized tasks.

Besides, the black box was mentioned during this interview as well. Boostor focuses primarily on the black box during the production, which stages are complex and hard to observe, such as mold forming and demolding, that have a significant impact on the yield rate. One example he shared was a new product that used ultra high strength carbon fiber and advanced weaving technology. Theoretically, it had a promise to achieve, while in practice, yield rates were difficult to predict and required a lot of trial and error to control production variables. As the CEO emphasized, true industrialization in the bicycle industry relies on digitalization, where every step of the process can be precisely recorded and replicated.

One thing that was mentioned several times during the interview was that the establishment of the Boostor brand itself was not just a profit driven commercial action, but also a strategic experiment. Although Boostor was officially registered in 2011, it

did not immediately begin manufacturing its products. Instead, its early efforts focused on developing digital competencies, especially in software systems and the digitalization of manufacturing processes. The founder built Boostor as a platform to test and validate various technologies and systems related to smart manufacturing, including full traceability, lifecycle management, and detailed data recording across the entire production process. One of the most innovative ideas was the integration of QR codes into every wheelset. These codes enable stakeholders within the supply chain, who are not end consumers, to access critical production data, including spoke tension measurements, hub specifications, production dates, and batch numbers. This system offers brand partners transparency and quality control, enabling them to precisely track raw materials, monitor quality metrics, and production workflows. By building such a digital system, Boostor aims to establish the technological foundation that is necessary for the industrialization of the carbon bike industry. The company views datafication and digitalization not as mere improvements in production, but as the foundation to facilitate the industry's move forward.

Boostor, as a strategic experiment, is separated from the existing OEM factory. As the CEO explained, the main factory had grown into a large and complex organization with established routines and operations. Implementing radical changes or experimental practices in that environment could result in internal resistance, reduced efficiency, or conflict with existing customer commitments. In contrast, establishing Boostor as an independent brand allowed for greater agility, creative freedom, and reduced risk of disruption to core OEM operations.

Moreover, the CEO acknowledged that OEM remains far more profitable than OBM in the short term. As such, Boostor functions as an experimental lab, where it develops the digitalization and dataization of the main manufacturing entity. Through Boostor, the company aims to establish a service-oriented business model. Instead of competing solely through product innovation, it aims to deliver digital solutions and management services to brand clients, enhancing their manufacturing efficiency, traceability, and quality assurance. Ultimately, Boostor seeks to become a first mover

in transforming the carbon bike sector from a labor-intensive industry into a data driven, digitally managed ecosystem.

5 Discussion of the results

The primary objective of this study is to examine how Chinese bicycle manufacturers participate in the context of global value chains and how they develop ACAP to facilitate their transition from OEM to OBM. By analyzing three Chinese bicycle companies – Elitewheels, Tavelo, and Boostor – through multiple case studies, this research examines how they developed and applied ACAP to upgrade from OEM roles to more autonomous and innovative positions within global value chains. The cases reveal varying patterns of knowledge acquisition, assimilation, transformation, and exploitation, reflecting their unique participation in GVCs.

5.1 Elitewheels

5.1.1 Impact of GVCs participation

As stated by the quality assurance manager, Elitewheels began as an OEM manufacturer for international brands, operating under a high power asymmetry and strict production control by brand power, which is highly consistent with the characteristics of captive global value chains (Antràs, 2020; Pietrobelli & Rabellotti, 2011). During this stage, the company primarily served as a contract manufacturer, only executing instructions without being involved in design or strategic decision making.

With the increase of orders, Elitewheels gradually participated in the production efficiency improvement part, and upgraded its capabilities by absorbing technical know-how from its clients, particularly through direct brand intervention in product development and quality assurance. Through mutual learning from face to face interactions, Elitewheels gained high competence and high codification of transactions during its development, which is in line with Antràs' (2020) ideas, stating a more relational form of GVCs governance. This suggests that even within captive global

value chains, capability building and organizational upgrading can emerge when firms are exposed to structured knowledge environments and high demand for performance.

Initially, Elitewheels seized the opportunity and, under the strict control of upstream enterprises, learned in-depth from them, improved production efficiency, and achieved a higher yield rate, marking the success of process upgrading. As a result, Elitewheels' capabilities have been continually improved and successfully transformed into relational value chains, enabling the company to work more closely with international clients. On this basis, Elitewheels proposed the strategic goal of building its brand and launched a functional upgrade, expanding key functions such as product design, brand building, and marketing (Gehl Sampath & Vallejo, 2018; Pietrobelli & Rabellotti, 2011). Ultimately, through the systematic development of internal capabilities, including employee training and the recruitment of outstanding talent, the company completed its transformation from OEM to OBM. In 2015, the company launched its own brand and start to be a OBM, while it still remained a small portion of OEM business. It largely focuses on producing under its own brand name and engaging directly with global markets, especially in Europe and the US. This marks a key functional upgrading point (Gehl Sampath & Vallejo, 2018; Pietrobelli & Rabellotti, 2011).

5.1.2 Practices of ACAP

Regardless of the transition from OEM to OBM or the upgrade from captive value chains to relational value chains, Elitewheels has demonstrated strong potential in developing both PACAP and RACAP.

In its OEM stage, the company acquired production knowledge through close collaboration with international clients, which significantly contributed to the development of its PACAP. Initially, the spread of knowledge occurred through a process of guided transmission from global clients. Rather than actively acquiring external knowledge, the company was immersed in a context of strict control and monitoring, where international clients directly intervened in production, offering technical instructions, quality assurance, and product design specifications (Gehl Sampath & Vallejo, 2018). This process played a foundational role in shaping the company's internal operational routes and competencies (Kostopoulos et al., 2011). Thus, Eltiewheels established a set of standardized procedures and quality benchmarks.

Factory workers and technical staff received consistent exposure to practice through their daily work instructions and improved personal skills. Over time, this kind of working experience or knowledge enabled the gradual internalization of advanced manufacturing skills, especially in carbon fiber processing and mass production quality stability. The accumulation of knowledge contributed to higher production efficiency and significantly improved the company's capability level. Therefore, despite being under the strict control of the clients during the OEM phase, Elitewheels benefited from the form of passive learning in the global value chain, which built the foundation for the subsequent development of its absorptive capacity and facilitated a smoother transition to OBM.

The transition to OBM required the firm to develop RACAP, which transforms and exploits knowledge for innovation (Zhou & Li, 2012). The key turning point was the establishment of a dedicated internal system led by an engineer recruited from Specialized, which is one of the global leaders in the bicycle industry. This system facilitated the identification of advanced technologies and evaluated their feasibility for

internal application. From raw carbon prepreg production to wheel rim assembly, this vertical integration guarantees that internal knowledge can transform into practical capabilities. Moreover, Elitewheels built a culture of continuous learning and reinvested its accumulated expertise into product development and branding. As Antràs (2020) suggests, the ability to transform and apply external knowledge is critical for sustained competitive advantage.

5.2 Tavelo bikes

5.2.1 Impact of GVCs participation

Initially, Tavelo operated as an OEM for international cycling brands, producing high-end carbon frames. With high competence and deeper relationships in production, Tavelo was placed in a relational value chains within the GVCs framework (Antràs, 2020; Pietrobelli & Rabellotti, 2011), where Tavelo was responsible for operating production tasks under the technical guidance of foreign lead firms. Thus, Tavelo had to improve its competence and learn through the high pressure of meeting its customers' high performance demands.

Over time, Tavelo shifted to ODM, taking on the responsibilities of designing and becoming an essential development partner for brands, which plays an increasingly outsourced role in R&D. During this stage, Tavelo benefited from 2 key strengths. First, the company had already developed advanced manufacturing capabilities and strict quality assurance control through its OEM experience. Second, as international clients increasingly demanded more customized and high-performance frame designs, Tavelo was required not only to manufacture but also to participate actively in the product development process. Transforming clients' ideas into manufacturable designs and feasible mass production has always put Tavelo under high pressure, but this has also made it successful, allowing it to continue learning and breaking through technical bottlenecks. Such dynamics push the company in a high governance mode, moving from relational global value chains to modular global value chains (Gehl Sampath & Vallejo, 2018; Pietrobelli & Rabellotti, 2011), where suppliers execute complex tasks

independently based on clearly defined technical standards and interfaces, while maintaining a moderate level of information exchange and coordination with lead firms.

The transition from OEM to ODM made a critical bridge between OEM and OBM, allowing Tavelo to develop key internal capabilities in frame geometry, material layup strategy, and aesthetics. This close participation in design and development significantly enhanced Tavelo's capabilities and made a successful case for product upgrading. Eventually, Tavelo uses this accumulated expertise to establish its brand, marking its transition from ODM to OBM, which reflects a shift not only in the firm's functional role but also in its global value chain structure, from being governed under global value chains to developing autonomous control of production, product development, marketing and distribution. This transition indicates a case of functional upgrading (Gehl Sampath & Vallejo, 2018; Pietrobelli & Rabellotti, 2011), where Tavelo moved from merely producing to also designing, branding, and marketing. This case illustrates a typical route for Chinese firms to leverage GVCs integration as a platform for upgrading competence and achieving self-brand development. Supported by accumulated experience, internal design expertise, and advanced manufacturing infrastructure, Tavelo completed its transition from contract manufacturing to an independent OBM company operating under modular value chains.

5.2.2 Practices of ACAP

Through extensive and tight collaboration with international brands and elite athletes, Tavelo forges its PACAP during its OEM and ODM stages. These interactions enabled Tavelo to internalize tacit knowledge, particularly the philosophy of design, including frame geometry optimization, carbon layup techniques, and performance balance. With the increasing demand for high-performance design and orders, the company was exposed to diverse customer requirements, evolving industry trends, and competitive product benchmarks, fostering a more dynamic and proactive approach to knowledge engagement, which indicates the organizational assimilation (Kostopoulos et al., 2011a; Qian & Acs, 2013).

As Tavelo began developing its own brand, the company leveraged its accumulated expertise and experience to create its own high-end products, translating external experience into internal innovations. Particularly, the interviewee emphasized that innovation in the bicycle industry is primarily driven by the trend, which means that when a new design emerges, other brands will follow suit and continually optimize their products rather than creating radical inventions (Escribano et al., 2009). They mentioned that firms often benefit more from adaptive integration of external knowledge than from isolated breakthrough inventions.

Discussing how they transformed and exploited the details, Tavelo strategically leveraged its rich design experience, great manufacturing competence, and consistent quality assurance management to test the possibility and feasibility of new technology. The challenge during the development of its Arow frame indicated that RACAP is constrained not by a lack of creativity but by the industrial demand for the yield rate of mass production. The company's strength lies in its responsiveness to global trends and its rich experience of integrating external design concepts into manufacturable products. The firm focuses on compatibility with global market expectations over technological innovation. This case highlights the interaction between design, manufacturability, and knowledge integration

5.3 Boostor

5.3.1 Impact of GVCs participation

The development of Boostor within the global value chain reflects a route of governance transformation and functional evolution. In its early stages, Boostor started as a subcontractor for other top OEM factories, operating under a hierarchical value chain, which was aligned with Atràs' (2011) view that the company had minimal autonomy, receiving specific technical support from upstream firms and executing tasks without participating in product developments or strategic decisions. This placed Boostor in the level of low competence, which is dependent on external directions and

constrained to simple, labor-intensive production (Gehl Sampath & Vallejo, 2018; Pietrobelli & Rabellotti, 2011).

As Boostor accumulated manufacturing experience and recruited skilled employees from leading OEM factories, it began to develop its own internal SOPs and quality assurance control systems. The production process was steadily improved in a black box manufacturing environment. This process of upgrading to technical and reliable production enabled the company to establish direct OEM partnerships with international cycling brands, thereby moving into captive value chain. In this stage, Boostor was responsible for executing more complex and standardized production tasks through deliberate knowledge transfer from lead firms, but was still constrained within a narrow range of functions (Pietrobelli & Rabellotti, 2011).

Unlike traditional OBM, Boostor established its brand as a digital transformation laboratory. This independent experimental OBM platform focused on testing various radical digital strategies, including QR codes for lifecycle tracking, production data collection, and real-time tracking systems. Boostor went beyond the traditional OBM manufacturing model by providing digital infrastructure services that can improve supply chain transparency, production efficiency, and quality assurance for other manufacturing customers. Rather than directly competing in consumer markets, Boostor aimed to leverage its OBM platform to transform from the traditional OEM role to a service-oriented manufacturing innovator. Currently, it has been successful in process optimization, bringing better products with high yield rates to its clients.

This strategic shift marks the beginning of a functional upgrade. By providing high value-added services, Boostor is no longer positioned as just a producer but as a solution provider. The company's digital services are designed to help other OEMs meet international quality and traceability standards, which drives Boostor towards a modular governance structure.

Similarly, these digital services are committed to improving the efficiency and yield of OEM factories to meet the higher standards and needs of international customers, which shows that Boostor is moving towards a modular value chain

(Pietrobelli & Rabellotti, 2011). In sum, Boostor demonstrates how a company can evolve within the GVCs by strengthening its internal capabilities and upgrading its function through technological experimentation and service innovation.

5.3.2 Practices of ACAP

The practice of ACAP in Boostor's development involves a complex and gradual process, particularly in its role as both a traditional OEM and a digital experimentation platform. According to the basic theory proposed by Camisón & Forés (2010), Boostor's evolution indicates how it identifies, assimilates, transforms, and exploits external knowledge.

In terms of knowledge acquisition and assimilation, Boostor benefited from its early exposure to the manufacturing practices of an industrial leading firm, where it acted as a subcontractor within hierarchical value chains. During this period, Boostor had limited design authority but gained access to the leading OEM factory's SOPs and quality assurance systems. Furthermore, it also actively recruited highly skilled worker who are from leading OEM factories, bringing with them their rich working experience and prior knowledge. This human resources strategy enabled Boostor to establish a foundational absorptive capacity (Kostopoulos et al., 2011), as demonstrated in its expertise in carbon fiber manufacturing, process control, and quality assurance management.

Rather than simply imitating external knowledge, the company began to transform and exploit, moving toward RACAP (Qian & Acs, 2013). The most representative performance is the establishment of its digital production system. This system is not copied from customer solutions, but developed on the basis of understanding customer needs and its own actual conditions, reflecting Boostor's ability to leap from passive reception to active creation (Escribano et al., 2009b). In addition, Boostor's innovation model emphasizes market orientation and feasibility of mass production, which means the company intends to identify existing successful products and leverage its unique manufacturing advantage to test the possibility of mass production, reliability, stability, and the control of cost. This shows that Boostor's use of absorptive capacity is more

focused on process optimization and process innovation, rather than radical product disruption.

The independent establishment of the Boostor brand has strengthened its operating mechanism and absorptive capacity. As a strategic lab separated from the OEM factory, Boostor flexibly tests new technologies, improves production systems, and feeds back the results to the traditional OEM system, forming a systematic knowledge conversion platform. Its absorptive capacity practice presents a clear path from knowledge acquisition, assimilation, transformation, and optimization to service output (Kostopoulos et al., 2011a; Qian & Acs, 2013). On the one hand, it accumulated advanced experience through the flow of human resources and industrial cooperation, while on the other hand, it transformed it into a digital system to provide customers with high value-added manufacturing management services, reflecting the key role of ACAP in improving manufacturing efficiency and promoting industrial upgrading.

5.4 Cross-case analysis

This section presents a cross-case analysis of the three case studies. The impact of GVCs, upgrading trajectories, and practices on absorptive capacity is shown in Table 2. Although all three firms have undergone transformation from OEM suppliers to independent roles, their paths, strategies, and mechanisms for external knowledge absorption indicate distinct differences.

Tabela II: Cross-case analysis

Study Dimension	**Case study**		
	Elitewheels	**Tavelo bikes**	**Boostor**
Impact of GVCs	From Captive to Relational From high client control to standardized production for multiple brands	From Relational to Modular From close client collaboration to independent ODM design	From Hierarchical to Modular From subcontractor to digital innovation

Upgrading type		Process and Functional upgrading OEM → OBM	Product and Functional upgrading OEM → ODM → OBM	Process and Functional upgrading OEM → OBM
Practices of ACAP	**PACAP**	Passive absorption from clients and talent skilled worker recruitment	Tight collaboration, learning under pressure and skilled labor recruitment	Tight collaboration and skilled labor recruitment
	RACAP	Through internal system brought by talent flow	Through test of production feasibility and quality control	Through developing digital production systems and providing services

Source: Own elaboration.

The three companies initially participated in international business as OEMs with different initial value chain models. Eventually, they moved to higher modes, where they were pushed to innovate and independently manage production to meet specific technical standards (Pietrobelli & Rabellotti, 2011).

Elitewheels operated under captive value chains, characterized by high power asymmetry and strict external control from international clients. However, through passive learning and structured quality assurance systems, Elitewheels gradually built competence and moved toward relational value chains. In contrast, Tavelo started under relational value chains, with higher technical capability and closer collaborative relationships with clients. The firm entered into a partnership with leading brands during its ODM stage, assuming both design and manufacturing responsibilities. Their corporation required Tavelo to improve under external performance pressure continually. As for Boostor, it presents a unique route, where it started as a subcontractor within hierarchical value chains and received specific instructions from upstream OEM factories. As its competencies improved and it focused on talent recruitment, Boostor built direct relationships with brands, transitioning into captive value chains. Furthermore, its ambition to digitalize manufacturing drives it to create an independent OBM brand as a digital innovation lab. The success of Boostor's

application laboratory further strengthened the manufacturing capabilities of its factories, enabling it to move towards modular value chains eventually.

In their process to OBM, a dynamic and interactive relationship exists between the GVCs governance structure and enterprise upgrading. The three companies demonstrate their unique upgrade paths in the global value chain. Elitewheels successfully transitioned from OEM to OBM through process and functional upgrades, enhancing manufacturing efficiency and developing brand capabilities. At the same time, Tavelo evolved from OEM to ODM and ultimately transitioned to OBM by enhancing design capabilities and implementing functional upgrades, thereby achieving product innovation and independent development. As for Boostor, it completed the dual upgrade of process and function by optimizing internal production systems and expanding digital services, moving from OEM to service-oriented OBM. Despite their different paths, all three have successfully transitioned to high-value-added roles in the global value chain.

In terms of ACAP, all three companies acquire external knowledge through close collaboration with upstream partners; however, they also exhibit distinct differences. Elitehweels followed a relatively passive absorption, absorbing knowledge through client strict instruction and improving internal capabilities through the recruitment of skilled workers. Its RACAP highly relied on the internal system that was brought and developed by Talent Flows. Likewise, Boostor also enhanced its RACAP by recruiting experienced staff. However, it also emphasized the digital capability building. It has developed a digital production infrastructure that enables transparency in the production process. Its RACAP philosophy is based on using these digital systems to test and apply external knowledge in the production process. Boostor is an experimental platform that experiments with various forms of external expertise and transfers them into industrial practice. Similarly, Tavelo also relies on production to conduct RACAP. It demonstrates a more proactive absorptive capacity, acquiring external knowledge through high pressure cooperation at the ODM stage, and building a RACAP with

manufacturing capabilities as the core through production feasibility testing and strict quality control.

6 Conclusions

Recalling the research questions, this research aims to develop a deeper comprehension of the impacts of participation in global value chains for Chinese bicycle companies, also intending to explore the function of absorptive capability in Chinese bicycle firms within the global value chains. To achieve this goal, this study conducted a series of case studies on three major companies in the Chinese bicycle industry.

6.1 Main conclusions

The first research question focused on how global value chains impacted Chinese bicycle companies. According to the typology of GVCs governance patterns proposed by Gereffi, Humphrey, and Sturgeon (2005), the three case companies followed distinct paths. Elitewheels evolved from captive value chains to relational value chains, while Tavelo transitioned from relational value chains to modular value chains. And Boostor moved from a hierarchical subcontracting role toward modular value chains. In all cases, upgrading, including process, product, or functional upgrading, was closely related to the transition in global value chain governance structure. The empirical results proved the dynamic interaction between power asymmetries, knowledge flows, and the possibility for firms in developing countries to move up the value chains through learning and strategic capability building. These findings further support previous research conducted by Gereffi, Humphrey & Sturgeon (2005) and Rabellotti and Rabellotti (2011).

Referring to the second question, it addressed how Chinese bicycle firms develop and apply ACAP within global value chains. The findings of the case studies demonstrate that firms take different ACAP strategies according to their global value

chains governance structure and upgrading objectives. Elitewheels, Tavelo, and Boostor each built their ACAP through different routes. Elitewheels relied on passive absorption during its early OEM stage and gradually improved its internal systems through talent flow. While Tavelo took a more proactive approach, learning under high pressure during the ODM stage, where they built close collaboration with international clients and established a highly quality control system. Boostor, uniquely, placed itself as a digital innovation platform, translating accumulated knowledge into service oriented manufacturing capabilities. These diverse practices further support previous research, such as Zahra & George (2002) and García-Villaverde et al. (2018).

Although there are significant differences in the practice path of absorptive capacity among the three enterprises, one thing is particularly prominent: they all attach great importance to the introduction and training of high-quality talents. Whether Elitewheels and Boostor employ experienced workers or Tavelo builds capacity through high-pressure collaboration at the ODM stage, the role of talent in corporate capacity building can not be ignored. This may reflect the bicycle industry, which remains highly labour-intensive and relies heavily on the skills of individual workers for its competitiveness. Therefore, the accumulation of talent has become the basic guarantee of enterprise knowledge absorption and ability upgrading.

6.2 Theoretical implications

This study contributes to a new empirical perspective for the combination of GVCs and ACAP theory. Firstly, this paper demonstrates how companies gradually achieve capability upgrading and governance evolution across different global value chains, thereby enriching our understanding of the dynamic evolution of GVCs governance structures. Secondly, this paper analyzes the practical application of ACAP in manufacturing enterprises and expands the theory of ACAP from high-tech and knowledge-intensive industries to labor-intensive industries, which provides additional evidence for the application of ACAP in different industrial contexts. It also demonstrates that a mix of production and service capabilities can facilitate functional

upgrades. Furthermore, the findings suggest that governance evolution and ACAP reinforcement are often mutually reinforcing processes.

6.3 Practical implications

For the managers of Chinese manufacturing enterprises, the research results show that in the OEM stage, enterprises should actively use customer resources to learn, and should not regard OEM as a low-end path; instead, it should be regarded as an important stage of capacity accumulation and system construction. The quality system and design capabilities developed through deep customer participation and high demand pressure often form the basis for subsequent functional upgrades and governance structure transformations.

As the main body of knowledge absorption, enterprises need to attach great importance to the construction and maintenance of a talent system. Especially in highly labor-intensive industries, such as carbon fiber bicycle manufacturing, the experience and skills of individual employees have a direct impact on product quality and innovation capability. Attracting, training, and retaining the core technical personnel is key to realizing knowledge absorption and ability transformation. At the same time, enterprises need to establish a systematic external knowledge absorption mechanism, especially in quality control and process digitization, which will help it transform from manufacturing executor to solution provider.

Furthermore, the research also emphasizes that enterprises should set up medium- and long-term technology accumulation and capability development goals, and promote enterprises to enhance their internal capabilities within the global value chain governance structure, thereby constructing high added value in manufacturing.

6.4 Limitations and future research

This study has several limitations. First, the sample size is limited, with only three companies analysed, which, while representative, do not capture the diversity of the industry as a whole. Second, due to access constraints, some information was collected

only from single interviewees, and the data mainly comes from semi-structured interviews, which may introduce information bias or incomplete perspectives. Third, the study focuses on high-end bicycle firms, which may not reflect dynamics in lower-cost or other segments.

Future research could expand the scope of the study by including more firms with different governance structures and industrial chain positions. Furthermore, introducing quantitative indicators to measure ACAP and building a more systematic model. It would also be helpful to explore the interaction between ACAP and industrial policy to better understand the transformation logic of Chinese manufacturing companies within global value chains. Finally, comparing enterprises from different countries participating in the same value chain can enrich the understanding of the upgrading mechanism under different institutional backgrounds.

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Appendix

- INTERVIEW SCRIPT-

1) **Interviewee Background**
   a. Name
   b. Company name and current position
   c. Key responsibilitie in current role
   d. Professional background and career path
2) **Global Value Chains engagement**
   a) When did your company begin participating in international markets, and through what forms (e.g., OEM, OBM)?
   b) Could you describe your company's current position in the global value chains (GVCs)? What types of clients or international markets do you serve?
   c) What do you think of the main benefits and challenges of participating in global value chains?
   d) Have international customers influenced your production, quality, or products design standards?
3) **Absorptive capacity practices**
   a) Through what channels does your company typically acquire external knowledge? (e.g. Clients, suppliers, exhibitions)
   b) How does your company identify which external knowledge is valuable or relevant to its development?
   c) Are there specific teams or mechanisms in place for learning from external sources? (e.g. Joint R&D, technical training)
   d) How does your company process or adapt external knowledge?
   e) How does your company transform this knowledge into actual practices? (e.g. Design, branding, product development)

f) Have you faced challenges when integrating external knowledge into your existing operations or strategies?

g) Could you provide examples where external knowledge led to a concrete innovation or change in your firm?

4) Firm Upgrading and Transition from OEM to OBM

a) Could you briefly describe your company's transition from OEM to OBM? What key drivers and challenges in your shift?

b) During this process, was there a key turning point? (e.g. specific market opportunity, client, technology)

c) Was the transition driven more by internal initiative or by external pressures from markets or clients?

d) What role did external knowledge and internal transformation play in this upgrading?

e) Are there still challenges your company faces when competing internationally or expanding its brand?