

Research on the Transformation Path of China's New Energy Vehicle Industry Entering the European Market in the Digital Age

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Abstract. The extension of China's new energy vehicles to Europe has gained momentum in recent years; but the tough regulatory environment and the high level of development in the systems of automobile industries in Europe have necessitated the transformation of traditional export patterns. Not much literature has been devoted to examining the necessary strategy adjustments for Chinese new energy vehicles in terms of changes in internationalization modes and competitive dynamics in Europe. This paper is based on theories related to the Eclectic Paradigm of International Production (OLI) and dynamic capabilities, using data from industries, government documents, and case studies at the firm level to investigate the effect of digital transformation on Chinese new energy vehicles' expansion and competitive advantage formation in Europe. The research findings indicate that Chinese new energy vehicles at present depend on battery technology, economies of scale, and their supply chain advantages for expansion in Europe; but traditional export patterns cannot help sustain in the long run. Digital transformation enhances data utilization, software capabilities, and user engagement capabilities, enabling firms to convert manufacturing advantages into digital competitive advantages and to drive their transition from product exports to digital-enabled localized operations. At the same time, European green regulations and data governance requirements further push firms to enhance their digital supply chain management and compliance capabilities

Keywords: New energy vehicles, European market, digital transformation, dynamic capabilities, OLI paradigm

1. Introduction

In the context of change caused by energy transition and digital development, new energy vehicles are increasingly becoming a key arena of international competition in the automobile industry. The European Green Deal aims to make Europe carbon neutral by 2050 and focuses on carbon emission reduction in the transportation sector, positioning new energy vehicles as an important part of Europe's green transition [1]. Meanwhile, digital technology development is reshaping the competitive landscape of the automobile industry and gradually becoming an important source of competitive advantage for firms. Backed by the battery industrial chain, production capacity, and

supply chain integration capabilities, Chinese new energy vehicle firms have rapidly entered the international market. However, the European market features a strict green regulatory environment, a mature automobile industrial chain, and a relatively high barrier to market entry. Consequently, the model of relying solely on product export is no longer sufficient for Chinese firms to establish a foothold in the European market. Therefore, how to leverage digital capabilities to enable the transformation of Chinese new energy vehicle firms has become a critical research question. Existing research is mostly dedicated to technological innovation in new energy vehicles, industry policy, and export performance. However, relatively little attention has been paid to how Chinese new energy vehicle firms can create new competitive advantages in the European market in the digital era. To address this gap, this paper draws on the OLI framework by Dunning, which suggests that firms seeking to go international should possess ownership, location, and internalization advantages [2]; and the theory of dynamic capabilities proposed by Teece, which involves sensing, seizing, and transforming processes. The integrated framework above will be used to analyze the sources of competitive advantage, the mechanisms of digital transformation, and the strategies of changing internationalization strategies of Chinese new energy vehicle companies in Europe [3]. The idea is to find out how digitalization allows these companies to shift from manufacturing competitive advantage to digital competitive advantage.

2. Analysis of China's new energy vehicle industry

2.1. The evolution of China's new energy vehicle's advantage

The competitive edge of the Chinese industry in new energy vehicles in global markets is not simply the result of subsidies provided by the government but the consequence of industrial policies, logistics development, and marketing as well. The theory that Dunning formulated called OLI is referred to as The Eclectic Paradigm of International Production or Dunning's Eclectic Paradigm where when companies go abroad, the first thing that needs to be done is to create ownership advantages in order to compete in foreign surroundings.

China's ownership advantage in the new energy vehicle industry lies in the production of power batteries, manufacturing capabilities, and supply chain integration. Whereas in the traditional automobile industry, strength in engine and mechanical manufacturing was the major advantage, in the case of new energy vehicles, value creation is shifting towards batteries, electronic control, and digitalization [4]. Hence, supply chain control has become an important factor for achieving cost and technology advantages. The power battery industry forms a critical foundation for China's competitiveness in new energy vehicles. According to data from the International Energy Agency (IEA), Chinese firms hold a major share in the global production of power batteries and have achieved control over battery material processing, cell production, and supply chain support. This industrial agglomeration reduces the production costs of new energy vehicles and accelerates technological iteration [5]. Table 1 summarises the key foundations of China's EV industrial advantage.

Table 1. Foundations of China's EV industrial advantage

Source of advantages	Formation	Impact on international competition
Battery power industry chain	Concentration of battery materials, cell manufacturing and supply system	Reduce production costs, enhance supply stability

Table 1. (continued)

Manufacturing scale	The large domestic market for new energy vehicles drives large-scale production	Promote cost reduction and rapid technological iteration
Supply chain integration	High-level collaboration between component firms and vehicle manufacturers	Improve production efficiency and market response speed

Prior research indicates that the mere existence of traditional manufacturing strengths does not guarantee an organization's competitive advantage in the international market, as competitive advantage has become increasingly dependent on the ability to continuously reconfigure resources [6]. For Chinese new energy vehicle firms, the core challenge is not a lack of manufacturing capability, but rather the ability to convert manufacturing strengths into digital competencies, such as software development and user engagement skills.

2.2. Europe as a strategic and institutional market

The importance of the European new energy vehicle market lies not only in the growth of consumer demand, but also in the institutional effects of this market on firm-level capability development. According to OLI theory, location advantage includes not only market size, but also institutional conditions and the policy environment that shape competitive behavior of firms [2].

In recent years, efforts to promote decarbonization and energy transition in European transport have continued. New energy vehicles have become an important development trend in the European automotive industry. However, compared with the Chinese market, the European market imposes more institutional requirements on market participants, such as carbon emission control, battery lifecycle monitoring, and data protection. In other words, participants entering the European market need competitive products, and the appropriate technical and managerial capabilities to succeed there, as demonstrated in Table 2 below:

Table 2. Institutional requirements of the European EV market

Institutional factors	Key requirements	Capability needed
Green transition policies	Reduce carbon emissions in the transportation sector	Low-carbon supply chain management capability
EU Battery Regulation	Track information on the battery life cycle	Digital data management capability
GDPR	Protect user data security	Data governance capability

This suggests that apart from being a sales market, the European market also acts as a testing ground for the innovation capabilities of NEV companies. According to Porter, high-standard competitive conditions can force firms to innovate and thus become better innovators [7]. This implies that while stricter institutional demands can raise entry barriers for firms, they also push them to acquire advanced technological and management skills.

The significance of the European market to Chinese NEV enterprises is that there is an essential need for firms to compete not only through manufacturing but rather technologically, digitally, and

governance-wise.

2.3. The limits of export-based internationalisation

Although Chinese new energy vehicle companies have established strong manufacturing advantages, the traditional export model limits their ability to further enhance overseas competitiveness. According to OLI theory, internalization advantage explains why companies need to internalise key operations to reduce market transaction costs and gain control over strategic resources [2].

At present, Chinese new energy vehicle companies mainly rely on exports to enter overseas markets — that is, producing domestically and then selling through overseas channels. This model can reduce overseas investment risks, but it also limits firms' control over customer relations, market data, and service systems, as shown in Table 3 below:

Table 3. Limitations of traditional export strategies

Export mode characteristics	Short-term advantages	Long-term restrictions
Domestic production	Reduce manufacturing costs	Limited response speed in overseas markets
Dependence on distribution channels	Quickly enter the market	Insufficient control over consumer data
One-time sales	Expand product sales volume	Lack of sustainable service revenue

However, in the context of the digital economy, the export model may face even greater difficulties. As Bharadwaj et al. argue, digital technologies are reshaping the value-creation process of businesses, thereby making data and digital platforms new strategic assets [8]. Hence, for NEV manufacturers, simply selling vehicles is not enough to build a sustainable competitive advantage.

2.4. Digital transformation as a new source of international advantage

Overall, Chinese new energy vehicle firms already have strong ownership advantages. However, digitalization is transforming the way international competitive advantages are created, as shown in Table 4 below.

Table 4. Transformation of competitive advantages in the EV industry

OLI dimension	Traditional advantages	Digital transformation direction
Ownership Advantage	Manufacturing capabilities, battery technology, supply chain	Software capabilities, data resources, digital services
Location Advantage	Market size and resource conditions	System adaptation and digital governance capabilities
Internalization Advantage	Export channels and overseas sales	User connection and digital ecosystem

This means that digitalization can enable firms to reconfigure their existing resources. Manufacturing capabilities can serve as a foundation for data generation, and data capabilities can

add further layers of improvement to products and customer services [3].

Hence, the primary focus for the internationalization of Chinese new energy vehicle firms in Europe should be not only on increasing export volume, but also on leveraging digital technologies to convert existing competitive advantages into sustainable international competitive advantages. This analysis also helps to provide a theoretical and industry context for the further examination of selected automotive brands, namely Tesla, BYD, and NIO, in the next chapter.

3. Digital transformation as a mechanism for reconfiguring EV international advantages

3.1. Reconfiguring ownership advantage

Based on the theoretical framework introduced above, digitalization is redefining the nature of ownership advantages of new energy vehicle firms. Competition in traditional automotive industries is based on manufacturing scale, mechanical technology, and supply chain management, whereas competition in new energy vehicles is gradually becoming dependent on a combination of battery technology, software capabilities, data assets, and intelligent service offerings [4].

Chinese new energy vehicle firms possess a solid manufacturing base. According to statistics from the IEA, China occupies an essential place in global production of new energy vehicles and the power battery supply chain. Nevertheless, manufacturing scale per se does not necessarily translate into digital competitive advantage [5]. Rather, it depends on the ability of firms to leverage the data generated through vehicle usage for product and service improvements [3]. Table 5 below illustrates the main digital capabilities of selected EV firms.

Table 5. Digitalisation-related resources of EV firms

Firms	Main digital abilities	Competitive Advantage
Tesla	Autopilot, OTA upgrade, vehicle networking system	Continuously enhancing vehicle value through software
BYD	DiLink intelligent system, battery management system	Transforming manufacturing advantages into digital product capabilities
NIO	NIO App, User community, battery swapping system	Strengthening user stickiness through services

As shown in the table above, different companies have developed different approaches to utilising data. The core strength of Tesla lies not only in its ability to collect vehicle data, but also in its capacity to continuously optimize algorithms and perform software upgrades by using that data, thereby adding value to its cars beyond their initial selling price. BYD, on the other hand, has more users, and its strength lies in accumulating digital assets through its production scale. Therefore, the critical challenge faced by Chinese NEV manufacturers is not a shortage of data assets, but rather how to more efficiently convert their scale advantages into digital asset advantages.

3.2. Digital transformation and the evolution of internalization advantage

The conventional internationalization strategy primarily focuses on exports and overseas distribution channels; however, this strategy limits firms' ability to control customer relationships and market information. According to OLI theory, internalization advantage is defined as the reduction of transaction costs and the improvement of market control through internalising core processes [2].

China's NEV exports have increased significantly in recent years; however, rising export volumes do not always translate into overseas market control, as illustrated in the table 6 below:

Table 6. Limitations of export-based internationalisation

Mode	Advantages	Restriction
Vehicle export	Reduce risks in overseas investment	Lack of consumer data
Distribution channel	Quickly expand market coverage	User relationships are controlled by a third party
Product sales	Increase sales volume	Lack of continuous service value

Digitalization has transformed this approach. By leveraging in-vehicle networking technologies, digital service platforms, and user engagement systems, firms can reduce their reliance on traditional distribution methods and obtain continuous feedback from overseas customers, as shown in the table 7 below.

Table 7. Digital-enabled internationalisation strategies

Firms	European entry strategy	Digital support
BYD	Export and local production layout	Intelligent vehicle system, cloud services
NIO	Direct sales and battery swapping service	User community, digital platform
MG (SAIC)	Channel expansion	Digital marketing platform

The above-mentioned cases demonstrate how new energy vehicle firms enter international markets in the context of digitalization. Competition among firms is no longer only about one-time product delivery, but rather about sustaining relationships with users in overseas markets

3.3. Comparative analysis of digital transformation paths

In order to further investigate the way digitization generates different forms of competitive advantages for firms internationally, this paper examines three models of entry represented by Tesla, BYD, and NIO. Table8 below compares the digital transformation models of these three firms.

Table 8. Digital transformation models of EV firms

Firms	Digitalization model	Mechanism	Competitive advantage	Restriction
Tesla	Software-driven model	Leverage vehicle data optimization technologies and improve the product continuously via OTA technology.	Form Digital Ownership Advantage and enhance user control ability	Dependence on software capabilities and data scale

Table 8. (continued)

BYD	Manufacturing integration model	Integrate batteries, production and smart system to turn industrial strengths into digital strengths.	Transform scale advantage into digital product advantage	The software ecosystem still needs improvement
NIO	User ecosystem model	Connect customers via apps, communities and battery swap services.	Enhance user relationships and service value	Expansion costs are high

Based on the above table, Tesla follows the software-driven business model, with its competitive advantage lying in the control of vehicle data and software capabilities that enable cars to become continuously upgradable digital products rather than one-time sale goods [3].

It seems like a more feasible option when taking into account the endowment capabilities of the companies making new energy vehicles in China.

For the case of NIO, the problem lies in developing sustainable customer relationships using digital platforms. But then, since this strategy will take a lot of service infrastructure, its expansion internationally becomes quite expensive.

4. Strategic transformation paths for Chinese EV firms in Europe

4.1. Developing digital capabilities beyond manufacturing advantages

As stated earlier in the previous chapter, there is already a strong production advantage for the Chinese new energy vehicle companies, but in the context of digital economy development, the competitive advantage of the new energy vehicle industry is increasingly based on data and software for creating value continuously [8]. Based on Li, one of the most valuable assets that the Chinese firms have is their sizeable customer base. Through the analysis of vast amounts of data collected through vehicles in relation to operations, battery performance, driving behavior, and other aspects, the firms will be able to optimise their product [9]. However, only having large amounts of data is not enough to gain a competitive advantage; it is related to the capability of the firms to analyse data and take advantage of it. On this point, Tian et al. propose that Chinese new energy vehicle firms move from their manufacturing capabilities to digital capabilities [10]. For example, utilising data to optimise battery management, intelligent driving, and in-car services can transform vehicles into continuously valuable products.

4.2. Moving from export-oriented expansion to digital-enabled localisation

As mentioned above, rising NEV exports from China do not necessarily guarantee that firms are deeply integrated into the European market. The conventional export model enables firms to gain rapid entry into overseas markets, yet it restricts their ability to manage customer relationships, market information, and service systems, as illustrated in Table 9 below.

Table 9. Challenges of export-based internationalisation

Main challenges	Reason	Impact on firms
Insufficient brand influence	European consumers have limited knowledge of Chinese brands.	Restricts long-term market competition
High reliance on channels	Sales are made through importers and distributors.	Difficult to directly obtain user data
Insufficient localization	The overseas service network is still under construction.	Reduces market adaptability

In light of the above mentioned challenges, the Chinese enterprises should change from simple exporting to digitalized localization for their entry into the European market. Digitalization would enable such enterprises to lessen dependence on the traditional way of operation and gain more insight about foreign customers. For example, by using in-vehicle networking systems, such enterprises would be able to obtain real-time information regarding the operation of the vehicles and customize their products according to each market; in addition, by using digital service platforms, they would be able to update the software and offer after-sales services.

The above mentioned transition would be shown in BYD's European business plan, which includes localization of production, establishment of marketing network and development of intelligent services. In such a case, Chinese enterprises do not have to give up their strong points in manufacturing. On the contrary, they should establish digital operations along with manufacturing in order to transform their strategy from selling vehicles to managing customer relationships. From OLI perspective, this would be the transformation of the internalization advantage from traditional asset control to digital market control.

4.3. Building digital ecosystems and governance capabilities for long-term market integration

The aim of digital internationalization is not only to improve the sales process , but also to build lasting relationships between the firm and its customers, its supply chain partners, and the regulatory environment. In this regard, the key elements of this approach are summarised in Table 10 below:

Table 10. Digital ecosystem and governance strategies

Strategic direction	Objective	Digitalization effects
Digital service ecosystem	To increase the value of user lifetime	Enhance user relationships through software and intelligent services
Supply chain digital governance	To meet European regulatory requirements	Improve battery tracking and supply chain transparency
Data governance capability	To reduce the risk of market entry	Comply with European data protection requirements

A key difference between new energy vehicles and traditional vehicles is that after sale, they continuously generate data and service demands [11]. In response, automakers need to build a digital ecosystem integrating vehicles, users, and service systems. For instance, through software upgrades and digital service provision, Tesla has strengthened its ability to manage user relationships [12].

However, it is not necessary for Chinese firms to follow this path exactly. Instead, they should combine their own strengths to develop a digital ecosystem tailored to their contexts. For instance, BYD can use their strengths in batteries and manufacturing by utilizing intelligent vehicle systems and energy management; NIO adds user value by using their user community and service network [13].

Furthermore, the regulatory obligations of the European market environment have resulted in digital governance becoming another capability that is needed for international business activities. Information management systems are needed in order to ensure lifecycle management of batteries, supply chain transparency, and data protection. Thus, the importance of digital governance not only stems from regulatory obligations, but also from increased operational efficiency. For instance, an information management system of batteries can help comply with the European regulations and optimize supply chain risk management. As a result, digital governance is shifting from a cost of compliance to a competitive advantage.

5. Conclusion

In this paper, we have explored the pathway of transformation of China's new energy vehicle industry, especially in terms of its growth towards the European market in the age of digitalization. In particular, we have analyzed how the process of digital transformation can affect the international competitive advantage and internationalization strategies of the Chinese NEV enterprises in Europe. It is concluded that digital transformation is not only an issue concerning the improvement of the production efficiency but also the critical driving force that helps the Chinese companies to move from traditional manufacturing and exporting mode to digital internationalization mode.

The initial competitive advantage of the Chinese NEV enterprises in Europe was related to battery technology, manufacturing capacity, and supply chain integration ability. These resources allowed the Chinese companies to quickly increase NEV exports and establish competitive advantages in costs. However, as the NEV market in Europe has matured, it became increasingly difficult for the Chinese enterprises to continue their internationalization on the basis of manufacturing capacity. With the increasing competition in the NEV market, the source of the competition becomes the software, data, and intelligent services.

Furthermore, regulations in the European market have also contributed to making digitalization increasingly significant. To address battery lifecycle management, supply chain transparency, and data governance regulations in the region, Chinese firms operating in Europe not only need to provide competitive NEV products but also should have digital governance capabilities that satisfy regulatory requirements in Europe. Therefore, digitalization not only plays a key role in creating value through high-value-added products but is also a necessary condition for market integration.

In general, the evolution of China's NEV industry from a manufacturing-driven to a digitalized one can be observed when Chinese NEV companies become increasingly present in Europe. In the process, the manufacturing-integrated digitalization strategy represented by BYD may better reflect the current resource endowment of China's NEV industry, considering the fact that manufacturing advantages still play the most important role in China's NEV industry. However, Chinese companies need to cultivate software capabilities, data analytics capabilities, digital services ecosystem, and localization capabilities in order to achieve sustainable competitive advantages in Europe.

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