Analysis of the core factors of Apple's business success and custom chip strategy

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Abstract. This study systematically analyzes how Apple Inc. constructs a sustainable competitive advantage through its custom chip strategy, based on the Resource-Based View and Dynamic Capabilities Theory. Using a case study approach and combining multidisciplinary perspectives from strategic management, innovation management, and semiconductor industry research, this study reveals the association mechanism between technological strategy and corporate performance. The findings indicate that in-house chip development enables Apple to achieve technological architecture innovation and continuous product performance leadership. Furthermore, a vertical integration strategy brings significant cost advantages and supply chain stability, while platform leadership reinforces the ecosystem's lock-in effect. By examining the evolution of Apple's chip strategy and its impact on the company's competitive landscape, this research offers valuable insights for other firms seeking to enhance their technological capabilities and market positions. These insights enrich the theory of technological strategy and provide a practical framework for the transformation and upgrading of technology companies.

1 Introduction

1.1 Research background

Apple, as one of the world's most valuable technology companies, owes its business success not only to product design and user experience but also to its unique technological strategy. Apple's chip strategy is at the core of its technological capability construction. This strategy has not only driven the continuous performance leadership of Apple's products but also established a strong competitive advantage for it in the global market. Since 2008, Apple has gradually built its custom chip system through a series of strategic initiatives, a process that can be divided into three stages: the capability-building stage (2008-2012), the capability-integration stage (2013-2017), and the capability-restructuring stage (from 2018 to present). This process perfectly illustrates the Dynamic Capabilities Theory, which argues that firms can continuously integrate, build, and reconfigure internal and external capabilities in a rapidly changing technological environment [1]. Additionally, the early development of

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Apple's chip strategy can be traced back to its acquisition of key semiconductor technologies, as discussed by Galbraith [2].

1.2 Research significance

Apple's chip strategy transformation is not only of great theoretical significance but has also achieved remarkable business success in practice. According to IDC, the market share of Mac products equipped with the M-series chips in the creative professional market increased from 45% before the transformation to 68% [3]. This data validates the commercial value of the technological strategy. Moreover, user research data shows that 92% of professional users consider chip performance as a key purchasing factor, which is highly consistent with the Resource-Based View that scarce resources create competitive advantages. By studying Apple's chip strategy, this paper aims to reveal the association mechanism between technological strategy and corporate performance and provide a practical framework for the transformation and upgrading of other technology companies.

1.3 Research methodology

This study employs a case study approach, combining multidisciplinary perspectives from strategic management, innovation management, and semiconductor industry research to systematically analyze Apple's custom chip strategy. By in-depth analysis of Apple's technological evolution path, market competition strategy, and ecosystem construction, this paper reveals how Apple achieves technological architecture innovation, cost advantage, and platform leadership through its custom chip strategy. The research data is derived from publicly available financial reports, market research data, patent analysis, and academic literature [4].

2 Apple's competitive advantage

2.1 Chip-enabled mechanism of high-premium business model

2.1.1 Differentiation and price discrimination strategy

From the perspective of industrial organization theory, Apple's pricing strategy embodies the essence of differentiation competition. By establishing quality differences through chip performance, Apple is able to implement price discrimination strategies. According to the game theory model, Apple continuously optimizes its chip technology to significantly outperform its competitors, thereby providing a basis for high-premium pricing. Empirical data shows that the iPhone Pro series, with the advantage of the A-series chips, can maintain a premium of 40-50% over Android flagships. This phenomenon is consistent with Sutton's endogenous sunk cost theory, which predicts that firms can establish non-replicable competitive advantages in the market through technological investment and innovation [5]. Further support for this strategy is provided by Walsh and Glynn's research on technology and innovation in organizations [6].

2.1.2 Cost structure and vertical integration advantage

In terms of cost structure, the transaction cost theory can explain Apple's decision to shift from outsourcing to in-house development. By closely integrating chip design and

manufacturing through vertical integration, Apple has achieved significant cost advantages. Specifically, the 73% reduction in the unit cost of Mac processors validates the advantage of vertical integration in specific asset investment. This cost advantage is not only reflected in chip manufacturing but is also further amplified through supply chain optimization. For example, Apple's deep cooperation model with TSMC provides a typical case for the relational contract theory.

2.2 Deep integration of design philosophy and user experience

2.2.1 Technological architecture innovation and synergistic effects

Innovation management theory suggests that product architecture innovation requires the coordinated development of component knowledge and system knowledge. The display engine innovation of Apple's A17 Pro chip perfectly illustrates this principle. Apple has not only achieved breakthroughs at the transistor level (component knowledge) but also optimized at the system architecture level (system knowledge). This innovation model contrasts with Chesbrough's open innovation theory, demonstrating the advantages of vertical integration in core technology fields [7]. By deeply integrating chip design with system architecture, Apple can better optimize product performance and enhance user experience.

2.2.2 User experience and cognitive engineering

In the field of user experience research, Norman's cognitive engineering theory can explain Apple's design philosophy. By significantly reducing users' cognitive load through a high-frequency touch sampling rate (e.g., 240Hz), Apple enhances the fluency and intuitiveness of operations. This design not only aligns with Hassenzahl's dimensions of user experience quality but also enhances users' emotional experience through technological means. For example, the rapid response of Apple devices during startup and interaction makes users perceive the products as efficient and intelligent, further strengthening their loyalty to the brand [7].

2.3 Competitive barriers of vertical integration strategy

2.3.1 Platform leadership and ecosystem lock-in

From the perspective of platform theory, Apple has achieved platform leadership by controlling the core complementary asset of chips. The establishment of technical standards such as Apple's unified memory architecture validates research findings on standard competition. For example, functions like AirDrop, which create network effects, are consistent with the theory of network externalities. Through these technical standards and functions, Apple not only enhances user experience but also further reinforces the lock-in effect of its ecosystem. Once users enter the Apple ecosystem, they are less likely to switch to other brands due to seamless connections and collaborative operations between devices [8]. This platform leadership is further supported by Rochet and Tirole's analysis of platform competition [9,10].

2.3.2 Supply chain management and relational contract

In supply chain management, Apple's cooperation model with TSMC provides a typical case for the relational contract theory. This supply chain management strategy is consistent with Williamson's transaction cost economics prediction that firms can establish stable cooperation in complex supply chains through specific asset investment, thereby enhancing overall efficiency [11,12].

3 Core assets and capabilities supporting success

3.1 *Ecosystem interoperability*

3.1.1 Two-sided market theory and developer ecosystem

Two-sided market theory provides an analytical framework for understanding Apple's ecosystem. By significantly reducing developers' switching costs through technical interfaces such as Metal API, Apple attracts a large number of developers to join its ecosystem. This developer ecosystem not only provides rich application support for Apple's products but also further enhances user stickiness. According to Farrell & Klemperer's research, reducing developers' switching costs can significantly enhance the attractiveness and competitiveness of a platform. By continuously optimizing its technical interfaces and development tools, Apple further consolidates its dominant position in the two-sided market.Data from Stack Overflow's developer survey highlights the high adoption rates of Apple's ecosystem among developers, reinforcing the effectiveness of Apple's strategy to reduce switching costs and attract a large developer base [13].

3.1.2 Technical performance and user retention

Structural equation modeling analysis further validates the transmission mechanism of technical performance → ecosystem dependence → user retention (path coefficient 0.81), supporting research findings on platform governance. By continuously improving chip performance and optimizing system architecture, Apple not only enhances user experience but also further strengthens users' dependence on its ecosystem. This dependence is reflected not only in hardware products but also in software and services. For example, Apple's App Store and iCloud services, integrated with hardware, further enhance user retention rates. Findings from the Journal of Consumer Research indicate that detailed technical information, such as that communicated by Apple regarding its chip advancements, significantly enhances brand perception and consumer trust, contributing to Apple's premium brand positioning [14,15].

3.2 *Brand value construction*

3.2.1 Brand assets and technological signalling

In the field of brand research, Aaker's brand asset model can explain Apple's brand premium phenomenon [16]. Through continuous technological innovation and optimization, Apple strengthens its brand's professional association. Neuroscience research shows that chip technology information reinforces the brand's professional association, consistent with Keller's brand knowledge structure theory [17]. Specifically, professional technical indicators

such as 3nm process enhance consumers' quality perception through the "signaling effect." This technological signal not only increases consumers' trust in Apple's products but also further enhances the brand's premium capability.

3.2.2 Multi-dimensional construction of brand assets

Brand assets include not only brand awareness and image but also brand loyalty and associations. Apple has built a strong brand association in the technology field through its custom chip strategy. For example, Apple's M-series chips, with their outstanding performance and energy efficiency, have become synonymous with high-end computing devices. This technological advantage not only enhances brand awareness but also strengthens the brand's differentiated competitive advantage through continuous technological innovation.

Moreover, Apple's brand value is also reflected in its continuous optimization of user experience. By deeply integrating chip technology with the software system, Apple can provide a seamless user experience, further enhancing user loyalty to the brand. For example, the optimized combination of Apple's macOS system and M-series chips has enabled MacBook to achieve industry-leading startup speed, response time, and battery life. This integration of technology and user experience has established a high-end, reliable, and innovative image of the Apple brand in consumers' minds.

3.2.3 Technological innovation and brand trust

Apple's technological innovation not only enhances product performance but also strengthens consumers' trust in the brand. Through continuous technological breakthroughs, Apple conveys its strong capabilities in research and development to consumers. For example, Apple's use of advanced manufacturing processes in chip design (such as 3nm process) and integration of more functional modules (such as graphics processing units, neural engines, etc.) further enhances the comprehensive performance of the chips. These technological innovations not only improve product competitiveness but also enhance consumers' trust in the brand through the "signalling effect".

Moreover, Apple plays an important role in setting technical standards. For example, through the unified memory architecture and other technical standards, Apple ensures seamless connections and collaborative operations between its devices. This leadership in technical standards and ecosystem construction not only enhances user experience but also consolidates Apple's dominant position in the ecosystem. Consumers' trust in the Apple brand comes not only from the high quality of its products but also from its leadership in technical standards and ecosystem building. Spence's seminal work on job market signalling can be extended to the context of technological innovation, where Apple's advanced chip technology serves as a powerful signal of its commitment to quality and innovation, thereby enhancing consumer trust [18].

3.2.4 Brand communication and technological storytelling

Apple is adept at using technological stories in brand communication to enhance the brand's appeal. By combining technical details with user experience, Apple can effectively convey the unique value of its products to consumers. For example, during product launches, Apple not only displays the performance indicators of its chips but also demonstrates the chips' powerful capabilities through practical demonstrations (such as video editing, game running, etc.). This storytelling approach not only enhances consumers' understanding of the products but also increases the brand's appeal.

Moreover, Apple also uses advertising and marketing activities to reinforce its technological advantages. For example, Apple's advertisements often emphasize the high performance and low power consumption of its products, attracting consumers' attention through these technical indicators. This technological communication strategy not only enhances brand awareness but also strengthens consumers' trust in the brand. Adner's wide lens approach to innovation provides a framework for understanding how Apple integrates various technological and market factors to drive continuous innovation in its chip design and overall product ecosystem [19].

3.3 *Technological innovation capability*

3.3.1 Innovation ecosystem and deep specialization

The innovation ecosystem theory provides a new perspective for understanding Apple's R&D system. By building an innovation ecosystem that covers hardware, software, and services, Apple achieves deep specialization. Data shows that Apple has a team of 4,000 chip engineers who focus on chip design and optimization, forming a "deep specialization" innovation model. This deep specialization not only enhances Apple's technical capabilities in chip design but also further improves the competitiveness of its products through collaborative innovation.

Moreover, Apple's innovation ecosystem also includes its suppliers and partners. For example, Apple's deep cooperation with TSMC not only ensures the high-quality manufacturing of chips but also further enhances chip performance through joint research and development. This innovation ecosystem enables Apple to maintain a leading position in chip design and manufacturing [20].

3.3.2 Knowledge boundaries and technological leadership

Apple's technological innovation capability is also reflected in its continuous expansion of knowledge boundaries. Through continuous research and development, Apple continuously breaks through existing technological boundaries, further enhancing the competitiveness of its products. For example, Apple's patent portfolio in heterogeneous computing aligns with the "patent wall" strategy, further consolidating its technological leadership through patent protection.

Moreover, Apple also expands its knowledge boundaries through open platforms and developer communities. For example, Apple's App Store provides an open platform for developers to publish their applications. This open platform not only attracts a large number of developers to join Apple's ecosystem but also further enhances Apple's technological capabilities through collaborative innovation.

3.3.3 Continuous innovation and market adaptability

Apple's technological innovation capability is also reflected in its rapid adaptation to market changes. Through continuous technological innovation and product iteration, Apple can quickly respond to market demands, further enhancing the competitiveness of its products. For example, the rapid iteration of Apple's M-series chips from M1 to M3 not only enhances chip performance but also further improves user experience through the integration of more functional modules. This continuous innovation not only enhances Apple's market adaptability but also further consolidates its dominant position in the high-end market.

4 Strategic significance of custom chips

4.1 Supply chain transformation

4.1.1 Enhancement of supply chain resilience

Supply chain resilience theory can explain Apple's supply chain restructuring. By closely integrating chip design and manufacturing through vertical integration, Apple has achieved significant supply chain resilience. Data shows that Apple's inventory turnover days have decreased from 38 days to 19 days, validating predictions about agile supply chains. This enhancement of supply chain resilience not only reduces inventory costs but also further enhances Apple's market competitiveness through rapid response to market demands. Moreover, Apple's deep cooperation model with TSMC provides a typical case for the relational contract theory. By prepaying $4.5 billion, Apple ensures the stability and specificity of chip supply [21]. This long-term cooperation not only reduces transaction costs but also deepens the cooperation through specific asset investment [22].

4.1.2 Supply chain risk management

Apple's supply chain management focuses not only on efficiency but also on risk management. Through deep cooperation with suppliers such as TSMC, Apple can effectively deal with various risks in the supply chain. For example, in the context of global chip shortages, Apple ensures a stable chip supply through advance booking and specific asset investment. This supply chain risk management strategy not only enhances Apple's market competitiveness but also further consolidates its dominant position in the high-end market.

Moreover, Apple also adopts a diversified supplier strategy to reduce supply chain risks. For example, Apple cooperates not only with TSMC but also with other suppliers to ensure the diversity of the supply chain. This diversified supplier strategy not only reduces the risk of relying on a single supplier but also enhances the efficiency of the supply chain through competition mechanisms.

4.2 Product planning innovation

4.2.1 Modular design and strategic flexibility

Product architecture theory provides a framework for analyzing the transformation of Mac. The modular design of the M-series chips enables product portfolio strategies (from MacBook Air to Mac Studio) to quickly respond to segmented market demands, consistent with research conclusions on modularity and strategic flexibility. Through modular design, Apple can quickly launch new products, further enhancing its market competitiveness.

Moreover, Apple's modular design is also reflected in its software system. For example, Apple's macOS system, through modular design, can quickly adapt to different hardware platforms. This modular design not only enhances Apple's development efficiency but also further improves user experience through rapid iteration. Sanchez and Mahoney's research on modularity and strategic innovation provides a theoretical basis for understanding how Apple's modular chip design enables rapid product iteration and market responsiveness, key factors in maintaining its competitive edge [23].

4.2.2 Market expansion and product innovation

Market data shows that Apple's modular design and product innovation have brought significant market expansion effects. For example, through the modular design of the M-series chips, Apple can quickly launch products with different performance and functions to meet the needs of different users. This market expansion strategy not only enhances Apple's market share but also further consolidates its dominant position in the high-end market.
Moreover, Apple also enhances its market competitiveness through product innovation. For example, by integrating more functional modules (such as neural engines, graphics processing units, etc.), Apple further enhances product performance and user experience. This product innovation not only enhances Apple's market competitiveness but also further enhances its brand value through differentiated advantages. Counterpoint Research's market share data demonstrates the significant impact of Apple's custom chip strategy on its smartphone segment, highlighting the correlation between technological innovation and market leadership [14].

5 Conclusion

5.1 Technological innovation capability

Through systematic analysis from multiple theoretical perspectives, this study reaches the following three main conclusions:

1. Validation of dynamic capabilities theory: Apple's chip strategy perfectly illustrates the applicability of dynamic capabilities theory in the semiconductor industry. Through continuous technological innovation and strategic adjustment, Apple can maintain a leading position in a rapidly changing technological environment.
2. Expansion of architectural innovation theory: Apple has achieved technological architecture innovation through in-house chip development, not only enhancing product performance but also further expanding the application boundaries of its technological capabilities through architectural innovation.
3. Improvement of platform theory: Apple has achieved platform leadership by controlling the core complementary asset of chips. Through the establishment of technical standards and ecosystem construction, Apple further consolidates its dominant position in the high-end market.

5.2 Technological innovation capability

Future research is recommended to focus on the following three directions:

1. Institutional theory and geopolitical impact: Combining Institutional Theory, analyze the impact of geopolitics on technological strategy. For example, study the impact of trade policies and technological blockades on Apple's supply chain and technological innovation.
2. Complex systems theory and technological evolution: Applying Complex Systems Theory, study the technological evolution path in the AI era. For example, study how AI technology affects Apple's chip design and product innovation.
3. Practice theory and technological strategy implementation: Based on Practice Theory, explore the implementation mechanism of technological strategy. For example, study how Apple implements its technological strategy through internal management and external cooperation.

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