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Reverse Outsourcing, Knowledge Base Reconfiguration, and Technological Autonomy of Latecomer Firms: A Case Study of Huawei

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ABSTRACT

Against the backdrop of core technology blockades and intensified global competition for innovation resources, how latecomer firms can break through technological barriers to achieve technological autonomy is an important question that demands both theoretical and practical answers. Traditional technology introduction pathways are constrained by blockades from developed countries, while "reverse outsourcing" offers a viable pathway for latecomer firms to achieve technological autonomy. Drawing on the knowledge-based view, this paper defines reverse outsourcing as an innovation model in which latecomer firms proactively integrate global high-end innovation resources, reversely acquire frontier knowledge, and achieve autonomous internalization. Its core mechanism lies in reconfiguring the firm's knowledge base through the importation, internalization, and recombination of external knowledge, thereby driving a qualitative transformation from "output capability" to "innovation capability." This paper constructs a five-stage operation mechanism model, revealing the intrinsic mechanism through which reverse outsourcing empowers technological autonomy in latecomer firms via knowledge base reconfiguration. The findings reveal that reverse outsourcing, by substituting "talent embedding" for "technology introduction," enables latecomer firms to directly capture frontier knowledge at the source of technology, and to bridge domestic innovation capability gaps through systematic reverse technology transfer. Using Huawei as a typical case, this paper validates the theoretical logic that reverse outsourcing reconfigures the knowledge base to drive technological autonomy in latecomer firms, providing a new theoretical explanation and practical reference for latecomer firms pursuing technological autonomy under technology blockade conditions.

KEYWORDS

Reverse Outsourcing; Knowledge Base Reconfiguration; Latecomer Firms; Technological Autonomy; Reverse Technology Transfer.

1. INTRODUCTION

The global industrial chain is currently undergoing a profound restructuring, with some developed countries promoting "decoupling and supply chain disruption" and continuously escalating blockades against China's core technologies. The dilemma of being constrained by "bottleneck" technologies essentially reflects the passive situation faced by latecomer firms after the traditional technology introduction pathway has been blocked. For a long time, the technological catch-up of latecomer firms has primarily relied on the traditional pathway of "introduction–digestion–absorption–re-innovation" —— introducing mature technologies from developed countries and accumulating

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independent capabilities through digestion and absorption. However, as developed countries intensify their blockades on core technology transfer, this traditional pathway is becoming ineffective. Firms face a fundamental dilemma: without introduction, they cannot close the technology gap; with introduction, they face the risks of technology blockade and "low-end lock-in."

Against this background, "reverse outsourcing" as a technology acquisition model is becoming a strategic choice for leading latecomer firms to break through technological blockades and achieve technological autonomy. Huawei's practice of establishing R&D centers in major global technological innovation hubs and directly hiring local top-tier technical talent is a typical example of reverse outsourcing. Reverse outsourcing empowering latecomer firms to achieve technological autonomy is not only a strategic choice at the firm level, but also an important pathway for safeguarding China's industrial chain security under the new dual-circulation development pattern [1].

However, how does reverse outsourcing empower latecomer firms to achieve technological autonomy? What is its intrinsic mechanism? Existing research primarily focuses on the conceptual definition and macro-effect analysis of reverse outsourcing, lacking a systematic explanation of its micro-mechanisms for empowering technological autonomy. Drawing on the knowledge-based view, this paper constructs a five-stage operation mechanism model of reverse outsourcing reconfiguring the knowledge base to empower technological autonomy in latecomer firms, and uses Huawei as a typical case for validation, aiming to reveal the theoretical logic and practical pathways through which latecomer firms achieve technological autonomy via reverse outsourcing.

2. CONCEPTUAL CONNOTATIONS AND THEORETICAL FOUNDATIONS OF REVERSE OUTSOURCING

2.1. Defining Reverse Outsourcing

Reverse outsourcing was first proposed by Sen to explain actions taken by India and China to address their shortages of high-end talent. Subsequently, scholars have defined reverse outsourcing from various perspectives. Tholons defined reverse outsourcing as follows: developing countries, as original contractors, employ professional and technical personnel from developed countries, which are the original clients, to complete tasks originally outsourced by developed countries to developing countries. Liu Danlu et al. defined reverse outsourcing as an outsourcing process in which firms in developing countries with relatively lower labor costs, in turn, act as the active outsourcers [2]. Zhang Yueyou and Liu Danlu further pointed out that reverse outsourcing is a new form for developing countries to aggregate global innovation resources, and a new type of international outsourcing model in which developing countries enter the global division of labor from the high end of the value chain and proactively acquire global innovation resources [3]. In essence, reverse outsourcing is an outsourcing activity in which developing countries act as the active clients, with developed countries as the contractors, by means of employing professional and technical personnel from developed countries, acquiring firms in developed countries, or establishing subsidiaries and offshore R&D centers in developed countries.

Synthesizing the above definitions, this paper defines reverse outsourcing as: a strategic innovation model in which latecomer firms, as active clients, reversely acquire frontier technological knowledge and high-end innovation resources from developed countries by employing professional and technical personnel, establishing overseas R&D centers, and implementing cross-border mergers and acquisitions, and realize technological autonomy through internalization and absorption.

Reverse outsourcing is distinguished from traditional technology introduction by four core features: First, direction reversal —— knowledge flow shifts from a one-way "North-to-South" movement (from developed to developing countries) to a "reverse" acquisition by latecomer firms from

developed countries; Second, subject transformation —— latecomer firms shift from passive technology recipients to active integrators of innovation resources; Third, object upgrading —— the acquisition targets are not mature production technologies, but frontier knowledge still in formation and high-end intellectual resources; Fourth, goal transition —— the objective is not merely to close the technology gap, but to achieve knowledge base reconfiguration and technological capability leapfrogging.

2.2. Analytical Perspective Based on the Knowledge-Based View

The knowledge-based view holds that firms are collections of knowledge, and that competitive advantage stems from their possession of heterogeneous knowledge resources and their capabilities to integrate, create, and apply knowledge. A firm's knowledge base determines its innovation capability and technological development trajectory. The fundamental reason why latecomer firms are in a catch-up position is the significant gap in breadth, depth, and frontier orientation of their knowledge base compared with leading firms.

The core logic of reverse outsourcing driving technological autonomy lies precisely in its ability to help firms reconfigure their knowledge base. Knowledge base reconfiguration refers to the systematic adjustment and optimization of a firm's existing knowledge structure through the importation, internalization, and recombination of external knowledge, enabling it to advance from a knowledge state of "being able to produce" to one of "being able to innovate." In this process, firms must not only acquire new knowledge elements, but also establish new knowledge linkages and form an independent knowledge architecture and technological trajectory.

2.3. Theoretical Foundations

The knowledge-based view provides the core analytical framework for understanding how reverse outsourcing reconfigures a firm's knowledge base. Through reverse outsourcing, firms are able to capture frontier knowledge directly at the source of technology, incorporate external knowledge elements into their internal knowledge system, and reconfigure their knowledge base through deep integration with existing knowledge.

Absorptive capacity theory emphasizes that a firm's capability to identify, absorb, and utilize external knowledge is a critical factor determining the effectiveness of technology transfer. Cohen and Levinthal pointed out that absorptive capacity is path-dependent —— firms need relevant prior knowledge to identify, absorb, and utilize new external knowledge [4]. The effectiveness of reverse outsourcing is highly dependent on the absorptive capacity of latecomer firms —— only those with sufficient prior knowledge can effectively internalize captured frontier knowledge and transform it into autonomous innovation capability.

Technological catch-up theory suggests that the technological catch-up of latecomer firms need not follow only the "linear introduction" pathway, but can also achieve leapfrogging through reverse importation. As a "reverse importation" model, reverse outsourcing enables latecomer firms to directly connect with global frontier knowledge networks even under conditions of significant technology gaps.

3. THE OPERATION MECHANISM OF REVERSE OUTSOURCING RECONFIGURING THE KNOWLEDGE BASE TO EMPOWER TECHNOLOGICAL AUTONOMY

The core mechanism through which reverse outsourcing drives technological autonomy lies in the reconfiguration of the firm's knowledge base through the systematic importation, internalization, and recombination of external knowledge. Drawing on the knowledge-based view, this paper constructs

a five-stage operation mechanism model of reverse outsourcing reconfiguring the knowledge base to empower technological autonomy in latecomer firms: Global Innovation Identification → Reverse Outsourcing Organization → Reverse Collaboration and Knowledge Importation → Knowledge Deconstruction and Recombinant Innovation → Autonomous Internalization and Industrial Leadership. The five stages are sequentially linked and progressively advanced, jointly forming a complete cycle from "external knowledge introduction" to "knowledge base reconfiguration" to "technological autonomy."

3.1. Stage One: Global Innovation Identification

The prerequisite for knowledge base reconfiguration is that firms can accurately identify the gaps in their own knowledge base and precisely locate external knowledge sources capable of filling these gaps. The core of traditional technology introduction is "buying technology" —— purchasing patents, equipment, or production lines, acquiring technological outcomes that have already matured. The core of reverse outsourcing is "buying intelligence" —— directly acquiring high-end talent and innovation teams that possess frontier knowledge. The essence of this transformation is: upgrading the "product orientation" of technology introduction to the "source orientation" of knowledge acquisition.

The core task of this stage is: latecomer firms establish a global technology monitoring system, systematically scan high-end innovation resources such as R&D institutions, design firms, and laboratories in developed countries, and evaluate their technical expertise and cooperation feasibility [5]. Firms need to accurately identify reverse cooperation partners that can compensate for their knowledge base weaknesses and lead technological leapfrogging, and rationally plan investment regions and timelines according to the technological endowments of different countries or regions. The success of this stage depends on the firm's global innovation identification capability —— whether it can precisely locate external high-end innovation nodes available for collaboration within complex global innovation networks. Awate et al. point out that latecomer firms need to shift from "passively waiting for technology diffusion" to "actively scanning global innovation sources" [6].

The knowledge base reconfiguration effect at this stage is reflected in: through a systematic examination of their own knowledge base, firms clarify the strategic direction of "what is lacking" and "where to obtain it," laying the cognitive foundation for subsequent knowledge importation and recombination.

3.2. Stage Two: Reverse Outsourcing Organization

Based on the completion of global innovation identification, firms enter the reverse outsourcing organization stage. The core task of this stage is: firms establish specialized cross-border collaboration teams, clarify intellectual property ownership, knowledge transfer mechanisms, and phased objectives through cooperation agreements, and establish efficient communication channels and trust mechanisms.

There are three main approaches to knowledge acquisition in reverse outsourcing: First, establishing overseas R&D centers. Latecomer firms establish R&D institutions in major global technological innovation hubs (such as Silicon Valley, Munich, Tokyo, etc.) to directly embed themselves in local knowledge networks. Overseas R&D centers are not only "tentacles" for knowledge acquisition, but also "nodes" connecting global innovation resources. Second, employing professional and technical personnel from developed countries. This is the most core knowledge acquisition approach in reverse outsourcing. Latecomer firms introduce "knowledge carriers" into the firm by directly hiring overseas top technical experts. Unlike purchasing patents, hiring high-end talent acquires "living knowledge" —— encompassing not only codifiable technical knowledge, but also tacit experience and judgment that is difficult to transfer. Third, implementing cross-border mergers and acquisitions. By acquiring

firms in developed countries that possess core technologies, firms rapidly acquire their technological accumulations, R&D teams, and intellectual property. Cross-border M&A, as a lever for technological catch-up, can help firms cross technological thresholds and acquire systematic knowledge assets.

The knowledge base reconfiguration effect at this stage is reflected in: firms establish institutionalized external knowledge acquisition channels, providing a stable "knowledge input" mechanism for the expansion of the knowledge base. It is through this systematic reverse outsourcing organization that latecomer firms such as Huawei achieve knowledge flow from external innovation sources to internal firm boundaries.

3.3. Stage Three: Reverse Collaboration and Knowledge Importation

Acquiring external knowledge is only the first step; whether it can be incorporated into the firm's knowledge base depends on the firm's absorptive capacity. The core challenge of knowledge importation in reverse outsourcing is: how to transform tacit knowledge embedded in specific talent and teams into systematic knowledge assets that are reusable and diffusible within the firm's knowledge base.

The core task of this stage is: the firm's R&D team deeply engages in the external team's R&D process, importing key technical knowledge in real-time through joint work, personnel exchange, and data sharing, understanding technical principles and mastering core methods through collaboration.

The knowledge acquired by latecomer firms through reverse outsourcing has a high degree of "individual embeddedness" —— knowledge is attached to specific technical personnel rather than stored in corporate documents or databases. Therefore, the key to knowledge importation lies in achieving the "de-personalization" and "organizationalization" of knowledge. Specific pathways include: first, establishing cross-border R&D collaboration mechanisms that enable regular personnel exchange, joint research, and knowledge sharing between overseas R&D centers and domestic R&D teams, allowing frontier knowledge acquired overseas to flow within the organization; second, building knowledge codification systems that convert the experience, judgment, and creativity of overseas talent into codifiable and reusable technical documents, design specifications, and patent outcomes, transforming individual knowledge into organizational knowledge; third, forming institutionalized channels for reverse technology transfer that systematically transfer frontier ideas from overseas R&D centers to the home country headquarters. Huawei does not develop new products overseas, but rather transfers innovative ideas to China by employing highly motivated talent.

The knowledge base reconfiguration effect at this stage is reflected in: external knowledge is incorporated into the firm's knowledge system, the breadth of the knowledge base is expanded, and knowledge is organizationally precipitated through codification.

3.4. Stage Four: Knowledge Deconstruction and Recombinant Innovation

The most critical transformation of reverse outsourcing occurs at this stage. Awate et al. distinguish between two types of firm capabilities: output capability —— the ability to produce frontier products; and innovation capability —— the ability to invent frontier technologies [6]. Traditional technology introduction typically helps firms acquire only output capability —— being able to produce advanced products, but not necessarily being able to innovate continuously. The goal of reverse outsourcing is to achieve a qualitative transformation from "output capability" to "innovation capability," which in essence is a deep reconfiguration of the knowledge base from "being able to produce" to "being able to innovate."

The core task of this stage is: based on internal R&D platforms, firms analyze, validate, and adaptively modify imported external knowledge, achieve localized reconfiguration of technical knowledge, and form preliminary independent technology solutions.

The essence of knowledge deconstruction and recombinant innovation is: deeply integrating externally acquired knowledge with the internal knowledge system to form the firm's own knowledge architecture and technological trajectory. This process is not simple "knowledge superimposition," but "knowledge reconfiguration" —— integrating fragmented external knowledge into a systematic internal knowledge system. Research shows that Huawei bridges its domestic innovation capability gaps through systematic reverse technology transfer, transferring complex ideas from technology frontier centers to China [7].

The knowledge base reconfiguration effect at this stage is reflected in: the firm's knowledge base transitions from "fragmented" to "systematic," from "externally dependent" to "autonomously integrated," and the network of knowledge associations is reestablished, forming an independent knowledge architecture.

3.5. Stage Five: Autonomous Internalization and Industrial Leadership

The ultimate value of reverse outsourcing lies not in accomplishing a one-time technological breakthrough, but in establishing sustainable technological autonomy capability. The core feature of the autonomous internalization stage is: the firm has established an independent knowledge architecture and technological R&D system, and reverse outsourcing has transformed from a "knowledge acquisition channel" into a "strategic node of the global innovation network."

The core task of this stage is: firms solidify the reorganized knowledge system into their own R&D architecture and production systems, complete independent development of core technologies and intellectual property deployment, and achieve complete internalization of reverse outsourcing outcomes. At this stage, overseas R&D centers are no longer merely "input ports" for knowledge, but organic components of the global innovation network —— not only importing knowledge to the home country, but also participating in the co-creation of global frontier technologies. The firm upgrades from "knowledge recipient" to "knowledge co-creator," and from "technology follower" to "technologically autonomous firm."

The knowledge base reconfiguration effect at this stage is reflected in: the firm's knowledge base completes the qualitative transformation from "catch-up oriented" to "leadership oriented," forming sustainable knowledge creation and integration capabilities. Research shows that by transferring strategic ideas, Huawei has successfully compensated for its domestic innovation capability deficiencies and is able to create competitive technologies.

4. BOUNDARY CONDITIONS OF REVERSE OUTSOURCING RECONFIGURING THE KNOWLEDGE BASE

Reverse outsourcing is not applicable to all latecomer firms. The effectiveness of its empowerment of technological autonomy through knowledge base reconfiguration depends on the following boundary conditions:

First, the firm's absorptive capacity is a prerequisite. Reverse outsourcing acquires frontier knowledge rather than mature technologies, imposing higher demands on the absorptive capacity of firms. Firms lacking sufficient prior knowledge, even if they acquire frontier knowledge, cannot effectively understand and internalize it. A firm's absorptive capacity is path-dependent —— firms need relevant prior knowledge to identify, absorb, and utilize new external knowledge.

Second, the scale of the domestic market is a critical support. One fundamental condition for reverse outsourcing empowering technological autonomy is the enormous market potential of developing countries. The vast domestic market provides application scenarios and iteration space for technologies acquired through reverse outsourcing.

Third, sustained strategic investment is a guarantee. Reverse outsourcing is a long-term strategy rather than a short-term tactic. Firms need to make sustained investments in global innovation identification, cross-border collaboration organization, knowledge importation and internalization, among other aspects. According to Huawei's 2024 Annual Report, Huawei's cumulative R&D investment over the past decade has exceeded RMB 1,249 billion [8].

Fourth, the institutional environment is an important condition. Sound intellectual property protection systems, flexible talent introduction policies, and an open international business environment are all important institutional guarantees for the effective operation of reverse outsourcing.

5. CASE ANALYSIS: HUAWEI'S REVERSE OUTSOURCING PRACTICES

Huawei is a typical case of achieving technological autonomy through reverse outsourcing to reconfigure its knowledge base on a global scale. Its reverse outsourcing practices exemplify the above five-stage operation mechanism.

5.1. Global Innovation Identification and Strategic Layout

Huawei has systematically laid out its strategic presence in major global technological innovation hubs. Huawei's overseas R&D layout is not a simple "capacity transfer," but "extending R&D tentacles to the sources of knowledge" —— focusing on wireless communication algorithms in Stockholm, Sweden; aesthetics and industrial design in Paris, France; mathematical algorithm optimization in Moscow, Russia; and chip design and AI frontiers in Silicon Valley, USA.

Huawei has established approximately 16 overseas R&D centers globally, distributed across Sweden, France, Russia, the United States, India, Germany, and other countries, focusing on different technology areas such as wireless communication algorithms, aesthetic design, mathematical algorithms, chip design, and software platforms, forming an R&D network covering major global innovation hubs. Research shows that Huawei excels at rationally planning investment regions and processes according to the technological endowments of different countries or regions [9]. This global innovation identification capability enables Huawei to precisely locate high-end innovation nodes available for collaboration on a global scale.

5.2. Reverse Outsourcing Organization and Collaboration Initiation

Unlike traditional overseas R&D, Huawei's overseas R&D centers are strategically centered on "directly hiring local top technical experts." Research shows that Huawei does not primarily rely on acquiring technologically advanced firms, but rather directly hires technical experts through greenfield investments to internalize specific professional knowledge. Huawei transfers innovative ideas to China by employing experienced technical personnel, rather than developing new products overseas. Huawei establishes R&D institutions through greenfield investments in major global technological innovation hubs, directly embedding itself in local knowledge networks. This approach enables Huawei to acquire global top-tier intellectual resources at relatively low cost.

5.3. Reverse Collaboration and Knowledge Importation

What distinguishes Huawei is its systematic reverse technology transfer strategy. Huawei acquires local innovative ideas by employing highly motivated talent and systematically transfers them to China. This "talent embedding" strategy enables Huawei to directly capture frontier knowledge at the source of technology, rather than waiting for technology to diffuse to its home country. Ideas are transferred faster within firms than knowledge. By establishing effective international technology transfer capabilities, Huawei forms a spatial knowledge strategy that can, at least temporarily, compensate for domestic innovation capability deficiencies [7].

5.4. Knowledge Deconstruction and Recombinant Innovation

The most critical outcome of Huawei's reverse outsourcing practices is the leap from "output capability" to "innovation capability." Research shows that this systematic transfer of complex ideas enables Huawei to bridge domestic innovation capability gaps, possessing the output capability to compete in global markets even before establishing domestic innovation capabilities [7]. Research indicates that Huawei transfers new knowledge from overseas branches to China much faster than in the reverse direction through reverse technology transfer. New knowledge generated in overseas branches is rapidly transferred to China, enabling Huawei to compensate for domestic innovation capability deficiencies.

Huawei's breakthrough in 5G communications is a prime example. Huawei began investing in 5G basic research in 2009, and after more than a decade, its polar code solution was adopted as a 5G international standard. This breakthrough did not originate from external technology introduction, but rather from integrating global intellectual resources and feeding them back into Huawei's global R&D system.

5.5. Autonomous Internalization and Industrial Leadership

Through sustained reverse outsourcing practices, Huawei has transformed from a "technology recipient" to a "co-creator of global innovation." Its overseas R&D centers are no longer merely "input ports" for knowledge, but "strategic nodes" participating in the co-creation of global frontier technologies. Huawei's influence in 5G standard-setting and its leading role in the release of the UBIOS standard both signify its transformation from a "technology follower" to a "technologically autonomous firm."

Huawei's R&D investment in 2024 reached RMB 179.7 billion, accounting for approximately 20.8% of its annual revenue [8]. This sustained high-intensity investment enables the knowledge acquired through reverse outsourcing to be fully digested, absorbed, and re-innovated, ultimately transforming into the firm's autonomous technological capabilities. Through this strategy, Huawei has not only achieved technological autonomy but has also established a leading position in the global communications sector.

6. CONCLUSION

Drawing on the knowledge-based view, this paper has constructed a five-stage operation mechanism model of reverse outsourcing reconfiguring the knowledge base to empower technological autonomy in latecomer firms —— "Global Innovation Identification → Reverse Outsourcing Organization → Reverse Collaboration and Knowledge Importation → Knowledge Deconstruction and Recombinant Innovation → Autonomous Internalization and Industrial Leadership" —— and validated it using Huawei as a typical case. The main conclusions are as follows:

First, reverse outsourcing is an effective pathway for latecomer firms to achieve technological autonomy under technology blockade conditions. Unlike traditional technology introduction, reverse outsourcing substitutes "talent embedding" for "technology introduction," enabling firms to directly capture frontier knowledge at the source of technology. Research shows that Huawei bridges domestic innovation capability gaps through systematic reverse technology transfer, transferring complex ideas from technology frontier centers to China.

Second, the core mechanism through which reverse outsourcing empowers technological autonomy lies in reconfiguring the firm's knowledge base. Reverse outsourcing achieves the qualitative transformation of the firm's knowledge base from "being able to produce" to "being able to innovate" through five stages: Global Innovation Identification (knowledge gap diagnosis) → Reverse

Outsourcing Organization (knowledge acquisition channel construction) → Reverse Collaboration and Knowledge Importation (external knowledge internalization) → Knowledge Deconstruction and Recombinant Innovation (deep knowledge base reconfiguration) → Autonomous Internalization and Industrial Leadership (knowledge base capability solidification).

Third, the effectiveness of reverse outsourcing empowering technological autonomy depends on the firm's absorptive capacity, the scale of the domestic market, sustained strategic investment, and the institutional environment. Reverse outsourcing is not a "shortcut," but a strategic choice requiring long-term investment and systematic management.

Fourth, Huawei's practice demonstrates that systematic reverse technology transfer enables firms to acquire the output capability to compete in global markets through frontier knowledge captured by overseas R&D nodes even before domestic innovation capabilities are fully established, ultimately achieving the transformation from "follower" to "technologically autonomous firm."

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