

ALGORITHMIC GOVERNANCE AND THE RECONFIGURATION OF GLOBAL VALUE CHAINS: A CASE STUDY OF SHEIN'S ON-DEMAND MANUFACTURING MODEL

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Abstract: This paper examines how algorithmic governance reshapes global value chains (GVCs) in the context of platform-based fast fashion. While prior research has explored platform governance and GVC organization separately, less attention has been paid to how algorithmic systems intervene in production processes at an operational level. Drawing on a qualitative case study of SHEIN, this study uses multiple sources of secondary data, including company disclosures, industry reports, and third-party analyses. A process-tracing approach is adopted to reconstruct the development of SHEIN's on-demand manufacturing model. The findings suggest that algorithmic governance operates through three interrelated mechanisms: real-time demand sensing, small-batch production, and dynamic supply chain coordination. Together, these mechanisms enable a shift from a forecast-driven "push" model to a data-driven "pull" model, reducing inventory risk while improving responsiveness. By linking platform governance with GVC analysis, this paper provides a mechanism-based explanation of how data capabilities reshape production organization. It also highlights digital embedding as an alternative pathway for firms to participate in global value creation.

Keywords: Global value chains; Algorithmic governance; Platform economy; On-demand manufacturing; Digital embedding

1 INTRODUCTION

1.1 Research Background: GVC Transformation Driven by New Quality Productive Forces

The global apparel industry is pivoting toward a new paradigm of 'New Quality Productive Forces' (NQPF), where traditional resource-heavy manufacturing is supplanted by an innovation-led framework characterized by hyper-efficiency and high-tech integration. Unlike traditional productivity models that rely on the massive consumption of labor and capital, NQPF is driven by revolutionary technological breakthroughs and the innovative integration of production factors, with data emerging as a core factor of production. In the context of Global Value Chains (GVCs), this transformation manifests as a transition from labor-intensive, resource-heavy manufacturing to a digitalized, intelligent, and highly efficient ecosystem.

From a GVC perspective, governance refers to how power and coordination are structured across geographically dispersed production networks[1]. In traditional apparel value chains, lead firms typically coordinate suppliers through forecasting, standardized orders, and cost-based competition. This "industrial-age" productivity model results in rigid production systems, high inventory risks, and limited responsiveness to volatile global markets.

In recent years, however, the proliferation of digital platforms has catalyzed the development of NQPF, enabling more flexible and responsive production systems. By leveraging real-time data and algorithmic governance—the "new tools" of digital productivity—platform-based firms can achieve a "pull-based" coordination of dispersed suppliers. This represents a fundamental reconfiguration of GVC organization: the primary driver of value creation is no longer mere manufacturing scale, but the algorithmic capacity to synchronize fragmented supply with real-time demand.

Despite a growing body of research on digital platforms and GVCs, these two strands of literature have largely developed in parallel. Studies on platform governance tend to focus on data control, while GVC research emphasizes upgrading trajectories. However, there remains a critical research gap in understanding how New Quality Productive Forces, specifically through algorithmic systems, intervene in production at an operational level to transform coordination mechanisms within GVCs.

1.2 Literature Review and Research Gap

Existing research has shown that digital technologies can reduce transaction costs and improve coordination efficiency. Digitalisation plays a key role in upgrading processes within global value chains[2]. However, most studies treat technology as a general enabling factor, rather than examining the specific mechanisms through which algorithms reshape production processes and supplier relationships. As a result, we still lack a clear explanation of how platform-based firms are able to sustain rapid production cycles without relying on traditional scale advantages.

1.3 Case Selection and Research Value

1.3.1 Case selection

SHEIN is selected as a critical case due to its distinctive data-driven production model. Unlike traditional fast fashion firms, SHEIN operates through a highly responsive system characterized by small-batch production and rapid iteration. This makes it a suitable case for examining how algorithmic governance operates within production networks.

1.3.2 Research value

Theoretical value: This study challenges and expands on traditional GVC theories (e.g., governance model, smile curve) built on the industrial age paradigm, revealing how data and algorithms can become a new and powerful governance mechanism in the digital age. This study extends the concept of algorithmic governance to explain how platforms can be coordinated and controlled through technology rather than ownership. This mechanism facilitates a structural uplifting of the manufacturing segment within the value chain, challenging its traditional positioning at the low-value-added "bottom" of the industrial-age paradigm. At the same time, research shows that the enterprise upgrading path does not necessarily have to be through "functional upgrading" (self-branding), but can also achieve value climbing through "digital embedding" in the intelligent platform ecosystem and improving flexibility and digital capabilities, which provides a new perspective for understanding the industrial upgrading of developing countries.

Practical value: For manufacturing enterprises, this study reveals that digital transformation is a necessary option for survival and development, and points out the specific path to improve flexible production capacity through technological transformation to connect with global intelligent platforms. For platform enterprises, SHEIN provides a business model that can be used as a reference and uses intelligent algorithms to integrate fragmented supply chains. For policymakers, this study emphasizes the importance of cultivating local industrial Internet platforms and data ecosystems, and calls for policies to focus on supporting enterprise digital transformation, data talent training, and data-based business model innovation.

2 THEORETICAL FRAMEWORK: THE ALGORITHM-COORDINATED GVC

2.1 From Traditional Lead Firm to "Digital Platform Lead Firm"

In this study, "algorithmic governance" denotes a fundamental restructuring of leadership within Global Value Chains (GVCs). Algorithms increasingly function as the primary mechanism for organizational coordination and control. In this context, algorithmic governance signifies a decisive shift in the locus of power. Rather than relying on the sheer gravity of tangible assets—such as manufacturing facilities—or traditional brand equity, platform leadership now exerts a form of 'soft coordination' that leverages real-time data processing and inherent network externalities to command global production networks.

Traditional industrial lead firms typically exercise "captive governance" over suppliers by controlling scarce upstream and downstream resources. These firms leverage global cost differentials to allocate production through a centralized "command-and-execute" relationship, where suppliers function as passive recipients of standardized orders.

In contrast, the power of digital platform lead firms stems from matching efficiency and network effects. While suppliers remain strategically integrated into the ecosystem, they are no longer anchored by rigid, long-term contractual obligations alone, but rather by the dynamic opportunity to access platform-generated traffic and algorithmically allocated orders. The coordination logic is no longer unidirectional; instead, algorithms drive production via real-time data sensing, while operational feedback from the production side continuously optimizes the algorithmic models, creating a self-evolving closed-loop system.

The key distinction between New Quality Productive Forces and traditional productivity lies in "data" displacing land and capital as a core factor of production. In this context, the algorithmic system serves as a quintessential "production tool" within the realm of digital trade, reshaping how value is created and captured in modern economies[3].

2.2 The Mechanism of Intelligent Algorithms in Reshaping GVCs

In this study, "algorithmic governance" denotes a fundamental restructuring of leadership within Global Value Chains (GVCs). Algorithms now function as the primary mechanism for organizational coordination and control[4]. Specifically, the locus of power has shifted from "hard control" anchored in tangible assets (manufacturing capacity) and traditional intangible assets (brand premiums, patents) toward "soft coordination" driven by data processing and network externalities.

Traditional lead firms typically maintain "captive" relationships with suppliers by monopolizing critical upstream resources. Under this industrial paradigm, lead firms utilize global cost differentials to manage production through a top-down "command-and-execute" framework, treating suppliers as passive executors of predetermined orders.

In contrast, the influence of digital platform lead firms is rooted in matching efficiency. Although suppliers remain dependent on the platform, their integration is maintained through high-frequency algorithmic order allocation rather than traditional long-term contractual rigidity. This coordination is no longer a linear, one-way process. Instead, algorithms dictate production based on real-time market signals, while the resulting operational data is fed back to refine the governing models, creating a self-evolving loop.

2.2.1 Demand-side: predictive analytics

This study conceptualizes algorithmic governance as a mechanism that links data sensing with supply chain transformation. Specifically, it operates through three interrelated processes: demand sensing, production adjustment, and supply chain coordination. Data and digital platforms increasingly shape production systems and market

coordination[5]. The traditional fashion industry is characterized by high levels of inventory uncertainty due to reliance on demand forecasting. In contrast, SHEIN's model is based on continuous demand sensing using real-time data. Algorithms collect and process large volumes of information from social media platforms such as TikTok and Instagram. Through natural language processing and image recognition, emerging fashion trends can be identified and translated into quantifiable demand signals. At the same time, user behavior within the platform is tracked to construct detailed consumer profiles, enabling personalized recommendations and targeted marketing. By improving the accuracy of demand signals, this system reduces uncertainty on the production side and supports a shift toward more responsive and flexible value chain organization.

2.2.2 Supply-side: agile production and coordination

SHEIN subverts the traditional "push" supply chain (predicting → mass production → pushing the market → high inventory risk) to a "pull" supply chain (accurate matching of real-time demand → agile production → near-zero inventory). Digital technologies enhance supply chain visibility and responsiveness[6]. By enabling reconfigurable production systems, algorithms allow firms to dynamically adjust production scale based on real-time demand signals[7].

Algorithmic coordination replaces traditional bidding mechanisms by enabling data-driven matching between demand and supply. Specifically, algorithms allocate orders based on suppliers' digital profiles—including historical performance, product specialization, production speed, cost, and location—as well as order-specific requirements such as process complexity and delivery time. This allows for more efficient and flexible allocation of production tasks across dispersed suppliers.

Furthermore, real-time dynamic scheduling is achieved through the digitalization of the entire production chain, including raw materials, manufacturing, quality inspection, and logistics. By integrating real-time operational data—such as inventory levels, transportation status, and capacity constraints—firms can continuously optimize production and distribution processes. This reflects the broader transformation toward Industry 4.0, in which digital technologies enable real-time monitoring and adaptive decision-making in supply chains[8].

In addition, this system generates a data-driven feedback loop, whereby increased data availability enhances algorithmic accuracy, which in turn improves matching efficiency and attracts more participants to the platform. As a result, fragmented demand and flexible production capacity can be efficiently coordinated in real time.

Based on these demand signals, production is organized in small batches, allowing for rapid testing and iterative adjustment. This represents the second stage of the mechanism. At this stage, algorithms coordinate suppliers through real-time data flows, thereby transforming the organization of production within the value chain.

This mechanism reflects a broader transformation toward digitally enabled supply chains, in which digital technologies facilitate real-time coordination and adaptive production across distributed networks[9].

2.3 Theoretical Dialogue: Algorithmic Governance Reconfiguring GVC

2.3.1 Comparison of governance models: from traditional coordination to algorithmic platforms

Traditional apparel production systems are typically organized through forecasting, standardized orders, and relatively stable coordination mechanisms between lead firms and suppliers. Such arrangements rely on pre-planned production cycles and limited real-time adjustment, which constrains responsiveness to rapidly changing market demand.

In contrast, the model represented by SHEIN reflects a shift toward algorithmic platform-based coordination. In this system, production decisions are no longer primarily determined *ex ante*, but continuously adjusted through real-time data inputs and algorithmic processing. Orders are dynamically allocated across suppliers, and production activities are monitored and optimized through digital systems.

This shift transforms the underlying governance logic of the value chain. Coordination moves from relatively static and relationship-based arrangements to highly dynamic, data-driven processes. As a result, the basis of control shifts toward the ability to process and utilize data in real time, enabling more flexible and scalable organization of production networks.

2.3.2 Reconfiguring the smile curve: algorithmic empowerment of manufacturing

The traditional "smile curve" framework suggests that manufacturing activities tend to generate relatively low value-added compared to upstream R&D and downstream branding functions[10]. However, the integration of algorithmic systems into production processes is reshaping the mechanisms of value capture across the chain.

First, algorithms extend beyond design and marketing functions and become embedded in manufacturing operations. By linking real-time demand data with production execution, manufacturing is transformed from a forecast-based, large-scale process into a highly responsive system characterized by small-batch production and rapid adjustment. This enhances the strategic importance of manufacturing by introducing agility as a critical value-generating capability.

Second, algorithmic coordination reduces mismatches between supply and demand. As production is continuously adjusted based on real-time signals, excess inventory and associated losses are significantly reduced. This may shift manufacturing away from a purely cost-driven role toward a more strategic function within the value chain.

Taken together, these changes suggest that digital technologies do not merely optimize existing processes, but reconfigure the underlying logic of value distribution across the value chain. Manufacturing, traditionally positioned at the lower end of the smile curve, suggesting a potential re-balancing of value distribution, although further empirical evidence is required to substantiate this shift.

3 RESEARCH METHODOLOGY

3.1 Case Study Design

This study follows a qualitative case study approach based on publicly available data. Because the core problem "how intelligent algorithms reshape GVC" is a typical "how" problem, it is suitable for in-depth exploration through cases. As an extreme and typical case, SHEIN can maximize the revelation of the internal mechanism of the phenomenon. The single-case design allows for a focused and in-depth examination, aiming to enable analytical induction rather than statistical generalization, providing a basis for constructing new theories.

3.2 Data Collection

3.2.1 Corporate disclosures and official reports

Primary materials include official ESG and sustainability documents, specifically the SHEIN 2024 Sustainability and Social Impact Report. These documents provide verified operational metrics regarding the adoption of Digital Thermal Transfer Printing and the utilization of the Centre of Innovation for Garment Manufacturing (CIGM). These evaluations focus on water conservation and energy efficiency related to digital printing technologies, as highlighted in corporate sustainability frameworks. Furthermore, public technical patent filings related to SHEIN's automated order-dispatching systems were analyzed to deconstruct the technical implementation of algorithmic governance.

3.2.2 External market intelligence and independent contextual data

To maintain objectivity, this study supplements corporate reports with external data, primarily consumer transaction records and market share estimates from Earnest Analytics. These third-party datasets allow for a direct comparison between the platform's performance and traditional industry incumbents, avoiding the potential bias of self-reported narratives. Additionally, the analysis incorporates independent technical audits and investigative reporting from outlets like Reuters. Integrating these diverse sources provides a more grounded perspective on the platform's algorithmic governance and its broader market impact.

3.3 Data Analysis

3.3.1 Familiarization and initial categorization

All collected materials were carefully reviewed to identify recurring patterns, concepts, and relevant events related to SHEIN's algorithmic governance. Key passages were highlighted to capture the operational logic of real-time demand sensing, agile production, and supply chain coordination. This stage ensured a comprehensive understanding of the dataset and informed subsequent thematic categorization.

3.3.2 Theme development

The highlighted information was then aggregated into broader themes that reflect the underlying mechanisms of SHEIN's production model. Examples of themes include "demand-side forecasting mechanism," "supply-side coordination mechanism," and "role of data as a production factor." Grouping the data in this way helps to systematically trace causal links between digital tools and value chain outcomes.

3.3.3 Theme refinement and narrative construction

Finally, the themes were reviewed and refined to ensure internal consistency and relevance to the research question. Relationships among themes were mapped to construct a coherent narrative explaining how intelligent algorithms transform global value chains. This approach allows the study to generate theoretically grounded insights from secondary data without relying on quantitative analysis or computational coding.

4 CASE ANALYSIS: DECONSTRUCTING SHEIN'S ALGORITHM-DRIVEN GVC

4.1 Background of SHEIN

Founded in 2008 and transitioning to its digital-first model in 2012, SHEIN has redefined the competitive landscape of global fashion. By 2025, the platform has established itself as a major player in cross-border e-commerce, characterized by its rapid expansion and substantial influence on global retail dynamics. The competitive dominance of SHEIN, evidenced by its 43.6% U.S. market share as of early 2025, serves as more than a sales metric; it represents an empirical validation of a superior coordination logic that effectively sidelined traditional incumbents like Zara and H&M[11].

The core of SHEIN's success lies in its 'Data-Driven Real-Time Fashion' architecture, supported by a digitally integrated supply chain that can condense the entire product cycle—from manufacturing to fulfillment—to as few as five days[12]. By replacing high-risk, speculative inventory models with "algorithm-light" precision, SHEIN represents a micro-level practice of "New Quality Productive Forces"—leveraging digital intelligence to optimize resource allocation and minimize waste in global trade.

4.2 Mechanism of Algorithmic Coordination

4.2.1 Demand sensing

By leveraging algorithmic data scraping and real-time social media analytics and web crawlers, SHEIN identifies global fashion trends from social media in real-time. The logic chain: Traffic Algorithm → Sales Forecast → Automatic Dispatching → Real-time Replenishment. This "Digital Infrastructure" ensures that trend discovery is no longer a human guess but a calculated certainty.

4.2.2 Demand validation

The recommendation algorithm functions as a personalized shopping assistant, constructing comprehensive user profiles through collaborative filtering techniques. By analyzing real-time interaction data—such as browsing history, dwell time, and "add-to-cart" actions—the system significantly enhances the accuracy of demand forecasting.

Unlike traditional retail models that rely on historical sales cycles, this mechanism allows the platform to validate consumer interest before large-scale production. By ensuring that production resources are strategically allocated only to products with high predicted engagement, the system effectively mitigates inventory risks from the demand side. This "test-and-learn" approach transforms speculative manufacturing into a data-confirmed response, aligning supply precisely with evolving market trends.

4.2.3 Coordination and scheduling

Based on the digital GVC governance framework[13], the system functions as a central command center. When an order is placed, the algorithm automatically dispatches tasks to a select cluster of agile suppliers based on real-time capacity and expertise. This achieves Minimum Stock Testing (MST), where production scales are precisely calibrated to real-time market signals[14], drastically reducing sunk costs and mitigating the risks associated with initial inventory investment.

4.3 Reshaping the Value Chain: From "Push" to "Pull"

SHEIN's algorithmic precision aligns with the concept of "New Quality Productive Forces," which prioritizes innovation-led, sustainable development. Beyond operational efficiency, this model fosters a "Green GVC" by addressing the industry's most significant environmental challenge: structural overproduction. While traditional fashion retail typically suffers from substantial inventory waste due to inaccurate forecasting, SHEIN's on-demand strategy—characterized by initial micro-batches of 100–200 units[15], enables the company to consistently maintain unsold inventory at low single-digit percentages[16]. This precision achieves sustainability at the source by activating production resources only in response to real-time market signals.

Furthermore, the adoption of digital thermal transfer printing and cool transfer denim printing technologies demonstrates how digital intelligence translates into environmental productivity. In 2024, approximately 51% of SHEIN's directly sourced printed fabrics utilized Digital Thermal Transfer Printing, a process that saved an estimated 550,000 cubic meters of water. Additionally, the CIGM developed over 60 new tools for suppliers, leading to an average productivity increase of 40%[17].

4.4 New Division of Labor and "Digital Capture"

The success of SHEIN reshapes the power logic of GVC. Digital capture refers to the platform acts as the "Brain" (capturing maximum profit via algorithms), while manufacturers act as "Limbs" (executing orders via flexible labor). However, this model may also lead to a form of digital dependence, in which suppliers rely on platform-generated orders while having limited bargaining power. In this sense, production activities become increasingly shaped by platform-based data systems, requiring firms to adapt to algorithmically mediated coordination.

5 DISCUSSION: IMPLICATIONS FOR GVC THEORY AND PRACTICE

5.1 Theoretical Implications

This study contributes to the emerging literature on algorithmic supply chains, where multiple actors are coordinated through seamless data flows and automated decision-making processes[18]. By intersecting this perspective with Global Value Chain (GVC) theory, this paper demonstrates that algorithmic governance constitutes a novel coordination logic that fundamentally reshapes the organization of global production networks.

More specifically, this study extends existing GVC research by proposing an Algorithm-Coordinated GVC Model. It reveals that algorithms have evolved into a sophisticated governance mechanism that operates through real-time data integration and rule-based autonomy, enabling platforms to synchronize dispersed suppliers with unprecedented precision. Compared with traditional governance forms based on equity ownership or rigid contractual control, this mechanism is more flexible, scalable, and less visible, yet remains highly effective in governing complex international production fragmented across borders.

Furthermore, this study revisits the traditional upgrading trajectory of firms in developing countries. Historically, GVC literature suggests a linear progression from Original Equipment Manufacturing (OEM) to Original Design Manufacturing (ODM) and eventually Original Brand Manufacturing (OBM). However, the SHEIN case unveils an alternative trajectory of "horizontal upgrading" through digital embedding. This pathway demonstrates that algorithmic coordination can effectively bridge the value gap between manufacturing and branding, thereby flattening the structural disparity inherent in the traditional "Smile Curve."

By integrating into platform ecosystems and enhancing digital connectivity, manufacturing firms can achieve strategic value-climbing without the immediate necessity of developing independent brands. This finding provides critical counter-evidence to the long-standing assumption in GVC literature that functional upgrading must follow a rigid, linear path. It implies that digitalization may partially decouple value capture from brand ownership, offering a new perspective on industrial upgrading in the digital economy, as demonstrated by this study.

5.2 Managerial and Policy Implications

5.2.1 For enterprises: cultivating "digital partnership" capabilities

From a managerial perspective, digital transformation has shifted from an operational option to a strategic imperative. To thrive in algorithm-governed networks, firms should prioritize the following:

Agile Production Excellence: Transition from scale-oriented to responsiveness-oriented models. Firms must optimize internal processes to handle high-frequency, small-batch orders with precision and speed.

Data Interoperability: High-level synchronization between internal systems (e.g., MES/ERP) and lead platforms is the "entry ticket." Developing this "digital fluency" allows firms to operate as integrated partners rather than isolated vendors.

Strategic Algorithmic Positioning: Beyond cost-cutting, firms should leverage superior data performance and fulfillment reliability to secure preferential algorithmic allocation, translating operational efficiency into strategic bargaining power within the ecosystem.

5.2.2 For policymakers: balancing governance and security

To foster a resilient and sustainable digital economy, policymakers should prioritize the following strategic areas:

Cultivating Indigenous Digital Ecosystems: Governments should support the development of sovereign industrial internet platforms. This reduces long-term dependence on foreign digital infrastructures and enhances the nation's strategic participation in global algorithmic governance.

Establishing Robust Data Governance Frameworks: It is essential to create a regulatory environment that balances data fluidity with security. Policies should promote seamless data circulation within supply chains while strictly safeguarding national security, intellectual property rights, and personal privacy.

Reforming Talent Development Systems: Education systems must be recalibrated to produce a new generation of "digital laborers." This workforce should possess a dual competency in both traditional manufacturing expertise and advanced data literacy, enabling them to adapt to the demands of an AI-driven economy.

6 CONCLUSION

6.1 Summary of Findings

This study identifies a transformative mechanism through which algorithmic governance reshapes Global Value Chains (GVCs). Specifically, the findings reveal that algorithms function as a real-time coordination nexus, integrating demand sensing, rapid production adjustment, and supply chain synchronization into a seamless data-driven closed loop.

The case of SHEIN demonstrates that this mechanism significantly mitigates inventory risk and enhances responsiveness, enabling platforms to capture value through data-driven orchestration rather than traditional brand-building alone. Furthermore, the study identifies a path for "horizontal upgrading" of manufacturing firms, where digital embedding into platform-based networks allows suppliers to recapture value previously lost to market mismatches, effectively elevating the "trough" of the traditional smile curve.

6.2 Limitations and Future Research

Despite its contributions, this study has several limitations. First, it relies primarily on secondary data, which constrains the analysis of micro-level processes within firms. Second, as a single-case study, the findings may have limited generalizability.

Future research can extend this study in several directions. First, comparative studies across different platform models could provide a more comprehensive understanding of algorithmic governance. Second, further research could explore the social and ethical implications of algorithmic coordination, including data privacy and labor conditions. Third, quantitative methods may be employed to test the theoretical propositions proposed in this study. Finally, future studies could investigate effective policy tools for regulating platform-based economies.

These directions will contribute to a deeper understanding of the transformation of global value chains in the digital era.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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