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Power and governance in global value chains: upgrading of Pakistani mobile application vendors in an era of platforms

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Abstract

This study integrates Gereffi et al.'s governance framework with Dallas et al.'s power typology to explain the functional upgrading of low-capability suppliers under increasing industry complexity. We argue that governance alone cannot account for upgrading in platform-mediated global value chains, without accounting for how institutional and constitutive power interact. By examining Pakistani mobile application vendors in Apple's iOS and Google's Android ecosystems, we demonstrate that while platform codification facilitates initial learning, it does not by itself lead to functional upgrading. Instead, upgrading depends on both platform codification and suppliers' ability to gain legitimacy, enabling shifts from captive to modular governance.

Keywords: **global value chains, power, governance, platforms, mobile application.**

JEL classifications: **F63, L23, L86.**

1. Introduction

Global value chains (GVCs) have long provided a central analytical lens for examining how firms and regions participate in the global economy, particularly with respect to value creation, capture and upgrading. Within this literature, governance has been a core concern, especially in relation to the cross-border coordination of inter-firm relations and its implications for access to markets, knowledge and higher-value activities (Gereffi et al. 2005; Kano et al. 2020). Yet governance in GVCs is not only about coordination; it is also fundamentally about power (Alford 2020). Through the interaction of coordination

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and power, lead firms and other actors shape not only the organization of production, but also the conditions under which local suppliers and workers are included in, or excluded from, processes of upgrading (Choksy et al. 2022).

Early GVC scholarship conceptualized power primarily within dyadic buyer–supplier relations, where lead firms exercise control over specifications, processes, quality, delivery, and pricing, thereby shaping supplier learning and upgrading (Humphrey and Schmitz 2002; Ponte and Gibbon 2005). Power is thus understood largely through coordination and bargaining asymmetries, with captive governance in particular constraining suppliers in developing countries to low-value activities (Choksy 2015). However, a growing body of work shows that some suppliers operating under similar governance conditions are nevertheless able to broaden participation, strengthen capabilities and achieve functional upgrading (Sako and Zylberberg 2019; Sinkovics et al. 2019; Choksy et al. 2025a). This variation suggests that governance alone cannot explain upgrading outcomes, pointing to the need to more fully account for broader dynamics of power.

Recent scholarship has responded by moving beyond dyadic perspectives to conceptualize power as multidimensional (Henderson et al. 2002; Coe et al. 2008; Yeung and Coe 2015). Dallas et al. (2019), for example, highlight how power operates not only through bargaining, but also through institutional, demonstrative and constitutive forms that are embedded in standards, norms and wider coordination systems. While these contributions significantly deepen our understanding of power in GVCs, a key gap remains. We still lack a clear explanation of how governance structures and different forms of power interact to enable or constrain supplier upgrading under similar conditions (Ponte and Sturgeon 2014; Kano et al. 2020).

This study addresses this theoretical puzzle through the case of Pakistani mobile app vendors (AVs) operating within platform-mediated GVCs.[1] Digital platforms represent a distinctive and increasingly important mode of organizing production, characterized by standardized interfaces, modular architectures and extensive codification. Through these features, platforms such as Android and iOS enable coordination at unprecedented scale while simultaneously reshaping power relations between supplier firms and other actors. As such, they provide a particularly revealing empirical lens for examining how governance and power interact to shape upgrading dynamics.

The case of Pakistani mobile application vendors (AVs) offers a paradox. On the one hand, with the birth of smartphones, the mobile app industry witnessed explosive technical complexity and more exacting industry standards, driven by advances in hardware, platform standards, and user experience (UX) requirements (Holzer and Ondrus 2011). However, despite having no presence in the pre-smartphone era, Pakistani AVs rapidly expanded their participation and prominence in global app development and achieved functional upgrading. This is even more notable given Pakistan's peripheral position and challenging institutional environment (Sinkovics et al. 2019; Choksy et al. 2025a,b).[2]

Normally, when suppliers are less capable, GVC theory would associate surging technical complexity and more exacting standards with captive governance, in which lead firms exert tighter control over production, thereby raising entry barriers and constraining upgrading (Dolan and Humphrey 2004; Kaplinsky and Morris 2018; Ponte et al. 2023). Consistent with this view, prior research shows that high task complexity and power asymmetries tend to hinder functional upgrading among developing-country suppliers (Lema 2014; Choksy et al. 2024a). However, in our case of Pakistani AVs, complexity and standardization appear to facilitate rather than constrain entry and upgrading. Against this backdrop, our study addresses the following question: *how did Pakistani mobile AVs achieve functional upgrading and*

1. The 2010s saw the globalization of mobile apps and rapid increase in technical complexity, driven by advances in hardware, platform-specific standards, and user experience requirements (Holzer and Ondrus 2011). In 2025, the mobile application market stood at US$298 billion and was projected to exhibit a growth of 14 per cent per annum from 2023 to 2030 (Fortune Business Insights 2025).
2. Pakistani AVs have expanded in global markets, as evidenced by rising app downloads and higher rankings in the global freelance app development market (Data Darbar 2024; Sherwani 2025).

escape captive ties in the face of surging complexity and heightened standardization in the mobile telecommunications industry?

To address this question, we integrate two complementary frameworks. First, the GVC governance framework (Gereffi et al. 2005; hereafter GHS) identifies the key drivers of governance—complexity, codification, and capabilities. Second, the power framework developed by Dallas et al. (2019; hereafter DPS) distinguishes between different forms of power, including institutional and constitutive. Our analysis yields two main insights. First, the effects of GHS governance drivers depend critically on how power is exercised. When power operates primarily through dyadic buyer–supplier relations, increasing complexity and standardization tend to reinforce exclusionary dynamics when suppliers are less capable. In contrast, when power operates institutionally through platforms, complexity and codification can have inclusionary effects by lowering coordination costs and lowering entry barriers. Second, institutional power alone is insufficient to achieve functional upgrading. Suppliers must also acquire legitimacy within professional communities—a process of constitutive power. In our case, engagement with agile methodologies and open-source communities enables AVs to build such legitimacy, facilitating movement into higher-value activities and the loosening of initially captive ties.

The study makes two main contributions. Conceptually, by integrating GHS and DPS, we show that upgrading outcomes depend not only on supplier capabilities or dyadic governance structures, but on the interaction between institutional and constitutive forms of power. Empirically, we identify a pathway through which low-capability suppliers can achieve functional upgrading by leveraging platform-based codification, when paired with legitimacy building within community-driven norms. While particularly visible in platform-mediated industries, this mechanism has broader implications for understanding upgrading dynamics across GVCs.

The remainder of the study is structured as follows. Section 2 reviews governance and power in GVCs, focusing on the GHS and DPS frameworks. Section 3 outlines the methodology. Section 4 examines the evolution of institutional power in mobile platforms. Section 5 analyses governance and power dynamics among Pakistani AVs. Section 6 discusses the findings and outlines theoretical and policy implications. The Supplementary Appendix provides supporting qualitative and quantitative material.

2. Literature review

2.1 Governance and power in GVCs

Governance is a central concept in GVC research, with GHS's (2005) seminal GVC governance theory focusing on inter-firm linkages. GHS proposed three interactive variables (transactional complexity, transactional codification, and supplier capabilities) which combine to yield five governance types: traditional market and hierarchy, with three intermediary forms: modular, relational, and captive governance (see Table 1).

In terms of power, the GHS framework argues that it varies *by degrees*, depending on the nature of lead firm-supplier relationships: market coordination contains minimal power asymmetry, but power asymmetry steadily increases from modular to relational to captive to hierarchy. Nevertheless, in the GHS framework, power remains a unitary and undifferentiated concept of coercive 'bargaining' power.

While GHS (2005: 99) acknowledged that various factors (e.g. institutions, trade policies, and even consumer culture) affect changes in governance, they remained parsimoniously focused on three variables that determine governance. In doing so, they offered a predictive 'theory of linkages' (Sturgeon 2009), concentrating on relative bargaining power in dyads to explain any governance changes at the linkage-level. However, scaling the GHS framework has proven challenging because governance at one dyad does not necessarily 'travel' to other up/downstream linkages or to whole chain governance dynamics (Ponte and Sturgeon 2014), leading some to argue that the framework necessitates multi-scalar analysis (Dallas 2014).

Table 1. Governance (Gereffi et al. 2005) and power (Dallas et al. 2019): comparison and implications for platforms and supplier upgrading.

	'Governance' (Gereffi et al. 2005)	'Power' (Dallas et al. 2019)
Actors	1 Dyads: buyer–supplier	1 Dyads 2 Collectives (e.g. meta-organizations, social movements)
Classification criteria	1 Complexity 2 Codifiability 3 Competence	1 Number of actors (dyads/collectives) 2 Transmission mechanism of power (direct/diffuse)
Types of governance and power	*Five types of governance* power increases Market: Simple + High codification + High competence Modular: Complex + High codification + High competence Relational: Complex + Low codification + High competence Captive: Complex + High codification + Low competence Hierarchy: Complex + Low codification + Low competence	*Four categories of power* Bargaining: Dyads + Direct power Demonstrative: Dyads + Diffuse power Institutional: Collective + Direct power Constitutive: Collective + Diffuse power
Application to platforms	Difficulty 'travelling' beyond dyad and integrating platforms: • Platforms are not dyadic • Complements are not necessary inputs; they are 'options'	Platforms: 1 Institutional power: formal standards (offers *opportunities* to complementors) 2 Constitutive power: legitimacy (*enables* complementors to upgrade)
Supplier/complementor Upgrading and lead firm	• Supplier upgrading changes governance type • Degrades relative buyer power (e.g. captive → modular or hierarchy → relational)	• No change in type of power. • App developer has no impact on platform sponsor; it can only change governance type with other complementors (e.g. app orchestrator)

Over time, the analytical lens of GVC and global production networks (GPNs) research has expanded to encapsulate new forms of governance and power, such as governance through 'normalizing' (Gibbon and Ponte 2008), and by incorporating a wider variety of non-firm actors that shape governance (Coe et al. 2008).

Given this, some GVC researchers have applied alternative theories of power. For instance, some have found inspiration in Foucault's governmentality (Gibbon and Ponte 2008; Raj-Reichert 2015) and its concept of 'disciplining' actor behaviours, even when traversing long geographic distances. Others have found Gramsci's flexible concept of hegemony useful to describe the ever-tenuous balance of power, for instance between firms and citizen groups in negotiating corporate social responsibility (CSR) practices (Bair and Palpacuer 2015; Alford 2020).

These important contributions, along with the rapid diversification of non-firm actors in GVCs, were integrated together into DPS's (2019) framework of power in GVCs. DPS systematized power in GVCs by organizing the literature along two dimensions: the 'arena of actors' (from dyadic to collectives) and 'transmission mechanisms' (from direct to diffuse). Paradigmatic 'dyads' are buyers–suppliers, while 'collectives' include groups of aligned actors, such as multistakeholder initiatives or social movements

(Grabs and Ponte 2019). 'Direct' power involves the intentional exercise of power by an individual or collective of actors, through explicit incentives or sanctions. 'Diffuse' power is exercised in often unintentional ways, whereby actors may not be fully aware of their influence or even of each other as in/out-group members. Examples include any emergent norms, conventions and best practices that shape actor behaviours.

This two-by-two typology yields four ideal power types: bargaining, demonstrative, institutional and constitutive (see Table 1). As mentioned, *bargaining power* (dyadic/direct) is most commonly analysed in GVC research, and includes instances when firms directly collaborate through supplier-buyer relationships. *Demonstrative power* (dyadic/diffuse) occurs when powerful actors unintentionally affect behaviour, such as when lead firm demands for supplier upgrading 'induce imitation in other supplier tiers or among competitors' (Dallas et al. 2019: 679). *Institutional power* involves 'the strategic actions of groups of actors who collectively set rules through a formal organization' (Dallas et al. 2019: 679), such as a government agency, an industry association, or a technology platform—the focus of this study. Finally, *constitutive power* involves uncoordinated (or weakly coordinated) actions performed by individuals within groups, which—often unintentionally—become powerful. Examples include the uncoordinated diffusion among consumers of quality conventions or sustainability norms that impact GVC governance (Dallas et al. 2019; Ponte 2019).

2.2 Institutional and constitutive power in digital platform-mediated GVCs

Our empirical work focuses on the institutional power of digital platforms, and the enactment of constitutive power by Pakistani firms. As massive global platforms, Apple iOS and Google Android exert institutional power, which allow them to capture the vast majority of global market share of mobile operating systems (OS). While platforms vary widely, iOS and Android are *innovation* platforms, controlled by a platform leader (Apple and Google), that facilitate independent firms to develop complementary innovations (mobile apps) (Baldwin and Woodard 2009; Gawer and Cusumano 2014; Gawer 2022).

Platforms are organizationally distinctive, rendering strict comparisons with GVCs difficult (Grabher and van Tuijl 2020), though recent research aims to unify the literatures (Thun et al. 2025). Platforms have been conceptualized as both 'nodes' within a larger GVC (Butollo and Schneidemesser 2022; Loonam and O'Regan 2022), and as a new type of lead firm (Salminen et al. 2022) that can even replace conventional GVCs. While too vast literature to review here, this study focuses selectively on how platforms derive their institutional power. Unlike GVCs in which lead firms' contract with a limited number of chosen suppliers through dyadic coordination, platforms use codified tools and architectures to attract and orchestrate broad ecosystems of contributors (including complementors and users), making them extremely scalable (Van Alstyne et al. 2016; Butollo and Schneidemesser 2022; Jovanovic et al. 2022) (see Table 1).

Platforms deepen the ecosystem by codifying not just interface standards, but also a vast array of tools, knowledge and skill-sets, which lowers entry barriers and stimulates complementor entry (Kapoor and Agarwal 2017; Butollo et al. 2022; Jovanovic et al. 2022; Pan et al. 2025). When successful, network effects take hold, in which each additional complementor attracts more users, generating feedback loops that attract even more complementors (Rochet and Tirole 2003), thus creating 'winner-takes-most' monopolies (Parker et al. 2014). These features are why researchers have described platforms as 'indispensable infrastructure' (Repenning and Hardaker 2024) and paralleled them to 'company-states' (Törnberg 2023). For these reasons, DPS classify platforms as 'institutional' power, which we adopt in this study. This is consistent with what Andreoni and Roberts (2022) describe as platform-mediated industrial governance, where platforms simultaneously centralize control and decentralize innovation.

In contrast to institutional power, *constitutive power* is diffuse in that the arena lacks clear institutional boundaries or well-defined membership. Norms and legitimacy structure relationships, rather than formal rules. In relation to our case, constitutive power is evident in how Pakistani AVs (software developers) acquire legitimacy within the broader software community. Despite lacking formal membership

boundaries, communities share common norms, values, beliefs and definitions (Suchman 1995), and the behaviours of actors are perceived by the community as legitimate when they act within these normative boundaries (Haack et al. 2021). As discussed in Section 5, Pakistani AVs had to learn how to properly 'enact' or perform software developer norms in order to be perceived as legitimate within the community, thereby attracting foreign clients and ensuring their survival and opportunities to upgrade.

The DPS framework systematized the study of power in GVCs, namely institutional and constitutive power. Scholars have shown how institutional power is exercised not just through state regulation, but increasingly via private actors such as digital platforms that govern access to resources, users and innovation (Andreoni and Roberts 2022; Visser and Alford 2024). Simultaneously, the role of constitutive power—rooted in norms, legitimacy, and performative alignment with community expectations—has gained prominence in explaining how actors can shape outcomes despite lacking formal authority (Archer and Elliott 2021; Dallas and Shiu 2023). These developments underscore the analytical importance of distinguishing power not only by its source (firm vs. institution), but also by its mode of transmission and its effects.

2.3 Integrating the GHS and DPS frameworks

This study integrates the DPS power framework with the GHS governance framework, using the latter's three core variables (complexity, codifiability and capabilities). Our key argument is that the interactions between GHS's three variables and their impact on entry barriers and upgrading vary depending on the type of power—bargaining or institutional. Figure 1 visually summarizes the argument presented in the remainder of this section.

The empirical vignettes presented in the GHS governance framework highlight relatively consistent trade-offs among codification, complexity and supplier capability, as well as the mode of governance linking dyads of lead and supplier firms. 'Complexity' has many dimensions (Lloyd 2001), but this study follows GHS in examining the technical and informational complexity of products and their implications for inter-firm governance. Complex products are difficult to produce, meaning that only firms with greater resources and capabilities can succeed—entry barriers that frequently exclude developing country firms (Kaplinsky 2000). However, according to GVC literature, less capable firms from developing countries can be integrated into the production of *complex* products through lead firms, who provide pathways for upgrading (Humphrey and Schmitz 2002). This is particularly evident in GHS's 'captive'

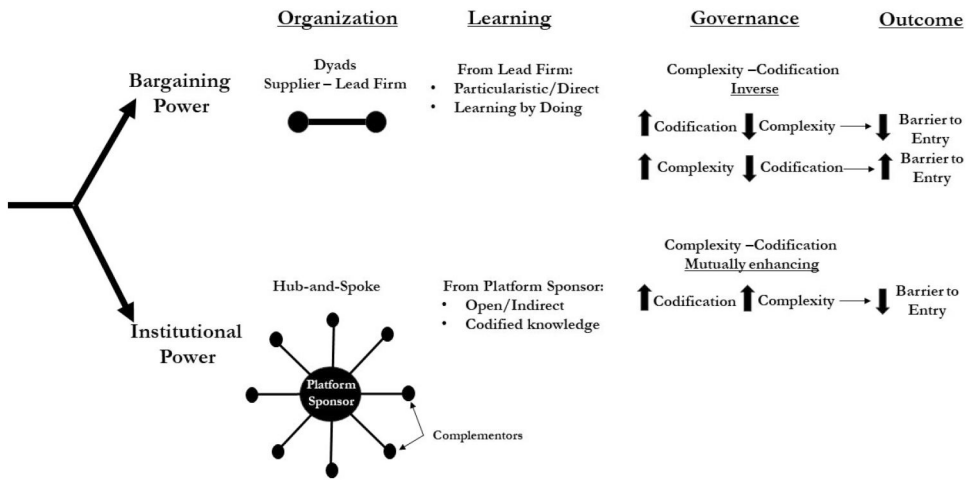

Figure 1. How the type of power alters the relationship between complexity, codification, and entry barriers.

ties, in which lead firms incorporate low-capability suppliers by establishing explicit standards and protocols ('codification'), which help mitigate technical complexity, *relative* to the supplier's (low) capabilities. This is possible because complexity and codification are inversely related, meaning that, as complexity increases, codification becomes more difficult to achieve; but, when codification is possible, 'complexity can be mitigated by codification' (Gereffi et al. 2005: 87, 90).

While reducing complexity through codification allows greater market access to developing country firms, GVC research also shows that the proliferation of lead-firm driven standards still imposes heavy demands and new entry barriers on suppliers, thereby fostering market concentration among larger, more capable suppliers. These countervailing trends are not a contradiction because, without codification, no low-capability suppliers could contribute to complex products; however, once codification is possible, they impose new entry barriers that only *relatively* more capable firms can achieve.

This dynamic is well-illustrated in Gereffi et al. (2005) framework, in which the shift from captive to modular governance is a function of moving from 'low' to 'high' supplier capabilities. In several of their vignettes codification initiates industrial transformation, such as Shimano's *de facto* standardization of the drive system in bicycles; Intel's modularization in semiconductors (p. 91); and contract manufacturers in electronics assembly (p. 95). This codification led to intense consolidation in adjacent supplier industries. For instance, Intel's modularization of semiconductors consolidated the PC component industry and PC contract manufacturers (Kawakami 2011). For complex products, the basic logic of modular governance is that codification creates more well-defined and independent modules, which deepens supplier specialization and allows suppliers to independently innovate and then interconnect with other modules through standardized interfaces.[3]

Beyond GHS, GVC research repeatedly shows that standardization increases demands on suppliers, which generally excludes less capable (and often smaller) suppliers from the chain. This dynamic occurs after standardization in process and product quality (Dolan and Humphrey 2004); health and safety (Fuchs et al. 2009); and environmental sustainability (Ponte 2022) among other areas (Kaplinsky and Morris 2018).

These dynamics between complexity, codification and capabilities fall under DPS's dyadic bargaining power, which is the central type of power underpinning GHS's governance framework. However, codification can occur beyond cases of dyadic transactions, as exemplified by platforms, which DPS considers a form of institutional power. In Section 4, we detail the creation of mobile app platforms by Apple and Google, which codified relationships with a global-scale ecosystem containing hundreds of thousands of app developers who, over a short time, created millions of mobile apps. Unlike in traditional GVCs, these are mostly indirect and non-particularistic relationships based on codified rules, tools and analytic resources which permit rapid scaling (Butollo and Schneidemesser 2022; Jovanovic et al. 2022).

Such rapid scaling of a new industry would not be possible through codification within dyadic bargaining power. It is impossible for platform leaders to individually contract with innumerable suppliers. Rather, codification is done through collective institutional power, whereby the platform leader orchestrates a massive expansion of complementors to scale the platform. Unlike traditional lead firms, platform leaders do not 'bargain' directly with complementors. In fact, complementors supply to end-users, and supply nothing to the platform leader itself, which serves largely as a self-interested market-like coordinator of complementors and users.

Massive scaling is also possible because platform leaders codify far more than just products, processes and transactional interfaces (as in dyadic standards). The platform leader codifies vast amounts of knowledge and skills themselves in the form of a broad array of software development tools (Butollo et al. 2022; Jovanovic et al. 2022), which lowers entry barriers, expands the supply base and scales the product, while also enabling greater product complexity. Codification and complexity are therefore mutually enhancing (not inversely related like in GHS), and as we will elaborate in Sections 4 and 5, they

3. By contrast, for simple products, codification lowers entry barriers, allowing the entry of weaker suppliers.

facilitated the internationalization of mobile app development and enabled Pakistani software AVs to participate and upgrade.

Thus, we argue that the same drivers of governance change (complexity, codification and capabilities) can follow two distinct pathways–dyadic bargaining power and collective institutional power—with very different implications for entry barriers, industry structure and upgrading. Furthermore, as discussed below, codification through institutional power has created entirely new industries and linkages (such as UX), a dynamic that aligns with the platform-driven reconfiguration of service and software value creation (Jovanovic et al. 2022).

This integrated framework is used as a guiding lens on how governance dynamics based on dyadic bargaining power differ from those shaped by collective institutional power. In the empirical sections, we draw on this framework primarily to analyse how institutional power is exercised through codification in mobile app platforms, and how suppliers navigate these governance structures. At the same time, the framework remains open to capturing additional power dynamics that emerge from the empirical material. In this way, the framework provides an analytical point of departure for the empirical analysis, while allowing the findings to extend and refine our understanding of power in GVCs.

3. Methods

3.1 Context

In 2025, the mobile application market, a sub-sector of the larger software development industry, stood at US$298 billion and was projected to exhibit a growth of 14 per cent per annum from 2023 to 2030 (Fortune Business Insights 2025). Globally, there are only two mobile OS, each of which has an app store. While Google Android captures 80 per cent market share in terms of devices, in 2022 Apple iOS and its app store accounted for more than 62 per cent of the market's global revenue. We focus on the Pakistani mobile app sector's integration into the global mobile app GVC. Pakistan's ICT exports have shown an annual growth rate of 23.1 per cent from 2020 to 2024 to $2.85bn—driven predominantly by mobile app development services (State Bank of Pakistan 2022; Ministry of Finance, Government of Pakistan 2025; Sherwani 2025). Pakistan is also ranked fourth globally for freelance app development (The News International 2019; International Trade Administration, U.S. Department of Commerce 2024), and mobile app downloads rose to 3.6 billion in 2023 (Data Darbar 2024). Against this backdrop, we focus on Pakistani mobile AVs as a theoretically and empirically significant case to address our research question (Choksy et al. 2025a).

3.2 Research design

To address our research question, this study adopts a mixed-methods design anchored in multi-stage pattern matching, whereby theoretically informed expectations are updated and refined with empirical observations through both qualitative exploration and quantitative testing (Sinkovics 2018; Sinkovics et al. 2022).

Operationally, our findings are based on analysis of the following primary and secondary sources: (1) existing publications on the mobile app, software and mobile communication industries; (2) in-depth interviews carried out by one of the authors; (3) an analysis of industry reports, newspaper articles, company websites and other relevant documents published from the 1990s to 2020; and (4) a survey of Pakistani app developers in 2021.

3.3 Qualitative sampling and data collection

We did a mix of judgemental and snowball sampling to conduct in-depth interviews. We examined the Pakistan Software Housing Association (PASHA)'s database of 180 software firms. Among these, we selected fifty based on two criteria: (1) being engaged in exporting mobile app services to foreign clients,

and (2) holding a successful portfolio of mobile app services and products during our first round of interviews. PASHA connected us to eighteen of the fifty AV firms, which became our final sample for this study. While these eighteen AVs were not representative of the industry, they were renowned in Pakistan at the time of our initial interviews and provided in-depth insights into their relationships with foreign clients; engagement with platform leaders; and upgrading in mobile app GVCs (see Table 2 for the individual profiles of our sample Pakistani AVs). Our geographical focus was on AVs operating in Karachi and Lahore, two Pakistani cities with a high concentration of major software companies. We anonymized the names of these AVs to maintain confidentiality.

We collected qualitative data in four stages: (1) January 2013; (2) August 2013; (3) May 2014 to July 2014; and, finally, (4) August 2018 (see Supplementary Table A1 [see online supplementary material for a colour version of this table] for more details of our primary and secondary data collection across different stages).

3.4 Pattern matching analysis

Drawing upon Sinkovics et al. (2022), our multi-stage pattern matching analysis consists of exploration through qualitative analysis, followed by validation and testing through quantitative analysis. Our qualitative analysis takes an abductive approach (Sinkovics et al. 2019), whereby integration of GHS and DPS frameworks provided initial theoretical assumptions (as explained at the end of Section 2.3). To inform Section 4, we conducted a thematic analysis of industry reports and journal articles to trace the evolution of the global mobile telecom and app industry. These sources were coded against the GHS variables (complexity, codification, and capabilities), as well as bargaining versus institutional power, to identify shifts in governance as platforms gained institutional power over time. To inform Section 5, we analysed primary interviews and secondary data at the firm level (projects, client relationships, and milestones).

We conducted initial coding, in which raw interview material was coded against the theoretical concepts and framing discussed in Section 2.3. Second, as patterns emerged across cases, we engaged in axial coding, clustering order codes into higher-order categories such as 'managerial discipline through agile', 'trust and legitimacy-building', and 'community learning through open-source'. Finally, through selective coding, we compared these categories systematically across firms, as detailed in Supplementary Table A2 (see online supplementary material for a colour version of this table, Sinkovics and Alfoldi 2012).

To assess the broader applicability and robustness of our qualitative findings, we developed two conceptual models to validate the links between our four core themes: *agile methodology, open-source adoption, legitimacy, and functional upgrading* (see Section 5 and Supplementary Appendix B). These themes also informed the construction of the survey instrument. We measured our constructs with reflective multi-item scales adapted from well-established studies in leading academic journals, ensuring content validity with insights from our qualitative interviews. Each item was rated on a six-point Likert scale from 1 (strongly disagree) to 6 (strongly agree).

Survey data were collected between May and August 2021 using online surveys, with participants randomly sampled through social media and digital platforms. The survey was collected from Pakistani software companies offering mobile app development services to international clients.[4] A total of 150 responses were received initially. After removing fifty invalid entries, the final sample consisted of 100 companies.

We employed PLS-SEM to analyse the survey data by using SmartPLS4, which allowed us to examine the strength and direction of the relationships among the key constructs identified qualitatively. The detailed results of the quantitative analysis, including measurement model assessment and structural model outcomes, as well as mediation analysis, are provided in Supplementary Appendix B.

4. The interviewees and survey respondents are separate groups but share common characteristics as Pakistani software companies serving international clients.

Table 2. Profile of app vendors.

App vendors	Location in Pakistan Year of establishment Year of entry into the mobile app domain	End-markets	No. of employees	Sources of data collection[a]	Interviewee designation
AV#A	Karachi 2007 2008	2007: US	200+	IDI, ISC, CoW, LNK, CLT, NFP	Head of Services
AV#B	Lahore 2009 2009	2009: US 2013: Saudi Arabia, Qatar, and Oman	30	IDI, CoW, LNK, NPF	CEO
AV#C	Lahore/Islamabad 2005 2008	2008: UK 2020: US	30	IDI, CoW, LNK, CLT, NPF	CEO
AV#D	Karachi 2007 2009	2009: US and UK	30–50	IDI, CoW, LNK, CLT, NPF	CEO
AV#E	Lahore 2007 2009	2008: US and Canada	300+	IDI, IAW, CoW, LNK, CLT, NPF	CEO
AV#F	Lahore 2007 2007	2008: US 2014: US, UAE, and Pakistan 2020: Estonia	200+	IDI, IAW, CoW, LNK, CLT, NPF	Head of Services
AV#G	Lahore 2007 2009	2007: US	150+	IDI, CoW, LNK, CLT, NPF	Head of Services
AV#H	Lahore 2007 2009	2007: US 2014: US and UK	100+	IDI, CoW, LNK, CLT, NPF	CEO
AV#I	Karachi 2009 2009	2009: US	10–20	IDI, CoW, LNK, CLT, NPF	Head of Products and Services
AV#J	Lahore 2009 2009	2009: US	20–30	IDI, ISC, CoW, LNK, CLT, NPF	Head of Services

(continued)

Table 2. (continued)

App vendors	Location in Pakistan Year of establishment Year of entry into the mobile app domain	End-markets	No. of employees	Sources of data collection[a]	Interviewee designation
AV#K	Lahore 2009 2009	2009: US 2014: Singapore and UAE 2020: Australia and UK	30–50	IDI, CoW, LNK, CLT, NPF	CEO
AV#L	Lahore 2009 2009	2009: US	200+	IDI, CoW, LNK, CLT, NPF	CEO
AV#M	Lahore 2007 2007	2007: US and Japan	30–50	IDI, CoW, LNK, NPF	CEO
AV#N	Karachi 2007 2008	2007: US and UK 2014: Malaysia 2020: UK, China, and UAE	50+	IDI, CoW, LNK, CLY, NPF	Head of Services
AV#O	Karachi 2007 2009	2007: Netherlands and UK 2014: US 2020: Pakistan	20+	IDI, CoW, LNK, NPF	Head of Services
AV#P	Karachi 2009 2009	2007: US and UK	20+	IDI, CoW, LNK, NPF	CEO
AV#Q	Lahore 2007 2007	2007: US	50	IDI, IAW, CoW, LNK, CLT, NPF	CEO
AV#R	Lahore 2009 2009	2009: US 2020: US and Pakistan	50	IDI, IAW, CoW, CLT, LNK, NPF	CEO

Note: CLT, client testimonials; COW, company website; IAW, interviews available on web; IDI, in-depth interviews; ISC, interview with selected clients in 2018; LNK, LinkedIn page; NPF, news platforms.

4. Evolving governance and power dynamics in the mobile app GVC

This section traces the industrial transformation of mobile app production from traditional GVCs to the rise of platform leaders that govern through institutional power. After a brief mapping of the mobile app value chain (Section 4.1), we detail this transformation in complexity, codification, and governance across three points in the mobile app value chain—app development, distribution, and consumption (Section 4.2). As power shifted from the bargaining power of traditional mobile network operators (MNOs) to the institutional power of platform leaders, like iOS and Android, the industry was transformed. Apps became increasingly complex and diversified, while app development and distribution processes became codified. This lowered entry barriers for developers and integrated users more deeply into the value chain, spawning new industries.

4.1 Outlining the mobile app value chain

The mobile app value chain is divided into three main functions: (1) app development; (2) app distribution; and (3) app consumption (see Figs 2 and 3). Each function has both hardware and software dimensions. *App development* involves two distinct tasks—*architectural design* and *implementation*. Architectural design is akin to defining 'blueprints' to ensure mobile app development comprises specific features, requirements and compatibility with mobile devices (Holzer and Ondrus 2011; Lema 2014). Implementation involves transforming software designs and requirements into a mobile app solution through coding, programming, and software testing activities Lema 2014).

App distribution is conducted through app portals, which are essentially marketplaces where users can access available apps, connect with service providers and receive support with billing, payment systems and other services. Finally, the rise of platforms has opened a brand-new value chain function—*app consumption*—which incorporates users into the value chain itself through user ratings, feedback and data analytics.

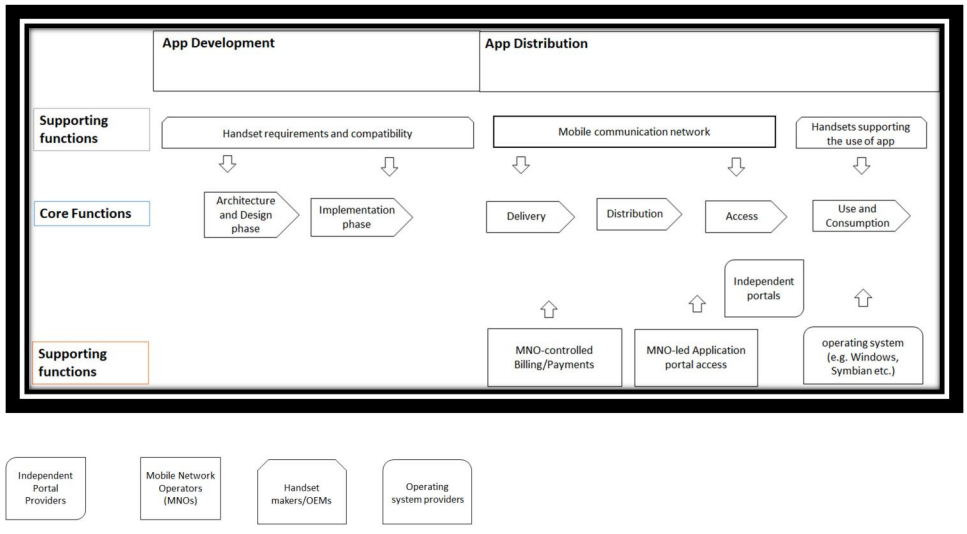

Figure 2. Mobile app VC before 2007.

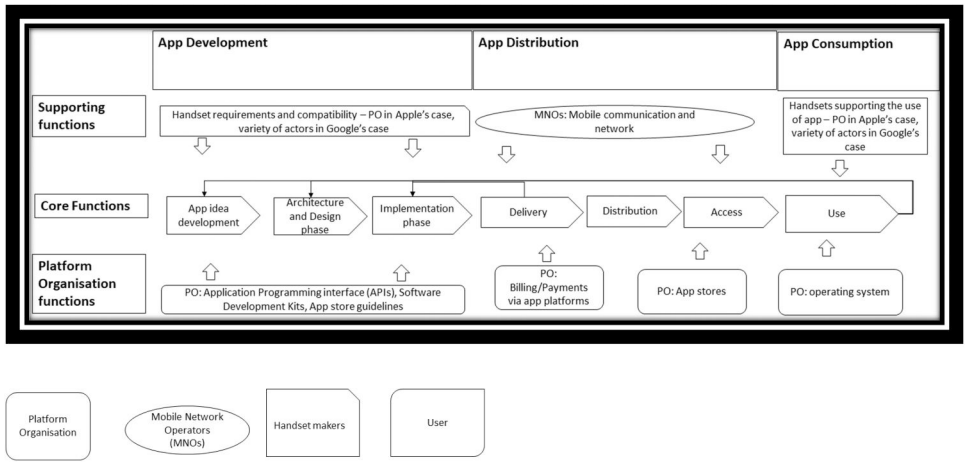

Figure 3. Mobile app VC after 2007.

All the functions and tasks found in the app value chain are supported by hardware manufacturers, including device manufacturers/original equipment manufacturers (OEMs),[5] which integrate major subsystems used by mobile apps (e.g. cameras, displays, and power management). Finally, the OS integrate these varied subsystems, including the core software that runs mobile apps. The mobile app value chains as shown in Figs 2 and 3 aligns with Frederick's (2019) GVC mapping.

4.2 The transformation of the mobile app value chain

Until the advent of smartphones, the mobile telecom industry was organized as a linear GVC characterized by MNOs like Vodafone and Verizon as lead firms; OEMs such as Nokia and Motorola; and integrated app developers (IADs).[6] MNOs wielded bargaining power over OEMs and IADs through their specialized network expertise (Mortier and Mulligan 2011).[7]

In the early 2000s, advances like 3G technology spurred hardware upgrades, a shift from voice to internet services, and OS that integrated hardware with apps. These changes laid the foundation for the rapid rise and evolution of smartphones.

The launch of the iPhone in 2007 marked a significant turning point, introducing touch displays, iOS, improved internet access and wireless content downloads. In 2008, spurred by Apple's success, Google released Android as an open-source OS for non-Apple devices. iOS and Android grew into a global OS duopoly by becoming pivotal platform leaders, supplanting traditional MNOs and streamlining app development for creators. Below, we explain the evolution of the mobile app value chain by elaborating on how mobile app development, distribution and consumption evolved both before (Fig. 2) and after (Fig. 3) the rise of platforms.

5. In the GVC literature, OEMs are responsible for the production and management of the equipment manufacturing activities. In the context of the mobile industry, device manufacturers such as Nokia fit this description as they were responsible for the complete hardware manufacturing of the device.
6. The term IAD is meant to invoke the term integrated design-manufacturer in semiconductors, which similarly predated the vertical specialization into design and manufacturing. In the context of the mobile app value chain, they were the app developers that integrated all value chain activities in order to comply with the requirements of OEMs.
7. MNOs possessed specialized knowledge of the complexities of network management and of maximizing bandwidth efficiency, which required each OEM handset model to be attuned to their network, while also exercising tight control over the very expensive data-intensive services available to consumers

4.2.1 App development

During the late 1980s, mobile *app development* was limited, with app architecture 'blueprints' handled in-house by handset OEMs, and app implementation handled by vertically IADs who designed and built the apps. However, as MNOs remained network gatekeepers and owned the critical mobile functionality demanded by customers, OEMs were tightly tied to MNO networks and had to conform to their protocols while, in turn, IAD apps conformed to OEM requirements.

After the emergence of platform leaders, *app development* became much more complex, but also more unified and centralized through codification, opening app development up to a global pool of app developers. Simultaneously, the complexity of mobile phones skyrocketed through enhancements in smartphone hardware, OS features and internet connectivity (Holzer and Ondrus 2011; Campbell-Kelly et al. 2015). Apple's iOS and Google's Android OS became the focal software that integrated hardware, apps and internet connectivity across the mobile app value chain (see Fig. 3).

This integration was achieved through codification. First, hardware and software interfaces were codified through application programming interfaces (APIs), which are standards that enable different hardware and software applications to interoperate (e.g. camera and apps). However, beyond interoperability, the platform leaders codified much more. For instance, they created standardized software 'tool kits', called software development kits (SDKs) (Mortier and Mulligan 2011). In terms of implementation (coding and testing), SDKs enabled any third-party developer worldwide to build applications for the platform (see Fig. 3). These kits include libraries, debuggers and handset emulators, among many other useful development tools. Thus, through SDKs and open APIs, platform leaders codified not just the interfaces between modules, but also nearly every stage of production along with tools, testing, debugging and other forms of knowledge. This rapidly lowered entry barriers by crowdsourcing app innovations and outsourcing mobile app development to a global base of freelancers, while developers experimented with new applications (Bergvall-Kåreborn and Howcroft 2013).

Furthermore, Android ensures smartphones are 'Android compatible' through its Android compatibility definition document (CDD). All Android-powered phones must pass its compatibility test suite, which ensures that apps can run reliably within a consistent execution environment across diverse smartphone brands. For unavoidable variation across Android phones, Android provides dynamic resource management, in which app developers create a single set of code, and Android tools adapt code to the specific smartphone device requirements. These standardizations and tools vastly simplified the app development process.

Combined, these factors enabled platform leaders to establish their institutional power in the app production segment. In turn, this lowered entry barriers for app developers, de-verticalized the value chain and vastly expanded the number and variety of mobile app firms. It also enabled the internationalization of certain production tasks to locations such as Pakistan, which, in turn, experienced a sudden, massive scaling of mobile apps and the reshaping of the industry's organization (International Trade Administration, U.S. Department of Commerce 2024; Sherwani 2025). Platforms eliminated traditional suppliers, including IADs, which were replaced by brand new vertically-specialized entrants—AVs and AOs.[8] AOs increasingly outsourced app development (software engineering, programming and coding, testing and app updating) and app design tasks to AVs in lower-cost developing economies, including Pakistan. Beyond participation in GVCs, the codification process (e.g. SDKs) significantly facilitated learning for the new AVs from developing economies.

8. We use the term 'app orchestrators' to refer to international clients who 'orchestrate' app ideas, design, and marketing in relation to the publication process and performance of apps (Sinkovics et al. 2019). The term 'app vendor' has a more comprehensive connotation and covers both the app development and design functions.

4.2.2 App distribution

Before the emergence of platform leaders, app distribution was highly fragmented and dominated by MNOs. MNOs orchestrated a walled garden model whereby apps were available through each MNO's unique portal, incorporating a limited set of OEM handsets that were marketed and subsidized by MNOs. The MNOs' walled garden approach was accomplished through codification; however, codification was dyadic, meaning that their mobile offerings needed to be customized in order to achieve technical and business-compatibility with each mobile handset.

In the late 1990s, new actors such as independent internet portals (e.g. Quios, Room33, and Iobox) gave some mobile users access to more diverse application services (see Barnes 2002). Simultaneously, the largest OEMs introduced technologies that bypassed reliance upon MNO portals for mobile app distribution. However, this created new challenges around customer billing, as customers would receive invoices from many different, mostly unknown portal service providers. Consequently, MNOs took over billing as a service, which not only strengthened their strategic position but also provided them with a new important revenue stream (see Fig. 2).

Through their privileged position as 'gatekeepers', MNOs wielded substantial bargaining power by charging high fees on data usage and payments (Holzer and Ondrus 2009a; Feijoo et al. 2012). The bargaining power held by MNOs over IADs enabled them to charge commission rates ranging between 50 per cent and 70 per cent on value-added services and applications (Holzer and Ondrus 2009a,b, 2011; Bergvall-Kåreborn and Howcroft 2013). This extortionate rent extraction, in addition to the very high costs of data, constrained the entire mobile app market (see Fig. 2).

From 2007, platform leaders built up their institutional power by codifying many app distribution tasks, displacing the hold of MNOs on distribution (including billing and payments) and substituting old portals with new app platforms that exerted far more control over value chain tasks (see Fig. 3). In 2008, Apple created an independent app store that enabled the direct publication of apps to the iOS platform, thus circumventing MNO gatekeepers (Campbell-Kelly et al. 2015). This was followed by Google's Android app store, named 'Google Play' in 2012 (Lee and Raghu 2014). Given the diversity of phones that adopted Google's free Android OS, Google standardized complexity by providing feature management standards in which app developers pre-specified which hardware or software features their app required (e.g. camera type), and Android would automatically filter apps for each phone, simplifying distribution frictions for app developers.

Through powerful network effects, these two-sided platforms tightly fused together app developers and app consumers for the first time; over the course of a few years, this removed MNOs as lead firms and undermined the handset products of most major OEMs, including Motorola and Nokia (Mortier and Mulligan 2011; Campbell-Kelly et al. 2015). App stores combined the prior functionality of internet portals and MNOs' billing and payment services. This forged a direct link between app developers and users, while also establishing an integrated billing system (see Fig. 3). Given their vast scale, platform leaders could afford to charge more reasonable 30 per cent fees, in contrast to MNOs' prior levy of 50–70 per cent of the app price (Holzer and Ondrus 2011).

4.2.3 App consumption

The most significant transformation ushered in by platforms, which further strengthened their institutional power, was the integration of users directly into the value chain itself (see Fig. 3)—something unachievable by MNOs. The direct linking of developers and users by app stores created entirely new industries centred around UX, which is now critical to all phases of the mobile app value chain. UX refers to the users' overall experience when interacting with an app. Similar to app production and distribution, platforms completely codified users' perceptions and feelings before, during and after their interaction with an app (Feijoo et al. 2012; Campbell-Kelly et al. 2015). Through platforms, app usage and ratings are very closely monitored. These generate personal data and important iterative feedback loops between consumption and production, as well as new industries around data analytics and advertising. Crucially,

they also allow AOs/AVs to iteratively improve app development, leading to 'agile methodology' practices (discussed in Section 5).

UX has made the app development, distribution and consumption functions more complex, with important implications for AOs and AVs. In *app development*, there is now much more emphasis on app idea development focused on market scanning and identifying user needs, which plays a key role in developing an app's requirements and user interface (UI) (Choksy 2015; Sinkovics et al. 2019). UI, which has become a key software architecture and design task, refers to the visual and interactive elements of a mobile app, enabling users to interact with the mobile device through buttons, menus, navigation and other graphical elements. In *app distribution*, marketing and promotion tasks include communicating the value proposition and unique features of apps to target users and highlighting the benefits of using apps (Choksy 2015; Sinkovics et al. 2019) (see Fig. 3).

The next section presents our analysis of the transformation of this newly created GVC. Building on the above mapping of the mobile app GVC, we illustrate the fusion of power, governance and upgrading through the case of Pakistani AVs. By leveraging the institutional power of platforms, Pakistani AVs rapidly upgraded their capabilities and transformed the mode of AD-AO governance from captive to modular, while also achieving substantial functional and interchain upgrading.

5. Power and governance in the rise of Pakistani mobile app developers

This section integrates qualitative exploratory insights with quantitative validation. We begin with qualitative themes drawn from interviews with Pakistani AVs to unpack how legitimacy emerges and contributes to AV functional upgrading and GVC governance changes. We do so by analysing Pakistani startups' adoption of two collective practices in the software industry–agile methodology (Section 5.2) and open-source (Section 5.3). We use these insights to derive patterns about the role of agile methodology and open-source adoption in enabling functional upgrading through legitimacy. These patterns are then quantitatively tested using survey data from 100 valid respondents via PLS-SEM.

5.1 Legitimacy as constitutive power

Since platforms are simply sets of formal, codified rules and resources, they possess no value unless they successfully attract complementors (AVs and AOs) and users at scale (Baldwin and Woodard 2009). However, complementors and users are not atomistic actors individually engaging with formal platform standards. Rather, they are socialized within broader, often transnational software communities endowed with values, norms and best practices—constitutive power—which make the platforms work.

Drawing upon Dallas and Shiu's (2023) work on 'legitimacy' as a form of constitutive power, in this section, we argue that Pakistani AVs achieved functional upgrading[9] once they gained legitimacy. They accomplished this by adopting socially accepted practices when 'enacting' platform services, including agile methodology and open-source adoption.

Legitimacy resides in a communal perception that 'the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions' that is 'possessed objectively, but created subjectively' (Suchman 1995: 574). Legitimacy derives from a collective social dynamic whereby it is granted by the collective to certain actors or actions (i.e. created subjectively); however, once established, it compels others to follow along (i.e. it becomes an objective reality) (see Dallas and Shiu 2023 for application to GVCs). In our case, AVs gained legitimacy when AOs and others in the industry perceived that they were successfully enacting socially appropriate practices of software design, UX and software development.

9. We found two patterns of functional upgrading: (1) the acquisition of more tasks within the app development function across different industry domains, and (2) the vertical integration of the app development, distribution, and consumption functions.

Table 3. Examples of legitimacy acquisition (AV#E).

Business references	*We have grown organically using references because, in that case, it becomes relevant. If someone had a great experience with us, and they recommend us. We drive new business by attending biannual US conferences to connect with partners. Existing clients are asked to refer us to potential clients, leading to organic growth through word-of-mouth recommendations. This referral process continues whether I'm in the US or not, resulting in new contacts and opportunities.* *Signing up someone like MNE-ABC built a lot of credibility for us and the quality work we did for them became a great reference point*
Industry reputation	*Allworld Network, an organization that ranks high-growth businesses in emerging markets, compiles a list of the 100 fastest-growing companies in Pakistan. In 2011, we were the fastest-growing company in Pakistan's software industry and ranked second in 2012. Overall, we secured the 20th spot among all sectors in Pakistan. This recognition significantly boosts our visibility. Allworld Network showcases participating companies and hosts award ceremonies—in our case, held in Istanbul. This event provided networking opportunities and served as a valuable platform for us.* *We developed a cutting-edge 3D game called ABC, an excavator simulator for Android and iPhone, in partnership with a California-based company. This app, considered one of Pakistan's most advanced tablet applications in engineering and physical modelling, earned us multiple awards. Among them was recognition from the Pakistan Software House Association and a prestigious win in the e-learning category at the competitive 2013 Asia-Pacific ICT Awards, where we competed against organizations from countries such as Singapore, Australia, Malaysia, Indonesia, and China.*
Portfolio	*Signing up someone like MNE-ABC built a lot of credibility for us and the quality work we did for them became a great reference point. We also work with MNE-BCD, which is one of the most important MOOCs (Massive Open Online Courseware) started by content from MIT, Berkley, and Harvard. Our partners in the past have included MNE-CDE—the largest job search engine in the world, and my alma mater—ABC University. People who look at our portfolio know who we have worked with, and thus associate a certain level of quality with us.*

We present a comparison of two illustrative AVs from our sample, to highlight the role of legitimacy and how it shapes upgrading trajectories. Although both firms operated within similar technical contexts and faced equivalent levels of complexity, one succeeded in gaining community legitimacy while the other did not. This contrast provides insight into how constitutive power operates through collective recognition and symbolic alignment with global best practices.[10]

From the selection of quotations provided in Tables 3 and 4, AV#E's engagement with open-source forums, agile methodologies, and UX-driven design earned it recognition from lead firms, developer communities and even other AVs. By contrast, AV#I's reliance on traditional GVC inter-firm linkages and its failure to participate in community practices left it isolated and stagnated, despite starting with similar capabilities as AV#E.

10. Those of our sample Pakistani AVs that had not adopted the best practices of global software communities had either exited the market (three firms) or had never escaped their captive relationship with AO clients (two firms), even if they had still been able to upgrade to a degree. More specifically, among our five underperforming sample AV firms, two (AV#B and AV#J) had been exposed to agile methodology via AO's managerial discipline but had never struck out on an independent path by engaging in legitimating practices with other firms. Likewise, the three AVs that had exited (AV#I, AV#L, and AV#P) had attempted to attain functional upgrading but had failed due to poor investment decisions in launching unsuccessful products and had never engaged with their peers to build legitimacy. All three AVs had subsequently gone out of business (AV#I and AV#P in 2015 and AV#L in 2014).

Table 4. Examples of lacking legitimacy (AV#I).

Professional work ethic	*The client mindset emphasizes meticulous quality and thorough completion to avoid embarrassment, reflecting a deep commitment to professionalism. In contrast, our approach is more about 'let's just do it and see', handling problems only as they arise. This suggests not only a difference in work ethic but also in management style, where personal relationships can override true accountability.*
Barriers to building legitimacy	*In Vietnam or the Philippines, Americans and Japanese easily hop on a plane to interact face-to-face with their offshore teams for two to three weeks, realizing they learn much more this way than through video calls. The challenge lies in the reluctance of international clients to feel secure about visiting Pakistan, hindering innovation and success. While video conferencing tools are helpful, they're not sufficient. This remains a persistent issue without a quick fix.*
Difficulty in acquiring larger projects or larger clients	*Though we've experienced growth, we seem to have reached a plateau. Capturing projects beyond a certain threshold is proving challenging; while projects up to US$5–10k are attainable, the US$40–50k range presents difficulties. Acquiring larger projects within our current domain appears to have reached saturation point.* *Larger clients typically focus solely on managing relationships. If they become frustrated, they will shift operations to the Philippines or India.*
Lack of trust and excessive monitoring	*We have a customer from the UK who demands to engage with us continuously for eight hours. Our project manager ends up resembling a call centre operator, always on the headphones, eager to provide input on every detail despite not being a product specialist. This drains productive hours, leading us to limit meetings to prevent excessive time consumption. While some customers exhibit such behaviour, it's essential to manage it effectively. Ideally, dedicating half an hour per customer proves sufficient. Productive interactions within a set timeframe are valuable, as excessive coordination in unproductive discussions can result in adverse outcomes.* *We strive to take charge of the technology we create for our clients. We've observed many clients attempting to dictate the execution of tasks, wanting to oversee even the minutest technological decisions*.

5.2 Agile methodology: from managerial discipline to upgrading

As discussed, platforms introduced UX when they integrated users into the app development process (see Section 4). After platforms enabled continuous iterations between user feedback and app development, agile methodology emerged as the preferred best practice to enhance UX. Agile methodology is a management practice that challenges traditional linear management practices by focusing on circular, iterative workflows comprising fluid production stages and imperfect product releases (Choksy et al. 2024a). It involves four steps: (1) understanding client needs; (2) developing software demos; (3) communicating with clients; (4) iteratively incorporating feedback (see Table 5).

When Pakistani AVs first entered the industry in 2007, they offered low value-added services and had weak UX capabilities. The creation and codification of UX by platforms initially rendered AVs captive to AOs, especially in relation to bridging consumer culture gaps to build effective UX. As AOs operated in end-user markets, they possessed a better understanding of UX and could leverage data streams and metrics from new app platforms. For instance, when working with a Danish client on an app for neurological scans and testing, AV#O lacked any understanding of the Danish end-users and industry domain, making them reliant on foreign AOs:

> We were making a school management system app for a client. There is a vast difference between systems in Pakistan and the Danish market. Because of this, we are very much dependent upon the client.

Table 5. Agile software development in practice.

Agile software development	Selected quotes
Step 1: App vendors (AVs) meet with clients to identify their needs and receive their input. This helps app developers define the *core vision, ideas, expectations* of app orchestrators related to UX and UI. At the end of the process, app developers and app orchestrators aim for mutual understanding and achieve cognitive proximity on the expectations of a given app.	*They have different ideas and, with all these different ideas, what they wanted was a team that could work with their innovation head and create a quick prototype with the i-Phone (AV#A)* *Agile helps you identify the core requirements and develop the proof of concept and then basically building the skeleton above and lean helps in building the actual software product (AV#N).*
Step 2: Based on interactions with clients, AVs work on developing software demos that aim to transform the idea, vision and expectations into a workable solution. As part of this exercise, app developers engage in 'stand-up meeting' exercises, whereby they conduct ten-minute stand-up calls with client teams to discuss progress and goals.	*Usually, we do a ten-minute stand up daily either within the team itself, or sometimes the client/partner can be included as well. We discuss the issues we are facing; each member of the team mentions their goals of the day they need to accomplish and report any issues. The process is designed to take care of problems of lack of communication and if there are any bottlenecks (AV#F).*
Step 3: Once the software demo is developed, app orchestrators evaluate the app and identify the extent to which the demo reflects initial discussions around clients' ideas, vision, and needs related to UX and UI.	*They give feedback on what they want to change. They would explain to us with material like I already mentioned that presentations, videos what they want to generally accomplish (AV#E).*
Step 4: Based on the feedback, app developers then repeatedly engage in a similar process until the app developer and app orchestrator reach a mutual understanding of UX.	*It was evaluated again and again, in a scrum where you have very, very short cycles, releasing an innovation or a version of the product every three weeks right (AV#H).*

Given the platform's stringent UX criteria, the cultural gap with app consumers, and the reliance on video-conferencing, AOs initially imposed agile methodology on AVs as a form of managerial discipline from afar, using online interactions to monitor progress, demand transparency and enforce quality standards. For example, AV#G, a technology consulting company based in Lahore, complained that the 'customer has been communicating with me almost every day. We email 10 times a day, he talks to me at least 3-4 times a day'.

While agile methodology started off as a form of managerial discipline, as the practices spread through the Pakistani AV community, they bestowed legitimacy upon those that enacted them properly with the AOs and final clients.

As detailed in Supplementary Appendix A, we identified two pathways through which our sample AVs utilized agile methodology to build up their legitimacy, which, in turn, contributed to transforming the GVC governance with AOs from captive to modular: (1) engaging with a community of users; and (2) leveraging a community of freelancers and entrepreneurial teams.

Seven of our Pakistani AV participants (AV#A, AV#E, AV#K, AV#M, AV#O, AV#Q, and AV#R) had used agile methodology to engage with a community of users, which they accessed via the platforms' app stores. These engagements had largely occurred during the first step (identifying client needs) and fourth step (feedback) of agile methodology, which includes app user ratings, reviews and feedback. Apple and Google have tools that automate the sharing of early versions of apps with small groups of users for feedback. Our sample AVs had utilized these to refine and enhance their apps based on how people actually used them. Additionally, analytics from these platforms show how users behave and engage with apps. These data enabled AV#E to take a closer look at user interactions and make improvements for a better UX (Dybå and Dingsøyr 2008; Lema 2014).

For instance, while working with a North American retail client, AV#E leveraged agile methodology step 3 to identify foreign consumer demand, stating:

> We do a 10 minutes stand-up daily, we discuss the issues we are facing; clients provide feedback based on their understanding of user.

As a result, AV#E improved their reputation which had enabled them to acquire new clients and larger projects. Furthermore, they functionally upgraded by vertically integrating the app development, distribution, and consumption functions (see Supplementary Appendix B for further details):

> We signed up MNE-ABC, which brought much credibility for us. Some of the major turning points were signing brand names known around the world as our partners

In addition to direct interactions between suppliers and clients, legitimization can also occur through entrepreneurial teams and freelancing. We found that six of our sample AVs (AV#D, AV#E, AV#F, AV#G, AV#H, and AV#N) had enhanced their legitimacy this way. These communities included developers formally employed by the AVs who were working on part-time freelancing initiatives or given autonomy to work as entrepreneurs on their team projects (see Choksy et al. 2024b). For example, AV#D highlighted that certain employees, while still employed at their firm, would utilize agile methodology in their freelancing projects, bringing back new UX capabilities and leading to AV#D's functional upgrading.

> When they engage in freelancing, they acquire new skills that ultimately enhance our organisation. Freelancers often prove to be highly productive developers and UX experts, as they have already tackled similar challenges during their personal projects.

Among our participant AVs, the twelve AVs (AV#A, AV#D, AV#E, AV#F, AV#G, AV#H, AV#K, AV#M, AV#Q, AV#N, AV#O, and AV#R) which had enacted agile methodology with clients had been able to achieve functional upgrading, enabling them to sever captive ties with particular AOs.

5.3 Open-source adoption

Similar to agile methodology, software developer communities also engage with each other on open-source platforms where they both use and contribute to open-source projects. Open-source software is often seen as contradicting traditional business and intellectual property (IP) practices, which prioritize exclusive and proprietary rights to foster innovation (Weber 2004). However, as the cost of software replication and distribution is near zero, communities of developers have cultivated a global culture of open sharing by using non-proprietary licensing. Android OS is an open-source project that provides free and open-source code to software developers. Although Google manages the licensing, the IP remains community-owned with contributions made by a global network of developers, highlighting the importance of a shared culture and best practices in sustaining open-source platforms.

Our interviews indicated that nine of our participating Pakistani AVs—AV#C, AV#E, AV#F, AV#G, AV#H, AV#K, AV#M, AV#N, and AV#Q (Supplementary Table A2, see online supplementary material for a colour version of this table)—had utilized Android's open-source platform community to diversify their skill portfolios and contribute to the community's software tools, code libraries and tests. By

participating, they had gained legitimacy as normatively 'worthy' software developers among GVC actors, including among AOs and new clients in adjacent GVCs.

AV#F had developed an internal incubator to contribute to open-source communities, improving its reputation and recognition among software architects, product managers and engineers. They stated:

> We've established an engineering incubator to nurture diverse skill… participating in the open-source community, where we undertake projects with clients and contribute to the community. This commitment to open-source collaboration has greatly enhanced our learning journey, providing invaluable experiences.

Through the open-source community (in which contributions are publicly tracked by developers), AV#F had gained legitimacy by integrating new product ideas, marketing, UX, software design and development capabilities, which were learned through the internal incubator initiative for the AV's own product development.

Open-source, as a global software culture, had thus penetrated Pakistan and been leveraged by our sample AVs to gain legitimacy and, ultimately, achieve upgrading. Critically, contributing to the Android open-source community enhanced app developers' online reputations, providing opportunities to explore, experiment and develop skills without formal client commitments. Seven of our sample AVs (AV#C, AV#E, AV#F, AV#H, AV#K, AV#M, and AV#Q) engaged with open-source adoption that improved their overall legitimacy and achieved functional upgrading (Supplementary Table A2, see online supplementary material for a colour version of this table).

5.4 Quantitative analysis: analysing the role of legitimacy in upgrading

Our qualitative analysis indicates that adopting agile methodology enables functional upgrading among mobile AVs. The open-ended and flexible nature of agile methodology, characterized by iterative development, engagement with a community of users, and the ability to draw on a broader pool of freelancers and entrepreneurial teams, enables continuous software improvement and sustained learning over time, ultimately supporting functional upgrading. Engagement with agile practices also provides recognition and enhances firms' legitimacy among clients and within the broader software community. This growing legitimacy, in turn, facilitates further functional upgrading. These patterns are illustrated in Fig. 4.[11]

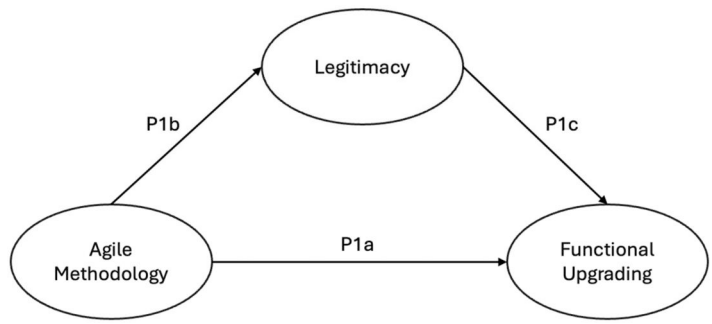

Figure 4. Conceptual model 1.

11. In the models, relationships are labelled as P1a, P2b, etc. to represent the patterns identified in this section and to clarify their testing in the quantitative analysis.

Similarly, open-source adoption appears as an additional pathway through which Pakistani mobile AVs achieve functional upgrading. By drawing on open-source communities, these firms access and contribute to software tools, code libraries, and tests, allowing them to build new skills and learn across different domains and industries without needing formal client projects. Participation in open-source communities also strengthens their legitimacy by enabling the incorporation of new product ideas, marketing insights, UX inputs, and software design and development capabilities. This enhanced legitimacy, in turn, supports further functional upgrading. These patterns are illustrated in Fig. 5.

Having developed these models through qualitative analysis, we now subject them to quantitative analysis by testing the structural relationships with PLS-SEM (see Supplementary Appendix B for details). As shown in Fig. 6, we found that agile methodology significantly promotes functional upgrading (path coefficient: 0.189). Additionally, agile methodology is positively associated with enhanced legitimacy (path coefficient: 0.319), supporting the idea that practicing agile methodologies builds reputational trust among clients and software communities. Furthermore, legitimacy also leads to functional upgrading (path coefficient: 0.273). Mediation analysis indicates that legitimacy partially mediates the relationship between agile methodology and functional upgrading, strengthening the argument that legitimacy is a key mechanism facilitating functional upgrading (see Supplementary Tables B4 and B5 [see online supplementary material for a colour version of these tables] for a detailed analysis).

Interestingly, as shown in Fig. 7, our PLS-SEM analysis shows no significant *direct* causal relationship between open-source adoption and functional upgrading (path coefficient: 0.030). However, our findings still highlight two important relationships that show there is an *indirect* pathway between open-source

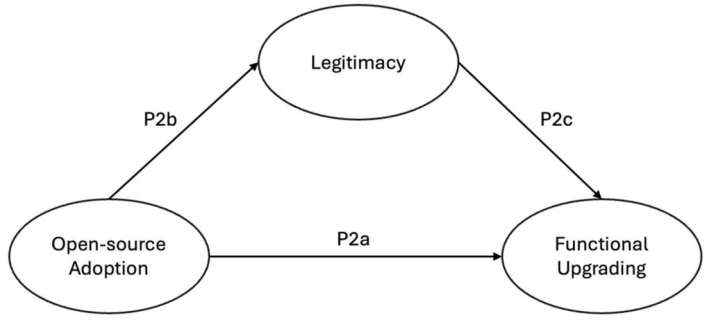

Figure 5. Conceptual model 2.

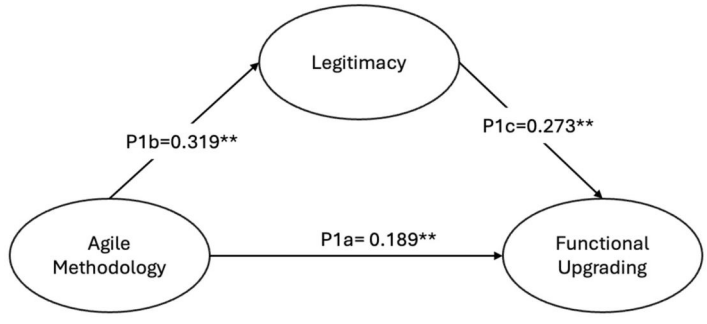

Figure 6. Assessment of the structural model for model 1. $^{**}P < .05$.

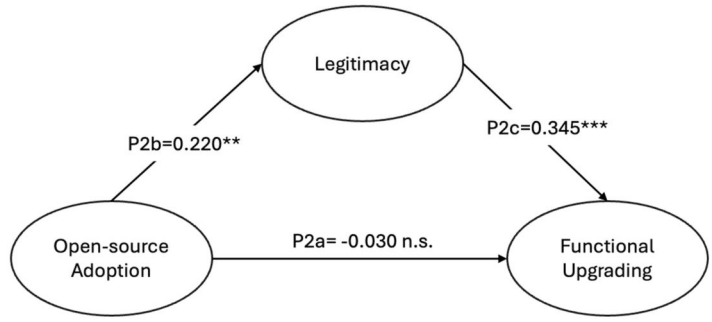

Figure 7. Assessment of the structural model for model 2. ***$P < .001$; **$P < .05$; n.s., not significant.

adoption and functional upgrading. First, it shows that engaging in open-source adoption enhances legitimacy (path coefficient: 0.220), which is consistent with exploratory analysis that open-source signalling increases developer credibility within global software communities. Second, our results support the idea that legitimacy enhances functional upgrading (path coefficient: 0.345), reinforcing the notion that legitimacy acts as a key mechanism facilitating functional upgrading. These findings highlight the independent significance of both relationships and underline the importance of building legitimacy to enhance functional upgrading, even when open-source adoption does not have a direct impact (see Supplementary Tables B4 and B5 [see online supplementary material for a colour version of these tables] for detailed analysis).

6. Discussion and conclusion

Our study has sought to address the following core research question: *how did Pakistani mobile AVs achieve functional upgrading and escape captive ties in the face of surging complexity and heightened standardization in the mobile telecommunications industry?* Beyond explaining this empirical puzzle, the study makes a conceptual contribution by integrating GHS governance framework with DPS power typology (see Tables 6 and 7).

As shown above, the GHS framework helps unpack how codification, complexity, and capability normally shape governance outcomes, but it cannot explain why Pakistani AVs—despite low initial capability—were able to scale, specialize, and escape captive governance. The DPS framework adds this missing explanatory power by showing that institutional and constitutive power reconfigure entry barriers, enabling new forms of decentralized coordination. The combined framework thus shows that functional upgrading of low-capability suppliers in developing economies is not merely driven by internal capability or bilateral bargaining, but also by suppliers' ability to leverage ecosystem-level codification and gain legitimacy through community-driven norms.

6.1 Governance and power in platform GVCs

Our analysis reconceptualizes the relationship between governance and power in GVCs. The same governance drivers—complexity, codification, and capabilities—produce different outcomes depending on whether bargaining or institutional power dominates. In traditional dyadic buyer–supplier relationships shaped by bargaining power, rising complexity typically raises entry barriers, while codification only facilitates participation when suppliers have sufficient capabilities.

In platform-mediated GVCs, as shown in Table 6, institutional power operates differently. Platforms codify tools, standards, and knowledge—such as SDKs, UX protocols, and analytics dashboards—at scale.

Table 6. Institutional power and captive AO-AV linkages.

Function	Codification	Complexity	Supplier capability	Functional upgrading outcome
App development	Entry was enabled via platform APIs, SDKs, and documentation; AO orchestrated codified requirements with AVs	High software design complexity due to • Device fragmentation • Multi-platform compliance and • Nature of tasks linked to software design;	AVs lacked capabilities in software design; AV frequently interaction with AO via agile software development (as managerial discipline)	Limited functional upgrading; mostly in app development and to some extent in software design.
App distribution and marketing	Platform rules for uploads and updates were codified.	Approval involved navigating complex review policies (e.g. data permissions, ad policies) (Section 4)	AVs lacked marketing know-how (SEO, ad monetization). AVs mainly observing AO marketing activities.	No evidence of upgrading but indirect learning through observation
App consumption	Dashboards (Firebase, Google Analytics) and UX guidelines were codified.	Complexity high as Users had high, fast-evolving UX expectations across devices;	AV's Weak understanding of data analytics and UX; AVs unable to meet them independently without interacting with AO via agile software development (managerial discipline).	Limited improvement in UX and user data analytics depending on projects and differed among participant companies (Supplementary Table A2, see online supplementary material for a colour version of this table)

Table 7. Interaction of constitutive and institutional power and shift to modular governance.

Function	Codification	Complexity	Supplier capability	Functional upgrading outcome
App development	• Community level standardization of agile methodology • Open-source libraries shared on GitHub and other forums enabled AVs to internalize codified routines from PO.	Complexity managed through • Peer-driven practices like sprints, version control, and iterative development using agile methodology. • Through open-source exposure and agile iteration, AVs learned to navigate UX and feedback loops	Developers improved legitimacy and capabilities: • Open-source contribution, collaborative debugging, and • Agile workflows improved technical responsiveness and decision-making.	Upgrading to software design
App distribution and marketing	With time, AVs built confidence using: • Distribution dashboards integrated release pipelines, marketing APIs, and • App launch strategies	AVs adapted through iterative learning from • Past rejections and • Community-shared experiences.	Legitimacy and capabilities built through: • Exposure to GitHub project branding, community-led promotion, and user reviews taught AVs how to present apps, engage users, and optimize reach. • Successful independent app launches, and brand development improved marketing capability.	Upgrading beyond app production to launching and marketing owned apps
App consumption	Leveraged community tutorials via • Analytics tools (Firebase, Mixpanel) • UX libraries, and community benchmarks.	Higher community norms to • Monitor feedback loops • Improve engagement • Personalize experience continuously	Agile adaptation and continuous community feedback enabled • Improvement in navigation • UI bugs, and user responsiveness • Reputation and legitimacy enhanced through data-driven iteration, user trust, and analytics capabilities.	Upgrading in UX, analytics-driven learning, and product branding.

This codification simultaneously increases system-level complexity while lowering entry thresholds for low-capability suppliers. As a result, institutional power enables broad participation, learning, and coordination, creating opportunities that conventional governance frameworks might not anticipate.

However, as shown in Table 7, codification alone did not immediately translate into functional upgrading because suppliers lacked the capabilities required to meet the rising industry complexity, especially in areas like UX, software design and data analytics. Many Pakistani AVs initially remained locked into captive relations with app orchestrators despite having access to platform resources. Here, constitutive power—gained through legitimacy within professional and software communities—proved decisive. By enacting collectively endorsed norms and practices, including agile methodology and open-source engagement, AVs signalled competence and alignment with global software standards. This legitimacy became a durable power resource, enabling suppliers to move into higher-value functions such as software design and UX development.

Our findings refine the understanding of how institutional and constitutive power interact in GVCs. While Dallas et al. (2019) conceptualize institutional and constitutive power as analytically distinct—respectively rooted in formal, rule-based structures and in informal, normative systems—they emphasize that these forms of power often coexist, interact, and evolve. Our study shows that AVs who successfully upgraded were those able to navigate both types of power simultaneously (see Table 7): accessing codified platform resources while enacting legitimacy through communal software norms. Therefore, we argue that institutional and constitutive power in platform GVCs are not just co-present—they are mutually reinforcing. Their interaction is foundational to understanding functional upgrading for low-capability suppliers in highly complex industry GVCs. This interplay represents a key theoretical insight: the effects of governance drivers are contingent on the form of power that predominates, highlighting the need to consider governance and power together when explaining outcomes in complex, platform-mediated value chains. This directly responds to recent calls in GVC research to develop integrative frameworks that explain how power dynamics intersect with governance to shape upgrading (Ponte et al. 2023).

6.2 Implications for upgrading in GVCs

Our study contributes to the existing GVC upgrading literature, which has tended to identify dyadic linkages; internal learning (Humphrey and Schmitz 2002); strategic interaction and relational contracting (Choksy et al. 2017, 2024a, 2025a,b; Sinkovics et al. 2019); or institutional sources (Ponte et al. 2014) as primary facilitators of upgrading. This study shows a new pathway by which low-capability suppliers can achieve functional upgrading and liberate themselves from captive governance—even when conventional GVC governance frameworks would predict persistent captive lock-in. We find that, in combination, collective forms of power—both institutional and constitutive—play a critical role in facilitating Pakistani AV upgrading.

Building on the conceptual insight from governance and power, functional upgrading occurs when low-capability suppliers leverage both institutional and constitutive power. Institutional power reduces complexity at scale and broadens participation and initial learning by providing access to codified tools, standards, and development knowledge. A comparable role of institutional power can be observed in other contexts where supplier upgrading is facilitated in meeting lead firm or international standards (Pietrobelli and Rabellotti 2011), such as the Association of Chilean Salmon Industries, which facilitated compliance with international food safety and quality standards, among other assistance (Rainbird and Ramirez 2012). In sustainability-governed agri-food, certification and reporting standards provide codified pathways for suppliers to access global markets despite limited capabilities (Oberlack et al. 2023; Ponte et al. 2023). These contexts resemble our empirical case in that institutionalized codification reduces complexity away from individual suppliers.

Yet, upgrading requires more than technical capability or compliance. Suppliers must also gain recognition and legitimacy within professional communities—a clear manifestation of constitutive power. Agile methodology and open-source engagement were central mechanisms through which

constitutive power was established. By demonstrating competence through these practices, AVs accrued legitimacy from peers, clients, and broader professional communities. This legitimacy allowed them to convert institutional access into higher-value activities, such as integrated service delivery, software design and UX development. Those AVs that actively leveraged constitutive power moved from captive to modular governance arrangements, secured larger projects, and achieved functional upgrading. In contrast, AVs that merely complied with codified standards without establishing legitimacy remained constrained to low-value roles.

This understanding challenges prevailing assumptions in the GVC upgrading literature that low-capability suppliers are structurally limited in the absence of dyadic learning or supportive national institutions. Instead, upgrading can occur through ecosystem-level mechanisms, where institutional access provides opportunity, but constitutive power–rooted in community recognition, norms, and professional legitimacy—determines which suppliers can translate access into higher-value outcomes. Functional upgrading, therefore, emerges from the interaction of institutional and constitutive power rather than from capability accumulation alone. Similar dynamics can be plausibly expected in other collectively governed settings. In certification-based value chains, for instance, many suppliers achieve compliance but remain locked into low-value activities, while a smaller subset gains recognition as reliable, innovative, or exemplary actors and is able to expand into design, coordination, or branding roles (Ponte and Gibbon 2005; Ponte et al. 2023). In knowledge-intensive service sectors, suppliers often enter global markets through codified service models, but functional upgrading tends to occur only when they are recognized as competent problem-solvers within wider professional communities (Sako and Zylberberg 2019; Choksy et al. 2024a).

6.3 Future studies

Future studies could build upon our research in two ways. First, we focused only on the limited area of overlap between governance and power; namely, by highlighting how the effects of the key drivers of governance (complexity, codification, and capabilities) differ depending on the mode of power (bargaining and institutional). The broad nature of both the GHS and DPS frameworks (which offer five types of governance and four types of power) provides many research opportunities to explore other ways in which governance and power interact and mingle. It is highly likely that different industry contexts will reveal new interactions between power and governance. Second, we focused on firms; however, collective forms of institutional and constitutive power usually derive from the actions of a wider range of GVC actors, including NGOs, CSOs, and governments. These non-firm actors are particularly important in understanding how power dynamics shape economic, social and environmental upgrading in GVCs. Future research into governance and power would benefit from expanding the analytical and empirical lens to incorporate the role of firm and non-firm actors shaping governance and power dynamics in GVCs, and the implications of this for different forms of upgrading.

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Supplementary material

Supplementary material is available at *Journal of Economic Geography* online.

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