

Coordinating Digital-Driven Rural Industrial Integration in Sichuan's Ethnic Minority Areas: A Multi-Actor Governance Framework

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Abstract: Studies of rural digitalization commonly identify infrastructure gaps, limited skills, and fragmented resources, but listing these constraints does not specify how public and private actors should coordinate their responses. Focusing on the ethnic minority areas of Sichuan Province, China, this paper develops a multi-actor governance framework for digital-driven rural industrial integration. It distinguishes five actor groups—local governments, producer organizations, processing and service enterprises, digital platforms, and rural households—and considers the incentives and coordination failures that may arise among them. Building on polycentric governance and collective-action scholarship, the paper proposes a phased policy sequence: diagnose binding constraints and establish basic safeguards; develop producer capabilities and stable cross-industry relationships; and support differentiated value creation with outcome-based evaluation. It also recommends assessing integration through durable economic linkages, participation, and benefit distribution rather than infrastructure coverage or online sales alone. The framework does not claim to evaluate current programs empirically. Instead, it specifies responsibilities, sequencing principles, and criteria that can guide subsequent local implementation and research.

Keywords: Rural industrial integration; Multi-actor governance; Policy sequencing; Digital platforms; Ethnic minority areas.

1. Introduction

Digital technologies can expand market access in rural economies, but online connectivity is not sufficient to build integrated relationships among agricultural producers, processing firms, logistics providers, and service businesses. Hong and Su (2024) provide evidence from China that rural e-commerce platforms may contribute to industrial structural transformation [1]. However, the extent to which rural actors can exploit these opportunities depends on complementary infrastructure, organizational capability, and the institutional arrangements under which exchange takes place.

The challenge is especially relevant to Sichuan's mountainous ethnic minority areas, where economic activities can be dispersed and the costs of transporting agricultural products remain significant. The provincial Action Plan for Rural Primary, Secondary and Tertiary Industrial Integration identifies processing, supply chains, digital commerce, and tourism-related activities as development priorities [2]. Such policy directions involve numerous actors with different incentives and implementation capacities.

Zhang (2024) discusses infrastructure, financing, talent, regulation, and resource fragmentation constraints in the digital transformation of rural industries in Liangshan Prefecture [3]. A list of these constraints alone offers limited guidance for coordination. The present paper therefore asks: who should address each constraint, in what order, and under which rules should the gains and risks of coordination be shared?

The analysis draws on polycentric governance and collective-action research. Ostrom (2010) argues that complex economic settings can involve complementary decision centers rather than a simple market-versus-state division [4]. Markelova et al. (2009) examine the conditions under which collective action can improve smallholder

market access [5]. These insights suggest that digital rural development requires both differentiated responsibilities and credible mechanisms for cooperation.

This paper contributes a governance design framework organized around actor roles, incentive conflicts, phased implementation, and outcome-based assessment. It is based on published research and policy documents, not new fieldwork. Its proposals should consequently be treated as analytically derived options rather than verified accounts of programs currently operating in every part of Sichuan.

2. From Constraint Lists to Coordination Problems

A useful starting point is to distinguish a resource deficit from a coordination failure. Insufficient broadband, storage, or trained personnel is a resource problem. A coordination failure arises when complementary investments depend on one another, but no single actor has the incentive or authority to undertake them simultaneously. For example, a processor may hesitate to invest in packaging equipment before producers adopt consistent quality standards; producers may postpone adopting those standards without a reliable buyer; and logistics firms may not open a route before shipment volumes become predictable.

Digital platforms can lower certain information costs but do not eliminate these mutual dependencies. Zhang and Qiu (2024) show that rural e-commerce benefits are realized through the interaction of digital technology with local industrial practices rather than technology alone [6]. You and Zhang (2026) likewise highlight the importance of platform literacy and interactions among different actors in central and western China [7]. Taken together, these studies support examining arrangements that turn isolated investments into coordinated choices.

Three types of coordination problem are relevant. First,

investment complementarities link connectivity, product quality, storage, and transport. Second, bargaining and distributional concerns arise when small producers depend on concentrated buyers or platforms. Third, policy fragmentation occurs if departments or localities separately finance infrastructure, training, production, and tourism initiatives without connecting them to viable local supply chains. These problems should be analyzed according to their consequences for cross-industry relationships, not as generic symptoms of rural underdevelopment.

Accordingly, governance should be organized around the economic task. If the main obstacle is an unreliable cold chain, another e-commerce training course is unlikely to solve it. If quality variation prevents a producer group from supplying processors, marketing subsidies may expand inquiries without securing repeat orders. A constraint-diagnosis approach therefore asks which missing complement prevents the next productive relationship from forming.

3. Actor Roles and Incentive Alignment

3.1. Local government: Public goods and credible coordination

Local governments are comparatively well placed to provide or facilitate infrastructure with public-good characteristics, coordinate planning across administrative departments, and establish basic market safeguards. They can also publish transparent eligibility and performance criteria for support programs. Their task is not to manage each enterprise's sales but to reduce barriers that individual firms cannot efficiently overcome on their own.

A potential risk is output-oriented evaluation. Counting newly constructed facilities, training participants, or online storefronts can reward visible activities without showing whether rural industries have become more integrated. Public investment should therefore address documented bottlenecks and offer prospects for sustainable use. Periodic reviews can inform decisions to close or redesign facilities that fail to attract sufficient demand.

3.2. Cooperatives and producer organizations: Aggregation and accountability

For dispersed households, collective organizations may provide product grading, group purchasing, shared marketing, and coordination of deliveries. Markelova et al. (2009) show why collective action is important for overcoming smallholder market barriers, while also emphasizing the importance of institutional design [5]. Producer organizations can make agricultural supply more reliable for processors and logistics firms, but their effectiveness depends on members' incentives and participation.

Governance rules should make service charges, grading procedures, purchase arrangements, and surplus distribution understandable to members. Where producer organizations function merely as nominal intermediaries, they may add another layer of cost without strengthening coordination. A meaningful performance measure is whether individual producers obtain more dependable access to downstream activities and retain an appropriate share of value.

3.3. Enterprises and service providers: Commercial viability and quality commitments

Processing firms, logistics operators, and tourism businesses bear substantial responsibilities for productive investment, product development, service quality, and commercial risk. Their participation will be sustainable only when expected demand and coordination benefits justify costs. Public policy should therefore avoid replacing commercial judgment with a requirement to launch projects regardless of demand.

Contracts and repeat interactions can coordinate delivery volumes, quality requirements, investment responsibilities, and dispute resolution. Enterprises should also recognize their capacity to influence household incentives. Unpredictable procurement or unilateral changes to quality requirements may undermine the supply relationships on which integration depends. More stable purchasing commitments can encourage producers to make complementary investments.

3.4. Digital platforms and service intermediaries: Access without dependency

Platforms supply market access, payment systems, information, and sometimes logistical services. However, these advantages can coexist with unequal bargaining power, platform fees, and dependence on proprietary channels. Zhang (2021) documents the contradictory distributional dynamics of platform-mediated rural production in China. Thus, platform development should not be equated with community-wide economic gains [8].

Practical governance safeguards can include transparent fee information, training on account and data portability where feasible, clear terms for promotional services, and accessible complaint procedures. Producer organizations may also reduce dependency by maintaining multiple sales channels. These measures aim to improve market functioning and bargaining awareness without presuming that every platform arrangement is exploitative.

3.5. Households and communities: Participation and locally grounded decisions

Households make production, labor, and participation decisions, while communities may contribute knowledge and cultural resources that are important for differentiating products and services. Programs that overlook these decisions risk encouraging nominal participation or allocating benefits to outside intermediaries. Training and organizational arrangements should therefore be tailored to actual roles: a producer may need quality-control skills, a cooperative manager inventory-management skills, and a tourism entrepreneur service-management skill.

Where cultural assets contribute to a commercial offering, the terms of participation and benefit allocation warrant explicit attention. Digital marketing should support community-approved products and experiences rather than assume that distinctive cultural traditions can automatically be converted into tourism revenue. Social inclusion and commercial viability are complementary objectives, not substitutes for each other.

4. Phased and Differentiated Policy Implementation

A multi-actor framework becomes operational only when measures are sequenced. A uniform investment package applied to every locality is unlikely to perform equally well because the binding constraints differ across product types, market distances, and existing industrial capabilities. The following stages are proposed as adaptable decision principles, not as a rigid timetable.

4.1. Stage I: Diagnose the binding constraint and establish minimum conditions

The initial task is to map a specific product or service chain and identify where cooperation breaks down. Relevant questions include whether potential buyers exist, whether products meet quality requirements, whether logistics are economically feasible, and whether producers can organize predictable volumes. A simple chain map can reveal whether the principal obstacle lies in technology, organization, physical infrastructure, or demand.

Public support should first address constraints with clear complementarities. Improving digital access may be valuable where producers already possess marketable products and reliable delivery capacity. In other places, grading and shared logistics may generate more immediate value than additional online promotion. Basic contractual transparency and quality safeguards should be introduced early because they reduce the risk of committing resources to unstable relationships.

4.2. Stage II: Build repeat transactions and organizational capabilities

The intermediate stage focuses on turning occasional sales into repeat relationships. Cooperatives can coordinate quality assurance and delivery; downstream businesses can offer clearer procurement terms; and digital intermediaries can provide transaction and information services. Training should be connected to a specific operational task, such as maintaining traceable product information or coordinating consolidated shipments.

Policies at this stage should reward genuine participation and reliable exchanges rather than the mere registration of enterprises or e-commerce accounts. Pilot arrangements may be useful if results are assessed in terms of transaction costs, service utilization, producer participation, and continuity of contracts. Where a pilot fails, the diagnosis should ask whether expected complementarities were absent rather than automatically concluding that local actors resisted digitalization.

4.3. Stage III: Diversify value creation and evaluate distributional outcomes

Only after basic coordination becomes credible should programs place greater emphasis on more elaborate processing, branding, and bundled products or services. Agricultural products may be associated with local tourism or other experiences where consumer demand, service quality, and community participation support a viable business model. Differentiation is desirable when it adds value, but not simply because a product can be advertised using regional or cultural symbols.

Evaluation should examine whether new downstream activities produce benefits that endure beyond promotional subsidies. Important questions are whether producers obtain

stable demand, whether processing and service enterprises can cover their costs, and whether households share in the gains. Community consultation may be especially important where tourism or cultural commercialization affects collective assets.

5. Evaluation and Governance Safeguards

A major implication of the framework is the need to measure industrial integration rather than digital inputs. Infrastructure coverage, numbers of online stores, or gross sales may describe technology use, but they cannot independently establish integration. Better indicators would reflect relationships and outcomes: the proportion of participating producers in repeat agreements, the share of output entering coordinated processing or service channels, compliance with quality standards, utilization of shared logistics, and continuity of cooperation after support is reduced.

Distributional assessment is also necessary. A program can increase sales while leaving small producers with limited bargaining power or exposing them to excessive platform expenses. Indicators might therefore include transparent deductions, the timeliness of payments to producers, member participation in cooperative decisions, and the accessibility of dispute processes. These are proposed measurement dimensions, not data or results collected by the present study.

Responsibility for evaluation should be shared but differentiated. Government agencies can disclose program outputs and public spending; producer organizations can provide member-level participation records with appropriate privacy safeguards; and commercial partners can report aggregate cooperation outcomes when contracts permit. Independent review can reduce the risk of self-reported success. Because activities and capacities vary, evaluation should combine a small set of common indicators with locally relevant measures.

The governance approach must also acknowledge trade-offs. Infrastructure investment can improve accessibility but impose high maintenance costs; standardization may facilitate market entry but exclude producers unable to meet requirements; and platform scale can improve demand matching while increasing dependence. Transparent evaluation should make these trade-offs visible rather than assume that every digitalization intervention produces a net benefit.

6. Conclusion

The central challenge of digital-driven rural industrial integration is not merely a shortage of technology but the alignment of complementary investments and incentives among rural actors. Building on research about rural e-commerce, collective action, and polycentric governance, this paper proposes a framework that allocates responsibilities across government, producer organizations, enterprises, platforms, and households.

In practice, local policy should begin by identifying what prevents producers, processors, and service providers from maintaining stable economic relationships. Investment in processing, branding, and other higher-value activities is more likely to be effective when these basic relationships are already in place.

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Data Availability

No original datasets were generated or analyzed in this conceptual study.

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