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Integration effects on agricultural cooperative performance: A study case in Java Island, Indonesia

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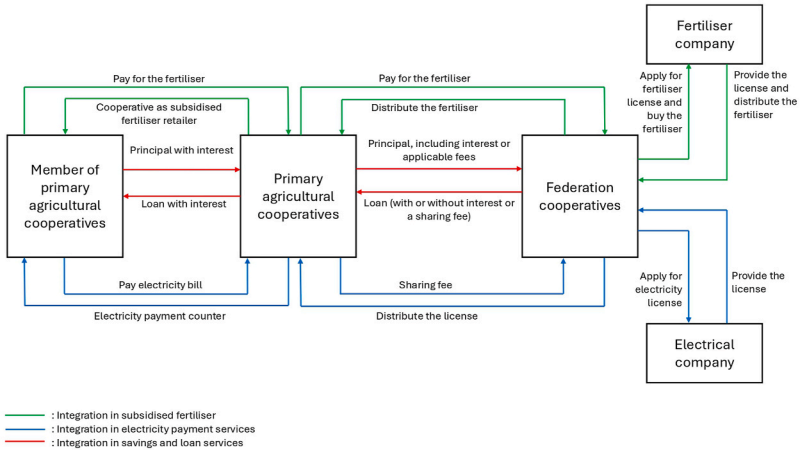
GRAPHICAL ABSTRACT



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ABSTRACT

Agricultural cooperative development in Indonesia is closely linked to government intervention. Policymakers have advocated for a federation system that integrates agricultural sector programmes with cooperatives at both national and rural levels. This study aims to assess the effects of such integration on the performance of agricultural cooperatives by analysing data from annual reports of cooperatives for 2022 and 2023. Furthermore, through the use of panel data regression and Data Envelopment Analysis (DEA), framed within Transaction Cost Theory (TCT), Resource Dependence Theory (RDT), and Dynamic Capabilities Theory (DCT), this research explores how federated integration affects cooperative performance. Various types of integrated services were examined to understand how their characteristics and implementation relate to performance outcomes. By linking theoretical frameworks with empirical evidence, this study provides detailed insights into how integration can enhance cooperative performance and underscores the importance of adapting integration strategies to evolving operational environments.

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1. Introduction

Cooperatives serve a strategic function in sustainable agricultural development by facilitating collective efforts, enhancing resource utilisation, and expanding market access for smallholder farmers (Wollni and Zeller, 2007). The Cooperative Life Cycle Framework (LCF) explains that cooperatives are established for economic purposes, with members formulating their organisational bylaws and governance structures. Moreover, challenges such as limited capital, inefficiencies, and growth obstacles often necessitate strategies, such as mergers and acquisitions, to improve performance (Cook, 2018). While the LCF has been influential in Western contexts, its relevance in Asian agricultural cooperatives requires further examination. In many Asian countries, the development of cooperatives has been driven by government initiatives, which include promoting farmer membership, formulating bylaws, and establishing hierarchical federation systems that integrate cooperatives at national, provincial, and local levels (Siregar et al., 2024). These federations linked local cooperatives to support programmes, thereby facilitated coordinated agricultural development efforts (Honma and Mulgan, 2018). Furthermore, government-supported cooperatives have been shown to bridge the divide between smallholders and modern agriculture by fostering capital accumulation, technological adoption, and member cohesion (Zhong et al., 2023). However, evolving conditions have reduced state involvement, making participation in federation systems voluntary (Maclachlan and Shimizu, 2022). This shift has introduced new governance dynamics and raised questions about the value of federation integration. Studies have examined federation systems in terms of development pathways (Choi et al., 2020), success factors (Park and Hwang, 2019), scale efficiency (Harimaya and Kagitani, 2020), and member retention decisions (Maclachlan and Shimizu, 2022). Nevertheless, there is limited empirical evidence of how federation system integration affects the performance of primary agricultural cooperatives. Addressing this gap is strategic in enhancing cooperative resilience and informing policies to support sustainable agricultural cooperatives.

Federation models in Asia demonstrate considerable diversity. For instance, China implements a five-tier system (Guo et al., 2008), Japan (Ishida, 2002) and India (Gaikar, 2017) operate within three-tier frameworks, and South Korea utilises a two-tier model (Choi et al., 2020). In Indonesia, the federation system has undergone major restructuring. Previously characterised by vertical integration across local, provincial, and national levels, the integration now operates through two distinct channels: one connecting the national federation with provincial entities, and another linking provincial federations with primary cooperatives (Induk KUD, 2025). Unlike countries with standardised federation policies, Indonesia presents a complex scenario due to its decentralised governance and the varying capacities of local institutions. The absence of mandatory integration, coupled with inconsistent government support and differing levels of cooperative maturity, has led to a fragmented cooperative landscape. This fragmentation poses challenges for evaluating whether federation integration enhances cooperative performance. Furthermore, Indonesia's focus on strengthening agricultural cooperatives for rural development and food security highlights the need for evidence-based policy interventions. Understanding the effect of federation integration models on agricultural cooperative performance is essential for achieving improved outcomes.

The integration system in Indonesia was initiated in the 1970s and has evolved over the decades in response to various political, economic, and agricultural challenges. This study addresses a gap in the literature by examining the effect of integration on the performance of agricultural cooperatives in Indonesia. Furthermore, this study explores the functioning of integration within Indonesia's federation system and identifies factors that contribute to cooperative outcomes. The research question is: How does integration within a federation system affect agricultural cooperative performance, and what factors are associated with the outcomes?

This study contributes to the existing literature by utilising Transaction Cost Theory to assess the effect of federation integration on cooperative performance, applying Resource Dependence Theory to examine how integration facilitates access to financial and institutional resources, and incorporating Dynamic Capabilities Theory to understand how federated structures enable cooperatives to adapt, coordinate, and optimise internal capabilities. These theoretical perspectives provide a comprehensive framework for addressing the research question. Furthermore, this study extends and contextualises these established theories by examining how federation integration affects cooperative performance in the Indonesian context, offering insights beyond the empirical settings in which these theories were originally developed.

2. Literature review and theoretical framework

2.1. Studies of integration within federation system in Indonesia

Since the 1970s, Indonesia has implemented a federated system for its agricultural cooperatives, yet scholarly exploration of this organisational framework remains limited. Notably, Indonesia is distinguished in Asia as a unique case where cooperative integration operates independently of direct state intervention, relying instead on the autonomous decisions made by individual cooperative stakeholders (Siregar et al., 2024). The academic discourse on federated agricultural cooperatives in the country is underdeveloped, with current literature predominantly addressing topics such as environmental conservation (Budiningsih et al., 2019), member welfare (Gosari et al., 2019), marketing of agricultural products (Busthanul et al., 2021), determinants of cooperative performance success (Hendriani, 2018), and the relationship between organisational capability, innovation, and competitive advantage (Sumantri et al., 2023). Furthermore, despite its potential to address systemic challenges such as inefficiency, capital constraints, and sluggish growth, there remains a research gap concerning the structure, governance, and performance implications of the federated system (Carman, 1997).

Countries such as Japan, South Korea, China, and India have extensively explored federated cooperative systems through scholarly literature. In Japan, research has focused on the interactions between agricultural cooperatives, political parties, and government agencies, with an emphasis on institutional structures and activities (Ishida, 2002), the processes involved in agricultural policy (Mulgan, 2003), and reforms within agricultural cooperatives. These reforms address: a) policymakers' perspectives on party management (Sasada, 2015), b) the increasing capacity of executive leadership in Japan's agricultural sector to facilitate market-oriented changes (Maclachlan and Shimizu, 2016), and c) the decline in both agricultural support and perception (Mulgan, 2016). Additionally, studies have empirically examined the efficiency and economies of scale at the prefectural federation level (Harimaya and Kagitani, 2020). In South Korea, the political context of cooperative governance has led to research on organisational transformation (Burmeister, 1999), developmental phases (Choi et al., 2020), and the broader cooperative movement (Kim, 2013). Similarly, China's federated cooperative system is closely linked to government intervention, prompting studies on policy support (Deng et al., 2010), historical evolution (Guo et al., 2008), organisational failures (Hu et al., 2017), operational efficiency (Huang et al., 2013), marketing functions (Liu et al., 2019), and macro-level effects on agricultural economic growth, considering cooperative number, membership size, and government subsidies (Zhong et al., 2023). In India, scholarly attention includes evaluations of federated entities (Gaikar, 2017), the roles in market linkage (Gummagolmath and Lakshmi, 2022), and institutional challenges (Saraf et al., 2023). In summary, the strategic importance of federated cooperative systems in the development of agricultural cooperatives is undeniable. Nonetheless, there is a gap in academic research regarding practical implementation. This gap underscores the

need for thorough examinations to assess the effects of integration on the performance of agricultural cooperatives.

2.2. Theories for the study of integration effects on agricultural cooperative performance

Transaction Cost Theory (TCT), initially proposed by Coase in 1937 and further developed by Williamson (1981), suggests that organisations develop governance structures that minimise costs of economic transactions, such as search, negotiation, monitoring, and coordination. Within cooperative federations, TCT explains how integration reduces inefficiencies from fragmented operations and redundant efforts among cooperatives. Federated structures enable centralised decision-making, shared procurement and coordinated logistics, thereby reducing dependence on external entities while enhancing economies of scale. Uzea and Fulton (2014) conducted a study on 236 retail cooperatives in Western Canada affiliated with Federated Co-operatives Limited (FCL), demonstrating how joint ownership of a wholesaler enhances bargaining power, logistics efficiency, and marketing effectiveness. Similarly, Boland & Secor (2023) identified that federated systems capture greater value within the agricultural supply chain, enabling cooperatives to extend governance beyond the farm gate and engage in coordinated market activities. Furthermore, empirical evidence from China indicates that cooperatives provide machinery rental, technical assistance, and standardised production processes, enabling smallholders to access modern agricultural technologies efficiently and at reduced costs. These coordinated activities diminish fragmentation and enhance operational efficiency, facilitating smallholders' transition from labour-intensive to capital-intensive farming (Zhong et al., 2023).

Resource Dependence Theory (RDT), developed by Pfeffer and Salancik in 1978, offers a comprehensive framework for understanding how organisations manage external dependencies through strategic alliances and restructuring to secure essential resources (Pfeffer and Salancik, 2003). In the context of cooperative federations, RDT posits that integration serves as a strategic response to environmental uncertainties, particularly in securing financial, institutional, and regulatory support. Individual cooperatives often face challenges in influencing policy or attracting funding. However, federated structures enhance collective legitimacy and strengthen bargaining power with stakeholders. Oh (2023) documented the role of national federations in Japan and South Korea in channelling subsidies, loans, and agricultural inputs, thereby promoting productivity and community development. Similarly, Gupta et al. (2021) examined India's Minimum Support Price (MSP) scheme, where the National Agricultural Cooperative Marketing Federation of India (NAFED) functions as an intermediary to stabilise the incomes of member-owners, underscoring the pivotal role of federations in managing resource flows under conditions of uncertainty. Meanwhile, in China, a study in 2023 demonstrates that cooperatives mobilise member contributions and capital accumulation to overcome resource constraints, reducing reliance on government subsidies while promoting technological adoption and market participation. The study also identifies non-linear effects, namely the number of cooperatives at the county level has an inverted U-shaped effect on agricultural economic growth, while the average membership size exhibits a U-shaped effect. Cooperatives without members or capital (often referred to as fake cooperatives), do not contribute to growth, highlighting the importance of genuine membership engagement and capital accumulation (Zhong et al., 2023).

Dynamic Capabilities Theory (DCT), as articulated by Teece et al. (1997), underscores an organisation's ability to integrate, develop, and reconfigure competencies in response to evolving environments. Within federated cooperative systems, DCT provides a framework for evaluating how integration can enhance strategic adaptability and performance. Federated structures are pivotal in facilitating knowledge exchange and collaborative problem-solving, enabling cooperatives to cultivate and refine capabilities more effectively than when functioning independently. Hogeland (2002) examined Countrymark, a regional cooperative that faced aligning semi-autonomous local cooperatives with a unified vision. Countrymark addressed this challenge by implementing strategies such as shared branding, standardised products, and unified managerial practices. Similarly, Uzea & Fulton (2001) observed that in federated systems, communication practices, including face-to-face interactions, are essential in establishing common knowledge, fostering shared beliefs about cooperative strategies, and enabling collective action. Furthermore, a study in China demonstrates that cooperatives serve as strategic intermediaries between smallholders and modern agricultural systems, by mobilising member contributions and capital, cooperatives finance technology acquisition, establish market linkages, and facilitate participation in value-added supply chains. These activities reduce individual farmers' exposure to external uncertainties, accelerate technological diffusion, and improve operational efficiency (Zhong et al., 2023).

3. Research model and hypotheses development

Grashuis and Ye (2019) emphasised that agricultural cooperatives are established to address the challenges faced by their members while promoting organisational growth. According to Martínez-López et al. (2024), organisational growth is inseparable from financial performance, as economic viability enables cooperatives to remain competitive and ensure their sustainability. This assertion is supported by findings indicating that over half of the reviewed articles utilised financial metrics to assess cooperatives' performance.

The integration of agricultural cooperatives is expected to bring higher performance for the entity. However, the performance of cooperatives is affected not only by integration but also by various other factors, both internal and external. These factors include the age of the board of directors (Gezahegn et al., 2020), member participation (Pham, 2022), total assets (Pokharel et al., 2019), financial ratios, and the concentration of the cooperative, whether specialised or diversified (Pokharel et al., 2020).

3.1. Integration

Integration denotes the structural alignment of a primary cooperative with a secondary system through its affiliation with a larger federation. This alignment enhances cooperative performance by reducing transaction costs, achieving economies of scale, and granting access to shared services such as marketing and credit facilities. Federated cooperatives consolidate resources to enhance bargaining power. According to Barton et al. (1993), integration addresses issues related to information asymmetry and enforcement. Furthermore, Djohan (1995) highlights how federated systems streamline procurement, thereby reducing costs and improving service quality.

H1. Integration affects cooperative performance.

3.2. Age of the board of directors

The age of the board of directors serves as a strategic determinant of cooperative performance, influencing decision-making, risk tolerance, and long-term planning. Gezahegn et al. (2020) identified that younger board members contribute fresh perspectives and digital fluency, which are valuable in contemporary agribusiness. Conversely, older members offer industry knowledge and social capital, which are essential for effective risk management.

H2. The age of the board of directors affects cooperative performance.

3.3. Member participation

Member participation in cooperative activities, particularly in cooperative governance, is crucial for the long-term sustainability of a

cooperative (‘Aini et al., 2012). As both owners and users, members are expected to engage not only by attending training sessions and participating in policy-making through general meetings, but also by contributing to share capital and utilising cooperative services (Pham, 2022).

H3. Member participation affects cooperative performance.

3.4. Total assets

The total assets of a cooperative serve as an indicator of its capacity to invest in infrastructure, innovation, and service delivery, including land, buildings, equipment, transportation, and financial capital. A solid asset base empowers cooperatives to internalise operations such as storage and processing, resulting in cost reductions and enhanced net income. Cooperatives with substantial assets are well-positioned to engage in value addition or pursue vertical integration, thereby improving their overall performance. Grega (2003) emphasised that cooperatives with strong capitalisation are more resilient to market fluctuations. Lerman and Parliament (1991) observed that larger cooperatives demonstrate greater efficiency in asset utilisation.

H4. Total assets affect cooperative performance.

3.5. Financial ratios

Financial ratios serve as essential tools for evaluating the liquidity, leverage, and stability of cooperatives. The current ratio is a key indicator of a cooperative’s capacity to fulfil short-term liabilities, with higher values denoting robust liquidity, thereby enhancing creditworthiness and potential for growth (Richards and Manfredo, 2003). In contrast, the debt-to-asset ratio evaluates financial leverage, revealing the extent to which assets are financed through debt. Excessive debt levels can negatively affect profitability and constrain financial flexibility (Krasachat and Chimkul, 2015).

H5a. Current ratio affects cooperative performance.

H5b. Debt-to-asset ratio affects cooperative performance.

3.6. Cooperative concentration (specialisation vs. diversification)

Cooperatives exhibit a range of operational strategies, from focusing on a single commodity to offering a diverse array of products. The Herfindahl–Hirschman Index (HHI) is commonly used to assess such concentration. Cooperatives that specialise in a single commodity benefit from streamlined operations and specialised market knowledge, yet they are exposed to increased market risks. In contrast, cooperatives with diversified product lines are more adept at mitigating risks across different sectors. Ariyaratne et al. (2000) highlighted that diversification supports financial sustainability, while Pokharel et al. (2020) demonstrated that a balanced diversification approach enhances performance during external economic challenges.

H6. Cooperative Concentration (as measured by HHI) affects cooperative performance.

3.7. Efficiency as an outcome variable

In the context of cooperatives, efficiency pertains to the organisation’s ability in utilising resources to achieve desired outputs. Cooperatives often engage multiple inputs and aim to produce a variety of outputs. To navigate this complexity, Data Envelopment Analysis (DEA) is employed as a comprehensive method for evaluating efficiency (Banker et al., 1984). DEA evaluates Pure Technical Efficiency, Technical Efficiency, and Scale Efficiency by benchmarking cooperatives to best-practice units (Cooper et al., 2007). The applicability of DEA in agricultural organisations is demonstrated by Huang et al. (2013), while Xaba et al. (2020) underscore its effectiveness in pinpointing performance gaps. Additionally, efficiency reflects how cooperatives transform their unique characteristics, governance frameworks, and resources into financial outcomes, influenced by factors such as integration, the age of board members, member participation, financial ratios, and the concentration of cooperatives.

H7. Cooperative efficiency is affected by integration, board age, member participation, financial ratios, and concentration strategies.

4. Material and methods

4.1. Study area

Indonesia has been selected for this study due to the ongoing integration within its federated system. With the withdrawal of government intervention, primary agricultural cooperatives and federation governing boards are now tasked with independently managing the integration process. Cooperatives that engage in integration are expected to demonstrate improved performance compared to those operating independently (Djohan, 1995). Additionally, the integration process within the Indonesian federation has progressed beyond a vertical structure, evolving in two distinct directions: Firstly, the national federation integrates solely with the provincial federation (Induk KUD, 2025). Secondly, the provincial federation integrates exclusively with primary agricultural cooperatives (PUSKUD Jatim, 2024).

Jambi Province was initially selected for its alignment with the first integration path (provincial federation ↔ national federation). However, due to difficulties in securing stakeholder consent, the provincial federation was subsequently excluded. As a result, the study now concentrates on the second direction (primary agricultural cooperative ↔ provincial federation) in two regions: East Java (Jawa Timur) Province and Daerah Istimewa Yogyakarta. According to Induk KUD (2012), the federation in Jawa Timur is ranked among the top 100 cooperatives in Indonesia. Conversely, Soenarjo (1995) highlighted that the provincial federation in Daerah Istimewa Yogyakarta is the origin of the federation system, rendering the federation strategically important for the study.

In Jawa Timur Province, Bojonegoro Regency was selected for its active integration in savings and loan services and electricity payments between primary agricultural cooperatives and provincial federation cooperatives. Furthermore, according to Kementerian Koperasi dan Usaha Kecil dan Menengah Republik Indonesia (2017), one of the best agricultural cooperatives in Indonesia is located in this area and has integrated its operations with the federation cooperative, particularly in electricity payments and savings and loans services. This integration is expected to provide valuable insights into its effect on the performance of agricultural cooperatives. Additionally, in Daerah Istimewa Yogyakarta, primary agricultural cooperatives are involved in the integration of subsidised fertiliser distribution and electricity payment services through the provincial federation.

Integration within the federation system is structured as follows (as illustrated in Fig. 1): a) Federation cooperatives collaborate with electricity companies to manage services. Licenses are allocated to primary agricultural cooperatives to serve both farmer and non-farmer members;

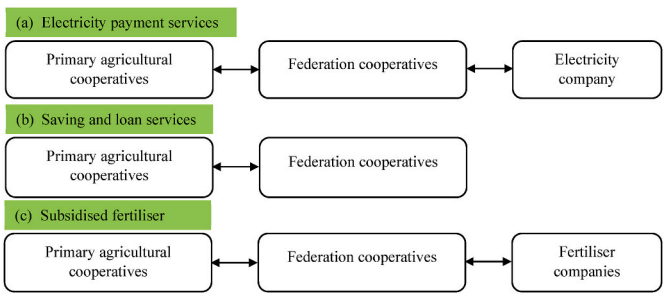

Fig. 1. Integration within federation system in Java Island, Indonesia.

b) As primary cooperatives often lack the capital necessary for savings and loan services, the federation offers financial support through low-interest loans or net income-sharing arrangements; c) The federation works in conjunction with fertiliser companies, leveraging its resources to procure, store, and distribute subsidised fertilisers to farmer-members.

4.2. Data collection

This study utilises both primary and secondary data. Primary data were collected through interviews with cooperative representatives, while secondary data were obtained from printed annual financial reports (Table 1). These reports provide information on total assets, liabilities, business volume (both overall and by business unit), and whether each cooperative is integrated into a federation system. Nevertheless, not every cooperative holds yearly meetings or issues reports. In Bojonegoro Regency, only 7 out of 26 agricultural cooperatives engaged in these activities, and in Daerah Istimewa Yogyakarta, the figure was 37 out of 61. Furthermore, most cooperatives retain reports only for the past two years (2022 and 2023). Consequently, this study analysed data from 44 cooperatives over this two-year period.

4.3. Data analysis

In addressing the research question, agricultural performance is evaluated using three primary indicators: income, net income, and efficiency. Subsequently, the effect of integration on the income and net income of agricultural cooperatives is examined by differentiating between cooperatives integrated within a federation system and those operating independently. Furthermore, to determine the appropriate panel data model (using data from 2022 to 2023 with 44 agricultural cooperatives each year), the Hausman test, Breusch-Pagan LM test, and F-test were conducted. The results indicate that the random effects model is the most suitable approach for estimating the panel data regressions, namely models (1) and (2).

$$INCOME_{it} = \beta_0 + \beta_1 ASSET_{it} + \beta_2 CR_{it} + \beta_3 DR_{it} + \beta_4 HHI_{it} + \beta_5 MP_{it} + \beta_6 AGE_{it} + \beta_7 ELECT_{it} + \beta_8 SAV_{it} + \beta_9 FERT_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

$$NET\ INCOME_{it} = \alpha_0 + \alpha_1 ASSET_{it} + \alpha_2 CR_{it} + \alpha_3 DR_{it} + \alpha_4 HHI_{it} + \alpha_5 MP_{it} + \alpha_6 AGE_{it} + \alpha_7 ELECT_{it} + \alpha_8 SAV_{it} + \alpha_9 FERT_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

Prior to evaluating the efficiency of integrated and non-integrated cooperatives, efficiency scores were generated using an output-oriented Data Envelopment Analysis (DEA) model. This orientation was selected due to its alignment with the objective of enhancing cooperative sustainability and member benefits through increased income (Abate, 2018). Both constant returns to scale (CRS) and variable returns to scale (VRS) assumptions were employed to decompose efficiency into technical efficiency (TE), pure technical efficiency (PTE), and scale efficiency (SE). The analysis incorporated the CCR model (Charnes et al., 1978) and the BCC model (Banker et al., 1984), both of which are well-established and widely recognised for isolating various efficiency components. Additionally, DEA assesses the ability of decision-making units (DMUs) to produce outputs using specified inputs (Cooper et al., 2007). Moreover, this study used income and net income as output variables, while total assets, total expenses, number of employees, board members, and members were considered as input variables (Table 1).

The efficiency score ranges from 0 to 1, with a score of 1 indicating relative efficiency, while scores below 1 denote inefficiency. For analytical purposes, the score is converted into a binary format: 1 for efficient (score = 1) and 0 for inefficient (score <1). This binary variable is used as the dependent variable in panel logit regression. Based on the results of the Hausman test, Breusch-Pagan LM test, and F-test, the

Table 1
Variables used in the study.

Variable	Symbol	Variable justifications	Source[a]
Total assets = $\sum_{i=1}^{n} A_i$ n = total number asset types (current, fixed, other assets) Ai = The value of *i*-th type of asset	ASSET	A solid asset base empowers cooperatives to lower costs and support growth. Cooperatives with substantial capitalisation are more resilient to market fluctuations (Grega, 2003), and larger cooperatives manage their assets with greater efficiency (Lerman and Parliament, 1991).	(A)
Current ratio = $\frac{\text{Current asset}}{\text{Current liabilities}}$	CR	Cooperatives with stronger liquidity are more stable and withstand income fluctuations (Richards and Manfredo, 2003).	(A)
Debt to asset ratio = $\frac{\text{Total Debt}}{\text{Total Asset}}$	DR	High debt levels reduce profitability and flexibility (Krasachat and Chimkul, 2015).	(A)
Herfindahl − Hirschman index = $\sum_{i=1}^{n} S_i^2$ n = total number of activities, services, or products within the cooperative. Si = share of each activity, service, or product in the cooperative's total operations	HHI	A higher HHI indicates specialisation, while a lower HHI reflects diversification. Diversification supports financial sustainability (Ariyaratne et al., 2000) and enhances performance during external shocks (Pokharel et al., 2020).	(A)
Member participation = $\frac{\text{Members' saving}_{t-}\ \text{Members' saving}_{t-1}}{\text{Members' saving}_{t-1}}$	MP	Member participation is evident through their savings, which strengthen cooperative capital. As cooperatives expand, member savings increase equity, thereby advancing organisational objectives(Bezabih et al., 2021).	(A)
Age	AGE	Younger leaders bring innovation and digital skills, while older leaders offer experience and risk management (Gezahegn et al., 2020).	(B)
1 = a primary cooperative integrated its electricity payment business with federation cooperative. 0 = otherwise	ELECT	A dummy variable was used to capture integration features, such as participation in electricity payments, savings and loans, or subsidised fertiliser business unit.	(A)
1 = a primary cooperative integrated its saving and loan business with federation cooperative. 0 = otherwise	SAV	Federated cooperatives consolidate resources to enhance their bargaining power. Integration helps reduce information asymmetry and enforcement issues (Barton et al., 1993), and enhances procurement efficiency (Djohan, 1995).	(A)
1 = a primary cooperative integrated its subsidised fertiliser business with federation cooperative. 0 = otherwise	FERT		(A)
Number of employees		Employees are one of the key inputs alongside capital for operational efficiency (Huang et al., 2013).	(A)
Number of members		In cooperatives, members act as both users and owners, contributing labour, capital, and governance, which collectively affect overall performance (Othman et al., 2014).	(A)
Number of board members		Larger boards could lead to coordination issues and affect efficiency (Huang et al., 2013).	(A)
Total expenses		An increase (decrease) in total expenses may reduce (increase) a cooperative's efficiency in converting inputs into outputs (Sufian and Habibullah, 2009).	(A)

[a] (A) = Annual report of cooperative, (B) = In-person interview.

pooled logit model was determined to be the most suitable for assessing the efficiency of agricultural cooperatives.

$$Logit\ (TE_{it}) = ln\left(\frac{P_{it}}{1-P_{it}}\right) = \beta_0 + \beta_1 CR_{it} + \beta_2 DR_{it} + \beta_3 HHI_{it} + \beta_4 MP_{it} + \beta_5 AGE_{it} + \beta_6 ELECT_{it} + \beta_7 SAV_{it} + \beta_8 FERT_{it} + \varepsilon_{it} \quad (3)$$

$$Logit\ (PTE_{it}) = ln\left(\frac{P_{it}}{1-P_{it}}\right) = \alpha_0 + \alpha_1 CR_{it} + \alpha_2 DR_{it} + \alpha_3 HHI_{it} + \alpha_4 MP_{it} + \beta_5 AGE_{it} + \alpha_6 ELECT_{it} + \alpha_7 SAV_{it} + \alpha_8 FERT_{it} + \varepsilon_{it} \quad (4)$$

$$Logit\ (SE_{it}) = ln\left(\frac{P_{it}}{1-P_{it}}\right) = \gamma_0 + \gamma_1 CR_{it} + \gamma_2 DR_{it} + \gamma_3 HHI_{it} + \gamma_4 MP_{it} + \gamma_5 AGE_{it} + \gamma_6 ELECT_{it} + \gamma_7 SAV_{it} + \gamma_8 FERT_{it} + \varepsilon_{it} \quad (5)$$

5. Results

This study examines the effect of integration on the performance of agricultural cooperatives, measured by income, net income, and efficiency. The results (Table 2) indicate that ASSET, DR, SAV, and FERT have significant positive effects on income, suggesting that larger asset bases, higher debt ratios, and integration through savings and loan services as well as subsidised fertiliser distribution enhance income. For net income, ASSET remains the most influential positive factor, whereas ELECT has a significant negative effect, implying that integration of electricity payment services is associated with lower net income.

The Data Envelopment Analysis (DEA) results indicate an overall improvement in cooperative efficiency. Average Technical Efficiency (TE) increased from 0.738 in 2022 to 0.910 in 2023 (Fig. 2a). Pure Technical Efficiency (PTE) also rose, from 0.889 to 0.954, suggesting improved resource utilisation (Fig. 2b). While PTE scores exceeded TE, indicating persistent scale inefficiencies, Scale Efficiency (SE) improved from 0.836 to 0.956, reflecting progress toward optimal scale operations (Fig. 2c).

Furthermore, factors such as member participation (MP), integration of savings and loan services (SAV), and fertiliser distribution (FERT) positively affect Technical Efficiency (TE), indicating that cooperatives more actively engaged in these areas use their resources more effectively (Table 3). For Pure Technical Efficiency (PTE), both HHI and MP have positive effects, while integration of electricity payment services (ELECT) is associated with reduced efficiency. Similarly, Scale Efficiency (SE) improves with higher MP and greater involvement in SAV and FERT integration.

Table 2
Regression results on factors influencing the income and net income of agricultural cooperatives.

	Income		Net Income	
	Coefficient	P>|z|	Coefficient	P>|z|
Cons.	10.89921***	0.005	−5.37462^{ns}	0.402
ASSET	0.31208***	0.001	0.72737***	0.000
CR	0.15224^{ns}	0.139	0.26893^{ns}	0.127
DR	0.25735*	0.055	−0.04332^{ns}	0.854
HHI	0.12621^{ns}	0.396	0.29939^{ns}	0.254
MP	0.00367^{ns}	0.694	0.00374^{ns}	0.893
AGE	0.41487^{ns}	0.576	1.57574^{ns}	0.156
ELECT	−0.45822^{ns}	0.158	−0.88839*	0.055
SAV	0.59068*	0.078	0.54028^{ns}	0.265
FERT	1.19922***	0.009	0.78713^{ns}	0.226
R2	0.4105		0.4240	
Prob > chi2	0.0020		0.0014	

Note: ns = not significant, * = significant at α = 10 %, ** = significant at α = 5 %, *** = significant at α = 1 %.

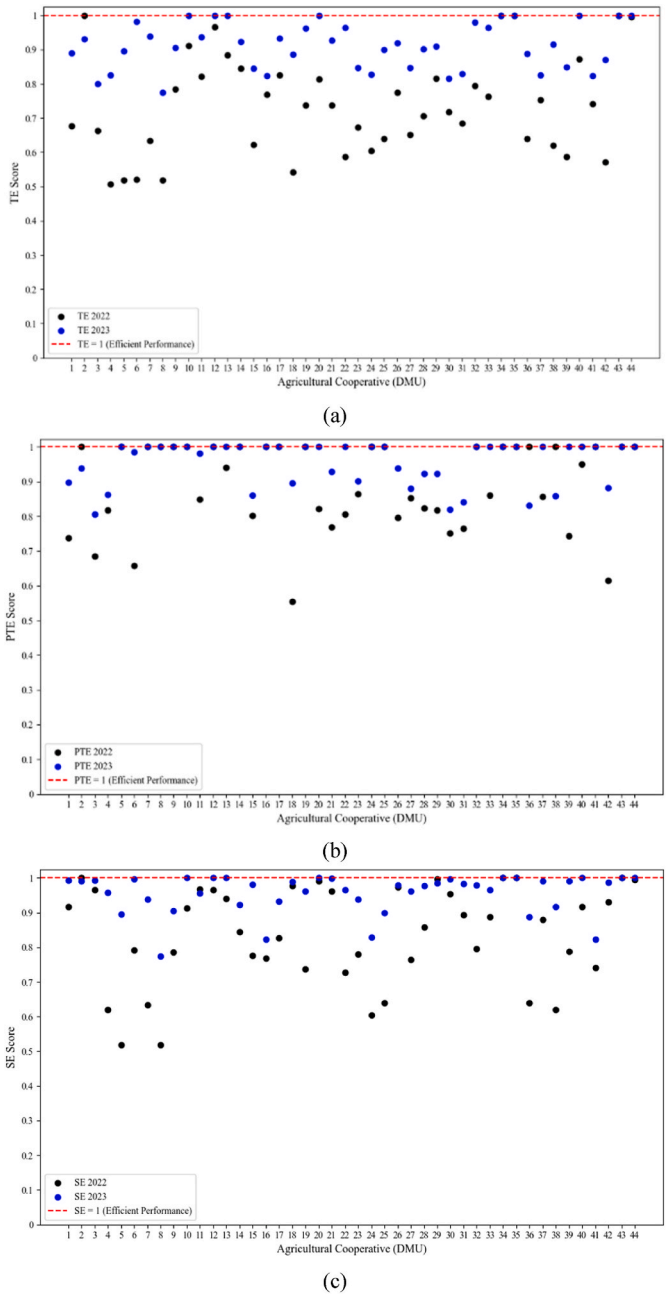

Fig. 2. Technical efficiency (TE) (a), pure technical efficiency (PTE) (b), and scale efficiency (SE) (c).

6. Discussions

This study examines how integration within federated cooperative systems affects the performance of agricultural cooperatives by comparing integrated and non-integrated entities, focusing on income, net income, and efficiency. The findings indicate that integration can enhance performance when aligned with cooperatives' core functions. However, integration might also hinder outcomes in sectors experiencing digital transformation. Beyond financial indicators, the study highlights the importance of cooperative integration and internal organisational factors in advancing broader sustainable development goals, such as resilience, institutional self-reliance, and member empowerment.

Empirical evidence from China illustrates how cooperatives mediate smallholder access to resources amid rapid agrarian modernisation

Table 3
Regression results on factors influencing the efficiency (TE, PTE, and SE) of agricultural cooperatives.

	TE		PTE		SE	
	Coefficient	P>|z|	Coefficient	P>|z|	Coefficient	P>|z|
Cons.	10.14548^{ns}	0.336	15.89662*	0.053	10.14548^{ns}	0.336
CR	0.44841^{ns}	0.326	−0.04181^{ns}	0.879	0.44841^{ns}	0.326
DR	0.18723^{ns}	0.780	−0.02730^{ns}	0.940	0.18723^{ns}	0.780
HHI	1.50188^{ns}	0.191	1.04103**	0.028	1.50188^{ns}	0.191
MP	0.21542*	0.065	0.10364*	0.093	0.21542*	0.065
AGE	−2.21709^{ns}	0.407	−3.0622^{ns}	0.114	−2.21709^{ns}	0.407
ELECT	−1.58814^{ns}	0.124	−1.58642**	0.045	−1.15881^{ns}	0.124
SAV	1.94746**	0.041	0.16991^{ns}	0.812	1.94746**	0.041
FERT	2.68599**	0.046	−0.35846^{ns}	0.729	2.6859**	0.046
R2	0.2769		0.1404			
					0.2769	
Prob > chi2	0.0089		0.0291			
					0.0089	

Note: ns = not significant, * = significant at α = 10 %, ** = significant at α = 5 %, *** = significant at α = 1 %.

(Zhong et al., 2023). Chinese cooperatives mobilise member contributions and capital accumulation to overcome resource constraints, reducing reliance on government subsidies while facilitating technological adoption and market participation. The study also demonstrates non-linear effects: the number of cooperatives at the county level has an inverted U-shaped effect on agricultural economic growth, whereas the average membership size exhibits a U-shaped effect. Cooperatives without members or capital (often considered fake cooperatives) do not contribute to growth, highlighting the importance of genuine membership engagement and capital accumulation for effective cooperative performance. This evidence complements the discussion on integration by showing that federated or networked cooperative structures can enhance operational efficiency, technological diffusion, and smallholder market participation, providing a concrete example of the mechanisms through which integration improves performance.

Assets are strategic to the sustainable operation of cooperatives, encompassing current, fixed, and long-term resources. These assets enable cooperatives to deliver services, invest in infrastructure, and realise economies of scale (Lerman and Parliament, 1991). This study found that increased assets correlate with higher income among agricultural cooperatives, consistent with prior research showing that larger cooperatives exhibit greater cost-efficiency and higher returns due to size and asset utilisation (Pokharel et al., 2020). A larger asset base also allows cooperatives to capitalise on economies of scale, reducing unit costs, enhancing purchasing power, and strengthening market positioning, which collectively contribute to improved performance and competitiveness (Barton et al., 1993).

Integration within a federation system emerges as a strategic enabler of sustainability, with effects varying by activity type. Integration of savings, loans, and subsidised fertiliser distribution significantly enhances performance, whereas integration of electricity payment services adversely affects outcomes. Regarding savings and loan integration, federated cooperatives operate as collective financial institutions owned by members. This shared ownership model facilitates resource pooling, lowers borrowing costs, and reduces reliance on external financial institutions. Rather than applying traditional interest rates, federations generate revenue through loan-sharing fees (PUSKUD Jatim, 2024), supporting self-financing mechanisms that strengthen long-term financial sustainability. This aligns with the governance structure of Japan Agricultural Cooperatives (JAs), which provide agricultural credit to members at relatively low interest rates (Harimaya and Kagitani, 2020). Furthermore, integration mitigates power asymmetries within financial systems, promotes financial inclusion, and ensures wealth circulates within the cooperative ecosystem, which are key principles of inclusive, member-driven development (Hillman et al., 2009).

The integration of subsidised fertiliser distribution also supports institutional sustainability. Primary cooperatives often lack the capital and regulatory capacity to act as licensed input distributors. Federation-level cooperatives bridge this gap by obtaining permits and operating as intermediaries, thereby expanding member access to agricultural inputs (PUSKUD Metaram, 2024). This model aligns with transaction cost and resource dependence theories by reducing bureaucratic friction and improving supply chain efficiency. Such integration enables cooperatives to reliably deliver agricultural support, strengthening their role in rural economies. This finding reflects the experience of the Sorosoro Ibaba Development Cooperative (SIDC) in the Philippines, which implements an integrated livestock value chain including feed milling, breeding, contract growing, processing, and distribution. This model minimises transaction costs and empowers smallholders by providing access to inputs, credit, and markets, exemplifying a scalable model of sustainable agri-food value chain development (Sumalde and Quilloy, 2015).

In contrast, the integration of electricity payment services has become unsustainable amid ongoing technological disruptions. Digital innovations such as mobile banking and online platforms have rendered traditional cooperative services less relevant. As revenues declined and operational costs remained fixed, economic viability weakened. Disruptive innovation theory (Christensen et al., 2015) and recent literature (Si and Chen, 2020), illustrate how emerging technologies can displace established services, particularly in institutions with limited adaptability. Cristobal-Fransi et al. (2020) emphasised the importance of integrating information and communication technologies (ICTs) in agricultural cooperatives for marketing, distribution, and customer engagement. However, many cooperatives struggle to fully adopt ICTs, limiting their ability to respond to market changes. Santos et al. (2024) argue that digital transformation is crucial for enhancing efficiency, productivity, and market access amid growing competition. These insights highlight the vulnerabilities cooperatives face when technological change outpaces institutional adaptation, underscoring the need for proactive digital strategies aligned with socioeconomic resilience.

Efficiency outcomes are indicative of important aspects of cooperative development. Between 2022 and 2023, Data Envelopment Analysis (DEA) showed substantial improvements: Technical Efficiency (TE) rose from 0.738 to 0.910, Pure Technical Efficiency (PTE) from 0.889 to 0.954, and Scale Efficiency (SE) from 0.836 to 0.956. These gains suggest enhanced resource allocation, improved management quality, and optimised scale. The PTE improvements indicate strengthened internal capabilities, including leadership, decision-making, and technology utilisation, consistent with the resource-based view (Barney, 1991) and dynamic capabilities theory (Teece et al., 1997). However, not all cooperatives achieved full efficiency. Residual inefficiencies underscore ongoing challenges, such as weak governance, underdeveloped technology, and capital constraints. Chaddad et al. (2005) observed that financial limitations restrict cooperative investment capacity, while Maietta and Sena (2010) noted that constrained entities might respond by minimising inefficiencies. Additionally, recent findings by Li and Wang (2024) suggest that digital transformation can enhance cooperative performance by reducing agency costs and by improving transparency.

This study identifies determinants of efficiency, highlighting the effect of internal governance and strategic choices on performance. The Herfindahl-Hirschman Index (HHI), measuring cooperative concentration, significantly affects pure technical efficiency (PTE), indicating cooperatives with a more focused set of business activities tend to perform better technically. This positive association aligns with literature showing that cooperatives with specialised product lines exhibit higher allocative efficiency (Ariyaratne et al., 2000). Although allocative efficiency and PTE assess different performance dimensions, both indicate effective resource utilisation and operational focus. This supports the idea that specialisation enhances operational discipline, improving both allocative and technical efficiency.

Member participation also positively influences TE and PTE. This

relationship stems from financial autonomy and operational flexibility gained through member savings, which reduce reliance on external borrowing. Núñez del Prado Nieto (2024) explained that utilising internal funds rather than costly external debt enables farmer organisations to retain control over financial decisions and avoid interest burdens. This autonomy supports strategic resource allocation, quicker decision-making, and sustained investment in productive inputs and services, thereby improving technical operations. Consistent member savings allow cooperatives to consolidate internal capital, including profits, shares, and fees, thereby improving liquidity and enabling prompt operational responses, capacity-building investments, and efficient scaling. These findings align with Bezabih et al. (2021), who underscore the vital role of member-contributed capital in cooperative success.

Lastly, the analysis of specific business integrations underscores a central conclusion: sustainability in federated cooperatives depends on strategic alignment. While entering disrupted sectors such as electricity payment (ELECT) has reduced efficiency, focusing on core areas such as savings and loans (SAV) and subsidised fertiliser distribution (FERT) has markedly improved both TE and PTE. These services not only enhance financial health but also strengthen institutional capacity and reduce member vulnerability. These insights emphasise the critical role of mission-aligned integration in fostering sustainable cooperative development, particularly in rural economies where cooperatives fulfil essential economic and social functions.

6.1. Theoretical implications

This study contributes to theory by demonstrating how established frameworks can be applied and extended in the context of federated cooperative systems. From the standpoint of Transaction Cost Theory (Coase, 1937; Williamson, 1981), integration addresses inefficiencies by centralising procurement and standardising service delivery. For example, cooperative initiatives in savings, loans, and fertiliser distribution contribute to lowering per-unit costs and improving delivery efficiency, aligning with research suggesting that federated models enhance coordination and reduce dependency on intermediaries. Additionally, Resource Dependence Theory (Pfeffer and Salancik, 2003) frames integration as a strategic response to external pressures, including capital constraints and regulatory challenges. Federations enable cooperatives to access expanded markets, such as those for fertiliser and electricity, although this can sometimes lead to power imbalances that limit autonomy. Finally, Dynamic Capabilities Theory (Teece et al., 1997) highlights cooperatives' capacity to adapt and improve efficiency through learning, knowledge sharing, and the integration of collaborative practices.

6.2. Practical implications

This study's findings offer valuable insights for cooperative managers, policymakers, and development stakeholders involved in advancing agricultural cooperatives. First, integration efforts should align with the core functions and needs of members. Services such as savings, loans, and subsidised fertilisers provide clear benefits, including increased income and efficiency through economies of scale and shared infrastructure. Managers should prioritise integration strategies that align with their core mission. However, not all integrations are beneficial. Engaging in complex or rapidly digitising sectors, such as electricity payments, can lead to inefficiencies and risks. Thorough feasibility studies and assessments of digital readiness are essential before pursuing expansion in these areas. Additionally, active member participation is crucial, as greater engagement enhances efficiency and performance. Leaders should promote transparency, education, and inclusive governance to strengthen member involvement and adaptability. Finally, policymakers can facilitate sustainable integration by implementing targeted capacity-building programmes, incentives, and digital infrastructure. Policies that address the diverse needs of cooperatives and encourage customised integration models will more effectively support rural development and improve supply chain resilience.

6.3. Limitations of the study

This study offers valuable insights into how integration affects the performance of agricultural cooperatives. However, this study has several limitations. The reliance on quantitative methods captures measurable outcomes such as income, net income, and efficiency, but does not account for qualitative aspects such as governance, leadership, trust, and member satisfaction. These elements are also essential for long-term cooperative success. Furthermore, although the analysis considers variables such as asset size and integration type, this study does not explore internal dynamics such as decision-making, communication, or power relations, all of which may have a notable impact on performance. Incorporating qualitative or mixed-method approaches could provide a more comprehensive understanding.

The study is further limited by its two-year timeframe, covering only 2022 and 2023. This short period restricts the ability to examine long-term trends, delayed impacts, or responses to external shocks such as market fluctuations or climate events. A longer observation period would allow for more robust and generalisable conclusions. Finally, the study does not address potential endogeneity or selection bias. Future research should consider longitudinal designs or matching techniques to better isolate causal effects and strengthen the validity of the findings.

7. Conclusions

This study enhances understanding of integration within federated cooperative systems by providing empirical insights into how different integration strategies affect cooperative performance. By linking the findings to Transaction Cost Theory, Resource Dependence Theory, and Dynamic Capabilities Theory, the study demonstrates how federated cooperatives strategically leverage internal resources, governance mechanisms, and inter-cooperative integration to enhance performance.

The results show that the integration of savings and loan services, along with the distribution of subsidised fertilisers, positively affects cooperatives' income and efficiency by achieving economies of scale, reducing transaction costs, and optimising resource utilisation. In contrast, the integration of electricity payment services negatively affects net income, primarily due to digital disruptions and shifts in member and non-member payment preferences. This highlights the need for alignment between integration strategies, technological developments, and market dynamics to prevent operational inefficiencies and financial losses.

From a practical perspective, the study provides valuable guidance for cooperative leaders and policymakers in evaluating integration opportunities. This study underscores the importance of member engagement, capacity building, and technological adoption as key drivers of improved performance. Supporting cooperatives in navigating digital transformation and fostering strategic flexibility is essential to maintaining competitiveness and ensuring long-term sustainability. Furthermore, the study contributes to the global cooperative literature by offering a detailed understanding of integration effects in a developing-country setting, where federated cooperative structures and resource dependencies play a critical role. The findings have broad relevance for cooperatives worldwide facing similar challenges related to digitalisation and evolving member expectations. By illustrating both the benefits and potential pitfalls of integration strategies, the study supports more evidence-based decision-making in cooperative development and governance.

CRediT authorship contribution statement

Abi Pratiwa Siregar: Writing – original draft, Visualization,

Validation, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Cathal O'Donoghue:** Supervision, Methodology, Formal analysis, Conceptualization. **Becky Whay:** Supervision, Conceptualization.

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Declaration of competing interest

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Data availability

Data will be made available on request.

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