WP 2022-02

August 2022

Working Paper

Dyson School of Applied Economics and Management
Cornell University, Ithaca, New York 14853-7801 USA

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Abstract

This paper constructs a new conceptual framework around the impacts of member heterogeneity on cooperative union (federated cooperative) performance considering both a union's capital factor structure and its service link operations structure, and that governance control rights serve as an integrated, additive influence. The framework is tested empirically with a large sample of cooperative union data from government sources and detailed case study interviews. We find that the influence of factor heterogeneity is resilient and positive when accounting for service link heterogeneity; however, excluding service link heterogeneity biases upwards expected union performance, particularly in less developed, poor regions in China. We also find democratic control rights is a key mechanism through which the heterogeneity of members affects the performance of the union. Our findings suggest that more detailed data in annual cooperative reporting will better identify the linkages and associations of union performance. In so doing, the results can better inform cooperative development priorities and governance processes to support sustainable development.

Key Words: Member heterogeneity; cooperative unions; federated cooperatives; performance

Acknowledgements

This work was supported by the National Social Science Foundation of China (Grant/Award Number 18VSJ062). Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the National Social Science Foundation of China.

1 | Introduction

According to the International Cooperative Alliance (ICA), “Cooperation among Cooperatives” is one of their seven cooperative principles; i.e., cooperatives serve their members most effectively and strengthen the cooperative movement by working together through local, national, regional, and international efforts (ICA 2022). While such efforts are ubiquitous across the globe (including ancillary support and/or subsidiary relationships), most cooperative networks are either loosely coordinated or formally created through mergers and acquisitions. Formally, a cooperative owned and utilized by other cooperatives (as members) is referred to as a “federated cooperative” or, in the case of China, a “cooperative union.” As with centralized (nonfederated) cooperatives, federated cooperatives serve a variety of functions depending on the needs and goals of their member owners (Svensson 1983).

Since the promulgation of the Law of the People's Republic of China on Specialized Farmers Cooperatives in 2007, (centralized) farmer cooperatives have developed rapidly. By 2020, the number of farmer cooperatives nationally reached 2.2 million, over four times that of 2011. While impressive in number, the relatively recent period of development has limited their overall market competitiveness. To overcome this weakness, cooperative unions have emerged with the Chinese government adding a specific chapter of cooperative unions into the cooperative law. According to the Law of the People's Republic of China on Farmers' Professional Cooperatives (2017 Revision), three or more farmer cooperatives may fund the establishment of a farmer cooperative union on a voluntary basis.

Agricultural cooperative unions play vital roles in the development and growth of local cooperatives to the benefit of individual farmer members. According to the Ministry of

Agriculture and Rural Affairs, more than 13,000 cooperative unions have been established as of 2020, with an average of 12 cooperative members. The rise of farmer cooperative unions has a variety of development forms and the formal exploration of cooperation among cooperatives has received recent attention to enhance the competitiveness of cooperatives and to better inform their sustainable development (Kong et al. 2018; Liang & Dong 2019).

Cooperative unions are not a simple sum of operations of its cooperative members, but deep, multi-dimensional coordination of operations, products, and industries (Kong & Huang 2021). Further, the federated structure can take advantage of network management of its cooperative members to avoid opportunistic behavior among them (Jones et al. 1997). The establishment of the farmer cooperative union aims to reduce transaction costs of the individual cooperatives and to consolidate and strengthen the market position of members by addressing problems of scale, operational inefficiencies, and limited market competitiveness, while also gaining market power and improving terms of trade with downstream food processors and retailers (Yuan 2008; Bijman 2016).

The limited research on cooperative unions largely focuses on their reasons for formation, operational attributes, and stability (e.g., Tan 2017; Zhang & Kong. 2018; Huang et al. 2020), but without specific attention to the characteristics of the union's member structure and the impacts of member heterogeneity on union performance. At the centralized (nonfederated) cooperative level, there exists an extensive research body on the financial and governance implications of member heterogeneity. Theoretically, Nilsson (2001) states that a homogeneous composition of members leads to a reduction of transaction and ownership costs. However, in practice, the heterogeneity of members grows over time and, through that, the

potential for high transaction costs (Cook 1995; Birchall & Simmons 2004). For example, large members may exert disproportionate control in the cooperative, using their power to change prices that extract higher rents than other members (Banerjee et al. 2001). Further, ineffective decision-making caused by membership heterogeneity may not maximize the collective well-being of members (Cook & Iliopoulos 2016) and identifying the monetary value of cooperative ownership held by members when members have different characteristics is problematic (Munch et al. 2021).

Of specific focus here is whether the outcomes of member heterogeneity equally apply for federated (cooperative union) structures. From a practical point of view, the cooperative union has two characteristics on member structure that imply a new conceptual framework is necessary. First, member cooperatives have organized the factor endowments of their farmer members (i.e., land, labor, capital) for their operations and already possess a certain degree of market negotiation power. They have also interacted with one another before establishing the union thereby promoting a higher demand for formal cooperation. Second, the membership structure within cooperative unions at the formation stage is more diversified. Most of members are cooperatives (at least three are required), but some unions allow a small number of firms and/or family farms to join as members. Compared with individual cooperatives, the range of members in cooperative unions is more diverse and promotes a unique structure of member heterogeneity.

Within the framework of the union system in China, each individual cooperative of the union needs to follow the principles of cooperatives. For example, when convening a general member meeting, decisions that come to the full membership are based on a one-member, one-

vote (1M1V) policy by law, albeit not comprehensively enforced. However, there is no investment restriction for members, and members' equity stock need not be proportional to their patronage. An unbalanced equity structure between large and small members is commonly regarded as a core reason for negative impacts of member heterogeneity.

Due to the different operational structures between member cooperatives, differences in equity structures among them are common and, as will be detailed later, early evidence suggests that cooperative unions with more unbalanced equity structures perform better than those that are more balanced. So how and why does this result differ from traditional concepts of member heterogeneity? This paper establishes a new conceptual framework to better inform assessments of member heterogeneity in cooperative unions and proposes an analytical approach to measure the relationship between member heterogeneity and cooperative union performance.

The conceptual framework is empirically applied through two approaches. First, using existing firm-level data on cooperative unions from 2014 through 2019 (N = 2,986) we econometrically evaluate union performance under alternative sources of member heterogeneity, albeit with data limitations that prevent full application of the new framework. Recognizing this limitation, we apply a case study approach based on detailed firm-level data collected from 38 cooperative union interviews in 2019 and 2020, the results of which form a strong argument for expanded data collection efforts in the future to improve empirical rigor.

2 | Conceptual Framework of Member Heterogeneity

In general, farmer cooperatives are contract organizations formed by owners of potentially different factor endowments for common benefit. In establishment of the firm, differences in

factor endowments lead to differences in members' inputs, participation goals, contributions to the cooperative, and risk preferences. Differences in member factor endowments are generally defined through three dimensions: farm, member, and product (Höhler & Kühl 2018). Under a heterogeneous membership structure, a small number of "core" members (i.e., those with higher investments) can hold controlling shares of residual control rights and residual claim rights resulting in an unequal relationship in which the interests of ordinary members are secondary to core members (Lin & Huang 2007). When this unequal relationship occurs, member heterogeneity becomes a common problem in the operations, management, and governance of cooperatives (Iliopoulos & Valentinov 2018).

Through observation of farmer cooperative unions in China, we find that a majority follow principles of democratic decision-making (1M1V) and demonstrate strong economic performance despite pre-existing heterogeneous member conditions. Therefore, traditional frameworks of member heterogeneity cannot explain this result. The new framework expands traditional theory to account for additional distinctions related to the union structure.

For individual cooperative development in China, small farmers are the direct owners of basic factors of production (i.e., land and labor) and the membership will necessarily include most of the small farmers. However, farmers with larger factor endowments are needed as the core leaders for the cooperative development process to be successful and directly induces one form of member heterogeneity (Liu & Yuan 2020). In deference, factor endowments for establishing cooperative unions are quite different. Member cooperatives have already accumulated the basic factors of production vis a vis their members, so for collective, federated activities the primary focus of attention is to capital aggregation. Operational activities among

member cooperatives may vary (i.e., marketing, supply, or service activities) and are only indirectly affected by farm-level land and labor endowments. Accordingly, in the framework of the union, the factor element of member cooperatives is mainly manifested in capital investment.

Further, since cooperatives have already accumulated factors from individual farmer members and are involved, on their behalf, in various industry sectors to improve member returns, the cooperative union has extending systematic characteristics. Thus, the member heterogeneity framework for cooperative unions should consider the "factor" (capital) structure and the "service link" structure simultaneously, as illustrated in the bottom of **Figure 1**. In the traditional framework (top section of **Figure 1**), service link structure heterogeneity (i.e., the composition of operations among members) is neglected, resulting in a missing variables problem and an incomplete and biased evaluation of member heterogeneity effects on performance.

The systematization of cooperation is embodied in the levels of additivity and complementarity of the service links provided by member cooperatives. Additivity implies that member cooperatives focus on the same service link, which can strengthen their competitive market power on that specific link. Complementarity implies that member cooperatives focus on the comparative advantage in services provided by each member and, in so doing, it is not necessary to rely on non-member firms to provide those services to the union.

Figure 2 illustrates the framework of assessing heterogeneity of a union's service link structure. Specifically, if member cooperatives produce different kinds of products, their common service links (e.g., for marketing) may be hard to consolidate and reduce the benefits

of additivity. However, if member cooperatives produce the same kind of products and their service link structure conforms to characteristics of additivity, link structure heterogeneity is low.

Defining complementarity of service links is less straightforward. In general, poor coordination between different service links leads to a mismatch between supply and demand that, in turn, leads to poor performance and potential business failure (Fisher et al. 1997; Ho & Tang 2004). Existing research has found that complementarity can have an impact on growth and development even without assumptions about economies of scale (Milgrom et al. 1991).

There are two main ways of judging the complementarity of service links in the existing literature: ex post and ex ante judgment. Since ex post judgement is based on performance (i.e., the outcome) itself (Athey & Stern 1998), it does not follow the conceptual framework proposed. An ex ante judgment, however, considers the level of interaction among service links, such as production and marketing in manufacturing. In this case, Bharadwaj et al. (2007) emphasize that there must be a plan between the two links so they understand each other and find solutions together. Complementarity is most likely realized in systems with complex interactions between multiple elements (Ennen & Richter 2010).

For empirical tractability, we explicitly define service link complementarity if both of two conditions exist. First, the primary business operations among member cooperatives covers all three service links (i.e., input supply, machinery services, and product marketing). If there is no member responsible for the services of a certain link, the union will need to rely on the service supply of external enterprises. Second, the union must have a unified service supply standard. If the supply of link services lacks standards, the quality of final products will vary

and reduce total market value. In this case, the service links are limited to information exchange only without a coherent plan between them (Bharadwaj et al. 2007).

2.1 | Union Performance

Due to the definitional adaptations in member heterogeneity for cooperative unions and differences in operating methods between the union and individual cooperatives, defining performance of cooperative unions is complex. Regarding performance of individual cooperatives, the literature largely evaluates cooperative-level economic benefits (e.g., Kyriakopoulos et al. 2010; Salazar & Gorriz 2011; Liang & Hendrikse 2013) and neglects the role of cooperatives to promote members.

Cooperative unions in China primarily build integrated communication platforms for the member cooperatives to which the members serve themselves through this platform. In so doing, union performance is largely reflected in the performance of member cooperatives by achieving through the union structure: (1) reductions in input prices (i.e., reducing production costs for member cooperatives), (2) increases in prices of products marketed (i.e., increasing sales for member cooperatives), and (3) increases in residual returns to member cooperatives based on patronage (i.e., higher patronage refunds). Union-level performance measured by the average sales per member (i.e., total sales of all members divided by the number of members) is commonly adopted in the absence of these individual member performance measures, thereby removing potentially useful variability in member performance effects through participation in the union.

2.2 | Analytical Structure

Based on the new framework of member heterogeneity, cooperative union performance is influenced by both its capital factor structure and its service link structure. In so doing, the positive function of service link cooperation may offset negative effects of factor structure heterogeneity. For example, additivity benefits for union members that focus on the same link can help smaller member cooperatives overcome scale challenges (Zeuli & Cropp 2004). Alternatively, complementarity benefits arise for unions that include all service links by cooperating with each other to improve their own market negotiations when purchasing agricultural input materials and selling agricultural products.

Implementation of successful federated structures addresses not only growth potential via economies of scale, but also an internal re-distribution of power among organizations through their residual control rights (Soegaard 1994). As such, a complete evaluation of member heterogeneity and cooperative union performance must account for the nature of the union's control rights (**Figure 3**). More fully democratic decision making (i.e., 1M1V adherence in our case) improves incentives for member cooperatives to have a closer relationship with the union, and to which active participation improves performance (Franken & Cook 2017). Formally, we test the following two hypotheses:

- **Hypothesis 1:** In cooperative unions, the influence of factor heterogeneity on performance differs when accounting for service link heterogeneity.
- **Hypothesis 2:** The effects of member heterogeneity (factor structure and service link structure) on performance are influenced by the distribution of control rights in cooperative unions.

3 | Data

3.1 | CCAD Data

Micro-data is taken from the sub-topic database of "Farmers' Professional Cooperatives" in the China Agriculture-related Enterprise Database (CCAD).[1] Data within CCAD includes basic financial and organizational information submitted from annual reports by cooperative unions between 2014 and 2019. The data represent an unbalanced panel given new formations, closures, and restructuring of unions over the period. The total number of observations over the six-year period is 2,986, with 1,903 unique cooperative unions. Nearly 40% of unions reported information for only one year, partly as a reflection of the strong growth in the number of unions over the sample period, but also due to the short-lived experiments of others.[2] As discussed above, the union performance variable in CCAD is limited to the average sales per member cooperative (i.e., total sales divided by the total number of members).

Factor heterogeneity is defined by an equity concentration ratio, i.e., the percentage of total member equity held by a subset of members. Specifically, for unions with at least 6 members, if the equity ratio of the top three investing members is over 50%, we classify factor heterogeneity as high (*factor* = 1), else low (*factor* = 0). Since for unions with less than 6 members this definition always results in a high concentration ratio, we instead consider if the equity ratio of the top investing member is over 50%.

[1] In the Chinese context, "Farmers' Professional Cooperatives" are cooperatives including cooperative unions as defined here. According to Article 6, "Regulations on the Administration of Registration of Farmers' Professional Cooperatives", the registered name of cooperative unions must contain the words "professional cooperative", and the database of cooperative unions is based on this distinction. If information is not submitted on time, concealed, falsified, or if they cannot be contacted through the registered domicile, the union will be listed in the "abnormal operation status" directory and publicized to the public through the enterprise credit information publicity system. Given such oversight, data integrity is regarded as high.

[2] Due to potential punishments for nondisclosure, some unions submit annual report information prior to having union operations fully operationalized. Sample sizes by year are 159, 244, 358, 665, 796, and 764 for 2014 through 2019, respectively. Robustness tests to evaluate selection bias issues are included in the empirical results that follow.

More limited data in CCAD prevents fully modeling service link structure heterogeneity, and only to the product category level (Figure 2).[3] Sales information is reported under four product categories: grains (N = 863), fruits and vegetables (N = 1,118), other crops (N = 1,007), and livestock (N = 1,417). If member cooperatives within a union market different types of products, their service link structure heterogeneity is defined as high (*link* = 1), otherwise low (*link* = 0).

To isolate the influence of member heterogeneity on performance, other influences of union performance are controlled for, including number of members (*members*), age of the union in years (*age*), total equity investments by members at the time the union was established (*fund*), and the level of government subsidies provided to the union at its formation (*subsidy*). To account for other market effects, product category and time (year) fixed effects are included.

A descriptive summary of CCAD model variables is shown in **Table 1** for the full sample (N = 2,986) and for high (N = 2,478) and low (N = 508) factor heterogeneity subsamples. Based on our definition, 83% of union observations are classified with high factor heterogeneity (*factor* = 1). The average equity concentration ratio of the top three investing members ($ratio_3$) is nearly 87% for the high factor heterogeneity sample relative to just under 30% for the low factor heterogeneity sample; $ratio_1$ shows an equally compelling difference (**Table 1**). However, a simple means difference test (i.e., not controlling for other variables) suggests that sales performance is indifferent (statistically) between the two factor structure groups, even though high factor heterogeneity unions have, on average, less members (*members*), are younger (*age*), and receive less capital investments from members (*fund*) and

[3] Full service link heterogeneity classification follows later in the detailed case study analysis.

the government (*subsidy*).

About 40% of unions market multiple product types (*link* = 1), our simple definition of service link structure heterogeneity in the CCAD data, and statistically indifferent, on average, across high and low factor heterogeneity unions (**Table 1**). Average sales performance across factor heterogeneity samples within individual product categories (i.e., grains, fruits and vegetables, other crops, and livestock) are similarly statistically indifferent, and for unions that market one (*link* = 0) or multiple products (*link* = 1) (**Table 2**).

3.2 | Case Study Data

Given the inability to fully model service link structure heterogeneity (**Figure 2**) with the CCAD data, detailed case studies were completed. Operating characteristics of cooperative unions in China vary geographically, with an average of three cooperative unions in each county-level area. To ensure a representative sample, the regions where unions were surveyed span the eastern, central, and northeastern provinces of China. From July 2019 through November 2020, 38 cooperative unions, located in 21 counties within 7 provinces, were interviewed.

Detailed interviews were conducted using a semi-structured interview method. During the interviews, relevant financial documents and other materials were made available. The interview content included organizational structure, operating mechanisms, equity structure, surplus distribution policy, decision-making mechanisms, and supply chain relationships. Detailed cases were developed to enumerate characteristics of member control rights, member heterogeneity, and their relationships to union member performance following the conceptual framework discussed above (**Figure 3**).

Factor structure heterogeneity is defined the same as with the CCAD data, however the full service link structure heterogeneity classification is used (**Figure 2**). Performance is measured specifically to the benefits members receive by being part of the union: (1) cost savings in purchasing inputs, (2) enhanced prices for products marketed, and (3) residual earnings distributed based on patronage.

4 | Empirical Results

4.1 | Baseline regressions

Due to the unbalanced nature of the CCAD data, we adopt a mixed regression method to control for both the time and industry fixed effects. In addition, some unions report zero product sales. This can happen if unions are waiting for the best time to formally begin operations, such as in pursuit of the government subsidy or when members sell their products individually if no enhanced collective sales opportunities are present. Some unions prefer to submit their annual report to prevent punishment of nondisclosure if they plan to start formal operations in the near future. To account for this censoring effect, we utilize a Tobit model specification, although initially report ordinary least squares (OLS) results for comparison.

In order to avoid interference of excessive heteroscedasticity, the economic performance variable is converted to its natural logarithm.[4] Total member investment (fund) and government subsidy (subsidy) are similarly transformed, while years of operation (age) is included in quadratic form to allow for a nonlinear response.

Model 1 (OLS) and Model 2 (Tobit) in Table 3 follow the traditional framework of

[4] Since the natural log of sales for unions reporting zero sales is undefined, we set those sales values to unity; i.e., ln(1) = 0.

considering only factor (capital) heterogeneity, with a result that shows unions with high factor heterogeneity are associated with higher levels of sales performance, ceterus paribus. Specifically, average sales per member are 2,760 yuan higher (Model 2) for high factor heterogeneity unions. Furthermore, expanding the framework to also consider service link heterogeneity does not materially affect the factor heterogeneity effect (2,770, Model 4); i.e., the difference is statistically insignificant. While the effect of high service link heterogeneity is negative in sign (as expected), it is not statistically different from zero. This may be due, at least in part, to the limited definition of the variable available within CCAD data.

4.2 | Regional Income Disparity

The consistently positive factor heterogeneity effect may be due other missing or confounding factors. Given differences in the levels of economic development across China, we consider regional income disparity. Cooperative unions are classified by location based on the overall level of regional economic development established by the National Bureau of Statistics (China) for East, Middle, West, and Northeast regions. Their division method is not simply based on administrative boundaries or physical geography, but fully reflects differences in economic development following their quartet method. Unions located in the East region are classified as a developed, affluent region ($income^{+} = 1$), otherwise a developing, poor region ($income^{+} = 0$). Models (5) and (6) in Table 4 use the full sample with level and member heterogeneity interaction $income^{+}$ variables. Models (7) and (8) comprise subsample regressions separated by economic development status (i.e., affluent, poor).

For ease of comparison with Table 3, Model 5 (Table 4) considers only factor heterogeneity, while Model 6 includes both factor and service link heterogeneity. As before,

high service link heterogeneity shows no association statistically with average sales performance and its inclusion does not statistically affect the magnitude of factor heterogeneity effects. However, the level factor effect remains positive and the interaction effect with $income^{+}$ is negative and over twice as large (in absolute value). The combined influence of regional economic development and member heterogeneity is shown in the models (7) and (8) that separate the data into affluent and poorer region subsamples, respectively. In this case, strong, positive factor heterogeneity effects remain only with unions operating in poorer, less developed regions (83% of sample observations). While not statistically significant, the negative signs on both the factor and link heterogeneity variables for the affluent, developed region (Model 7) are at least consistent with our conceptual framework.

4.3 | Robustness tests

Since CCAD data are non-randomized data and traditional statistical methods cannot completely control the perturbation of covariates, it is difficult to accurately infer the relationship between member heterogeneity and performance. Due to potential sample selection issues, we conduct robustness tests following propensity score matching (PSM) methods to randomize the non-randomized data before model estimation. We select matching variables to calculate the propensity score value of each sample cooperative, reducing the multi-dimensional standard to one dimension. Nearest neighbor matching searches for an association in a control group that has the same or similar main characteristics as the treatment group, and fits the high factor heterogeneity of the control group to the counterfactual of the low factor heterogeneity of the treatment group to the greatest extent. The result is two groups of samples that were successfully matched and only differed in the equity concentration ratio.

This effectively controls for the influence of confounding factors to obtain more accurate estimation results.

After completing the matching, the total number of observations successfully matched is 847. For all variables, the bias is under 10% after matching, satisfying the balance test requirement (**Table 5**). **Figure 4** shows the common support, where most of the observations are on support satisfying the overlap assumption. Using the matching sample, we re-estimate the models from Table 3 (2 and 4) and Table 4 (5 through 8).

Models 2^{PSM} and 4^{PSM} (i.e., those that do not control for regional income disparity) show similar results but with improved statistical precision (**Table 6**). The positive association with high factor heterogeneity is confirmed and indifferent when including the high link heterogeneity variable. Further, a negative high link heterogeneity effect remains and is now statistically significant at the 10% significance level. Similarly, consistent results follow in the regressions accounting for regional income disparity (5^{PSM}, 6^{PSM}, 7^{PSM}, 8^{PSM}), particularly for statistically significant effects of high factor heterogeneity (positive) and service link heterogeneity (negative) in poorer regions. In short, the PSM regression results strengthen our earlier full-sample results.

5 | Case Analysis

5.1 | Member benefits and heterogeneity

Based on the two-pronged definition of member heterogeneity, we divide case study unions into four types: HH, HL, LH, and LL. The first character refers to factor heterogeneity and the second character refers to service link heterogeneity, where H = high, and L = low. While low sample sizes in total (38) and individually (6 to 14) prevent meaningful statistical

inference, the distribution of specific member performance effects by member heterogeneity classification (**Table 7**) is informative in application of the conceptual framework proposed and for comparison with the econometric results from the CCAD data.

Holding factor heterogeneity fixed, lower service link heterogeneity increases member benefits along all three dimensions (i.e., cost savings, sales improvement, patronage refunds) (**Table 7**). Specifically, the percentage of unions receiving benefits increase for HL relative to HH and LL relative to LH. Defining an aggregate benefit as simply the difference in summed percentages results in gains of 150.0 and 147.7 points, respectively.[5] Aggregate gains are much lower for reduced factor heterogeneity when holding service link heterogeneity fixed; i.e., computed gains are 16.6 and 14.3 for LH relative to HH and LL relative to HL, respectively. The results suggest that service link heterogeneity is relatively more important, but that both forms of heterogeneity reduce member benefit.

5.2 | Democratic control

Due to their detailed nature, the influence of democratic control rights on member benefits and heterogeneity conditions (**Figure 3**) was also explored in the union interviews. Formally, if decision-making follows the 1M1V rule the union is classified as having democratic control rights. Democratic control also follows in the case of unions with many members that elect delegates to represent members, and with delegates following the 1M1V convention. In the absence of democratic control rights, member control rights are proportional to the level of capital invested (i.e., one share, one vote).

[5] The cumulative gain metric is useful for comparison purposes in the case study data. For example, the 150.0 point gain in benefit of HL from HH (i.e., a drop in link heterogeneity under high factor heterogeneity conditions) is calculated as the sum of the HL percentages (100+100+50) less the sum of the HH percentages (83.3+16.7+0.0). Other comparisons are similarly calculated.

As is shown at the bottom of Table 7, unions with low service link heterogeneity more often follow the 1M1V convention and, as shown above, are correlated with unions delivering more benefits to members (i.e., LL relative to LH and HL relative to HH). Further, the differences in voting rights by union classification follow similarly to the differences in aggregate benefits computed above. Note in particular, unions with low factor and low link heterogeneity have the highest aggregate gains and most often follow 1M1V convention whereas unions with high factor and high link heterogeneity have the lowest aggregate benefits to members, with none following the 1M1V principle. Based on this case study sample, democratic control rights appear to be a key influence mechanism between the relationship of member heterogeneity and performance of cooperative unions.

6 | Conclusions and Implications

This paper constructs a new conceptual framework around the impacts of member heterogeneity on cooperative union (federated cooperative) performance. Given the unique nature of the federated cooperative structure, we argue that member heterogeneity associated with both the capital factor structure and service link structure are important determinants of union performance, and that governance control rights serve as an integrated, additive influence. The framework is tested empirically with a large sample of cooperative union data based on required reporting of the Chinese government, but with limited detail to the union's service link structure, member benefits, and mode of governance control. Accordingly, we conduct detailed interviews with 38 cooperative unions and present preliminary evidence of the combined effects.

Formally, we address two hypotheses. Given preliminary evidence that suggests unions

with high factor heterogeneity are associated higher performance (and inconsistent with traditional theory) our first hypothesis proposes the influence of factor heterogeneity on performance differs when accounting for service link heterogeneity. Albeit with a more general definition of service link heterogeneity, we find with the large dataset that the influence of factor heterogeneity is resilient (and positive) when accounting for service link heterogeneity. However, excluding service link heterogeneity biases upwards expected union performance, particularly in less developed, poor regions in China; i.e., it's effect is large and negative. Furthermore, based on the detailed case studies, specific member benefits are reduced with high factor heterogeneity, but much less so than under high service link heterogeneity. The influence of both factors is key to understanding union performance and member benefits.

The positive association of high factor heterogeneity and union performance in low-income regions of China likely highlights different business mechanisms existing within such regions and, perhaps, the need of heightened control rights for high equity share members for unions to successfully compete in those areas. Since total capital effects are already controlled for (through *fund* and *subsidy*) this is not a capital scarcity outcome commonly associated with low-income areas, it is the concentration of that capital in the hands of a relatively small number of members that is associated with higher sales performance.

Our second hypothesis proposed that the effects of member heterogeneity (factor structure and service link structure) on performance are influenced by the distribution of control rights in cooperative unions. Through detailed union interviews, we find that democratic control rights are strongly linked to union performance and the nature of member heterogeneity. In other words, democratic control is a key mechanism through which the heterogeneity of

members affects the performance of the union. In this way, member heterogeneity affects the distribution of control rights. The case study findings, although limited in sample size, suggest that more detailed data collected in annual union reporting disclosures will improve empirical rigor and better identify the linkages and associations of union performance. In so doing, the results can better inform cooperative development priorities and governance processes to support sustainable development.

The expanded conceptual framework of member heterogeneity would also benefit to its empirical application in other countries with federated cooperatives, given data availability. In so doing, the impacts of member heterogeneity can be better explored under different operational structures, business environments, and government policy settings.

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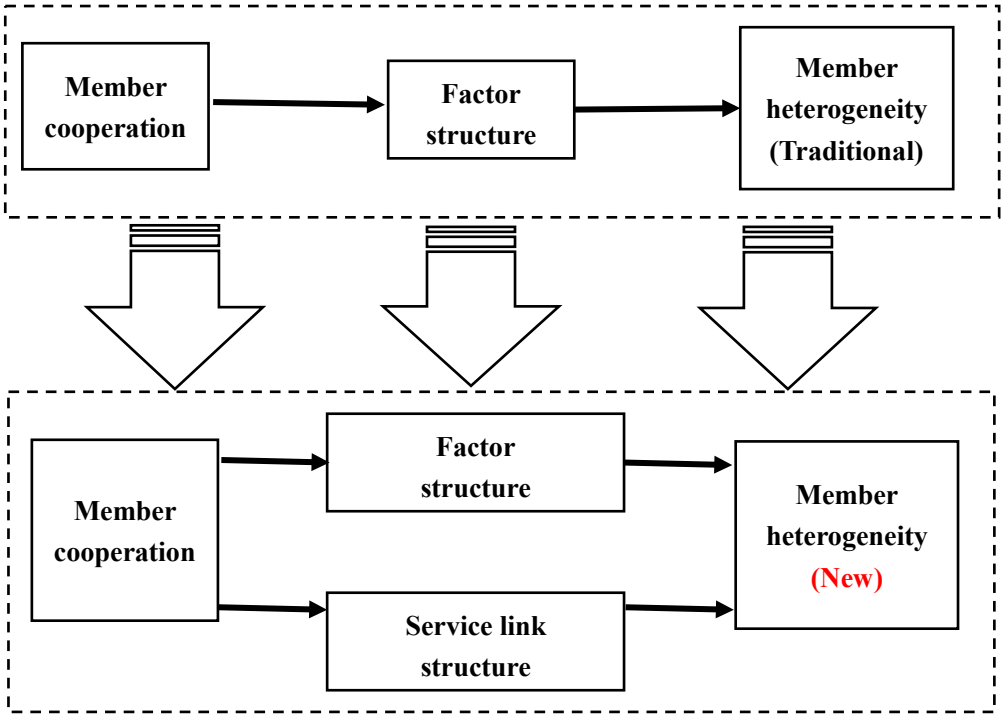

Figure 1. A new framework of member heterogeneity for cooperative unions

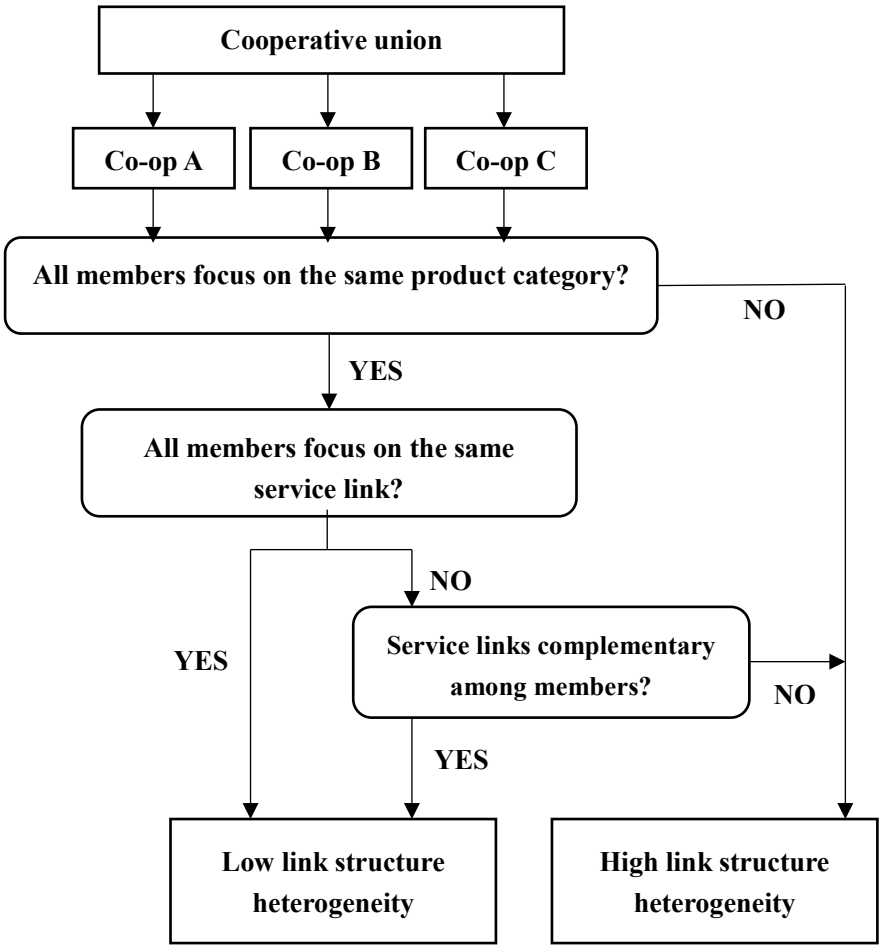

Figure 2. Classification framework of service link structure heterogeneity

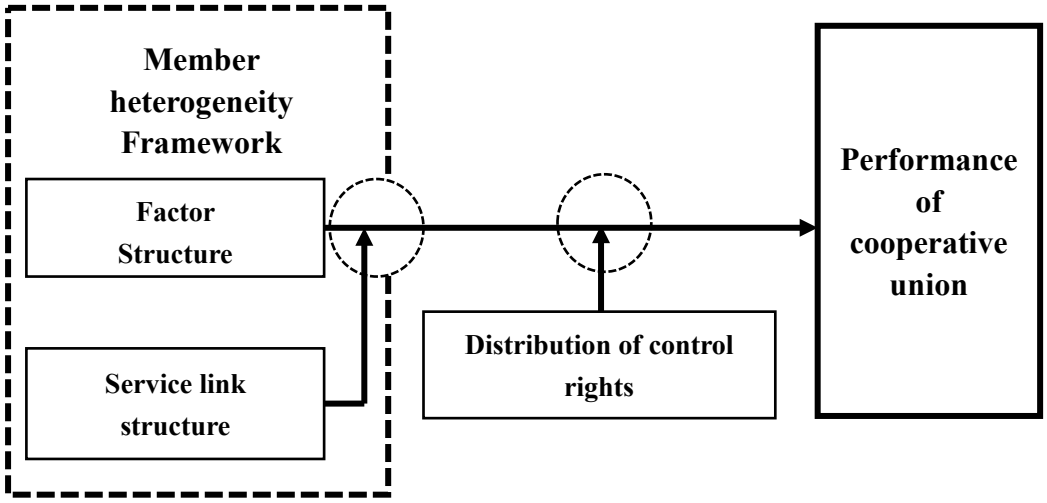

Figure 3. Analytical structure of member heterogeneity, democratic control, and performance

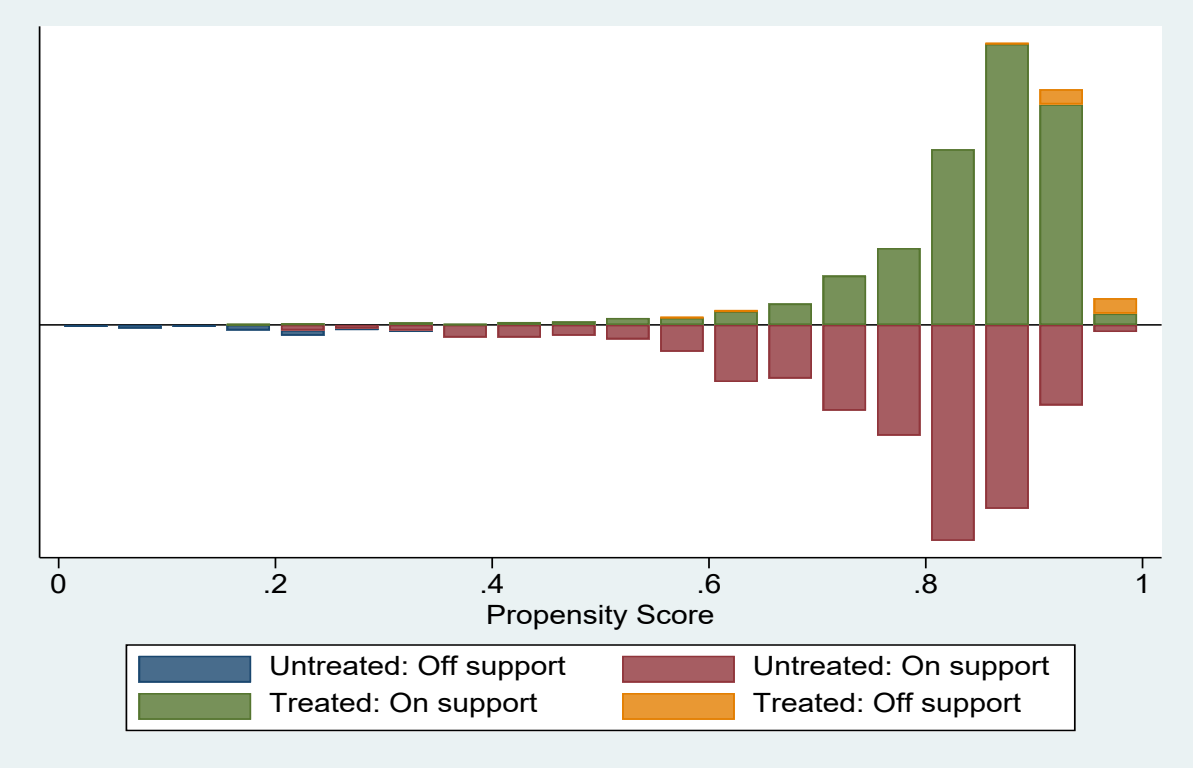

Figure 4. Common support of propensity score matching

Table 1. Variable means, by factor heterogeneity classification.

			Factor heterogeneity [a]			
		All	High	Low	t test [b]	
Variable	**Definition**	**N=2,986**	**N=2,478**	**N=508**	**Difference**	***p*-value**
asales	Average sales per member (10,000 yuan)	13.410	13.671	12.141	1.530	0.552
$ratio_1$	Equity ratio, top investing member	0.230	0.262	0.074	0.188	0.000
$ratio_3$	Equity ratio, top three investing members	0.770	0.867	0.297	0.570	0.000
factor [a]	Factor heterogeneity = high (1/0)	0.830	1.000	0.000	1.000	-
link [c]	Service link heterogeneity = high (1/0)	0.406	0.415	0.365	0.050	0.141
members	Number of members in cooperative union	13.172	12.011	18.837	-6.826	0.000
age	Age of cooperative union (years)	2.701	2.635	3.026	-0.392	0.000
fund [d]	Capital investment (10,000 yuan)	863.035	751.220	1,408.467	-657.247	0.000
subsidy [e]	Government subsidy (10,000 yuan)	1.004	0.690	2.538	-1.848	0.000

Source: CCAD (2014-2019).

[a] Factor structure heterogeneity is classified by an equity concentration ratio. For unions with at least 6 members, if the equity held by the top three investing members ($ratio_3$) is over 50% of total member equity, factor heterogeneity is classified as high (*factor* = 1), else low (*factor* = 0). For unions with less than 6 members, we instead consider if the equity held by the top investing member ($ratio_1$) is over 50%.

[b] Means-difference tests are used to compare whether the computed means are statistically different from one another. The null hypothesis is that the difference between the two means is zero, where the *p*-value represents the probability of obtaining the observed difference if the null hypothesis were true.

[c] Limited data in CCAD limits modeling service link heterogeneity to the product category level. If members within a union market multiple types of products, service link heterogeneity is defined as high (*link* = 1), else low (*link* = 0).

[d] Total capital investment provided by members at formation of cooperative union.

[e] Government subsidy provided to the cooperative union at its formation.

Table 2. Sales performance (*asales*) means by product category and factor heterogeneity classification.

	Factor Heterogeneity[a]		t test [b]	
Product/Union Category	**High**	**Low**	**Difference**	**p-value**
Grains	15.203 (N = 710)	10.109 (N = 153)	5.094	0.343
Fruits and vegetables	15.321 (N = 941)	16.880 (N = 177)	-1.559	0.755
Other crops	16.000 (N = 853)	13.748 (N = 154)	2.252	0.685
Livestock	13.539 (N = 1,174)	11.055 (N = 243)	2.484	0.436
Multiple product types (*link* = 1) [c]	13.987 (N = 1,028)	13.927 77(N = 196)	0.060	0.989
One product type (*link* = 0) [c]	13.446 (N = 1,450)	11.019 (N = 312)	2.427	0.436

Source: CCAD (2014-2019).

[a] Factor structure heterogeneity is classified by an equity concentration ratio, i.e., the percentage of total member equity held by a subset of members. For unions with at least 6 members, if the equity ratio of the top three investing members ($ratio_3$) is over 50%, factor structure heterogeneity is classified as high (*ratio* = 1), else low (*ratio* = 0). Since for unions with less than 6 members, this definition always results in a high concentration ratio, we instead consider if the equity ratio of the top investing member ($ratio_1$) is over 50%.

[b] Means-difference tests are used to compare whether the computed means are statistically different from one another. The null hypothesis is that the difference between the two means is zero, where the p-value represents the probability of obtaining the observed difference if the null hypothesis were true.

[c] More limited data in CCAD limits modeling service link structure heterogeneity only to the product category level. If member cooperatives within a union market different types of products their service link structure heterogeneity is defined as high (*link* = 1), otherwise low (*link* = 0). Other crosswise comparisons (not shown) also reveal insignificant differences (i.e., *link* = 1 versus *link* = 0 means within factor heterogeneity groups).

Table 3. Sales performance regressions considering factor and service link heterogeneity[a]

	(1)	**(2)**	**(3)**	**(4)**
	OLS	**Tobit**	**OLS**	**Tobit**
Variable	ln(*asales*)	ln(*asales*)	ln(*asales*)	ln(*asales*)
Intercept	0.177	-1.526 ***	0.147	-1.583 ***
	(0.177)	(0.335)	(0.179)	(0.339)
factor	0.140 **	0.276 **	0.140 **	0.277 **
	(0.071)	(0.132)	(0.071)	(0.132)
link			-0.131	-0.243
			(0.106)	(0.197)
members	-0.005 ***	-0.000	-0.005 ***	-0.000
	(0.002)	(0.003)	(0.002)	(0.003)
age	0.091 *	0.221 **	0.092 *	0.222 **
	(0.050)	(0.092)	(0.050)	(0.092)
age^2	-0.004	-0.013	-0.004	-0.013
	(0.006)	(0.012)	(0.006)	(0.013)
ln*(fund)*	0.128 ***	0.197 ***	0.129 ***	0.198 ***
	(0.017)	(0.032)	(0.017)	(0.032)
ln*(subsidy)*	0.358 ***	0.580 ***	0.358 ***	0.580 ***
	(0.045)	(0.078)	(0.045)	(0.078)
Product fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	2,986	2,986	2,986	2,986
R-squared	0.056		0.056	

Source: CCAD (2014-2019). Standard errors in parentheses; ***, **, * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5. Balanced tests of propensity score matching variables, CCAD 2014 – 2019.

		Mean		Bias
Variable	**Sample**	**Treated**	**Control**	**（%）**
members	Unmatched	12.010	18.837	-38.9
	Matched	12.019	13.459	-8.2
age	Unmatched	2.635	3.026	-21.7
	Matched	2.653	2.780	-7.0
age^2	Unmatched	9.529	13.061	-24.1
	Matched	9.642	10.420	-5.3
ln*(fund)*	Unmatched	5.776	6.218	-27.2
	Matched	5.841	5.840	0.0
ln*(subsidy)*	Unmatched	0.089	0.266	-24.6
	Matched	0.088	0.070	2.4

Table 6. Propensity Score Matching sample regressions (Tobit) considering factor heterogeneity, service link heterogeneity, and regional income disparity [a]

	(2^{PSM})	**(4^{PSM})**	**(5^{PSM})**	**(6^{PSM})**	**(7^{PSM})**	**(8^{PSM})**
Variable	ln(*asales*)	ln(*asales*)	ln(*asales*)	ln(*asales*)	ln(*asales*)	ln(*asales*)
Intercept	-1.506 **	-1.684 ***	-1.729 ***	-1.874 ***	-5.109 ***	-0.873
	(0.586)	(0.595)	(0.623)	(0.629)	(1.495)	(0.692)
income^{+}			0.410	0.452		
			(0.340)	(0.389)		
factor	0.364 **	0.366 **	0.468 **	0.473 **	-0.059	0.454 **
	(0.178)	(0.177)	(0.201)	(0.200)	(0.487)	(0.193)
*factor*income*$^{+}$			-0.459	-0.457		
			(0.463)	(0.461)		
link		-0.694 *		-0.827 ***	0.273	-0.880 **
		(0.373)		(0.377)	(0.994)	(0.398)
*link*income*$^{+}$				0.890 *		
				(0.455)		
members	-0.006	-0.006	-0.006	-0.006	-0.008	-0.006
	(0.005)	(0.005)	(0.005)	(0.005)	(0.013)	(0.005)
age	0.276 *	0.289 *	0.262 *	0.264 *	0.898	0.172
	(0.154)	(0.154)	(0.154)	(0.154)	(0.628)	(0.159)
age^{2}	-0.022	-0.024	-0.021	-0.022	-0.074	-0.013
	(0.018)	(0.018)	(0.018)	(0.018)	(0.092)	(0.018)
ln*(fund)*	0.279 ***	0.281 ***	0.302 ***	0.307 ***	0.564 ***	0.253 ***
	(0.062)	(0.066)	(0.066)	(0.066)	(0.169)	(0.072)
ln*(subsidy)*	0.505 ***	0.501 ***	0.505 ***	0.497 ***	0.534 *	0.515 ***
	(0.119)	(0.119)	(0.119)	(0.118)	(0.289)	(0.129)
Product fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	847	847	847	847	171	676

Source: CCAD (2014-2019). Standard errors in parentheses; ***, **, * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Model numbers with the PSM superscript refer to comparable full sample models in Tables 3 and 4.

[a] Cooperative unions are classified by location based on the level of regional economic development established by the National Bureau of Statistics (China) for East, Middle, West, and Northeast regions. Unions located in the East region are classified as a developed, affluent region (*income*$^{+}$ = 1), otherwise a developing, poor region (*income*$^{+}$ = 0).

Table 7. Member benefits heterogeneity classification and democratic control.

	Member heterogeneity group [a]			
	HH (N = 6)	**HL** (N = 12)	**LH** (N=6)	**LL** (N = 14)
Member benefit/Governance	**Percent**	**Percent**	**Percent**	**Percent**
Cost savings in purchasing inputs	83.3	100.0	83.3	100.0
Price improvements in selling products	16.7	100.0	33.3	92.9
Residual earnings distributed based on patronage	0.0	50.0	0.0	71.4
Democratic control rights [b]	0.0	58.3	33.3	78.6

Source: Author interview data. Total unions interviewed = 38. Percent = Percent of unions in that classification that receive the member benefit.

[a] Case study unions are grouped into four types: HH, HL, LH, and LL, where the first character refers to factor heterogeneity and the second character refers to service link heterogeneity, and where H = high, and L = low. Factor heterogeneity classification is based on the equity concentration ratio defined earlier and service link heterogeneity classification follows from **Figure 2**.

[b] If decision-making follows the 1M1V rule, the union is classified as having democratic control rights. Democratic control also follows in the case of unions with many members that elect delegates to represent members, and with delegates following the 1M1V convention. In the absence of democratic control rights, member control rights are proportional to the level of capital invested (i.e., one share, one vote).

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