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Short communication

The cost of joining forces: collective organisations and the economic performance of dairy farms in South West England

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Abstract. This note highlights the importance of sale agreements for the economic performance of dairy farms in South West England. The reduction in public intervention in milk supply governance led to market coordination through supply chain agreements (SCAs), resulting in unbalanced power dynamics that reduced farmers' bargaining power and made them vulnerable to unfair practices. Collective organisations are seen as a solution to protect farmers. Using Coarsened Exact Matching, the paper estimates the effect of collective organisation participation on selling prices, production costs, and markup in a sample of 200 farms in Somerset and Devon. The results show that collective organisations are associated with 7.3% higher production costs and 23 percentage points lower markup, mainly due to costs associated with milk collection, transport, storage, marketing, and adherence to strict quality standards. However, these costs are counterbalanced by secured market access, stronger negotiating power, and better alignment with market demand. These findings underscore the need to further investigate collective governance in developed agricultural markets.

Keywords: dairy farming, collective organisations, markup, coarsened exact matching.

Citation: Nota, P., Curzi, D. & Vigani, M. (2026). The cost of joining forces: collective organisations and the economic performance of dairy farms in South West England. *Bio-based and Applied Economics* 15(2): 89-94. doi: 10.36253/bae-17342

Received: February 21, 2025
Accepted: September, 16 2025
Published: August 2, 2026

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Disclaimer: The authors are solely responsible for the content of the paper. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

Competing Interests: The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy/confidentiality restrictions.

Editor: Fabio Bartolini

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1. INTRODUCTION

This note highlights the importance of sales arrangements for the economic viability of farms, analysing the case of dairy farming in Somerset and Devon, England. With the abolition of milk quotas in 2015, the dairy sector experienced a shift towards a more market-driven model. Moreover, since Brexit the United Kingdom (UK) has moved away from the European Union's Common Agricultural Policy (CAP) and developed a new framework centred on the Environmental Land Management (ELM) schemes. While ELM emphasizes environmental sustainability and productivity, it does not directly address key challenges for small producers, particularly those arising from vertical and horizontal relationships with other companies in the supply chain.

The English dairy sector has particularly experienced the effects of these changes. Since 2015, the number of dairy farms in England declined by about 3.3% every year[1]. Continued pressure on dairy margins contributed to the decline, with growth of milk-to-feed price ratios of only 0.8% per year insufficient to generate sustainable profits[2]. In addition, the abolition of the quota system changed the mechanism for aligning milk production to consumer demand, giving a more important role to supply chain agreements (SCAs). Within this evolving supply chain, smaller UK dairy producers deal directly with larger companies – both upstream (e.g., feed and energy suppliers) and downstream (e.g., dairy processors and retailers) – which have greater bargaining power and often set their private quality standards (Sexton, 2012). The growing gap in access to market information between farmers and their trading partners can also lead to unfair trading practices, further disadvantaging smaller producers (Fałkowski et al., 2017).

With the deregulation of the dairy market, reduced policy support, and concentrated market power, competitive pressures on milk producers have intensified. This motivates the development of alternative forms of contractual relationships. Collective organisations such as cooperatives can offer farmers improved bargaining power, better access to affordable inputs, and enhanced price stability. Most research on welfare distribution within agricultural supply chains focuses on price transmission (Bakucs et al., 2014), with few studies on contracts' effects on farmer welfare, largely in developing countries (Bellemare and Bloem, 2018). Exceptions include Michalek et al. (2018) on Slovak farms and Verhaegen and Van Huylenbroeck (2001) in Belgium. There are, however, no studies examining collective organisations' impact on the economic performance of UK dairy farmers. Using survey data from 200 dairy farmers in Devon and Somerset and a Coarsened Exact Matching (CEM) approach (Porro and Iacus, 2009; Iacus et al., 2012), we estimate the effect of participating in a collective organisation on selling prices, production costs, and markup. Additionally, with penalised regression, we explore which agreement and farmer's characteristics are linked to participating in collective organisations. The findings show that selling through a collective organisation results in 7.3% higher production costs and approximately 23 percentage points lower markups. These increased costs stem from milk collection, transportation, storage, marketing, promotion services, and the production of milk that meets the collective organisation's strict standards. However, these costs are offset by guaranteed market access, stronger bargaining power with retailers and processors, and better alignment with market demand, helping to prevent oversupply and the price volatility that can come with it.

The paper is organised as follows: Section 2 provides a conceptual framework for our research question. Section 3 describes the CEM and the penalised regression methodologies and provides an overview of the data. Section 4 shows the results. Finally, Section 5 provides a discussion of the results and concludes.

2. CONCEPTUAL FRAMEWORK

We adopt a transaction cost framework (Williamson, 1989) to analyse how farmers' decisions to either participate in a cooperative or sell through the spot market affect their performance. According to this framework, farmers are assumed to choose the option that minimises their overall transaction costs. Participation in a collective organisation is widely associated with enhanced bargaining power, improved market access, and lower transaction costs – such as those related to searching for buyers, negotiating terms, and enforcing agreements (Alho, 2015). In addition, collective arrangements can help reduce market uncertainties. However, while transaction costs may be lower within cooperatives, other types of costs can increase. These may include compliance with higher quality standards, coordination of logistics, and administrative overhead. Despite these additional costs, cooperatives often benefit from greater bargaining power through the pooling of commodities and resources, which can lead to higher farm-gate prices.

Based on this framework, we expect that joining a collective organisation has a positive effect on the price received by farmers. This hypothesis is frequently supported in the empirical literature, although the evidence comes primarily from developing countries (Grashuis and Su, 2019). In contrast, the effect on overall costs is less clear, as the reduction in transaction costs may be offset by increased production and coordination expenses. As a result, the net impact on farmers' markup depends on whether the price premium is sufficient to compensate for potential additional costs.

[1] Calculated on AHDB data extracted on 18 December 2024 from https://ahdb.org.uk/dairy/GB-producer-numbers

[2] Calculated on AHDB data extracted on 18 December 2024 from https://ahdb.org.uk/dairy/milk-to-feed-price-ratio

3. METHODOLOGY AND DATA

To reduce the imbalance in covariates between the treated and control groups and to evaluate the differences in outcomes between them, we use the Coarsened Exact Matching (CEM), a counterfactual matching methodology. To match a treated unit with similar control units, the CEM first coarsens each variable into substantively meaningful groups and then performs an exact match based on these coarsened data. Finally, it retains only the original (uncoarsened) values of the matched data. It is relevant to mention that higher coarsening (higher number of strata) is associated with a lower level of imbalance, which comes however at the expense of a higher drop in observations. After preprocessing data with CEM, the analysis can follow using a simple difference in means provided by a linear regression of outcome on treatment (for details see Porro and Iacus, 2009; Blackwell et al., 2009; Iacus et al., 2012). A limitation of our data is that we observe covariates only for the survey year, and not before the treatment (i.e. selling through a collective organisation). Therefore, we cannot ensure covariate balance in the pretreatment period, nor can we confirm their independence from participating in a collective organisation. Consequently, this analysis should not be interpreted as causal, but rather as a more accurate estimate compared to a simple comparison between treated and control groups.

In the second step, we investigate agreements and farmers' characteristics associated with participation in a collective organisation using a penalised regression approach. In particular, we apply (logit) LASSO, Elastic Net, and Ridge. Penalised regressions add a 'penalty' to the estimated coefficients, forcing them towards zero (LASSO and Elastic Net) or exactly to zero (Ridge), therefore reducing model complexity and allowing for the selection of explanatory variables. We use these methods to select supply chain features and farmers' characteristics associated with collective organisation agreements among 30 different explanatory variables.

3.1 Data description

Because of the lack of data on SCAs, we use survey data from a small but representative sample of 200 dairy farmers in Devon and Somerset (South West England). The sample includes 88 farms from Somerset and 112 from Devon. The total farm population in the two regions is approximately 1,300. With this sample size, the survey maintains a 5% margin of error (within the commonly accepted threshold ≤ 10%). In these two counties, there are approximately 20% of all English dairy farmers. The survey was conducted by telephone interviews in November-December 2017 and the questions covered refer to the 2016-17 financial year.

The binary treatment variable distinguishes between farms selling milk exclusively through a collective organisation – cooperatives, producer organisations (POs), inter-branch organisations (IBOs), or farmers' unions and associations – or through individual businesses with a bilateral contract (e.g., retailers). The outcome variables are milk selling price (€/litre), production costs (€/litre), and markup (%). The markup is calculated as follows:

$$markup = \frac{sellingprice - productioncosts}{productioncosts} \quad (1)$$

To enhance comparability between farms using different sales channels, we consider only those with exclusive contracts (i.e., towards a single collective organisation or individual business). Among the 200 farmers, 173 have an exclusive selling agreement. We considered 4 observations as outliers, i.e. those with a markup lower than the 1st and greater than 99th percentile of the sample distribution. After removing farmers with incomplete data and outliers, the final sample size for the analysis is 169 observations. Summary statistics of all the variables are presented in Table S1. 43.8% of farms in our sample participate in a collective sale agreement. The average selling price in our sample is about 0.25 euro per litre of milk, while the production cost is about 0.21 €/litre. The average markup is about 36%.

We use the CEM approach to reduce covariates imbalances among farmers. Covariates used for matching are the age (4 categories) and the education of leading farmers (4 categories), total milk production (litres), hectares used for milk production (ha), herd size (number of cows), yield (litre/cow), and full-time workers. In the Appendix, we provide a description of the strategy used to select the "preferred" cutpoints combination used for performing the CEM. Table S2 shows the covariates imbalances before and after matching. We focus on the 'Multivariate L1 distance' that represents the overall imbalance with respect to the full joint distribution (including interactions) of the covariates between the treated and control groups. Panel A shows a value of L1 before matching equal to 0.865. It represents a baseline reference for the unmatched data. A good matching solution would produce a reduction in such a statistic. After considering different alternative cutpoints to define the coarsening, we select those that reduce the value of the multivariate L1 distance, preserve statistical power, and minimise the loss of observations (see Appendix). Panel B shows a value of L1 after matching equal to

0.637, which is about 23 percentage points lower than the unmatched case (with 107 farmers being matched). Furthermore, Table S3 presents a more standard covariates (average) imbalance and a t-test for the difference in average values that never rejects the hypothesis that they are equal to zero.

4. RESULTS

Table 1 presents our main findings. The estimated coefficient for the treatment variable in column 1 shows that selling milk through a collective organisation rather than to individual businesses is associated with a slightly higher average selling price (0.003 €/litre), although not statistically significant. As shown in column 2, collective sales have statistically significant higher production costs of 0.015 €/litre (about +7.3% of the average costs). This increase in costs leads to a significant reduction in markup of 23 percentage points (column 3).[3] A back-of-the-envelope estimate suggests that the sample average farmer selling exclusively through a collective organisation would face a revenue increase of €5,550 and an increase in total costs of €27,750, based on average annual milk production of 1,850,000 litres. Robustness checks, such as unmatched OLS, the addition of covariates, and a Propensity Score Matching support these findings (see Table S4). Qualitatively similar results are reached using 150 different combinations of cutpoints in the CEM algorithm (see Figure S1).

To understand why SCAs with collective organisations imply higher production costs and lower markup, we further investigate five categories of agreements' characteristics associated with collective organisations using penalised (logit) regression, namely: i) special contract clauses (contract duration, services, producer protections); ii) pricing methods; iii) timing of milk delivery and pricing; iv) costs associated with the agreement; and v) required quality and production standards. Given a large number of variables (30 in total), we apply penalised regression methods (namely, Ridge, LASSO, and Elastic Net) to select those variables with higher predictive power.

Table A5 shows the standardised coefficients of the selected variables associated with the LASSO and Elastic Net estimations, while Figure S2 shows the absolute value of the standardised coefficients from the Ridge estimation. We then run a standard logit model regressing the binary variable that identifies the agreement with a collective organisation on the selected variables. Table 2 shows the estimated coefficients.[4]

Table 1. Regression results after CEM of selling to a collective organisation on farmer's outcomes.

	(1) Selling price €/litre	(2) Production costs €/litre	(3) Markup %
Collective (binary)	0.003	0.015*	-0.233*
	(0.006)	(0.008)	(0.126)
Observations	107	107	107
R^2	0.002	0.030	0.038

Note: the treatment variable 'collective' is = 1 if the exclusive sale is through a collective organisation, 0 otherwise. Standard errors in parentheses are robust to heteroskedasticity. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Dairy farmers selling through a collective organisation are more likely to get paid after the milk delivery and to receive a price that is based on the yearly organisation's profit. This SCA is also more likely to be associated with logistics (collection, storage, transport, handling, etc.), and marketing costs. Looking at the overall sample (Table 2, column 2), dairy farmers selling through a collective organisation are more likely to comply with higher quality standards for the milk (e.g., taste and nutritional content), increasing production costs. Conversely, they are less likely to receive a price based on production costs, therefore, their milk prices do not follow the volatility of input costs. Finally, they are less likely to comply with animal welfare standards.

To better understand the reasons why dairy farmers sell through collective organisations, we perform an additional analysis on two groups of variables: i) the farmers' perception towards the SCA; ii) the farmers' risk-taking attitude. These variables are measured on a 1-5 Likert scale (1 = strongly disagree, 5 = strongly agree) and they are analysed using a logit regression. Complete questions are available in the Appendix.

Table 3 summarises the results. Farmers who do not have alternative options are not associated with collective organisations. This implies that farmers do have other opportunities to sell their milk. Similarly, farmers stating that the sale agreement provides more stable prices from year to year than alternative buyers are less likely to rely on collective organisations. This means that cooperatives/PO offer less stable prices. However, they offer

[3] The sample size decreases from 169 to 107 observations after applying CEM. This reduction may raise concerns about generalizability and statistical power (see Appendix for further discussion). The statistical (post) power tests for each outcome (price, costs, and markup) are 0.21, 0.72, and 0.82, respectively.

[4] Note that we are not interested in the magnitude of the coefficients or their causal interpretation. We aim to highlight the presence or absence of relevant features in the case of collective organisations.

Table 2. Logit model using selected variables from LASSO and Elastic Net describing agreements' characteristics associated with collective organisations.

	(1) Matched obs. Collective	(2) Whole sample Collective
Payment after delivery	2.365***	3.195***
	(0.826)	(0.783)
Price varies with the share of profits	1.556***	1.855***
	(0.553)	(0.481)
Logistic costs	1.059**	0.918**
	(0.510)	(0.457)
Marketing costs		0.537
		(0.445)
Price varies with production costs		-0.957*
		(0.540)
Quality standards		2.057**
		(0.883)
Animal welfare standards		-2.393***
		(0.853)
Observations	97	161
Pseudo R2	0.25	0.34

Note: the dependent variable 'collective' is = 1 if the exclusive sale is through a collective organisation, 0 otherwise. The explanatory variables are all binary variables ('yes' = 1, 'no' = 0). The exact questions are provided in the Appendix. Eight farmers did not answer all the questions included, therefore the number of observations is lower than in Table 1. Standard errors in parentheses are robust to heteroskedasticity. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

more opportunities for negotiating prices, an advantage less likely when engaging with individual businesses (e.g., retailers). A negative perception is that farmers who see delays in payments are more likely to be associated with a collective organisation. Looking at the risk attitudes, farmers with higher attitudes towards production risks (such as adopting new milking regimes, new fodder, and new breed of cow), marketing, and pricing risks are less likely to be associated with collective organisations. Conversely, attitudes toward financial risks (e.g. new investments) increase the propensity to sell through a collective organisation. These results suggest that farmers seek stable market access and protection and to this end, they are willing to accept price volatility, higher costs and financial exposure which can be faced through a higher predisposition to taking financial risks.

5. DISCUSSION AND CONCLUSION

Sales agreements are fundamental to the economic viability of farms. Using a sample of farmers in Somerset and Devon, England, in this note we present the results of an empirical analysis showing that dairy farmers face a tradeoff between benefits and costs when selling through collective organisations. The benefits consist especially in market coordination, through higher negotiating power with respect to retailers and processors, and alignment with market demand to avoid oversupply that can lead to milk price volatility. Without the milk quota system, the pricing mechanism of the collective organisation is the main tool to regulate supply. Different types of collective organisations adopt different pricing mechanisms. A&B pricing mechanisms – farmers receive A prices on defined volumes of milk agreed in advance, while any excess of milk delivered is paid a B price discouraging overproduction – are among the most common tools to keep supply and demand tightly controlled. Larger cooperatives, such as ARLA, buy all the milk delivered but rely on their ability to export to tighten the supply reducing the need for price adjustments and allowing farmers to expand.

Table 3. Farmers' perception and risk attitudes and their association with collective organisations.

	(1) Matched Collective	(2) Whole sample Collective
No alternative options for selling milk	-0.213	-0.156
	(0.168)	(0.122)
Higher prices than alternative buyers	-0.119	-0.013
	(0.231)	(0.165)
More stable prices than alternative buyers	-0.400*	-0.497***
	(0.242)	(0.165)
More possibilities for negotiating prices	0.302	0.292*
	(0.205)	(0.154)
There are delays in the payments	0.166	0.295
	(0.269)	(0.224)
The costs of this sale agreement are too high	0.278	0.087
	(0.237)	(0.184)
Willingness to take production risks	-0.266	-0.382**
	(0.226)	(0.173)
Willingness to take marketing and price risks	-0.191	-0.062
	(0.248)	(0.187)
Willingness to take financial risks	0.600***	0.487***
	(0.230)	(0.168)
Observations	91	154
Pseudo R^2	0.12	0.12

Note: Explanatory variables are on a 1-5 Likert scale. The exact questions are provided in the Appendix. Ten farmers did not answer all the included questions, therefore the number of observations is lower than in Table 1. Standard errors in parentheses are robust to heteroskedasticity. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

However, these benefits come with costs that with deregulation have been partially shifted from public support to farms. Farmers pay for services such as milk collection, transport and storage, and for marketing and promotion. Moreover, farmers make products to the collective organisation's specifications, owning full responsibility for the competencies and capital needed for the process technology. Indeed, farmers selling through collective organisations show a higher propensity to take financial risks, such as taking loans for investments. However, these costs are the price farmers pay for having some confidence that their milk supply has a buyer and a decent price, instead of having to hope for a spot contract most probably not aligned with retailers' price.

The shift of costs from public support to individual farms highlights the need for nuanced policy that accounts for the dual role of collective associations as both market coordinators and informal insurance mechanisms. While farmers face higher costs and often receive lower prices due to stricter quality requirements, CAs offer significant value by reducing exposure to price volatility, thus stabilising farm income and lowering financial risk. Policymakers should recognise this implicit insurance function and consider supporting it through targeted instruments, such as subsidies for compliance with quality standards, investment support for required technologies, or risk-sharing mechanisms like income stabilisation tools.

While this note provides some evidence of the trade-offs farmers face with respect to selling practices and how SCAs affect their economic performance in a developed country, it has important limitations. First, the estimates cannot be considered causal, as we lack information on pre-treatment periods. Second, the results are based on a limited sample of farms from only two counties in England. Therefore, the findings cannot be generalised to the national level, nor to other developed countries. Finally, we are unable to clearly identify the mechanisms that lead farmers to participate in collective organisations, even when it may result in a lower markup. Further research is needed to explore both collective and contractual arrangements in modern agricultural markets. A critical step in this direction would be to improve the current lack of data on SCAs, with larger samples across multiple sectors and countries to analyse.

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