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What sets cooperative farmers apart from non-cooperative farmers? A transaction cost economics analysis of coffee farmers in Mexico

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Abstract

This study investigates what factors relate to the coffee farmer's cooperative affiliation decision and whether this decision impacts the farmer's cash holdings. First, we propose a cooperative affiliation model based on transaction cost economics theory. There is a lack of consensus in the literature on what factors explain the farmer's cooperative affiliation decision in the coffee sector. Overall, we find that the more specialized coffee farmers are, the more likely they will become cooperative affiliates. This is consistent with transaction cost economics predicting that cooperatives are business structures that can reduce transaction costs and safeguard specialized assets from opportunistic behavior. Specifically, logit regression models suggest that shade-grown coffee plantations, off-farm income, coffee farming experience, low-level market competition, farmland size, altitude, and private farmland are statistically related to the farmer's decision to affiliate with cooperatives. Results on farmland size and shade-grown coffee plantations can be particularly relevant for scholars, policymakers, cooperative leaders, and extension professionals in the region. Second, based on the affiliation model, we employ propensity score matching to evaluate the impact of the farmer's cooperative affiliation decision on cash holdings, particularly on cash shortness. It is often claimed that farmers do not affiliate with cooperatives because these organizations cannot pay them in full at harvest and coffee collection time. It is believed that cooperatives' inability to pay farmers early increases the likelihood of farmers' cash shortness and their need for additional financing to operate or cover household needs. However, this study finds no evidence that the affiliation decision is related to the likelihood of the farmer experiencing cash shortness around harvesting and selling time.

Keywords: Mexican coffee growers and cooperatives, Transaction cost economics, The economic impact of cooperative affiliation, Cash shortness, Propensity score matching

Introduction

Agricultural cooperatives are often referred to as structures that contribute to social and economic development, particularly for rural poor and marginalized groups (Bijman and Wijers 2019). A recent review of the literature on agricultural cooperatives concluded that farmer cooperatives are flawed and complex business organizations that nonetheless have a positive economic impact on their members (Grashuis and Su 2019). According to this review, the increased bargaining power of cooperatives pooling many farmers' production and input needs contributes to improving farm-gate input and output prices for farmer members. The review also found that membership in a cooperative tends to increase productivity and product quality at the farm level due to the increased access to inputs such as fertilizers and the technical knowledge that cooperatives provide. Regarding the effect of cooperative membership on household income—which captures a combination of increased productivity, input access, technical expertise, yields and quality, off-farm work opportunities, and in general, transaction costs and benefits of cooperative membership—Grashuis and Su (2019) found mixed results, with studies reporting positive, negative, or neutral effects.

Despite the potential economic benefits of agricultural cooperatives, many farmers decide not to join cooperatives, although given the opportunity (Zeweld-Nugusse et al. 2013; Milford 2014; Abate 2018). Further, in some cases, even farmers already affiliated with cooperatives decide not to use the cooperatives' services (Pascucci, Gardebroek, and Dries 2012; Abate 2018). Understanding this behavior is puzzling and is sometimes explained by the fact that cooperative membership or cooperative affiliation[1] involves relatively high transaction costs for farmers (Ménard and Valceschini 2005; Bernard and Spielman 2009; Pascucci, Gardebroek, and Dries 2012; Ciliberti et al. 2020), and cooperatives play diverse functions for farmers varying across countries and crops (Grashuis and Su 2019). Thus, cooperative membership research from the lens of *transaction cost economics* (TCE) theory on specialized cooperatives—managing *one* crop rather than several agricultural products—should contribute to understanding the puzzling behavior of some farmers deciding not to affiliate with cooperatives despite the potential benefits these organizations provide. Our study addresses this concern, specifically contributing to the literature on the economics of coffee in two ways: (1) proposing and testing a TCE-based model that explains the farmer's decision to affiliate with coffee cooperatives and (2) analyzing whether the cooperative affiliation decision impacts the farmer's cash holdings.

These contributions fill gaps in the coffee cooperatives literature. First, while the TCE framework is commonly used to model the cooperative affiliation decision in agricultural—other than coffee—cooperatives, we could not find any coffee-related paper modeling the cooperative affiliation with TCE or any other distinct theoretical framework. Because of this, there is a lack of consensus on what factors explain the farmer's cooperative affiliation decision, according to the four coffee-related papers we identified as closely related to our study (Grashuis and Skevas 2022; Ortega et al. 2019; Mojo et al.

[1] We use the terms 'cooperative membership' and 'cooperative affiliation' interchangeably in this paper.

2017; Shumeta and D'Haese 2016).[2] Therefore, our study represents the first attempt to model the cooperative affiliation decision based on TCE in the coffee sector. Modeling the cooperative affiliation/membership in the coffee sector is worthwhile because, unlike other crops, niche coffee markets related to the specialty coffee market, shade-grown coffee, fairtrade, and organic certifications make this a specialized commodity.

Our second contribution is also relevant to the economics of the coffee sector because the literature reports that coffee cooperatives cannot afford to fully pay farmers for their coffee beans at harvesting and selling time while intermediary buyers can (Bacon 2005; Milford 2014; Luna and Wilson 2015; Arana-Coronado et al. 2019; Mwambi et al. 2020). Thus, it is commonly argued that the lack of immediate full-payment capacity affects the farmer-cooperative relationship causing problems such as side-selling and disincentives for farmers to join cooperatives in the first place. However, previous research has not evaluated whether the coffee cooperative farmers (i.e., the cooperative affiliation decision) are worse off than non-cooperative farmers regarding cash holdings when harvesting and selling.

This study has two related objectives. We first propose and test a coffee cooperative membership model explaining the coffee farmer's decision to join a cooperative or operate as a non-cooperative farmer (i.e., this is what we refer in this paper as the cooperative membership or cooperative affiliation decision). The coffee cooperative affiliation model is based on the transaction cost economics theory (Williamson 1983, 2010). TCE predicts that economic agents choose a particular organization mode or business structure to conduct their business based on attributes of transactions. The model is tested with primary data collected from Mexican coffee farmers affiliated and peers not affiliated with cooperatives. Our results suggest that indeed TCE attributes, further explained in the following sections, statistically explain the coffee cooperative membership or affiliation decision.

In addition to modeling the cooperative affiliation decision, the second objective of this study is to investigate if coffee cooperative affiliation has an economic impact on farmers' output. Specifically, using propensity score matching (PSM), we evaluate what group of farmers is more likely to experience cash shortness around coffee harvesting and selling time to cover household consumption or farm working capital needs. PSM pairs coffee cooperative and non-cooperative farmers with similar observable characteristics. This research question is relevant in light of prior research documenting that one of the disadvantages of coffee cooperatives over intermediaries is that the former are not able to fully pay the farmer at harvest time, while local intermediaries can (Bacon 2005; Mujawamariya et al. 2013; Milford 2014; Luna and Wilson 2015; Arana-Coronado et al. 2019). Farmers may perceive the inability of cooperatives to fully pay them at harvest time as problematic, potentially causing cash shortness. Cash shortness relates to higher production costs due to working capital financing, may constrain the adoption of best agricultural practices due to a lack of resources, or may cause farmers to side-sell part of their harvested coffee at lower prices to obtain quick cash. At the household level, cash shortness may cause farmers to acquire short-term debt, with the consequent costs this

[2] Additionally, we identified two coffee cooperative studies based on TCE (Arana-Coronado et al. 2019; Mujawamariya, D'Haese, and Speelman 2013) but focused on the side-selling problem persistent among cooperative farmers.

represents. Furthermore, if farmers perceive that cooperative farmers are more likely to experience cash shortness than non-cooperative farmers, farmers may decide not to affiliate with cooperatives in the first place, forgoing other benefits. However, this study finds no impact of cooperative affiliation on cash shortness.

The following section presents a background on coffee cooperatives followed by the theoretical framework based on TCE. The fourth section describes the data collection and presents the models. Next, we provide and discuss the two main sets of results. A final section concludes the paper.

Background on coffee cooperatives in the area of study

Mexico is a relevant coffee supply region, ranking worldwide as one of the top ten producing countries in terms of volume in recent years (International Coffee Organization 2021). Coffee cooperatives, and in general coffee-related producer associations, are common business structures in this country helping small-scale farmers increase market opportunities and economic stability (Velandia et al. 2022). One direct benefit of coffee cooperatives over individual coffee enterprises is that cooperatives can obtain Fairtrade® certification while individual coffee farms cannot (Dammert and Mohan 2014; Luna and Wilson 2015; Arana-Coronado et al. 2019). Fairtrade certification helps cooperative farmers mitigate output price risk and contribute to rural development. This is because fairtrade-certified coffee, conditional on enough demand, obtains a minimum selling price and a price premium to be invested back in projects that benefit communities where certified coffee is grown (Fairtrade International 2022).

Certification processes, however, incur costs. Bray and Neilson (2017) conducted a meta-review of empirical research evaluating the economic, social, and sustainability impacts of certification programs (fairtrade and organic certification mainly) on smallholder coffee producers worldwide. After reviewing 51 studies, Bray and Neilson (2017) concluded that certifications are more likely to generate positive impacts despite some studies documenting neutral or adverse effects. Another meta-review, including certification of coffee and other crops, concluded that the impact of certification on smallholder farmers is moderately positive (DeFries et al. 2017). These reviews illustrate the importance and distinctiveness of coffee cooperatives producing certified coffee.

The cooperatives analyzed in this study process fairtrade certified coffee. Hence our results may not apply to non-certified coffee cooperatives. This is because, as discussed above, fairtrade certification is potentially a distinct benefit for farmers deciding to join these cooperatives. Other potential benefits for farmers, not specific to certified coffee cooperatives, include the following. Cooperative affiliated farmers may obtain better input and output prices due to the bargaining power of cooperatives, get political and networking benefits due to membership, safeguard their specialized investments or know-how, and receive government subsidies or credits through cooperatives. In contrast, potential costs of cooperative affiliation for farmers include time and resources spent to honor membership commitments such as attending meetings or leading the organization, transaction costs to monitor the performance and decisions by cooperative leaders, additional costs to comply with other coffee quality certifications when required by cooperatives, and forgoing other buying outlets that sometimes offer better transaction terms (e.g., prompt payment) and prices (Fulton and Giannakas 2001; Hendrikse

and Bijman 2002; Karantininis 2007; Pascucci et al. 2012; Luna and Wilson 2015; Abate 2018; Arana-Coronado et al. 2019).

Like in other coffee-supplying regions worldwide (Wollni and Brümmer 2012; Ruben and Heras 2012; Milford 2014; Mojo et al. 2016), coffee is produced in Mexico by small-scale farmers living in areas of a high level of poverty. The Mexican Department of Agriculture and Rural Development estimates that at least half a million farmers grow coffee in Mexico, with an average coffee farmer producing less than 2 tons per hectare (Secretaría de Agricultura y Desarrollo Rural 2019). Our sample for this study has coffee farmers affiliated and not affiliated with coffee cooperatives in the State of Veracruz, which is the second most important coffee-producing state in the country in terms of volume (Secretaría de Agricultura y Desarrollo Rural 2019). The communities where the surveyed coffee growers live are 1090 m above sea level (masl) on average, an elevation considered adequate for competitive, high-quality coffee production (Avelino et al. 2005; Tolessa et al. 2017; Worku et al. 2018). The level of education in the communities of surveyed coffee growers is low, with slightly below six years of formal schooling on average.

Economic framework

Transaction cost economics

A coffee farmer's decision to join a cooperative (y^1) or to operate as a non-cooperative farmer (y^0)—the affiliation decision—is modeled as a discrete choice according to Eq. (1) (Masten and Saussier 2002; Pascucci et al. 2012; Abate 2018):

$$y^* = \begin{cases} y^1, U(y^1) > U(y^0) \\ y^0, U(y^1) \leq U(y^0) \end{cases}, \tag{1}$$

where $U(y^1)$ and $U(y^0)$ represent the expected utility a coffee farmer associates with being affiliated or not with a cooperative, and y^* is the farmer's affiliation decision.[3] Equation (1) shows that a farmer will join a cooperative when his or her expected utility of doing so is higher than remaining as a non-cooperative farmer. Expectations regarding the benefits and transaction costs of cooperative membership are unobservable. However, whether a farmer decides to affiliate or not with a cooperative is observable, and TCE theory provides a framework to model this decision.

Masten and Saussier (2002) and Macher and Richman (2008) reviewed the TCE literature, with the latter surveying about 900 studies across economics and non-economics disciplines, finding considerable empirical support for this theory. Under TCE, an economic agent selects the organizational mode that minimizes the expected total transaction cost of consummating a series of commercial exchanges or transactions. (Organizational modes are also referred to as institutional arrangements or governance structures in TCE jargon.) The cost-minimizing process is based on the premise that transactions differ in their attributes—discussed below—and are aligned to organizational modes, which differ in cost and competence

[3] Pascucci, Gardebroek, and Dries (2012) modeled this farmer's decision as a double discrete decision-making problem. The farmer first decides to join a cooperative, and conditional on this decision, decides whether to use or not the services offered by the cooperative. We model this problem as a single discrete choice like in other studies (Fisher and Qaim 2012) and because our subset of coffee cooperative farmers includes only active cooperative members, defined as those cooperative members actually using the services of the cooperatives.

(Williamson 1983; Masten and Saussier 2002). TCE conceptualizes three broad discrete organizational modes: spot markets, large and hierarchically organized or vertically integrated enterprises, and hybrids or intermediate modes between markets and hierarchies (Williamson 1983, 2010; Masten and Saussier 2002).

Agricultural cooperatives represent one hybrid organizational mode with the potential to reduce transaction costs—that are relatively high in agriculture—relative to spot markets (Masten 2000; Fisher and Qaim 2012; Wossen et al. 2017). Coffee cooperatives in the study region typically receive harvested coffee cherries from cooperative affiliated farmers, process the cherries into green coffee, and sell green coffee to national or international buyers. The spot coffee market is represented by intermediaries, sometimes called coyotes, who buy dry cherries or parchment coffee at the farmer's gate, generally paying lower prices than cooperatives. One key competitive advantage of intermediary buyers over cooperatives is their ability to pay farmers full cash without delays (Milford 2014; Luna and Wilson 2015).

Identifying and explaining the TCE attributes influencing agents to choose an organizational mode is central to TCE research (Macher and Richman 2008). Asset specificity is the most relevant attribute impacting transaction costs, hence, determining cost-minimizing organizational models (Williamson 2010; Ciliberti et al. 2020). Consistently, asset specificity is by far the most tested TCE attribute (Macher and Richman 2008). (Other TCE attributes include uncertainty and frequency of transactions.) Asset specificity refers to specialized or dedicated transactions and investments, involving tangible or intangible assets, that are specific, tailored, or more convenient to operate with a particular type of partner or structure. Redeploying those assets for alternative partners or structures sacrifices economic value, making asset-specific transactions more vulnerable to opportunistic behavior. Asset specificity increases farmers' transaction costs because farmers need to apply safeguards or special governance structures to avoid opportunistic behavior. TCE thus predicts that as specialized or specific investment increases, farmers will prefer more integrated organizational modes—with the appropriate safeguards—such as cooperatives or vertically integrated channels, over spot markets. In addition, due to bargaining power, agricultural cooperatives may decrease input costs and increase output prices for farmers to recover the higher cost of specialized investments (Ciliberti et al. 2020).

The asset specificity attribute of TCE can be classified into dimensions, including human capital, dedicated assets, size or physical dimension, brand name capital, site or location, and temporal dimension (Macher and Richman 2008; Williamson 2010). Empirical studies generally focus on only a few asset specificity dimensions, depending on data availability and context or industry. TCE research in agricultural cooperatives typically tests asset specificity dimensions and attribute uncertainty only in a few cases (Pascucci et al. 2012; Arana-Coronado et al. 2019; Ciliberti et al. 2020). This study proposes and tests a coffee farmer's cooperative affiliation decision model explained by several TCE asset specificity dimensions. The model is then used to evaluate the impact of the affiliation decision on the farmer's cash holdings.

Explanatory variables for the coffee farmer cooperative affiliation decision model

Asset specificity variables include shade-grown coffee, income from coffee, no off-farm income, coffee farming experience, low-level market competition, and farmland size. Control variables include altitude and education level of the locations where coffee is produced, and whether farming takes place in a private or ejidal land.

Asset specificity

Shade-grown coffee One proxy of dedicated or specialized assets we propose is shade-grown coffee. In this type of plantation, common in Mexico and other Central American countries, coffee is grown in the shade of a forest canopy of tall trees and diverse habitats, thus promoting environmentally friendly practices (Moguel and Toledo 1999; Toledo and Moguel 2012). The eco-friendly attribute of shade-grown coffee is perceived as a positive attribute by consumers willing to pay a price premium even higher than the premium paid for organic coffee (Loureiro and Lotade 2005; Geeraert et al. 2019; Quiñones-Ruiz 2020; Vogt 2020). In general, shade-grown coffee is considered distinct from other coffee production systems or certifications and is typically suitable for the specialty coffee market (Jezeer and Verweij 2015). However, the shade-grown niche market is still considered underdeveloped (Larson 2003; Messer et al. 2000; Jha et al. 2014), implying a limited number of buyers and market opportunities, which make investments by farmers growing this type of coffee more specialized toward those buyers. Therefore, shade-grown coffee farmers in Mexico have incentives to affiliate with cooperatives and commercialize their coffee through these organizations (Jiménez-Ortega et al. 2022) or other specialty coffee market channels but not through intermediary buyers.

Income from coffee Coffee farm plantations can have coffee plants only or coffee and other crops. In the study area, some coffee farmers diversify their coffee plantations with banana, macadamia nuts, flowers and other herbs, or sugar cane. The percentage of income the farmers obtain from coffee relative to total farm income is another proxy of the degree of dedicated farmers. The higher the income from coffee relative to total farm income, the more dedicated the farmer is assumed to be. This specialization or diversification proxy is similar to the one proposed by Ciliberti et al. (2020) and Hao et al. (2018) in modeling the cooperative membership decision for agricultural cooperatives. Specifically for coffee farming, Mojo et al. (2017) included a similar variable—the number of crop types grown—to model the farmer's cooperative affiliation decision.

No off-farm income Another proxy of specialized or dedicated assets is whether coffee farmer households' income depends exclusively on the coffee farm plantation or they receive income from off-farm sources (Wollni and Zeller 2007; Hao et al. 2018). It is assumed that farmers without off-farm income (i.e., no off-farm jobs) are more dedicated because they devote more time to their farms. Specifically for coffee farming, Shumeta and D'Haese (2016) included off-farm income to model cooperative membership. Their argument, aligned with TCE, is that not having diverse sources of income makes farmers more vulnerable to poverty and more likely to prefer engaging in collective action to safeguard their income from coffee.

Coffee farming experience The number of years farmers have been producing coffee is included as another proxy of asset specificity, according to research in agricultural

cooperatives (Wollni and Zeller 2007; Priscilla and Chauhan 2019; Zhang et al. 2019; Ciliberti et al. 2020), and particularly in coffee cooperatives (Ortega et al. 2019). Human capital, built over time as coffee farmers accumulate farming experience, might be an incentive for farmers to affiliate with cooperatives if they are willing to contribute with their expertise to the cooperatives' decision-making process or if they believe that coffee cooperatives are more likely to safeguard their specialized human capital investment.

Low-level market competition We include the number of coffee buyers/traders known by the farmer as an indication of the level of competition in the market, as perceived by the farmer. A few buyers known by the farmer implies low market competition and higher farmers' dependency on a specialized market (buyer). Thus, we use the negative number of buyers (i.e., number of coffee buyers/traders known by the farmer $\times -1$) to indicate the degree of low-level market competition. We expect a positive relationship between low market competition—equivalently, high dependency on a specialized market—and the cooperative affiliation decision because farmers will likely try to safeguard their specialized businesses through cooperatives. This argument is in line with TCE's bilateral dependency in asset-specific investment situations. On coffee cooperatives, Mujawamariya et al. (2013) argue that the bilateral dependency between coffee cooperatives and farmers is higher than between coffee farmers and intermediary buyers. Coffee cooperatives are highly dependent on the supply of coffee by the farmers because they need high volumes of coffee to reduce processing and storage costs. In contrast, intermediaries are less dependent on coffee farmers because they do not necessarily process coffee, and they usually purchase commodities other than coffee—their investments, such as storerooms, can easily be shared by coffee and other commodities. The number of coffee buyers/traders known by the farmer has been used as a proxy for the degree of development of the market in agricultural cooperatives (Abate 2018) and specifically in coffee cooperatives research (Mojo et al. 2017).

Farmland size Farmland size has been extensively tested as a variable influencing cooperative membership in TCE studies related to agricultural cooperatives (Fisher and Qaim 2012; Shumeta and D'Haese 2016; Mojo et al. 2016; Ahmed and Mesfin 2017; Hao et al. 2018). Farmers with more extensive plantations might be more inclined to affiliate with cooperatives. Large farmers face a lower average fixed cost of membership and can profit from economies of scale (Fisher and Qaim 2012; Mojo et al. 2016; Hao et al. 2018).

Additionally, it has been suggested that agricultural cooperatives experience a "middle-class effect" (Bernard and Spielman 2009; Fisher and Qaim 2012). The middle-class effect predicts that the probability of farmers benefiting from collective action is higher among landholders with an intermediate level of assets (Bernard and Spielman 2009). Under specific settings, very small and large farmers are less likely to be affiliated with cooperatives than middle size farmers (Francesconi and Heerink 2010; Fisher and Qaim 2012; Ito et al. 2012). Thus, it is also plausible that the relationship between farmland size and the cooperative affiliation decision follows an inverse u-shape trajectory, in which cooperative affiliation is not attractive for farmers with minimum farmland size and stops being attractive for larger farms. To operationalize the effects of farmland size in our model, we include variables farmland size and farmland size squared, expecting a positive and negative relationship, respectively.

Control variables

Altitude The altitude of locations where the coffee bean is produced relates to the quality of the coffee drink (Avelino et al. 2005; Giacalone et al. 2016; Samoggia and Riedel 2018; Servín-Juárez et al. 2021). In particular, for Mexico—the area of study—Morales-Ramos et al. (2020) document that the higher the altitude, the better the quality attributes evaluated in a coffee beverage. Altitude has also been used as a control variable in coffee cooperative-related studies (Wollni and Zeller 2007; Rodriguez-Padron et al. 2012) since high-quality coffee farmers seek to be paid better prices by commercializing through cooperatives.

Education level Some cooperative membership/affiliation studies include farmer education-related variables as proxies for human capital or to control for the cooperative membership decision (Fisher and Qaim 2012; Abebaw and Haile 2013; Benmehaia and Brabez 2016; Wossen et al. 2017; Ma and Abdulai 2017; Abate 2018; Ji et al. 2019). Education might be positively associated with cooperative membership because informed farmers are expected to recognize the benefits of coffee cooperative membership better. Empirical studies documenting a positive relationship between farmer education and the cooperative affiliation decision in coffee cooperatives include Grashuis and Skevas (2022), Mojo et al. (2017), and Ortega et al. (2019).

Private farmland Several agricultural cooperative studies include farmland ownership tenure as a factor potentially related to the cooperative affiliation decision (Fisher and Qaim 2012; Padron-Rodriguez et al. 2012; Zeweld-Nugusse et al. 2013; Mujawamariya et al. 2013; Benmehaia and Brabez 2016; Meier 2016). Increased land tenure security has been linked to increased investment incentives, access to credit, and efficiency in land markets (Besley 1995). In turn, increased investment incentives may affect the farmer's cooperative affiliation decision. Fulton (1999) conceptualizes the cooperative affiliation decision as one long-term investment decision that is riskier than just selling a product on a spot market, thus predicting that the affiliation decision will depend on the farmer's degree of preference for risk. Empirically and specifically for coffee cooperatives, Meier (2016) finds that farmers with more significant investments in the quality of their coffee are more likely to commit to collective marketing through cooperatives in Uganda. In general, cooperative affiliation involves a long-term commitment that arguably is more likely to occur if farmers own the land they farm. Coffee farmers in our sample for this study hold two types of land titles: private and ejidal lands. The ejidal land system, a communal land tenure system prevalent in Mexico and unique for this country, is slightly more restrictive regarding land tenure security than the private land system (Castañeda-Dower and Pfutze 2013; Morett-Sanchez and Cossio-Ruiz 2017). In addition, on average, ejidal lands dedicated to agriculture are less productive than private lands in terms of output value per hectare and have lower fixed assets infrastructure than private lands (Thompson and Wilson 1994; Morett-Sanchez and Cossio-Ruiz 2017). Given the differences between private and ejidal lands, we include a dummy variable for private farmland owners as a control in our model.

To summarize, a positive relationship between dimensions of asset specificity variables and cooperative membership/affiliation is expected. (An exception is a negative relationship expected for farmland size squared, given the predicted middle-class effect.) Dedicated or specialized coffee farmers will be likely affiliated with cooperatives instead of

selling to a local intermediary buyer because the cooperative is expected to better safeguard the farmer's specialized investment. However, there is a caveat to this general prediction. Farmers producing the highest quality coffee beans might choose not to affiliate with cooperatives, given that agricultural cooperatives mainly deal with low to medium-quality products as they pool products of heterogeneous quality (Grashuis and Su 2019). These high-quality coffee bean farmers will likely not sell to intermediaries for the same quality-preservation reason. Instead, they may sell their coffee directly into the specialty coffee chain market or even vertically integrate their operations by establishing a coffee shop.

Equation (2) shows the cooperative membership decision as a function of TCE's asset specificity attributes and control variables, with the predictions in parenthesis.

$$\text{Cooperative membership} = f[\text{dedicated assets}(+), \text{size}(\pm), \text{controls}(\pm)] \quad (2)$$

The economic impact of cooperative affiliation on the farmer's cash shortness

We use the farmer's cooperative affiliation decision model to evaluate whether this decision impacts cash holdings by alleviating farmers' cash shortness, if any. We further explain this in the next section elaborating on estimation models.

Data and methods

Data

The analysis is based on responses from a cross-section survey implemented between January and August 2019. For the sample design and farmer selection, we contacted the leadership of five coffee cooperatives who agreed to collaborate with this research project. The cooperatives are located in Huatusco and Cordoba, two relevant coffee regions in the state of Veracruz, Mexico (Hernandez-Martinez et al. 2018; Morales Ramos et al. 2021). Considering our budget constraint and the number of coffee farmers affiliated with the five cooperatives, we surveyed 190 coffee farmers divided into 95 cooperative affiliates and 95 non-cooperative farmers. Five trained enumerators conducted the interviews.

Surveyed cooperative affiliated farmers were randomly selected from lists of all active cooperative members or affiliates provided by the leadership of the cooperatives. An active cooperative member is defined as a coffee farmer affiliated with a cooperative, who regularly sells his/her coffee through the cooperative and is actively involved with the activities of the cooperative. Surveyed non-cooperative farmers were those coffee farmers identified as peers or pairs of surveyed cooperative members/affiliates. A peer is defined as a non-cooperative coffee that is farming geographically close to an identified cooperative affiliated farmer. The leadership of cooperatives and surveyed cooperative members recommended potential peers to survey, thus following a snowball approach.

Table 1 breaks down the sample. The first column identifies the cooperative (A through E), and the second column shows the total number of active affiliated members and, in parenthesis, the shares across cooperatives. The third and fourth columns provide similar information for surveyed cooperative affiliated farmers and non-cooperative farmers. The shares across cooperatives in the two groups are similar in proportion (i.e.,

Table 1 Sample composition of coffee growers

Cooperative	Total active coffee cooperative members or affiliates (%)	Surveyed cooperative members or affiliates (%)	Surveyed non-cooperative coffee farmers (%)	Total surveyed cooperative affiliates and non-cooperative farmers (%)
A	26 (2)	8 (8)	8 (8)	16 (8)
B	17 (1)	11 (12)	8 (8)	19 (10)
C	276 (18)	15 (16)	16 (17)	31 (16)
D	350 (22)	17 (18)	18 (19)	35 (18)
E	900 (57)	44 (46)	45 (47)	89 (47)
Total	1569 (100)	95 (100)	95 (100)	190 (100)

This Table shows the number of coffee farmers and corresponding shares across cooperatives in parenthesis. Active cooperative members or affiliates (in column 2) are defined as coffee growers affiliated with a cooperative who also regularly sold their coffee through the cooperative and were actively involved with the activities of the cooperatives

percentages in the third and fourth columns). The last column shows the number and shares of coffee growers surveyed.

Estimation models

The farmer's cooperative affiliation decision logit model

Equation (1) represents the framework to model the affiliation decision according to the coffee grower's expected utility associated with each choice of being a cooperative or a non-cooperative farmer. The portion of the expected utility that is observable is expressed as a function of exogenous variables X_i derived from TCE theory and control variables (Eq. (2)), and a vector of parameters to be estimated,

$$U_i = \beta X_i + u_i, \tag{3}$$

where X_i includes the explanatory variables discussed in "Explanatory variables for the coffee farmer cooperative affiliation decision model" Section. The error term, assumed to be independently and identically distributed $(0, \tau)$, captures the unobservable portion of the coffee farmer's expected utility regarding the affiliation decision. The probability of farmer's affiliation decision is

$$P(Y_i = 1) = P(u_i < \beta X_i) = \beta X_i + u_i, \tag{4}$$

where $Y_i = 1$ if the coffee farmer's utility associated with being a cooperative affiliate exceeds the utility of remaining as a non-cooperative farmer and $Y_i = 0$ otherwise. We use logit regression to estimate Eq. (4), with the dependent variable set to 1 for cooperative affiliates and 0 for non-cooperative farmers. Regression model covariates were operationalized as follows.

The shade-grown coffee variable is set to 1 for farmers with shade-grown coffee plantations and 0 otherwise. The income from coffee variable is the percentage of income that farmers obtain from coffee relative to total farm income. The no off-farm income variable is equal to 1 for farmers whose income depends exclusively on the coffee farm plantation and 0 if they receive income from off-farm sources. Coffee farming experience is the number of years farmers have been producing coffee. The low-level competition market variable is calculated by multiplying the number of coffee buyers know by

the farmer by negative one. Farmland size is the total number of hectares in the coffee plantation.

The altitude of locations where the coffee bean is produced is measured in meters above the sea level at the municipality level, according to the National [Mexican] Institute of Statistics and Geography (INEGI 2019). Similarly, education level is the average years of schooling in those communities where the surveyed coffee farmers live (INEGI 2019). Finally, *private land* equals 1 if the farmer reported growing coffee in a private land and 0 if the coffee was grown in ejidal land. We checked for multicollinearity in our data using the *coldiag* command and estimated robust standard errors with the *vce(robust)* option in STATA.

Mixed-effect logit regression

In addition to logit regression, we estimate a mixed-effect logit regression (*melogit* command in STATA) at the farmers' community level (Hole 2007; Train 2009). This model captures the effects of potential omitted variables and unobserved characteristics associated with local factors (i.e., the 42 communities) or clusters. The fitness of the mixed effect logit regression model would imply that coffee farmers in the same community cluster share similar unobserved characteristics such as entrepreneurial ability, organizational culture, or technology adoption strategies that differ from farmers in other communities and may affect cooperative membership.

The economic impact of cooperative affiliation on the farmer's cash holdings

We also test whether and, if so, in what direction the cooperative affiliation decision affects the outcome of coffee farmers. The farmers were asked whether they typically have enough cash around coffee harvesting and selling time to cover household consumption or farm working capital needs or whether they usually experience cash shortness, which requires short-term financing. Farmers that reported typically experiencing cash shortness were coded as 1 and 0 otherwise. Since cooperative members *decide* to affiliate with cooperatives instead of being randomly assigned membership affiliation, self-selection or endogeneity bias may exist. Because of this, one cannot just compare the cash outcome responses of cooperative and non-cooperative farmers when measuring the impact of cooperative affiliation. Further, since it is impossible to observe the outcomes of cooperative farmers had they instead decided not to affiliate with cooperatives, a counterfactual control group needs to be identified among non-cooperative farmers.

We use propensity score matching, which is commonly used in agricultural cooperatives research (Bernard and Spielman 2009; Fisher and Qaim 2012; Ito et al. 2012; Abebaw and Haile 2013; Mojo et al. 2016; Shumeta and D'Haese 2016; Wossen et al. 2017; Ahmed and Mesfin 2017), to construct a control group of non-cooperative coffee farmers that are similar to coffee cooperative farmers in all relevant observed characteristics. We consider relevant observed characteristics of all the explanatory variables in the farmer's cooperative affiliation decision model discussed above. With PSM, the effect of cooperative membership on outcome cash is modeled in two stages. In the first stage, we generate propensity scores $p(X)$ or probabilities of farmers affiliating with coffee cooperatives according to the cooperative affiliation model. These

Table 2 Descriptive statistics

Variables	Mean	Std. dev.	Min	Max
Coffee cooperative membership/affiliation	0.468	0.501	0.000	1.000
Shade-grown coffee	0.347	0.473	0.000	1.000
Income from coffee	92.000	16.526	20.000	100.000
No off-farm income	0.513	0.501	0.000	1.000
Coffee farming experience	33.890	19.169	2.000	80.000
Low-level market competition	1.305	0.744	0.000	4.000
Farmland size	3.028	2.746	0.188	13.000
Farmland size squared	16.662	31.609	0.035	169.000
Altitude	1,090.494	178.251	540.000	1,354.000
Education level	5.738	0.834	3.800	8.400
Private land	0.649	0.479	0.000	1.000

Coffee cooperative membership/affiliation is a variable equal to 1 for cooperative farmers and 0 for non-cooperative farmers. Shade-grown coffee = 1 for farmers with shade-grown coffee plantations, 0 otherwise. Income from coffee is the percentage of income that farmers obtain from coffee relative to total farm income. No off-farm income is equal to 1 for coffee farmers whose income depends exclusively on the coffee farm plantation and 0 if they receive income from off-farm sources. Coffee farming experience is the number of years farmers have been producing coffee. Low-level market competition is the number of buyers known by the farmer multiplied by minus one. Farmland size is the total number of hectares on the plantation. The altitude of locations where the coffee bean is produced is measured in meters above the sea level at the municipality level (INEGI 2019). Similarly, education level is the average years of schooling in those communities where the surveyed coffee farmers live (INEGI 2019). Private land is equal to 1 if the farmer reported farming in a private land and 0 if the land ownership type was ejidal

scores build the control group by matching cooperative farmers with non-cooperative farmers that have similar propensity scores. Observations without suitable matches are dropped from the analysis. In the second stage, we estimate the effect of cooperative membership on outcome cash shortness by calculating the average treatment effect on the treated (ATT). The ATT is the difference in outcomes between cooperative farmer members/affiliates (i.e., the treatment) and non-cooperative farmers (i.e., the control) appropriately matched (Fisher and Qaim 2012),

$$\mathrm{ATT}_{\mathrm{PSM}} = E_{(p(X)|Y=1)}\{E[O(1)|Y=1, p(X)] - E[O(0)|Y=0, p(X)]\}, \tag{5}$$

where $O(1)$ represents outcomes for the treated with treatment (outcomes of cooperative members), $O(0)$ has outcomes for the control group without treatment (outcomes of non-cooperative farmers), $Y = 1$ indicates treated cooperative members, and $Y = 0$ represents non-cooperative farmers. The outcome is the farmer's response to the cash-related question. PSM estimations are conducted using *pscore* and *psmatch2* STATA codes with 1000 bootstrap replications and different matching algorithms.

Results and discussion

Descriptive statistics

Table 2 provides descriptive statistics, summarizing the sample with non-missing observations across all variables used in the regressions (e.g., $n = 154$). About one-third of coffee farms are specialized, shade-grown types of coffee plantations. Farmers in the sample are dedicated coffee farmers, with income from coffee representing 92% relative to total farm income. Furthermore, 51% of farmers depend exclusively on income from the coffee farm plantation, reporting zero off-farm income. Surveyed

Table 3 Regression results of the farmer's coffee cooperative membership/affiliation decision model

	Logit	Logit	MELogit
Shade-grown coffee	− 0.830**	− 0.917**	− 0.917*
	[0.3950]	[0.4590]	[0.4940]
Income from coffee	− 0.007	− 0.016	− 0.016
	[0.0115]	[0.0113]	[0.0116]
No off-farm income	0.665*	0.560	0.560
	[0.3760]	[0.3860]	[0.4770]
Coffee farming experience	0.0122	0.0172*	0.0172*
	[0.0085]	[0.0092]	[0.0103]
Low-level market competition	0.446*	0.669**	0.669**
	[0.2520]	[0.2740]	[0.2670]
Farmland size	0.599***	0.703***	0.703**
	[0.2120]	[0.2430]	[0.2950]
Farmland size squared	− 0.0337*	− 0.0415**	− 0.0415*
	[0.0190]	[0.0211]	[0.0255]
Altitude		0.00226	0.00226*
		[0.0015]	[0.0012]
Education level		− 0.248	− 0.248
		[0.2340]	[0.2300]
Private land		0.789*	0.789**
		[0.4580]	[0.4000]
Constant	− 0.649	− 1.320	− 1.320
	[1.1830]	[2.6970]	[2.4990]
N	159	154	154
Chi-square	26.88	32.31	48.31
Pseudo *R*-square	0.145	0.197	
Clusters	No	No	42
AIC	203.8	192.8	192.8
BIC	228.4	226.2	226.2

The dependent variable equals 1 for coffee cooperative members and 0 otherwise. Robust standard errors are provided in parentheses. *$p < 0.10$, **$p < 0.05$; ***$p < 0.01$. Clusters represent the number of communities in which surveyed coffee farmers operate. AIC is Akaike Information Criterion, and BIC is Bayesian Information Criterion. Explanatory variables are described in Table 2

farmers have almost 34 years of coffee farming experience on average. On farmland size, the average farm plantation has 3.0 hectares, with farms ranging from 0.2 to 13.0 hectares.

Coffee in the study area is produced in elevations ranging from 540 to 1354 masl, for an average altitude of 1090 masl, an elevation considered adequate for competitive, high-quality coffee production. On average, people from the communities of surveyed coffee growers barely finished their elementary education. Coffee growers reported knowing or having contact with 1.3 coffee buyers—other than cooperatives—on average, with the number of known buyers ranging from 0 to 4, suggesting that some growers deliver all their coffee to their cooperatives and do not keep contact with other buyers. Finally, about 65% of surveyed farmers reported farming on private land while the rest reported farming in ejidal-type of ownership land.

The farmer's cooperative affiliation decision model

Regression results are provided in Table 3. The logit specification with the TCE variables is shown first, followed by the logit extended with controls. The extended specification better explains the farmer's cooperative affiliation decision according to the chi-square, pseudo r-square, Akaike Information Criterion, and Bayesian Information Criterion. The last column in Table 3 shows the mixed effect logit specification results. The mixed effect specification controls for potential effects at the community or cluster level for the 42 communities in our sample. Multicollinearity was not an issue for the models because the Condition Indexes were under 30 (Belsey et al. 1980). Regarding goodness of fitness, the extended specification model explains around 20% of the variability, according to the pseudo r-square. Post-estimation receiver operating characteristic (ROC) curves compared the accuracy of predictions, producing similar ROCs for the models, around 0.79, a value considered at the high end of acceptable accuracy (0.70–0.79 is considered acceptable, 0.80–0.89, excellent, and 0.90–1.0 outstanding) (Mandrekar 2010).

The logit and the mixed effect logit models provided similar results. Seven and six out of ten explanatory variables are statistically significant at conventional levels for the mixed effect logit model and the logit model, respectively. The signs of the estimates for the TCE asset specificity variables are as predicted in "Explanatory variables for the coffee farmer cooperative affiliation decision model" Section, except for the variable shade-grown coffee. We provide a potential explanation for shade-grown coffee estimate after explaining the other results.

As predicted and consistent with prior research on coffee (Ortega et al. 2019) and agricultural cooperatives, commodity-specific farming experience positively influences the likelihood of farmers becoming affiliates of coffee cooperatives in Veracruz, Mexico. A possible explanation aligned with TCE is that commodity-specific farming experience increases the farmer's level of specialization or human capital. The more specialized farmers become, the more prone they are to affiliate with coffee cooperatives, perceived as specialized structures (i.e., organizations that, unlike intermediary buyers, deal with one commodity only and serve many coffee growers) likely to safeguard or make more efficient use of farmers' specialized human capital.

Also consistent with our prediction, the regression results suggest a positive relationship between low-level market competition and cooperative affiliation. Given the limited number of known buyers, coffee farmers perceiving a low-level market competition are likelier to affiliate with cooperatives. This is because a low-market competition environment can be related to a specialized market, and coffee farmers perceiving such a market environment will find it in their best interest to transact via cooperatives, which are structures able to safeguard specialized investments, according to TCE.

Regarding the TCE size attribute, the coefficient estimates of farmland size and farmland size squared are statistically significant, with positive and negative signs as predicted. This suggests a middle-class effect (Bernard and Spielman 2009; Fisher and Qaim 2012) on coffee cooperative affiliation. While several studies have documented this effect in agricultural—other than coffee—cooperatives (Francesconi and Heerink 2010; Fisher and Qaim 2012; Ito et al. 2012), we only identified one reporting the

middle-class effect for coffee cooperatives of Rwanda (Ortega et al. 2019). (Shumeta and D'Haese (2016) also tested this effect on coffee farmers from Ethiopia, finding a positive and statistically significant estimate for farmland but not significant for farmland squared.)

Thus, our farmland size finding adds to the limited empirical evidence of the middle-class effect in coffee cooperatives. The mid-class effect implies that very small and large farmers are less likely than mid-size farmers to affiliate with cooperatives. It is expected that large coffee growers intentionally decide not to affiliate with cooperatives because they have the resources to look for an alternative, economically more attractive market than the one reached by cooperatives. In contrast, small coffee growers might be excluded from being cooperative affiliates. The reason is that small-scale farmers lack the resources to comply with cooperatives' requirements, such as paying the cooperative affiliation fee, producing enough volume to have their plantations certified, or meeting the product quality threshold expected by cooperatives.

Therefore, our farmland size finding suggests that the middle-class effect for coffee growers in Veracruz, Mexico, may be problematic for the smallest—probably the poorest—coffee farmers if the cooperatives strategies (e.g., fairtrade certification or quality standards) intentionally or accidentally exclude these farmers from being cooperative members/affiliates. This is problematic because such exclusion will preclude some small-scale farmers from obtaining better prices for their coffee beans, safeguarding their investments, or obtaining the side-benefits cooperatives provide, such as training or access to governmental resources.

A line of research on agricultural cooperatives related to this finding investigates whether cooperatives are inclusive of small-scale farmers. A review article by Bijman and Wijers (2019) finds that while results are mixed, several studies show that small-scale farmers, poor farmers, and farmers living in remote areas are excluded from cooperatives. Bijman and Wijers (2019) argue that while this behavior is against the common assumption of farmer cooperatives helping poor and marginalized groups, theoretical reasons and limited empirical evidence show that cooperatives often exclude the smallest/most impoverished farmers. In particular, Bijman and Wijers (2019) claim that as cooperatives evolve from rural organizations focused on community development to rural business structures focused on the market, they tend to exclude small-scale farmers. Excluding small-scale farmers allow these cooperatives to remain competitive. Therefore, our middle-class effect result is consistent with research documenting that cooperatives with a business orientation tend to exclude small-scale farmers to compete in the market.

Altitude, education level, and private land are control variables in the models. The altitude of the localities where coffee is produced is positively related to the farmer's affiliation decision— this result, though, is only significant in one of the two models—. It is widely documented that altitude positively correlates with a coffee beverage's quality (Avelino et al. 2005; Giacalone et al. 2016; Samoggia and Riedel 2018; Servín-Juárez et al. 2021; Morales-Ramos et al. 2020). Assuming a direct relationship between the quality of coffee beans and coffee drinks, the altitude estimate suggests that farmers producing high-quality coffee beans seek to be paid better prices by commercializing their coffee through cooperatives. Also consistent with the prediction based on land rights-related

research in cooperatives (Besley 1995; Fisher and Qaim 2012; Mujawamariya et al. 2013; Meier 2016) and existing differences between private and ejidal lands in terms of infrastructure and productivity in the study area (Morett-Sanchez and Cossio-Ruiz 2017; Rodriguez-Padron et al. 2012), the estimate for private land is positive. This suggests that farmers with private and more productive lands have more security and are willing to make the long-term commitment that implies cooperative affiliation. Education level was not statistically significant.

Finally, the relationship between shade-grown coffee plantations and the farmer's affiliation decision is negative, inconsistent with our prediction, elaborated in "Explanatory variables for the coffee farmer cooperative affiliation decision model" Section. We predicted that shade-grown coffee farmers in Mexico have more incentives than other coffee growers to affiliate with cooperatives and commercialize their coffee through these organizations or other specialty coffee market channels but not through intermediary buyers. The regression results suggest that shade-grown coffee farmers prefer not to affiliate and commercialize their coffee through cooperatives. However, it is difficult to explain why farmers would prefer to sell their high-value coffee beans to intermediaries—who typically buy low to average coffee quality beans—unless farmers do not realize the final customer's willingness to pay a premium for those coffees. We instead argue that it is more likely that these farmers know the value of their products but recognize that cooperatives in the region cannot reach buyers for this niche of the specialty coffee market. If the latter were true, the negative coefficient of the shade-grown variable implies that shade-grown coffee farmers try to sell their coffee beans to specialty coffee chain buyers directly (outside of cooperatives but not through local spot markets) with the expectation of higher prices. However, we do not have evidence of commercialization channels other than cooperatives and spot markets (i.e., typical intermediaries buying low to average coffee beans) because the study assumes only these two discrete commercialization channels.[4] Therefore, further research on how shade-grown coffee farmers commercialize their products is worthwhile.

Thus, one plausible explanation for the shade-grown coffee result is that shade-grown coffee farmers, recognizing their highly-valued products, prefer to explore more profitable niche markets (e.g., the specialty coffee market) instead of diluting their coffee quality in cooperatives that pool the coffee cherries from many plantations with heterogeneous quality. This would imply that coffee cooperatives in this region facilitate transactions up to a certain level of quality (i.e., the quality required by fairtrade certification) but not necessarily serve the needs of farmers producing shade-grown coffee. This potential implication of our result is consistent with the expectation that cooperatives cannot fulfill *highly* specialized transactions at relatively low transaction costs (Ménard and Valceschini 2005).

[4] Alternatively, shade-grown coffee farmers with more economic resources can vertically integrate their operations by establishing a coffee shop instead of affiliating with cooperatives. While this is plausible in theory, it is challenging to execute in rural areas. Anecdotal evidence from this coffee region indicates that some farmers producing specialty coffee choose not to affiliate with cooperatives and instead supply specialty coffee shops and roasters or vertically integrate their operations by establishing a coffee shop. However, those cases are rather exceptions to the rule.

Table 4 Test of means across TCE variables affecting the farmer's cooperative affiliation decision model after balancing PSM treatment

	Mean		*T* test	
	Treated	Control	*t*	Difference *p* value
Shade-grown coffee	0.27	0.24	0.48	0.63
Income from coffee	88.28	92.32	− 1.47	0.14
No off-farm income	0.59	0.62	− 0.34	0.73
Coffee farming experience	36.51	31.78	1.46	0.15
Low-level market competition	− 1.18	− 1.13	− 0.48	0.63
Farmland size	3.89	4.01	− 0.24	0.81
Farmland size squared	24.44	26.04	− 0.25	0.81
Altitude	1,100.30	1,081.90	0.73	0.47
Education level	5.67	5.52	1.19	0.24
Private land	0.70	0.68	0.36	0.72

Variables are defined in Table 2

Table 5 Impact of the cooperative affiliation decision model on the farmer's cash shortness

STATA procedure	ATT method	*N* treatment	*N* Control	ATT	Std. error	*t*
pscore	Kernel	72	73	0.13	0.1050	1.23
pscore	Stratification	72	73	0.11	0.1140	0.93
psmatch2	Common support	71	80	0.06	0.1185	0.53
psmatch2	Common radius	71	80	0.09	0.0916	0.95
psmatch2	Kernel	71	80	0.11	0.0955	1.13

Average treatment effect on the treated (ATT) using different estimation methods

Standard errors were bootstrapped with 1000 repetitions

For 10%, 5%, and 1% $|t|$ = 1.81, 2.22, 3.17, respectively

Impact of the cooperative affiliation decision on cash holdings

In this section, we discuss the economic impact of the cooperative affiliation decision on an outcome. Farmers were asked whether they typically have enough cash—around coffee harvesting and selling time—to cover household consumption or farm working capital needs or whether they usually experience cash shortness, which requires short-term financing. Around 66% of farmers in the samples reported typically experiencing cash shortness. As elaborated in "Estimation models" Section, we use PSM in two stages by first matching coffee cooperatives with non-cooperative coffee farmers with similar propensity scores, then estimating the ATT between cooperative members and non-cooperative farmers appropriately matched.

The matching algorithm from STATA confirmed that the "balancing was properly satisfied," employing five blocks with common support. Table 4 provides the means of covariates across cooperative (i.e., treated) and non-cooperative (i.e., control) farmers after PSM treatment. The *p*-values of the covariates' mean differences show that, statistically, no differences exist between the two groups. This confirmed the

assumption and balancing property that the distributions of covariates are similar and randomly distributed for both treatment and control samples, and the matching is done appropriately.[5]

Table 5 shows the average treatment effect on outcome variable cash shortness using different matching methods and bootstrapping the standard errors. Column ATT gives the impact of the farmer's cooperative affiliation decision on cash shortness around coffee harvesting and selling time. Consistently across estimation methods, we do not find statistically significant differences in cash shortness between the two groups. For instance, the kernel matching method reports that 13% (or 11% with the psmatch2 STATA procedure) of coffee farmers are more likely to experience cash shortness if they were cooperative affiliates rather than non-cooperative farmers. The proportions of coffee cooperatives likely to experience cash shortness are lower at 6% and 9% when estimated with the psmatch2 STATA common support and common radius procedures. However, none of the ATT estimates in Table 5 are statistically significant. Therefore, we do not find evidence that the farmer's cooperative affiliation decision is related to the likelihood of the farmer experiencing cash shortness around harvesting and selling time.

The cash shortness finding is relevant since it has been documented that coffee cooperatives cannot afford fully pay farmers at harvesting and selling time but rather pay farmers partially, paying them the difference a few months later. This seems to be the case across coffee supply regions such as Nicaragua (Bacon 2005), other coffee regions in Mexico (Milford 2014; Luna and Wilson 2015; Arana-Coronado et al. 2019), and Rwanda (Mujawamariya et al. 2013). Furthermore, some coffee farmers claim that they do not join cooperatives due precisely to the inability of cooperatives to pay them fully at harvest time, which may increase the likelihood of cash shortness and additional financing. For example, 21% of non-cooperative farmers in our sample reported this as the main reason for not joining a cooperative. One possible implication of farmers receiving only partial payment is that they might need cash while waiting for the remaining payment and require working capital financing or another type of debt to operate or fulfill household needs. However, this study finds no evidence of farmer cash shortness caused by cooperative affiliation. Further investigation regarding the payment system of coffee cooperatives is encouraged since farmers believe this to be one of the relevant trade-offs to consider when deciding whether to affiliate with cooperatives or remain as non-cooperative farmers.

A couple of clarifications are necessary for a better interpretation of this result. This finding does not imply that coffee farmers will not benefit if coffee cooperatives improve the speed of the payment system. Cooperatives in the region should continuously look for strategies to improve their bargaining power to shorten the collection period from buyers and fully pay farmers quickly. Quicker payments are likely to benefit the coffee production process or the household families. Secondly, not having enough cash to operate during one production cycle does not imply that cooperative farmers receive lower payments, but rather that they receive cash later rather than

[5] Before the PSM procedure, the sample of cooperative and non-cooperatives differed across most variables, according to t-tests (untabulated).

sooner than non-cooperative farmers. Indeed, research has documented that coffee cooperative farmers obtain, on average better output (and input) prices than non-cooperative farmers selling to local buyers (Wollni and Zeller 2007).

Conclusions

This study analyzes samples of coffee cooperative affiliate farmers and non-cooperative farmers from the State of Veracruz, Mexico. First, we propose and test a farmer's cooperative affiliation model based on transaction cost economics theory. Next, based on the affiliation model, we evaluate whether the cooperative affiliation decision relates to farmers' cash shortness.

The affiliation model regression results indicate that TCE assets-specificity and control variables explain the coffee farmer's cooperative affiliation decision. The more dedicated or specialized the farmers are, the more likely they will become cooperative affiliates. This is in line with TCE's argument that agricultural cooperatives are hybrid business structures that can safeguard specialized assets from opportunistic behavior by transactional partners. While TCE is commonly used in cooperative farm studies, we are unaware of other study modeling the farmer's cooperative affiliation decision under the lens of TCE. Specifically, this study finds that shade-grown coffee plantations, off-farm income, coffee farming experience, low-level market competition, farmland size, altitude, and private farmland are statistically significant variables related to the coffee farmer's decision to affiliate with cooperatives. Our finding regarding two explanatory variables—farmland size and shade-grown coffee plantations—can be particularly relevant for policymakers, cooperative leaders, institutions providing extension services in the region, and scholars.

Farmland size positively influences the cooperative affiliation decision, but up to a certain point, farmland size negatively affects this decision. In other words, this finding supports the "middle-class effect in cooperatives" proposition by Bernard and Spielman (2009) and others, which predicts that very small and large farmers are less likely to affiliate with cooperatives than mid-size farmers. However, the middle-class effect for coffee growers in Veracruz, Mexico, may be problematic for the smallest—probably the poorest—coffee farmers if the cooperatives strategies (e.g., fairtrade certification or quality standards) intentionally or accidentally exclude these farmers from being cooperative affiliates. Such exclusion will preclude some small-scale farmers from obtaining better prices for their coffee beans, safeguarding their investments, or obtaining the side-benefits cooperatives provide, such as training or access to governmental resources.

Shade-grown coffee plantations and the farmer's cooperative affiliation decision are negatively related. This type of cultivation, related to high-quality coffee beans suitable for the specialty coffee market and to several environmental benefits, is prevalent in the region, with around one-third of farmers in our sample growing shade-grown coffee. Thus, it is important to understand why these farmers prefer not to take advantage of the benefits cooperatives may provide. This analysis argues that shade-grown coffee growers choose not to have their coffee bean's quality diluted in cooperatives that pool the cherry coffee from many plantations with heterogeneous quality. By preserving their coffee's high-quality, these farmers might sell their coffee to higher paying niches in the specialty coffee market. However, unless specialized buyers are available in the region offering these farmers better

terms, this may be problematic for shade-grown coffee farmers. By not selling through cooperatives, farmers forgo other benefits that cooperatives provide, and cooperatives forgo collecting coffees of the best quality. This finding is in line with the TCE theory predicting that agricultural cooperatives are hybrid organizational modes fulfilling intermediate specialized transactions but probably unable to fulfill *highly* specialized transactions at low transaction costs (Ménard and Valceschini 2005). Therefore, further investigation into the region's commercialization channels for shade-grown coffee is suggested.

It is documented in the literature on coffee that farmers do not affiliate with cooperatives because these organizations need to be more capable of paying farmers in full at harvest and purchasing time. It is believed that cooperatives' inability to pay farmers early increases the likelihood of farmers' cash shortness and their need for additional financing to operate or cover household needs. However, this study finds no evidence that the affiliation decision is related to the likelihood of farmers experiencing cash shortness around harvesting and selling time. While several studies have highlighted the importance of the payment system in cooperatives and this inability to pay farmers on time fully, this is the first paper that quantitatively evaluates the impact of the cooperative affiliation on cash shortness. Further investigation regarding the payment system of coffee cooperatives is encouraged since farmers believe this to be one of the relevant trade-offs to consider when deciding whether to join coffee cooperatives. 21% of non-cooperative farmers in our sample reported this as the main reason for not affiliating with a cooperative.

This study has some limitations, including the relatively small sample size and the fact that the organizations analyzed are fairtrade certified cooperatives, which restricts generalizing the results. Also, while our cooperative affiliation model is based on several asset-specificity variables, future research may include uncertainty TCE attributes. Regarding evaluating the economic impact of cooperative affiliation on cash shortness, one limitation is that we should have asked farmers for their actual cash holdings. Instead, we asked their perceptions regarding whether they typically experience cash shortness at harvesting and selling time. Finally, the study uses cross-sectional data, which, unlike panel data, does not allow to claim for strong causal relationships.

Author contributions

CTP conceptualized, prepared the draft of the manuscript, and led subsequent edits by the rest of the authors. CTP led the questionnaire preparation and RSJ led the data collection. ARD, RSJ, and CTP together discussed and ran the regression models in STATA. All authors read and approved the final manuscript.

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Availability of data and materials

Data can be made available to researchers trying to replicate this study, upon request to the authors.

Declarations

Competing interests

The authors declare no conflict of interest.

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References

Abate GT (2018) Drivers of agricultural cooperative formation and farmers' membership and patronage decisions in Ethiopia. J Coop Org Manag 6(2):53–63

Abebaw D, Haile M (2013) The impact of cooperatives on agricultural technology adoption: empirical evidence from Ethiopia. Food Policy 38:82–91. https://doi.org/10.1016/j.foodpol.2012.10.003

Ahmed M, Mesfin H (2017) The impact of agricultural cooperatives membership on the wellbeing of smallholder farmers: empirical evidence from Eastern Ethiopia. Agric Food Econ 5(1):6. https://doi.org/10.1186/s40100-017-0075-z

Arana-Coronado J, Trejo-Pech C, Velandia M, Peralta-Jimenez J (2019) Factors influencing organic and fair trade coffee growers level of engagement with cooperatives: the case of coffee farmers in Mexico. J Int Food Agribus Market 31(1):22–51. https://doi.org/10.1080/08974438.2018.1471637

Avelino J, Barboza B, Araya JC, Fonseca C, Davrieux F, Guyot B, Cilas C (2005) Effects of slope exposure, altitude and yield on coffee quality in two altitude terroirs of Costa Rica, Orosi and Santa Maria de Dota. J Sci Food Agric 85:1869–1876. https://doi.org/10.1002/jsfa.2188

Bacon C (2005) Confronting the coffee crisis: can fair trade, organic, and specialty coffees reduce small-scale farmer vulnerability in Northern Nicaragua? World Dev 33(3):497–511. https://doi.org/10.1016/j.worlddev.2004.10.002

Belsey D, Kuh E, Welsh R (1980) Regression Diagnostics: Identifying Influential Data and Sources of Collinearity. Wiley Series in Probability and Mathematical Statistics. John Wiley & Sons Inc, New York

Benmehaia M, Brabez F (2016) The propensity to cooperate among peasant farmers in Algeria: an analysis from bivariate approach. Int J Food Agric Econ (IJFAEC) 04(4):79–92

Bernard T, Spielman D (2009) Reaching the rural poor through rural producer organizations? A study of agricultural marketing cooperatives in Ethiopia. Food Policy Collect Action Smallhold Market Access 34(1):60–69. https://doi.org/10.1016/j.foodpol.2008.08.001

Besley T (1995) Property rights and investment incentives: theory and evidence from Ghana. J Polit Econ 103(5):903–937. https://doi.org/10.1086/262008

Bijman J, Wijers G (2019) Exploring the inclusiveness of producer cooperatives. Curr Opin Environ Sustain Sustain Sci Incl Bus A Multi-Stakehold Issue 41(December):74–79. https://doi.org/10.1016/j.cosust.2019.11.005

Bray J, Neilson J (2017) Reviewing the impacts of coffee certification programmes on smallholder livelihoods. Int J Biodivers Sci Ecosyst Serv Manag 13(1):216–232. https://doi.org/10.1080/21513732.2017.1316520

Castañeda-Dower P, Pfutze T (2013) Specificity of control: the case of Mexico's Ejido Reform. J Econ Behav Organ 91(July):13–33. https://doi.org/10.1016/j.jebo.2013.03.039

Ciliberti S, Frascarelli A, Martino G (2020) Drivers of participation in collective arrangements in the agri-food supply chain. Evidence from Italy using a transaction costs economics perspective. Ann Public Coop Econ 91(3):387–409. https://doi.org/10.1111/apce.12263

Dammert A, Mohan S (2014) A survey of the economics of fair trade. IZA Discussion Papers No. 8167:1–32

DeFries R, Fanzo J, Mondal P, Remans R, Wood S (2017) Is voluntary certification of tropical agricultural commodities achieving sustainability goals for small-scale producers? A review of the evidence. Environ Res Lett 12(3):033001. https://doi.org/10.1088/1748-9326/aa625e

Fairtrade International (2022) Choosing fairtrade coffee makes a difference. Choosing fairtrade coffee makes a difference. https://www.fairtrade.net/product/coffee.

Fisher E, Qaim M (2012) Linking smallholders to markets: determinants and impacts of farmer collective action in Kenya. World Dev 40(6):1255–1268. https://doi.org/10.1016/j.worlddev.2011.11.018

Francesconi GN, Heerink N (2010) Ethiopian agricultural cooperatives in an era of global commodity exchange: does organisational form matter? J Afr Econ 20(1):153–177. https://doi.org/10.1093/jae/ejq036

Fulton M (1999) Cooperatives and member commitment. Finn J Bus Econ 48(4):418–437

Fulton M, Giannakas K (2001) Organizational commitment in a mixed oligopoly: agricultural cooperatives and investor-owned firms. Am J Agr Econ 83(5):1258–1265. https://doi.org/10.1111/0002-9092.00276

Geeraert L, Berecha G, Honnay O, Aerts R (2019) Organoleptic quality of Ethiopian Arabica coffee deteriorates with increasing intensity of coffee forest management. J Environ Manag 231(February):282–288. https://doi.org/10.1016/j.jenvman.2018.10.037

Giacalone D, Fosgaard T, Steen I, Münchow M (2016) Quality does not sell itself': divergence between 'objective' product quality and preference for coffee in Naïve Consumers. Br Food J 118(10):2462–2474. https://doi.org/10.1108/BFJ-03-2016-0127

Grashuis J, Skevas T (2022) What is the benefit of membership in farm producer organizations? The case of coffee producers in Peru. Ann Public Coop Econ. https://doi.org/10.1111/apce.12390

Grashuis J, Su Y (2019) A review of the empirical literature on farmer cooperatives: performance, ownership and governance, finance, and member attitude. Ann Public Coop Econ 90(1):77–102. https://doi.org/10.1111/apce.12205

Hao J, Bijman J, Gardebroek C, Heerink N, Heijman W, Huo X (2018) Cooperative membership and farmers' choice of marketing channels—evidence from apple farmers in Shaanxi and Shandong Provinces, China. Food Policy 74(January):53–64. https://doi.org/10.1016/j.foodpol.2017.11.004

Hendrikse G, Bijman J (2002) On the emergence of new growers' associations: self-selection versus countervailing power. Eur Rev Agric Econ 29(2):255–269. https://doi.org/10.1093/eurrag/29.2.255

Hernandez-Martinez G, Vera-Espindola R, De La Rosa-Portilla A (2018) The coffee of Mexico. The richness of its regions, 1st edn. Cofecol, Mexico City

Hole A (2007) Fitting mixed logit models by using maximum simulated likelihood. Stand Genomic Sci 7(3):388–401

INEGI (2019) Instituto Nacional de Estadística, Geografía e Informática. Censo de Población y Vivienda 2010." Instituto Nacional de Estadística, Geografía e Informática. https://www.inegi.org.mx/sistemas/scitel/default?ev=5

International Coffee Organization (2021) Coffee Production by Exporting Countries." Trade Statistics Tables NA. International Coffee Organization. https://www.ico.org/trade_statistics.asp

Ito J, Bao Z, Su Q (2012) Distributional effects of agricultural cooperatives in China: exclusion of smallholders and potential gains on participation. Food Policy 37(6):700–709. https://doi.org/10.1016/j.foodpol.2012.07.009

Jezeer R, Verweij P (2015) Shade grown coffee—double dividend for biodiversity and small-scale coffee farmers in Peru. Hivos, The Hague
Jha S, Bacon C, Philpott S, Ernesto Méndez V, Läderach P, Rice R (2014) Shade coffee: update on a disappearing refuge for biodiversity. Bioscience 64(5):416–428. https://doi.org/10.1093/biosci/biu038
Ji C, Jin S, Wang H, Ye C (2019) Estimating effects of cooperative membership on farmers' safe production behaviors: evidence from pig sector in China. Food Policy 83:231–245
Jiménez-Ortega A, Aguilar Ibarra A, Galeana-Pizaña J, Núñez J (2022) Changes over time matter: a cycle of participatory sustainability assessment of organic coffee in Chiapas, Mexico. Sustainability 14(4):1–20. https://doi.org/10.3390/su14042012
Karantininis K (2007) The network form of the cooperative organization. In: Karantininis K, Nilsson J (eds) Vertical markets and cooperative hierarchies: the role of cooperatives in the agri-food industry. Springer, Dordrecht, pp 19–34
Larson B (2003) Eco-labels for credence attributes: the case of shade-grown coffee. Environ Dev Econ 8(3):529–547. https://doi.org/10.1017/S1355770X0300287
Loureiro ML, Lotade J (2005) Do fair trade and eco-labels in coffee wake up the consumer conscience? Ecol Econ 53(1):129–138. https://doi.org/10.1016/j.ecolecon.2004.11.002
Luna F, Wilson P (2015) An economic exploration of smallholder value chains: coffee transactions in Chiapas, Mexico. Int Food Agribus Manag Assoc 18(3):85–106
Ma W, Abdulai A (2017) The economic impacts of agricultural cooperatives on smallholder farmers in rural China. Agribusiness 33(4):537–551. https://doi.org/10.1002/agr.21522
Macher J, Richman B (2008) Transaction cost economics: an assessment of empirical research in the social sciences. Bus Polit 10(1):1–63. https://doi.org/10.2202/1469-3569.1210
Mandrekar J (2010) Receiver operating characteristic curve in diagnostic test assessment. J Thorac Oncol 5(9):1315–1316. https://doi.org/10.1097/JTO.0b013e3181ec173d
Masten S, Saussier S (2002) Econometrics of contracts: an assessment of developments in the empirical literature of contracting. The economics of contracts; theories and applications. Cambridge University Press, Cambridge, pp 273–293
Masten S (2000) Transaction-cost economics and the organization of agricultural transactions. In: Baye MR (ed.) Industrial organization. 9:173–95.
Meier F (2016) What determines women's participation in collective action? Evidence from a Western Ugandan coffee cooperative. Fem Econ 22(1):130–157. https://doi.org/10.1080/13545701.2015.1088960
Ménard C, Valceschini E (2005) New institutions for governing the agri-food industry. Eur Rev Agric Econ 32(3):421–440. https://doi.org/10.1093/eurrag/jbi013
Messer K, Kotchen M, Moore M (2000) Can shade-grown coffee help conserve tropical biodiversity? A market perspective. Endangere Species Update 17(6):125–125
Milford A (2014) Co-operative or coyote? Producers' choice between intermediary purchasers and fairtrade and organic co-operatives in Chiapas. Agric Hum Values 31:577–591. https://doi.org/10.1007/S10460-014-9502-X
Moguel P, Toledo V (1999) Biodiversity conservation in traditional coffee systems of Mexico. Conserv Biol 13(1):11–21. https://doi.org/10.1046/j.1523-1739.1999.97153.x
Mojo D, Fischer C, Degefa T (2016) Collective action and aspirations: the impact of cooperatives on Ethiopian coffee farmers' aspirations. Ann Public Coop Econ 87(2):217–238. https://doi.org/10.1111/apce.12103
Mojo D, Fischer C, Degefa T (2017) The determinants and economic impacts of membership in coffee farmer cooperatives: recent evidence from rural Ethiopia. J Rural Stud 50(February):84–94. https://doi.org/10.1016/j.jrurstud.2016.12.010
Morales Ramos V, Escamilla Prado E, Velásquez Morales J, Spinoso Castillo J (2021) Perfiles de Calidad Del Café de México. Biblioteca Básica de Agricultura. Fundación Colegio de Postgraduados en Ciencias Agrícolas, Texcoco
Morales-Ramos V, Escamilla-Prado E, Ruiz-Carbajal R, Pérez-Sato J, Velázquez-Morales J, Servín-Juárez R (2020) On the soil–bean–cup relationships in *Coffea Arabica* L. J Sci Food Agric 100(15):5434–5441
Morett-Sanchez J, Cossio-Ruiz C (2017) Outlook of Ejidos and Agrarian Communities in Mexico. Agricultura, Sociedad y Desarrollo 14:125–152
Mujawamariya G, D'Haese M, Speelman S (2013) Exploring double side-selling in cooperatives, case study of four coffee cooperatives in Rwanda. Food Policy 39(April):72–83. https://doi.org/10.1016/j.foodpol.2012.12.008
Mwambi M, Bijman J, Mshenga P (2020) Which type of producer organization is (more) inclusive? Dynamics of farmers' membership and participation in the decision-making process. Ann Public Coop Econ 91(2):213–236. https://doi.org/10.1111/apce.12269
Ortega D, Bro A, Clay D, Lopez M, Tuyisenge E, Church R, Bizoza A (2019) Cooperative membership and coffee productivity in Rwanda's specialty coffee sector. Food Secur 11(4):967–979. https://doi.org/10.1007/s12571-019-00952-9
Padron-Rodriguez B, Ruben R, Burger CPJ (2012) The driving forces and economic impact of co-operative membership: empirical evidence from the Mexican coffee sector. J Coop Stud 45(3):17–31
Pascucci S, Gardebroek C, Dries L (2012) Some like to join, others to deliver: an econometric analysis of farmers' relationships with agricultural co-operatives. Eur Rev Agric Econ 39(1):51–74. https://doi.org/10.1093/erae/jbr027
Priscilla L, Chauhan AK (2019) Economic impact of cooperative membership on dairy farmers in Manipur: a propensity score matching approach. Agric Econ Res Rev 32(1):117–123. https://doi.org/10.5958/0974-0279.2019.00010.7
Quiñones-Ruiz X (2020) The diverging understandings of quality by coffee chain actors—insights from Colombian producers and Austrian Roasters. Sustainability 12(15):6137. https://doi.org/10.3390/su12156137
Ruben R, Heras J (2012) Social capital, governance and performance of Ethiopian coffee cooperatives. Ann Public Coop Econ 83(4):463–484. https://doi.org/10.1111/j.1467-8292.2012.00473.x
Samoggia A, Riedel B (2018) Coffee consumption and purchasing behavior review: insights for further research. Appetite 129:70–81. https://doi.org/10.1016/j.appet.2018.07.002
Secretaría de Agricultura y Desarrollo Rural. 2019. "Sistema de Información Agroalimentaria de Consulta." Sistema de Información Agroalimentaria de Consulta. 2019. https://www.gob.mx/siap/documentos/siacon-ng-161430.

Servín-Juárez R, Trejo-Pech C, Pérez-Vásquez A, Reyes-Duarte A (2021) Specialty coffee shops in mexico: factors influencing the likelihood of purchasing high-quality coffee. Sustainability 13(7):3804. https://doi.org/10.3390/su13073804
Shumeta Z, D'Haese M (2016) Do coffee cooperatives benefit farmers? An exploration of heterogeneous impact of coffee cooperative membership in Southwest Ethiopia. Int Food Agribus Manag Rev 19(4):37–52
Thompson G, Wilson P (1994) Ejido reforms in Mexico: conceptual issues and potential outcomes. Land Econ 70(4):448–465
Toledo V, Moguel P (2012) Coffee and sustainability: the multiple values of traditional shaded coffee. J Sustain Agric 36(3):353–377. https://doi.org/10.1080/10440046.2011.583719
Tolessa K, D'heer J, Duchateau L, Boeckx P (2017) Influence of growing altitude, shade and harvest period on quality and biochemical composition of Ethiopian specialty coffee. J Sci Food Agric 97:2849–2857. https://doi.org/10.1002/jsfa.8114
Train K (2009) Discrete choice methods with simulation. Second. Cambridge University Press
Velandia M, Trejo-Pech C, Rodriguez-Padron B, Servín-Juárez R, Stripling C (2022) Challenges and managerial strategies of coffee cooperatives from the Huatusco region in Mexico: a leader's perspective. Agrociencia 56(8):1–16
Vogt M (2020) Developing stronger association between market value of coffee and functional biodiversity. J Environ Manag 269(September):110777. https://doi.org/10.1016/j.jenvman.2020.110777
Williamson O (1983) Markets and hierarchies: a study in the internal organizations. Free Press, New York, NY
Williamson O (2010) Transaction cost economics: the natural progression. Journal of Retailing, Special Issue of Journal of Retailing in Honor of The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2009 to Oliver E. Williamson, 86 (3):215–26. https://doi.org/10.1016/j.jretai.2010.07.005
Wollni M, Brümmer B (2012) Productive efficiency of specialty and conventional coffee farmers in Costa Rica: accounting for technological heterogeneity and self-selection. Food Policy 37(1):67–76. https://doi.org/10.1016/j.foodpol.2011.11.004
Wollni M, Zeller M (2007) Do farmers benefit from participating in specialty markets and cooperatives? The case of coffee marketing in Costa Rica1. Agric Econ 37(2–3):243–248. https://doi.org/10.1111/j.1574-0862.2007.00270.x
Worku M, Meulenaer B, Duchateau L, Boeckx P (2018) Effect of altitude on biochemical composition and quality of Green Arabica Coffee Beans can be affected by shade and Postharvest processing method. Food Res Int 205:278–285. https://doi.org/10.1016/j.foodres.2017.11.016
Wossen T, Abdoulaye T, Alene A, Haile M, Feleke S, Olanrewaju A, Manyong V (2017) Impacts of extension access and cooperative membership on technology adoption and household welfare. J Rural Stud 54(August):223–233. https://doi.org/10.1016/j.jrurstud.2017.06.022
Zeweld-Nugusse W, Van Huylenbroeck G, Buysse J (2013) Determinants of rural people to join cooperatives in Northern Ethiopia. Int J Soc Econ 40(12):1094–1107. https://doi.org/10.1108/IJSE-07-2012-0138
Zhang J, Wu J, Simpson J, Arthur CL (2019) Membership of Chinese farmer specialized cooperatives and direct subsidies for farmer households: a multi-province data study. Chin Econ. https://doi.org/10.1080/10971475.2019.1617928

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