

# Mergers of Consumer Cooperatives

Sina Khorasani

Owen Graduate School of Management, Vanderbilt University, sina.khorasani@vanderbilt.edu

Gizem Korpeoglu

Catolica Porto Business School, Universidade Catolica Portuguesa, ckorpeoglu@ucp.pt

**Problem definition:** Consumer cooperatives are consumer-owned and managed enterprises that aim to achieve buyer power and maximize their members' welfare. Recently, several cooperatives in major economies, such as the United Kingdom (UK), Italy, and Switzerland, have merged to increase their buyer power and provide lower prices for their members. We seek to understand how these mergers affect market outcomes and consumer welfare. **Methodology/results:** We build a game-theoretic model of a two-tier supply chain where multiple consumer cooperatives procure a product from a market on behalf of their member consumers. Multiple suppliers produce for this market and can increase their supply by incurring a scale-up cost. We show that mergers of cooperatives reduce the wholesale price, as intended. This enables consumers to allocate more of their income to purchasing other goods, which improves consumer welfare. However, the lower price also induces suppliers to reduce their production quantities, thereby causing each consumer to receive less of the supplied product, which reduces consumer welfare. We find that this underproduction is even more pronounced in industries with low scale-up costs. Thus, we show that mergers harm *all* consumers when the pre-merger number of cooperatives or the production scale-up cost is below a certain threshold. Otherwise, mergers benefit all consumers. We expand our results by considering horizontally and vertically differentiated cooperatives and show that our main results are robust. We also show that greater differentiation among cooperatives increases the benefit of mergers. **Managerial implications:** Mergers of cooperatives make a nuanced impact on consumer welfare due to their effect on wholesale prices and production incentives. Policymakers should maintain healthy competition among cooperatives to maximize consumer welfare, especially in markets with low production scale-up costs.

*Key words:* Cooperatives; Game Theory; Market Game; Supply Chain Management.

---

## 1. Introduction

Cooperatives are people-centered enterprises that are jointly owned and democratically managed by their members to realize their common economic, social, and cultural needs (ICA 2023). There are 3 million cooperatives in the world, and they represent at least 12% of the world population (ICA 2023). Cooperatives generate almost \$3 trillion in annual revenue and represent 4.3% of the world's GDP (UN 2014). There are three types of cooperatives depending on the economic role of their members. These are producer, worker, and consumer cooperatives. In this paper, we focus on consumer cooperatives that are formed and operated by their consumers to help them gain buyer power (the ability to influence prices) and ultimately maximize their welfare.

Consumer cooperatives make a substantial economic and societal impact (see, e.g., [Minaker et al. 2016](#), [Euro Coop 2023](#)). For instance, Coop Switzerland is the largest supermarket chain in Switzerland with 2.5 million members ([McHugh 2025](#)). Similarly, Coop Italia is the third largest supermarket chain in Italy with 6.4 million members ([Pekic 2025](#)), and the Cooperative Group is the sixth largest supermarket chain in the UK with over 5 million members ([ESM 2025](#)). These consumer-oriented cooperatives are grounded in the following principles:

“From the very beginning, the goal of the cooperative was to buy wholesale and resell at cost price to members, to protect consumers’ *purchasing power*” ([Coop Italia 2025](#)).

“For the Coop Group, the focus is on the consumers – the members of the cooperative. The company gears all its efforts to their [member-consumers’] needs. As a cooperative, the Coop Group *does not strive to maximize profits*” ([Coop Switzerland 2023](#)).

Consumer cooperatives often merge to increase their buyer power and provide lower prices for their members. For instance, in 2001, 14 Coop Societies in Switzerland merged with Coop Switzerland. Similarly, in 2002, the Co-operative Wholesale Society merged with the Co-operative Retail Services in the UK to form the Cooperative Group. More recently, in Italy, Coop Adriatica merged with Coop Veneto in 2014, merged with Coop Estense and Coop Northeast in 2016, and merged with Coop Sicilia and Coop Eridana in 2018 and operated as Coop Alleanza ([Coop Alleanza 2024](#)).

All these mergers not only affect the competition dynamics, but also influence suppliers’ production decisions and consumers’ membership decisions, leading to complex strategic interactions in supply chains. While it is expected for consumer cooperatives to increase their buyer power through mergers, it is unclear whether they can achieve their ultimate goal of maximizing consumer welfare. Therefore, we aim to understand how mergers of consumer cooperatives affect market outcomes and consumer welfare by factoring in production decisions of suppliers, membership decisions of consumers, and key forces of competition, such as seller power and buyer power ([Porter 1980](#)).

To this end, we build a game-theoretic model of the following two-tier supply chain. Multiple suppliers produce a product by incurring a (weakly) convex increasing production cost, capturing additional costs of scaling up production. Multiple consumer cooperatives procure this product for their member consumers. Consumers strategically choose which cooperative to join. To analyze the wholesale market between cooperatives and suppliers and to capture key forces of competition, we build on the market-game mechanism proposed by [Korpeoglu et al. \(2020\)](#). In our market game, each supplier chooses its production quantity to maximize its profit, and each cooperative determines its procurement budget by targeting a certain order quantity to maximize the average utility of its members. The wholesale price is determined by decisions of both suppliers and cooperatives.

To study mergers of cooperatives, we characterize and compare the unique equilibrium in each of the following two cases: i) the “pre-merger” case before mergers of cooperatives, and ii) the

“post-merger” case after mergers of (an arbitrary set of) cooperatives. We show that mergers of cooperatives lower the wholesale price by increasing cooperatives’ buyer power. Yet, anticipating this price reduction, suppliers reduce their production quantities to drive up the price and reduce their marginal costs. Thus, mergers of consumer cooperatives lead to a subtle tradeoff: each consumer receives less of the supplied product but has a higher leftover income to procure other goods. We show that the former effect dominates, and hence, mergers of cooperatives reduce consumer welfare when the pre-merger number of cooperatives or the production scale-up cost is below a certain threshold. In this case, consumers may benefit from policies that promote healthy competition among consumer cooperatives. On the other hand, mergers benefit all consumers when the post-merger number of consumer cooperatives or the production scale-up cost is sufficiently high. In this case, consumers may benefit from policies that reduce barriers for cooperatives to merge.

We further extend our results on several key dimensions and show that our main insights are robust. First, we consider horizontal differentiation among cooperatives where consumers have heterogeneous preferences about which cooperative fits them better and face “mismatch” costs when they join a cooperative that fits them poorly. Due to this mismatch cost, the merger enables the merged cooperatives to maintain a larger share of consumers than non-merged cooperatives. Regardless, the merger benefits consumers if and only if the production scale-up cost is above a certain threshold, where this threshold decreases with the mismatch cost.

Second, we consider a setting where mergers help the merged cooperatives vertically differentiate themselves from other cooperatives by offering a higher value to consumers (e.g., due to synergies in administration costs). We also factor in potential costs consumers incur when switching cooperatives. We show that vertical differentiation, as well as the switching cost, enables the merged cooperatives to maintain a larger share of consumers than other cooperatives. Yet, unless the merger provides a very high additional value to consumers, it harms them when the production scale-up cost is below a threshold. Even when the additional value is sufficient to increase the welfare of member consumers, the merger can still harm consumers who shop at other cooperatives.

Third, we consider competition between two cooperatives and a for-profit retailer and show that mergers of cooperatives can harm consumer welfare under low scale-up costs. Fourth, we consider a setting where suppliers enjoy decreasing marginal cost of production (i.e., scaling up production lowers the unit cost of production) and show that mergers of cooperatives harm consumer welfare. Finally, we show that our main results hold when we incorporate suppliers’ capacity constraints. In this case, a tight production capacity makes a similar impact as a high production scale-up cost.

Besides offering nuanced policy and managerial insights, our paper makes significant technical and conceptual contributions. We provide an equilibrium analysis of consumer cooperatives and their mergers by considering strategic interactions among consumers, cooperatives, and suppliers.

Our rich analysis incorporates realistic market features such as suppliers' seller power, cooperatives' buyer power, consumers' membership decisions, suppliers' production scale-up costs and capacity constraints, and cooperatives' (potential) horizontal and vertical differentiation. All these features help us uncover that *mergers of cooperatives that aim to promote their members' welfare may end up harming their members' welfare* (as well as other consumers' welfare). Our findings can help policymakers and cooperative managers gain insights into mergers of cooperatives.

## 2. Literature Review

Our paper relates to the literature on: i) competition in supply chains, ii) mergers in supply chains, iii) social responsibility in supply chains, iv) group purchasing and buying organizations, v) cooperatives, and vi) market games. We next discuss these literature streams and our contribution.

Our pre-merger analysis contributes to the literature on competition in supply chains with multiple suppliers and multiple retailers. This literature is concerned with quantity competition (e.g., [Corbett and Karmarkar 2001](#) and [Korpeoglu et al. 2020](#)), price competition (e.g., [Federgruen and Hu 2017](#) and [Arifoglu and Tang 2023](#)), and supply chain networks (e.g., [Bimpikis et al. 2019](#), [Nakkas and Xu 2019](#), and [Zhang et al. 2023](#)). We contribute to this literature by studying consumer cooperatives that engage in quantity competition, in the presence of strategic consumers and suppliers, by capturing cooperatives' buyer power and other players' incentives.

Our post-merger analysis contributes to the literature on mergers in supply chains. We focus on the literature that examines how mergers affect strategic interactions among supply chain players (e.g., [Cho 2014](#), [Cho and Wang 2017](#), and [Federgruen and Hu 2020](#)). The closest paper to ours is [Cho \(2014\)](#) who studies a horizontal merger of two profit-maximizing retailers, ignoring their buyer power and assuming exogenous demand functions. We contribute to this literature by studying mergers of member-welfare-maximizing consumer cooperatives by capturing their buyer power and considering endogenous demand. Our richer setup enables us to uncover a subtle tradeoff and generate new insights. In particular, [Cho \(2014\)](#) finds that horizontal mergers of downstream retailers lead to an increase in upstream prices, yet we show that mergers of cooperatives reduce the wholesale price. In [Cho \(2014\)](#), production can increase or decrease after a merger, whereas in our paper, production decreases after a merger because suppliers react to the lower wholesale price by reducing their production quantities. Analyzing this tradeoff between the lower wholesale price and reduced production, we identify two key factors that determine the impact of mergers on consumer welfare: the number of cooperatives in the market and the cost of scaling-up production.

Our paper is connected to the literature on social responsibility in supply chains. This literature focuses on auditing (e.g., [Privett and Erhun 2011](#) and [Zhang et al. 2022](#)) with some recent efforts to incorporate social responsibility into retail operations (e.g., [Korpeoglu et al. 2024](#) and [Hu et al.](#)

2024). Our paper contributes to this literature by studying member-welfare-maximizing consumer cooperatives and the impact of their mergers on consumer welfare.

Our paper relates to the extant literature on group purchasing organizations (GPOs). While this literature focuses on a single profit-maximizing GPO, we focus on multiple competing member-welfare-maximizing consumer cooperatives and their mergers. Both GPOs and mergers of cooperatives create value by increasing buyer power. Cooperatives reflect this value to their members by providing them with lower prices as they aim to maximize member welfare. On the other hand, we expect GPOs to capture most of this value, if not all, as they aim to maximize profits. Yet, GPOs may provide other benefits for their members. For example, [Saha et al. \(2019\)](#) show that a GPO enables its members to obtain critical pricing information that they would not obtain without a GPO. Our paper also relates to the small literature on group buying (e.g., [Hu et al. 2013](#)). While group buying requires the total number of committed purchases to exceed a certain threshold to make sales, we do not require such commitments to make sales. Moreover, the group-buying literature considers a profit-maximizing firm, whereas we consider member-welfare-maximizing consumer cooperatives and their mergers.

Our study contributes to the literature on cooperatives. Operations literature on cooperatives focuses on agricultural cooperatives (e.g., [Hendrikse 2011](#), [An et al. 2015](#), and [Qian and Olsen 2020](#)). While these papers study cooperatives on the supply side, we study cooperatives on the demand side and answer a different research question. There is also a small economics literature on consumer cooperatives (e.g., [Bekenstein 1943](#) and [Enke 1945](#)). Restricting attention to a single cooperative, this literature answers different research questions than ours, such as the optimal size of a consumer cooperative ([Anderson et al. 1979](#)), incentives to form a cooperative ([Sexton 1983](#)), and the cooperative entry decision in the presence of a for-profit retailer ([Sexton and Sexton 1987](#)). We contribute to this literature by studying mergers of consumer cooperatives in two-tier supply chains with an arbitrary number of cooperatives and suppliers and by capturing cooperatives' buyer power, suppliers' seller power, and consumers' strategic decisions of which cooperative to join. The importance of capturing these realistic features is evident in our results. For example, we show that mergers of consumer cooperatives may harm consumers because suppliers react to these mergers by reducing their production, and this underproduction may, in turn, harm consumers.

We model the wholesale market between cooperatives and suppliers using the market-game framework proposed by [Korpeoglu et al. \(2020\)](#) who adapt the market-game mechanism (e.g., [Shapley and Shubik 1977](#), [Dubey and Shubik 1977](#), and [Chen et al. 2017](#)) to study supply chains with multiple competing profit-maximizing retailers and multiple competing suppliers by assuming exogenous demand functions. We contribute to the market-game literature by studying member-welfare-maximizing consumer cooperatives and their mergers by considering strategic consumers, various production characteristics, and horizontally and vertically differentiated cooperatives.

### 3. Model

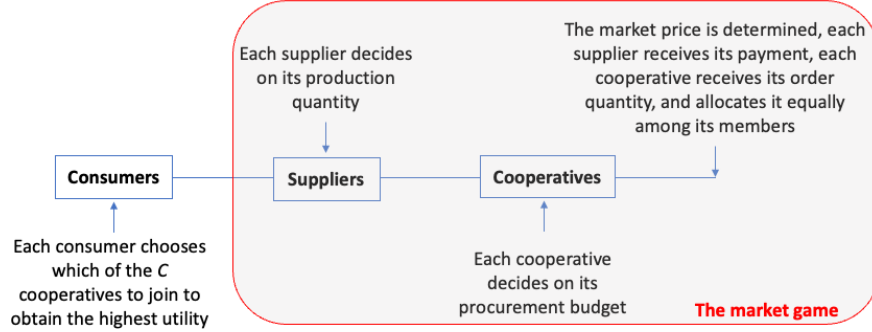
Consider a two-tier supply chain where  $C$  consumer cooperatives (hereafter, cooperatives) procure a product from  $S$  suppliers through a wholesale market on behalf of their member consumers. Following Tyagi (1999), Corbett and Karmarkar (2001), and Cho (2014), we assume that all suppliers, cooperatives, and consumers are identical before a merger. Below, we elaborate on our model of suppliers, consumers, and cooperatives. We then describe the game between these strategic players, and define the Nash equilibrium of this game.

**Suppliers.** Each supplier  $s \in \{1, 2, \dots, S\}$  produces and sells  $o_s$  units of output (hereafter, production quantity) and incurs a (weakly) convex increasing cost  $\psi(o_s) = ao_s^r$ , where  $a > 0$  and  $r \geq 1$ . Here,  $r$  represents the cost of scaling-up production, which allows the cost function to be linear or convex. A weakly convex cost function is supported by empirical evidence (e.g., Basu and Fernald 1997, Gao and Kehrig 2017), and it is commonly used in the literature (e.g., Cho 2014 and Bimpikis et al. 2019). We extend our main results to a general convex increasing cost  $\psi(o_s)$  in §7.1 and to a concave increasing cost  $\psi(o_s) = ao_s^r$ , where  $a > 0$  and  $r \in (0, 1)$  in §7.2. Each supplier  $s$  charges a wholesale price  $p$  for each unit it sells. Thus, supplier  $s$ 's profit  $\pi(o_s) = po_s - ao_s^r$ .

**Consumers.** There is a continuum of consumers with a measure normalized to 1. Each consumer is endowed with a fixed income  $I > \bar{I}$ , where  $\bar{I}$  is the minimal income necessary to ensure the existence of an equilibrium, and it is defined in the Appendix. As is common in the consumer theory and competitive markets literature, we assume that a consumer receives utility  $u(x)$  from consuming  $x$  units of the product procured from suppliers, and receives utility  $I - px$  from the remaining income by procuring other goods (cf., Mas-Colell et al. 1995). In our main model, we assume that  $u$  takes the commonly used isoelastic form  $u(x) = \gamma + \frac{1}{1-\theta} [x^{1-\theta} - 1]$ , for  $\theta \in (0, S) \setminus \{1\}$ , and  $u(x) = \gamma + \log(x)$ , for  $\theta = 1$ , and extend our main results to general concave increasing utility functions in §7.1. Here,  $\theta < S$  ensures positive production quantities in equilibrium. Consumers are strategic and choose which cooperative to join to obtain the highest utility.

**Cooperatives.** Let  $N_c$  denote the size of cooperative  $c \in \{1, 2, \dots, C\}$  after consumers choose cooperatives. Each cooperative  $c$  places an order  $q_c$  (hereafter, order quantity) and pays  $b_c$  (hereafter, procurement budget) to procure the supplied product. Each cooperative aims to maximize the average utility of its members and allocates its order quantity equally among its members. Thus, the utility of a consumer in cooperative  $c$ ,  $U_c = \gamma + \frac{1}{1-\theta} \left[ \left( \frac{q_c}{N_c} \right)^{1-\theta} - 1 \right] + I - \frac{b_c}{N_c}$ . We let  $\gamma$  capture administrative and operational costs and potential gains from joining a cooperative. In §6, we analyze the case where mergers lead to synergies and economies of scale, which vertically differentiate the merged cooperative from others, and also consider consumers' costs of switching cooperatives.

**The game.** Consumers begin the game by choosing their cooperatives. Then, suppliers and cooperatives play a sub-game where the wholesale price  $p$  is determined. For this sub-game, we build on



**Figure 1** The sequence of events.

the market-game framework developed in Korpeoglu et al. (2020), as it captures all salient forces of competition, including each supplier's seller power and each cooperative's buyer power.

In the market game, the price  $p$  is equal to the ratio of the total procurement budget  $B = \sum_{c=1}^C b_c$  to the total production quantity  $O = \sum_{s=1}^S o_s$ :

$$p \equiv \frac{B}{O} = \frac{\sum_{c=1}^C b_c}{\sum_{s=1}^S o_s}. \quad (1)$$

Thus, the price increases with procurement budgets and decreases with production quantities. A cooperative  $c$ 's order quantity  $q_c$  equals the ratio of its procurement budget  $b_c$  to the price  $p$ :

$$q_c = \frac{b_c}{p} = \frac{b_c}{B} O = \frac{b_c}{b_c + B_{-c}} O, \quad (2)$$

where  $B_{-c}$  denotes the total procurement budget of all cooperatives except cooperative  $c$ . Similarly,  $O_{-s}$  denotes the total production quantity of all suppliers except supplier  $s$ . Solving (2) for  $b_c$  yields  $b_c = \frac{q_c B_{-c}}{O - q_c}$ , which is increasing in  $q_c$ . Thus, for any given  $B_{-c}$  and  $O$ , there is a one-to-one mapping between a cooperative  $c$ 's order quantity  $q_c$  and procurement budget  $b_c$ , so we can represent cooperative  $c$ 's decision in terms of its procurement budget  $b_c$ . Finally, the market between suppliers and cooperatives clears as the total order quantity equals the total production quantity:

$$Q = \sum_{c=1}^C q_c = \sum_{c=1}^C \frac{b_c}{B} O = O = \sum_{s=1}^S o_s. \quad (3)$$

As is common in the supply-chain literature, we model the sub-game between suppliers and cooperatives as a two-stage Stackelberg game where suppliers move first (e.g., Corbett and Karmarkar 2001, Cho 2014, and Korpeoglu et al. 2020). We verify that all of our results hold when suppliers and cooperatives move simultaneously.

Figure 1 depicts the sequence of events as follows. The game starts with  $C$  cooperatives, each containing an infinitesimally small measure of loyal members. These loyal members can be the consumers who formed the cooperative and remain in it. This assumption enables us to focus on equilibria with  $C$  cooperatives, each with a strictly positive size. We take the (arbitrary) number of cooperatives  $C$  as exogenous because the formation of cooperatives is a longer-term decision

compared to membership, production, and procurement decisions. Instead, we analyze the impact of a change in  $C$  on market outcomes and consumer welfare through mergers of cooperatives.

In the first stage of the game, each consumer chooses which cooperative to join. In the second stage, each supplier decides on its production quantity by considering its impact on the wholesale price. In the third stage, each cooperative determines its procurement budget by targeting a certain order quantity and by considering its impact on the wholesale price. At the end of the third stage, the wholesale price is determined based on these procurement budgets and production quantities, each supplier receives its payment, each cooperative receives its order quantity, and allocates its order quantity equally among its members.

**The Nash equilibrium.** We derive the (unique) pure-strategy Nash equilibrium using backward induction. For this, we first define each cooperative's and each supplier's optimization problem, and derive their best-response functions. We then present an equilibrium condition for consumers' choice of cooperatives. For the rest of the paper, we use “ $\widehat{\phantom{x}}$ ” to denote equilibrium values and best-response functions. For example,  $\widehat{b}_c$  denotes cooperative  $c$ 's equilibrium procurement budget, and  $\widehat{o}_s$  denotes supplier  $s$ 's equilibrium production quantity. Given the total equilibrium procurement budget  $\widehat{B}_{-c}$  of other cooperatives and the total equilibrium production quantity  $\widehat{O}$ , each cooperative  $c$  chooses its procurement budget  $b_c \in [0, N_c I]$  to maximize the average utility of its members:

$$U_c = \gamma + \frac{1}{1-\theta} \left[ \left( \frac{q_c}{N_c} \right)^{1-\theta} - 1 \right] + I - \frac{b_c}{N_c} = \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N_c} \frac{b_c}{b_c + \widehat{B}_{-c}} \widehat{O} \right)^{1-\theta} - 1 \right] + I - \frac{b_c}{N_c}, \quad (4)$$

where the second equality stems from  $q_c = \frac{b_c}{b_c + \widehat{B}_{-c}} \widehat{O}$ . Given the total equilibrium production quantity  $\widehat{O}_{-s}$  of other suppliers and the anticipated (best-response) total procurement budget  $\widehat{B}$ , each supplier  $s$  chooses its production quantity  $o_s$  to maximize its profit:

$$\pi_s = p o_s - a o_s^r = \frac{o_s \widehat{B}}{o_s + \widehat{O}_{-s}} - a o_s^r, \quad (5)$$

where  $\widehat{B}$  is a function of  $o_s$  and the second equality stems from  $p = \frac{\widehat{B}}{o_s + \widehat{O}_{-s}}$ .

Given the best-response functions of cooperatives and suppliers, any equilibrium must be such that no consumer can be better off by moving to a different cooperative. Thus, the equilibrium measure of consumers in each cooperative is determined such that  $\widehat{U}_c = \widehat{U}_1$  for all  $c \in \{2, 3, \dots, C\}$  as any difference between  $U_c$  values leads some consumers to unilaterally switch their cooperatives.

## 4. Equilibrium Analysis of Cooperatives

In §4.1, we characterize the unique equilibrium of the game presented in §3. This is the “pre-merger” equilibrium before cooperatives merge. Then, in §4.2, we analyze the “post-merger” equilibrium after cooperatives merge, and identify conditions under which mergers benefit or harm consumers.

#### 4.1. Pre-Merger Analysis

The following proposition characterizes the unique equilibrium of the game presented in §3.

PROPOSITION 1. *The pre-merger market game has a unique pure-strategy Nash equilibrium. In equilibrium, each cooperative contains  $1/C$  measure of consumers, and uses the procurement budget*

$$\hat{b} = \frac{C-1}{C^2} (S\hat{\delta})^{1-\theta}, \quad (6)$$

*each supplier sells the production quantity*

$$\hat{\delta} = \left[ \frac{C-1}{C(ra)} S^{-\theta-1} (S-\theta) \right]^{\frac{1}{\theta-1}}, \quad (7)$$

*and the wholesale price  $\hat{p} = C\hat{b}/(S\hat{\delta})$ .*

Note from (7) that our assumption  $\theta < S$  ensures a strictly positive production quantity in equilibrium. Proposition 1 has two important implications. First, in equilibrium, each cooperative has  $1/C$  members. Thus, cooperatives are identical in the pre-merger equilibrium, because all cooperatives offer the same value to their members. The second implication is that suppliers' and cooperatives' equilibrium decisions are symmetric in the unique equilibrium. This result will come in handy when we compare the pre-merger and post-merger cases in the next section.

#### 4.2. Post-Merger Analysis

In this section, we present and analyze our post-merger setting to examine the impact of mergers of cooperatives on consumers. As discussed in §1, cooperatives merge to increase their buyer power and secure more favorable prices for their member consumers with the aim of increasing their welfare. We next analyze whether and when this outcome is attainable, particularly when accounting for strategic interactions of consumers, cooperatives, and suppliers.

To gradually build intuition on how strategic consumers react to mergers of cooperatives, we present our analysis in three steps. In step 1 (§4.2.1), we analyze the situation immediately after any two cooperatives merge before consumers switch between cooperatives. This helps us isolate and examine the interim effect of heterogeneity in cooperative sizes post-merger to determine whether a merger can leverage its larger consumer base to deliver a higher utility to its members than other cooperatives. We then use this interim analysis to examine consumers' switching decisions between cooperatives post-merger. In step 2 (§4.2.2), we characterize the unique post-merger equilibrium after consumers complete their switching. In step 3 (§4.2.3), we analyze the impact of mergers on equilibrium outcomes and consumer welfare.

**4.2.1. The interim effect of a merger before consumer switching.** Recall that the pre-merger equilibrium consists of  $C$  cooperatives, each with size  $1/C$ . Consider a market in which cooperatives 1 and 2 merge and compete with  $C-2$  (for  $C \geq 3$ ) other cooperatives to procure the

supplied product. Let  $c_{12}$  denote the merged cooperative with the goal of maximizing the average utility of its  $N_{c_{12}} = 2/C$  measure of consumers by choosing  $b_{c_{12}}$ , as follows:

$$\begin{aligned} U_{c_{12}} &= \gamma + \frac{1}{1-\theta} \left[ \left( \frac{q_{c_{12}}}{N_{c_{12}}} \right)^{1-\theta} - 1 \right] + I - \frac{b_{c_{12}}}{N_{c_{12}}} \\ &= \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N_{c_{12}}} \frac{b_{c_{12}}}{b_{c_{12}} + \hat{B}_{-c_{12}}} \hat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{b_{c_{12}}}{N_{c_{12}}}, \end{aligned} \quad (8)$$

where subscript  $m$  represents post-merger equilibrium outcomes. We aim to characterize the market-game equilibrium before any consumers switch between cooperatives and compare the utility of a consumer in the merged cooperative ( $c_{12}$ ) with that in a non-merged one ( $c_{-12}$ ). The following proposition characterizes the unique post-merger equilibrium without any consumer switching.

**PROPOSITION 2.** (i) Let  $\eta \in \left( \frac{1}{2}, \left( \frac{1}{2} \right)^{\frac{\theta}{1+\theta}} \right]$  be the unique solution to  $1 + (C-3)\eta - (C-2)\eta(2\eta)^\theta = 0$ . The post-merger market game before consumers switch cooperatives has a unique pure-strategy Nash equilibrium where each supplier sells the symmetric production quantity

$$\hat{o}_m = \left[ \left( \frac{C\eta}{1+(C-2)\eta} \right)^{-\theta} \frac{1+(C-3)\eta}{1+(C-2)\eta} \frac{1}{ar} S^{-\theta-1} (S-\theta) \right]^{\frac{1}{r+\theta-1}}, \quad (9)$$

each non-merged cooperative  $c \in \{3, 4, \dots, C\}$  uses the same procurement budget  $\hat{b}_m = \frac{\eta}{1+(C-2)\eta} \hat{B}_m$ , and the merged cooperative  $c_{12}$  uses budget  $\hat{b}_{c_{12}} = \frac{1}{1+(C-2)\eta} \hat{B}_m$ , where the total procurement budget

$$\hat{B}_m = \left( \frac{C\eta}{1+(C-2)\eta} \right)^{-\theta} \frac{1+(C-3)\eta}{1+(C-2)\eta} \hat{O}_m^{1-\theta}, \quad (10)$$

and the wholesale price  $\hat{p}_m = \frac{\hat{B}_m}{S\hat{o}_m}$ .

(ii) Furthermore, the utility of a consumer in the merged cooperative is strictly lower than that in a non-merged cooperative.

Proposition 2(i) characterizes the unique interim post-merger equilibrium before consumers switch cooperatives. Similar to the pre-merger case, suppliers' equilibrium production quantities are symmetric. Yet, cooperatives' procurement budgets are asymmetric. The merged cooperative adopts a different strategy considering its size advantage, while others play symmetric strategies.

Proposition 2(ii) offers insights into how incentives of cooperatives change in the presence of heterogeneity in their sizes after cooperatives 1 and 2 merge. Due to competing with smaller-sized cooperatives post-merger, the merged cooperative finds it optimal to spend less procurement budget per consumer compared to the pre-merger case (i.e.,  $\frac{\hat{b}_{c_{12}}}{N_{c_{12}}} < C\hat{b}$ ). This decision accomplishes the intended effect of driving down the wholesale price. However, smaller cooperatives do not have as much reduction in their procurement budgets per consumer post-merger (i.e.,  $\frac{C}{2}\hat{b}_{c_{12}} < C\hat{b}_m$  since  $\eta > \frac{1}{2}$  in equilibrium), so the price does not decrease as much as the merged cooperative intended. Because the merged cooperative spends a significantly lower procurement budget per

consumer with a relatively smaller decrease in price, each consumer in the merged cooperative ends up receiving significantly less of the supplied product. Hence, savings from the lower procurement budget do not offset the utility loss from consuming significantly less of the supplied product. Consequently, consumers in the merged cooperative receive a strictly lower utility than consumers in other cooperatives. This nuanced result explains why strategic consumers have incentives to switch from the merged cooperative to non-merged cooperatives. We next examine the post-merger equilibrium after consumers' strategic switching decisions.

**4.2.2. The equilibrium after merger(s).** We now present one of the two main theorems of this section, which characterizes the unique post-merger equilibrium. For this result, we do not restrict attention to the merger of two cooperatives, but instead consider an arbitrary collection of mergers, after which  $\tilde{C} < C$  cooperatives operate in the post-merger market.

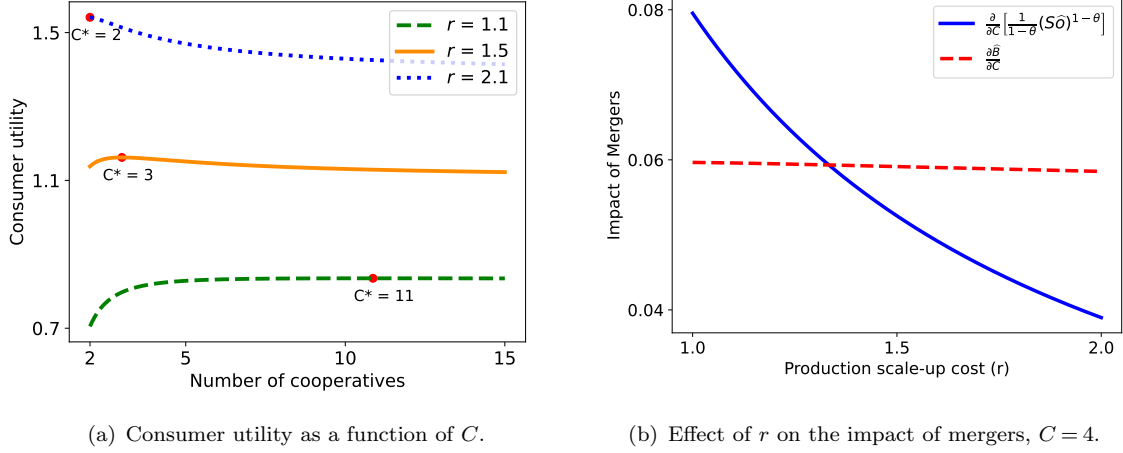
**THEOREM 1.** *Every post-merger market game with  $\tilde{C} \geq 2$  cooperatives admits a unique pure-strategy Nash equilibrium in which each cooperative contains  $1/\tilde{C}$  measure of consumers, and the market outcomes are determined as in Proposition 1.*

Theorem 1 shows that the unique post-merger equilibrium comprises equal-sized cooperatives after consumers strategically choose their utility-maximizing cooperatives. The intuition behind this result follows from Proposition 2(ii), where we show that heterogeneity in cooperative sizes leads to asymmetric procurement budgets, and hence the utility of a consumer in the merged cooperative is strictly lower than that in a non-merged cooperative. As a result, consumers in the merged cooperative move to non-merged cooperatives until they have the same size. In other words, the only equilibrium structure that eliminates profitable deviations for consumers is the homogeneous one with equal-sized cooperatives. We thus conclude that after any collection of mergers, the post-merger market is homogeneous in cooperative sizes – similar to the pre-merger market – but with fewer cooperatives. We exploit this result to examine the impact of mergers next.

**4.2.3. The impact of mergers.** So far, we have established that mergers lead to a smaller number of equal-sized cooperatives in the supply chain. Thus, in this section, we analyze how equilibrium outcomes and consumer utility change with the number of cooperatives. The following proposition presents comparative statistics on the equilibrium outcomes based on (6) and (7).

**PROPOSITION 3.** *The total procurement budget  $\hat{B}$ , the total production quantity  $\hat{O}$ , and the wholesale price  $\hat{p}$  are increasing in the number of cooperatives  $C$ .*

The intuition of Proposition 3 is as follows. When more cooperatives compete to procure the supplied product, each cooperative has less buyer power (i.e., the power to influence the price). Hence, each cooperative increases its procurement budget per consumer to preserve the amount



**Figure 2** (a) The optimal number of cooperatives  $C^*$  is non-increasing in the production scale-up cost  $r$ . (b) A higher scale-up cost diminishes  $\frac{\partial \frac{1}{1-\theta} (S\hat{\sigma})^{1-\theta}}{\partial C}$  more than  $\frac{\partial \hat{B}}{\partial C}$ . Setting:  $S = 5$ ,  $\theta = 1.1$ ,  $I = \gamma = a = 1$ .

of the supplied product per consumer. This leads to a higher total procurement budget  $\hat{B}$ . To get a larger share from  $\hat{B}$ , each supplier increases its production quantity, leading to a larger total production quantity  $\hat{O}$ . Yet, the total production quantity  $\hat{O}$  does not increase as much as the total procurement budget  $\hat{B}$ , so the equilibrium price  $\hat{p} = \frac{\hat{B}}{\hat{O}}$  increases with the number of cooperatives  $C$ . On the flip side, as  $C$  decreases due to mergers, each cooperative's buyer power increases, and hence, the equilibrium price decreases. We emphasize this expected result below.

REMARK 1. Mergers of cooperatives always reduce the equilibrium price.

Equilibrium predictions in Proposition 3 are consistent with empirical evidence. Fee and Thomas (2004) and Bhattacharyya and Nain (2011) show that horizontal mergers of downstream firms (such as cooperatives) lead to higher buyer power and lower wholesale prices. OECD (2008) corroborates that higher buyer power leads to lower wholesale prices and smaller quantities.

Proposition 3 highlights that a reduced number of cooperatives due to mergers has two opposing effects on consumer utility. On one hand, a smaller production quantity by suppliers decreases the consumption of the supplied product per consumer. On the other hand, a lower procurement budget per consumer increases the leftover income for other goods. Our next theorem builds on this tradeoff, and shows how consumer utility changes with the number of cooperatives  $C$ .

THEOREM 2. *There exists  $C^*$  such that  $\frac{d\hat{U}_c}{dC} > 0$  for all  $C < C^*$  and  $\frac{d\hat{U}_c}{dC} < 0$  for all  $C > C^*$ . In particular, given a production scale-up cost  $r \geq 1$ , the optimal number of cooperatives  $C^* = \max\{\frac{r}{r-1}, 2\}$ . Therefore, for any set of mergers among  $C$  cooperatives that end up in  $\tilde{C}$  cooperatives, consumer utility is higher (respectively, lower) post-merger if  $C^* \leq \tilde{C} < C$  (resp.,  $\tilde{C} < C \leq C^*$ ).*

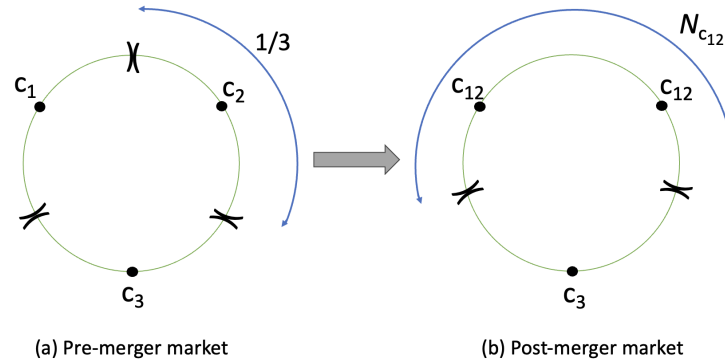
Theorem 2 shows that consumer utility is unimodal in the number of cooperatives as depicted in Figure 2(a). This is because mergers lead to a tradeoff between higher leftover income for other

goods (due to a lower price) and less consumption of the supplied product (due to underproduction). The effect of underproduction is more pronounced and may reduce consumer welfare when the pre-merger number of cooperatives is below a certain threshold. Therefore, cooperatives that aim to improve their members' welfare via mergers may end up reducing their members' welfare (as well as the welfare of consumers who shop at other cooperatives) in equilibrium.

Theorem 2 also indicates that the optimal number of cooperatives  $C^*$  is non-increasing in the production scale-up cost  $r$ ; see Figure 2(a). When scaling up production is very costly ( $r \geq 2$ ), mergers of cooperatives always benefit consumers. This is because a higher scale-up cost diminishes the merger's effect on reducing the utility derived from suppliers' production (i.e.,  $\frac{\partial \frac{1}{1-\theta}(S\hat{\sigma})^{1-\theta}}{\partial C}$ ) more than it diminishes the merger's effect on improving leftover income for other goods due to a lower price (i.e.,  $\frac{\partial \hat{B}}{\partial C}$ ); see Figure 2(b). In contrast, when scaling up production is not very costly, the effect of underproduction is prominent, and hence consumer welfare is maximized at  $C^* > 2$ .

We conclude this section with a few remarks. Our model predictions align with the observed practice that cooperatives merge to increase their buyer power and secure lower prices for their members. Yet, we identify a subtle tradeoff between reduced prices and underproduction. When the *post-merger* number of cooperatives is above a certain threshold, the benefit from reduced prices outweighs the disutility from underproduction, so mergers benefit consumers. In contrast, when the *pre-merger* number of cooperatives is below the threshold, mergers will harm consumers due to the substantial disutility from underproduction. This result underscores the importance of healthy competition among member-welfare-maximizing cooperatives when factoring in their buyer power.

Our result is particularly interesting when we contrast it with Cho (2014)'s result that mergers of profit-maximizing retailers always benefit all retailers. While both studies examine the impact of downstream mergers in supply chains, they differ significantly in the market structure and objectives of supply chain players. Cho (2014) considers profit-maximizing retailers that engage in Cournot competition in the retail market. After a merger, retailers achieve a higher profit share by charging consumers higher retail prices and hence extracting a larger consumer surplus. Cho (2014) employs the Cournot framework to model the wholesale market as well, where retailers have no direct influence on the wholesale price. As a result, Cho (2014) finds that mergers of retailers lead to an increase in the wholesale price. In our paper, consumer cooperatives maximize the welfare of their member consumers, so they have no incentive to reduce consumer surplus or maximize profits. We employ the market-game framework to model the wholesale market as it captures each supplier's seller power and each cooperative's buyer power. We show that mergers of cooperatives reduce prices but may not improve the welfare of their members.



**Figure 3** Market configuration in the pre-merger and post-merger equilibrium with horizontal differentiation.

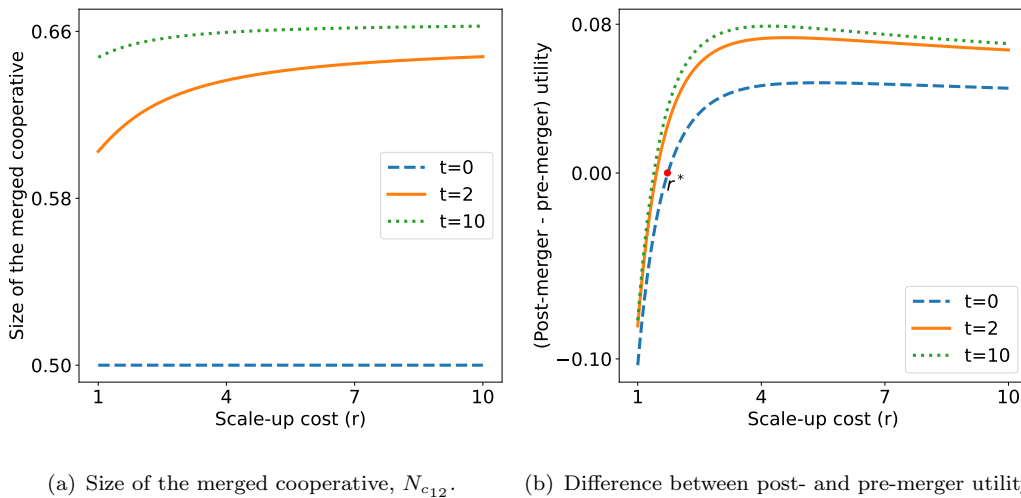
## 5. Cooperatives with Horizontal Differentiation

So far, we have assumed that cooperatives are identical before consumers join them, and shown that such a market admits a unique homogeneous equilibrium with equal-sized cooperatives. In this section, we extend our model to capture horizontal differentiation among cooperatives. Specifically, consumers may have different preferences about which cooperatives fit them better in terms of factors such as the location or mission of the cooperative.

To factor in horizontally differentiated preferences of consumers, we assume that  $C$  cooperatives in our supply chain are located equidistantly from each other along the circumference of a Salop's circle with a perimeter equal to one (Salop 1979). (Salop's circular model is widely used as an extension of Hotelling's linear model to capture horizontal differentiation of more than two products or firms. See, Jerath et al. 2016 for a recent application to retailing.) Consumers of measure one are uniformly distributed along the circumference of this circle. A consumer's utility is maximized if they join a cooperative at the same location as them. A consumer incurs a "mismatch cost"  $t > 0$  per unit distance between their location and their cooperative's location. Thus, the utility of a consumer in cooperative  $c$ , located at a distance  $d \geq 0$  from the consumer, is  $U_c = \gamma + \frac{1}{1-\theta} \left[ \left( \frac{q_c}{N_c} \right)^{1-\theta} - 1 \right] + I - \frac{b_c}{N_c} - td$ . All other model primitives, including objective and cost functions, are as in §3. Consumers are strategic and choose to join a cooperative that maximizes their utility in equilibrium. Below, we characterize the unique equilibrium of the pre-merger market with mismatch costs.

**PROPOSITION 4.** *The pre-merger market game with  $C (\geq 2)$  horizontally differentiated cooperatives admits a unique pure-strategy Nash equilibrium in which each cooperative contains  $1/C$  measure of consumers, and the market outcomes are determined as in Proposition 1.*

The intuition of this result follows from the intuition of Proposition 1. Given that cooperatives are evenly distributed along the perimeter of our circular market, the resulting equilibrium is unique and homogeneous in the size of cooperatives. Figure 3(a) illustrates the equilibrium configuration.



**Figure 4** Impact of scale-up and mismatch costs on merger outcomes. **Setting:**  $S = 5$ ,  $a = 1$ ,  $C = 3$ ,  $\theta = 2$ .

We are interested in uncovering the impact of mergers among horizontally differentiated cooperatives on strategic consumers. To this end, we consider a post-merger setting where cooperatives 1 and 2 merge and form cooperative  $c_{12}$  to jointly maximize their members' utility without altering their positions in the circular market; see Figure 3(b). To simplify the analysis without loss of generality, we present our post-merger results for the case of  $C = 3$  cooperatives. (Our analysis and insights can be extended to cases, where  $C > 3$ .) In this case, consumers who were initially located between  $c_1$  and  $c_3$  or between  $c_2$  and  $c_3$  should now decide whether to join cooperative  $c_{12}$  or  $c_3$ . The following theorem characterizes the unique post-merger equilibrium, and compares consumer utility in the pre-merger and post-merger cases.

**THEOREM 3.** (i) *If consumers incur per-unit-distance mismatch cost  $t > 0$ , the post-merger market admits a unique pure-strategy Nash equilibrium in which  $N_{c_{12}} \in (\frac{1}{2}, \frac{2}{3})$  measure of consumers join the merged cooperative  $c_{12}$  while the remaining consumers join the non-merged cooperative  $c_3$ , where  $N_{c_{12}}$  solves (EC.15) in the Online Appendix. The symmetric production quantity of each supplier is determined by (EC.14), and the total procurement budget of cooperatives is determined by (EC.13) in the Online Appendix. Furthermore,  $N_{c_{12}}$  increases with the mismatch cost  $t$ .*

(ii) *There exists  $r^* \in (1, \infty)$  such that mergers of cooperatives harm consumers if and only if the production scale-up cost  $r < r^*$ , where  $r^*$  decreases with the mismatch cost  $t$ .*

Theorem 3 provides several key managerial insights and extends the scope of our theory of cooperatives. First, we show that heterogeneity in cooperative sizes may emerge in equilibrium if cooperatives are horizontally differentiated. Second, in the presence of mismatch costs, the merged cooperative contains a larger measure of consumers than the non-merged cooperative (i.e.,  $N_{c_{12}} > \frac{1}{2}$ ), where this size advantage increases with  $t$ . However, the merged cooperative can only maintain

a consumer base less than the sum of the merging cooperatives' sizes in the pre-merger equilibrium (i.e.,  $N_{c_{12}} < \frac{2}{3}$ ). Figure 4(a) illustrates these insights given  $r$ . Third, and most importantly, we show that our main results are still valid when mergers lead to heterogeneity in cooperative sizes in equilibrium. Specifically, we prove that consumers benefit from mergers if and only if the production scale-up cost  $r$  is greater than a threshold  $r^*$ . This echoes Theorem 2, which implies that, consumer utility is higher post-merger if and only if  $r \geq \frac{C}{C-1}$ . This threshold (i.e.,  $r^* = 1.5$ ) is depicted in Figure 4(b) for the case of  $C = 3$  under a zero mismatch cost  $t = 0$ .

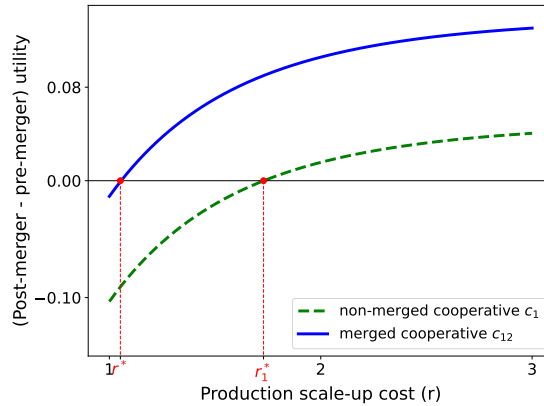
Theorem 3 further shows that the threshold  $r^*$  decreases with the mismatch cost  $t$ ; see Figure 4(b). The intuition is as follows. As the mismatch cost increases, more consumers prefer to stay with the merged cooperative rather than switching to the non-merged cooperative. This post-merger heterogeneity in sizes softens the intensity of competition among cooperatives. Thus, the mismatch cost reduces the decrease in cooperatives' procurement budgets per consumer, which reduces suppliers' underproduction after the merger. Thus, a higher  $t$  mitigates the effect of underproduction caused by a lower  $r$ , so it reduces the threshold  $r^*$ . As it turns out, there is some complementarity between scale-up and mismatch costs in the sense that they both strengthen the benefit of mergers.

## 6. Mergers Leading to Vertical Differentiation and Consumer Switching Costs

In this section, we consider the case where mergers lead to vertical differentiation among cooperatives. Suppose that each cooperative has a pre-merger vertical value  $v$ , which can be positive or negative. For example,  $v$  can be a cooperative's pre-merger transaction cost, which takes a negative value. To keep our analysis focused on the impact of mergers, we assume that each cooperative has the same pre-merger vertical value  $v$ . Thus, the pre-merger utility of a consumer in cooperative  $c$ ,  $U_c = \gamma + \frac{1}{1-\theta} \left[ \left( \frac{g_c}{N_c} \right)^{1-\theta} - 1 \right] + I - \frac{b_c}{N_c} + v$ . When cooperatives 1 and 2 merge as in §4.2, the vertical value of the merged cooperative increases to  $v_M$  (consistent with Cho 2014) due to factors such as economies of scale and potential synergies arising from enhanced capabilities, which vertically differentiate the merged cooperative from others. We assume that  $\Delta v \equiv v_M - v$  is below a threshold  $\bar{v}$  to ensure that non-merged cooperatives are operational after the merger.

To further enrich our framework in this section and capture a broader range of real-world applications, we assume that each consumer incurs a switching cost  $\alpha \geq 0$  if they choose to join another cooperative post-merger (e.g., by paying an additional membership fee to the new cooperative).

Because there is no differentiation in the pre-merger game, the pre-merger equilibrium is as in Proposition 1. We next present the post-merger equilibrium and conditions under which mergers benefit or harm consumers. As in §5, we focus on the case where  $C = 3$ , and cooperatives 1 and 2 merge without loss of generality. Our analysis and insights can be extended to cases with  $C > 3$ .



**Figure 5** Impact of scale-up and switching costs and vertical differentiation on merger outcomes. Setting:  $S = 5$ ,  $a = 1$ ,  $C = 3$ ,  $\theta = 2$ ,  $\Delta v = 0.8$ ,  $\alpha = 0.09$ .

**THEOREM 4.** (i) Suppose consumers derive vertical value  $v_M$  from the merged cooperative,  $v$  from other cooperatives, and incur a switching cost  $\alpha$  for changing membership post-merger. Let  $\Delta U$  be as in (EC.18) in the Online Appendix. The post-merger market admits a unique pure-strategy Nash equilibrium in which  $N_{c_{12}}$  measure of consumers join the merged cooperative  $c_{12}$ , and the remaining consumers join the non-merged cooperative  $c_3$ , where  $N_{c_{12}} \in (\frac{1}{2}, \frac{2}{3})$  if  $\Delta v < \Delta U - \alpha$ ,  $N_{c_{12}} = \frac{2}{3}$  if  $\Delta v \in [\Delta U - \alpha, \Delta U + \alpha]$ , and  $N_{c_{12}} \in (\frac{2}{3}, 1)$  if  $\Delta v \in (\Delta U + \alpha, \bar{v})$ . The symmetric production quantity of each supplier is determined by (EC.14), and the total procurement budget of cooperatives is determined by (EC.13) in the Online Appendix. Moreover,  $N_{c_{12}}$  increases with the vertical value difference  $\Delta v$ , and increases (decreases) with switching cost  $\alpha$  if  $\Delta v < \Delta U - \alpha$  ( $> \Delta U + \alpha$ ).

(ii) There exists a threshold  $v^*$  such that for any  $\Delta v < v^* + \alpha$ , there exists  $r^* \in (1, \infty)$  where mergers of cooperatives harm their member consumers if and only if the production scale-up cost  $r < r^*$ . Furthermore,  $r^*$  is decreasing in  $\Delta v$ .

(iii) When  $N_{c_{12}} \in (\frac{2}{3}, 1)$  post-merger ( $\Delta v \in (\Delta U + \alpha, \bar{v})$ ), there exists a region  $(r^*, r_1^*)$  where a merger benefits its members but harms the members of the non-merged cooperative.

Recall from Proposition 2(ii) that without the additional value  $\Delta v$  the merger generates, consumer utility in the non-merged cooperative is strictly higher than that in the merged cooperative, immediately after cooperatives merge, before consumer switching. Let  $\Delta U$  capture this utility difference. To understand the switching decisions of consumers after the merger, we should compare this utility difference with  $\Delta v$  and consumers' switching cost  $\alpha$ . When  $\Delta v < \Delta U - \alpha$ , consumers switch from the merged cooperative to the non-merged one until the switching cost makes any additional consumer indifferent to changing membership. The opposite pattern occurs when  $\Delta v > \Delta U + \alpha$ , and no switching occurs when  $\Delta v \in [\Delta U - \alpha, \Delta U + \alpha]$ .

Theorem 4(i) characterizes cooperative sizes in the post-merger equilibrium and shows that the merged cooperative maintains a larger size than the non-merged cooperative, and that its size

advantage increases with the additional value  $\Delta v$  the merger creates. Theorem 4(ii) verifies that our results are robust in the case of vertically differentiated cooperatives post-merger, even when consumers incur a switching cost. That is, unless the merger generates a very high additional vertical value  $\Delta v$  ( $> v^* + \alpha$ ), mergers are detrimental to all consumers in industries with low scale-up costs. These results are similar in spirit to Theorem 3 and have a similar intuition.

Theorem 4(iii) shows that when the merger leads to a substantial additional value (i.e.,  $\Delta v \in (\Delta U + \alpha, \bar{v})$ ) and the production scale-up cost is moderate ( $r \in (r^*, r_1^*)$ ), the merger benefits its members but harms the members of other cooperatives; see Figure 5. The intuition stems from two effects. First, when  $r \in (r^*, r_1^*)$ , the merger would harm all consumers without the additional value  $\Delta v$  the merger brings to its members. Owing to  $\Delta v$ , the merger benefits members of the merged cooperative. However, the merger harms members of the non-merged cooperative, as they cannot switch to the merged cooperative due to switching costs. Therefore, mergers of cooperatives may impose negative externalities on members of non-merged cooperatives once consumer switching costs are taken into account. This result reinforces our insight that policymakers should design effective regulations to promote healthy competition among cooperatives.

## 7. Extensions and Robustness Checks

Here, we consider and analyze three extensions that demonstrate the robustness of our findings.

### 7.1. General Utility and Cost Functions

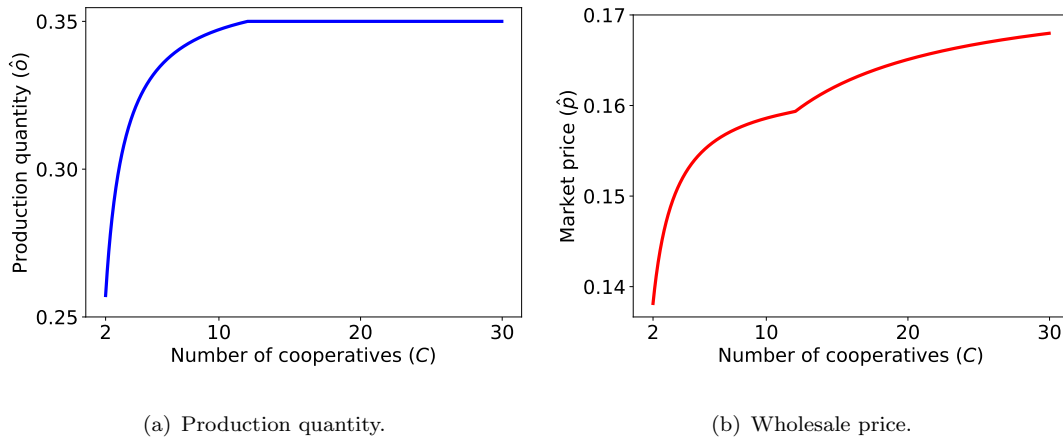
In this section, we extend our results to a more general setup. In particular, we assume each supplier  $s$  produces and sells  $o_s$  units of output and incurs a convex increasing cost  $\psi(o_s)$ . We also consider each supplier  $s$  faces a capacity constraint that restricts its production quantity  $o_s$  to a capacity  $\kappa$  (i.e.,  $o_s \leq \kappa$ ). On the consumer side, each consumer in cooperative  $c$  receives concave increasing utility  $u(\cdot)$  from consuming the supplied product and linear utility from the remaining income. We abstract away from consumers' cooperative selection and let  $N = 1/C$  be the size of each cooperative. Thus, the utility of a consumer in cooperative  $c$ ,  $U_c = u(\frac{q_c}{N}) + I - \frac{b_c}{N}$ . All other model primitives are as in §3. We first show the existence, uniqueness, and symmetry of a pure-strategy Nash equilibrium and characterize its parameters. To guarantee existence, we assume in this section that  $\psi''(o_s) \geq \underline{\psi}_1$  and  $\psi'''(o_s) \geq \underline{\psi}_2$ , where  $\underline{\psi}_1$  and  $\underline{\psi}_2$  are given in the Online Appendix.

**PROPOSITION 5.** *The general market game has a unique pure-strategy Nash equilibrium, which is symmetric. In equilibrium, each cooperative uses the procurement budget*

$$\hat{b} = \frac{C-1}{C^2} u'(S\hat{o}) S\hat{o}, \quad (11)$$

*and each supplier sells the production quantity*

$$\hat{o} = \begin{cases} \tilde{o} & \text{if } \tilde{o} < \kappa, \\ \kappa & \text{if } \tilde{o} \geq \kappa, \end{cases} \quad (12)$$



**Figure 6** Equilibrium production quantity  $\hat{o}$  and market price  $\hat{p}$  as a function of the number of cooperatives  $C$ .  
**Setting:**  $\kappa = 0.35$ ,  $S = 5$ ,  $u(q) = \gamma - \exp(-q)$ ,  $\psi(o) = \exp(0.1o)$ .

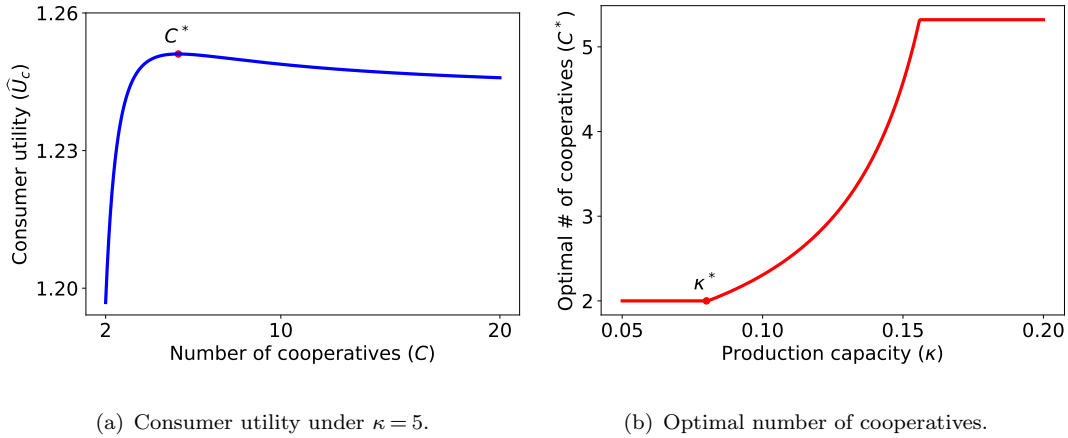
where  $\tilde{o}$  is the unique solution to  $\frac{C-1}{C} [u'(S\tilde{o}) + \tilde{o}u''(S\tilde{o})] = \psi'(\tilde{o})$ . Also, the price  $\hat{p} = C\hat{b}/(S\tilde{o})$ .

The characterizing equation for  $\tilde{o}$  indicates that suppliers have sufficient incentives to produce a strictly positive production quantity in equilibrium if and only if  $\frac{C-1}{C}u'(0) > \psi'(0)$  and  $-\frac{\tilde{o}u''(S\tilde{o})}{u'(S\tilde{o})} < 1$ . We assume these conditions hold to ensure positive production. (These conditions are satisfied in our base model in §3 when  $\theta < S$ .) Proposition 5 also characterizes the condition under which the production capacity constraint is binding. Using the above proposition, we examine how the number of cooperatives affects equilibrium outcomes.

**PROPOSITION 6.** *The uncapacitated production quantity  $\tilde{o}$  is increasing, the equilibrium production quantity  $\hat{o}$  is non-decreasing, and the price  $\hat{p}$  is increasing in the number of cooperatives  $C$ .*

Proposition 6 states that the uncapacitated production quantity  $\tilde{o}$  is increasing in the number of cooperatives  $C$ . The intuition is as in §4. A larger number of cooperatives intensifies competition, reduces each cooperative's buyer power, and induces them to increase their procurement budgets per consumer. Anticipating this increase in the total procurement budget, each supplier wishes to increase its production quantity in equilibrium. Yet, the production quantity is capped by the capacity  $\kappa$ . Thus, the equilibrium production quantity  $\hat{o}$  is increasing in  $C$  when the capacity constraint is not binding, and  $\hat{o} = \kappa$  is constant in  $C$  otherwise; see Figure 6(a).

Figure 6(b) highlights the role of cooperatives' buyer power in changing the wholesale price. A larger number of cooperatives reduces each cooperative's buyer power, thereby driving the wholesale price up. In contrast, when the number of cooperatives decreases through mergers, each cooperative's buyer power increases, and hence cooperatives secure lower prices for their members. This result is consistent with our finding in §4 and with the observed practice.



**Figure 7** Setting:  $S = 5$ ,  $I = 1$ ,  $u(q) = 1 - \exp(-q)$ ,  $\psi(o) = \exp(0.3o)$ .

Given these observations, cooperatives face a similar tradeoff as in §4 when merging. Mergers of cooperatives increase their buyer power and drive down the price of the supplied product. This enables consumers to enjoy a higher leftover income to procure other goods. However, suppliers respond to the lower price by reducing their production quantities, thereby reducing the quantity of the supplied product each consumer receives. Due to this tradeoff, consumer utility is unimodal in the number of cooperatives  $C$ . We formally show this result in Theorem 5 below.

**THEOREM 5.** (i) *There exists  $C^*$  such that  $\frac{d\hat{U}_C}{dC} > 0$  for all  $C < C^*$  and  $\frac{d\hat{U}_C}{dC} < 0$  for all  $C > C^*$ . (ii)  $C^*$  is non-decreasing in the production capacity  $\kappa$ . Furthermore, there exists  $\kappa^*$  such that when  $\kappa < \kappa^*$ , consumer utility is decreasing in  $C$ .*

Theorem 5(i) generalizes Theorem 2, which shows that consumer utility is maximized at the optimal number of cooperatives  $C^*$ ; see Figure 7(a), where  $C^* \approx 5$ . When the pre-merger number of cooperatives is below the threshold  $C^*$ , mergers of cooperatives lead to a substantial decrease in the total production quantity, which in turn harms consumer welfare. However, when the post-merger number of cooperatives is above  $C^*$ , mergers enhance consumer welfare by driving down the price through increased buyer power.

Theorem 5(ii) shows that the optimal number of cooperatives  $C^*$  is non-decreasing in the production capacity  $\kappa$ ; see Figure 7(b). Indeed, when the capacity constraint is very tight (low  $\kappa$ ), suppliers always produce at full capacity, and mergers benefit consumers by lowering prices without causing underproduction. As the capacity constraint increases, production quantity becomes unconstrained for low values of  $C$ . However, by Proposition 6, as  $C$  increases, production again hits the capacity limit. Figure 7(b) illustrates that, for some intermediate range, the optimal number of cooperatives happens at the point where  $\hat{o} = \kappa$  and so  $C^*$  increases with  $\kappa$ . Finally, beyond a certain point (around  $\kappa = 0.16$  in Figure 7(b)), the optimal number of cooperatives that maximizes

consumer utility ( $C^* \approx 5$ ) happens before the equilibrium production quantity reaches its upper bound and hence is unaffected by  $\kappa$ . Theorem 5 echoes the previous insights and generalizes our findings by showing that consumers benefit from healthy competition among cooperatives in industries that do not operate under capacity limitations, yet consumers always benefit from mergers of cooperatives in industries where production capacities are restricted.

## 7.2. Economies of Scale and Decreasing Marginal Cost of Production

Several industries in practice exhibit economies of scale, that is, the average cost of production decreases with the production quantity. The most prominent reason for economies of scale is that fixed costs spread over a larger production quantity as the production quantity increases (Carlton and Perloff 2015, p 60-62). We can incorporate such economies of scale into our model by adding a fixed cost to the production function. We verify that including such a fixed cost has no bearing on the equilibrium characterizations as long as all suppliers make positive profits in equilibrium. Thus, our results remain valid for industries that exhibit economies of scale.

Besides economies of scale, in some industries, the marginal cost of production may decrease as the production quantity increases. In this section, we extend our results to such industries by considering a concave increasing cost  $\psi(o_s) = ao_s^r$ , where  $a > 0$  and  $r \in (0, 1)$ . All other model primitives are as in §3. As we show in §EC.1.1 of the Online Appendix, we need to make a mild regulatory assumption  $\theta \in ((1 - r)S, S)$  to ensure the existence of an equilibrium where suppliers make positive profits. (If this assumption is violated, there may be settings where production quantities are zero or unbounded. Notice that this condition boils down to  $\theta < S$  for  $r \geq 1$  as in our base model.) Under this condition, we show that all of our equilibrium characterizations in §4 hold, and we extend Theorem 2 as follows.

**THEOREM 6.** *The unique symmetric pre-merger and post-merger equilibria under decreasing marginal cost of production take the form in Proposition 1 and Theorem 1, respectively. In this setting, mergers of cooperatives always harm consumers.*

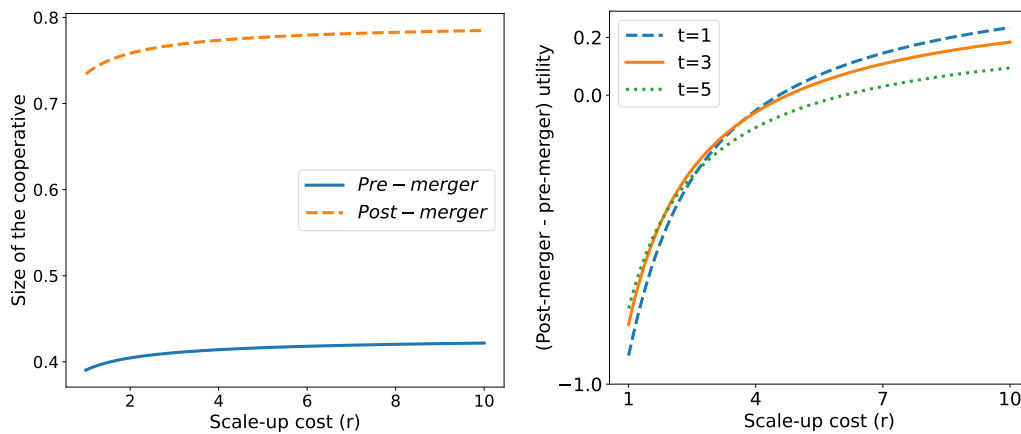
Theorem 6 shows the robustness of our results in cases where suppliers face a concave increasing cost function. First, it establishes that the market outcomes in Proposition 1 form the unique symmetric equilibrium in this setting. Second, it states that consumer utility increases with the number of cooperatives (or decreases with mergers) – a result consistent with our observation in the case of constant marginal cost of production (i.e.,  $r = 1$ ), where the optimal number of cooperatives  $C^* \rightarrow \infty$  as determined in Theorem 2. Finally, the intuition of this result is based on the same two forces: underproduction and the change in the wholesale price due to mergers. When fewer cooperatives compete to procure the supplied product after mergers, the total procurement budget decreases, and suppliers react to that by reducing their production quantities. However, in contrast

to our base model, the reduction in production quantities under a concave cost is higher than the reduction in procurement budgets, so the wholesale price increases after mergers. Thus, both forces reduce the welfare of member consumers because they now consume less of the supplied product at a higher price. Our results suggest that maintaining healthy competition among cooperatives is even more critical in industries that exhibit a decreasing marginal cost of production.

### 7.3. Downstream Competition with a For-Profit Retailer

In this section, we identify conditions under which mergers of cooperatives benefit or harm consumers in the presence of a for-profit retailer (hereafter, retailer). To gain sharper insights into how competition between cooperatives and the retailer changes strategic interactions among supply chain players, we extend our results in §5 by analyzing a supply chain where  $C = 2$  cooperatives and one retailer procure a product from  $S$  suppliers. In particular, we assume that the retailer and two cooperatives are located equidistantly from each other along the circumference of a Salop's circle with a perimeter equal to one. We thus alter the setup in §5 by replacing a cooperative with a retailer to compare the results with Theorem 3. This way, we can capture horizontally differentiated preferences of consumers in joining a cooperative or buying from the retailer by incurring a per-unit distance mismatch cost  $t > 0$ . The retailer chooses its procurement budget  $b_f$  to procure a certain order quantity  $q_f$  and charges a retail price  $p_f$ , so the retailer's profit  $\pi_f = (p_f - p)q_f$ , where  $p$  is the wholesale price. As before, the wholesale market between suppliers (sellers) and cooperatives and the retailer (buyers) clears such that  $Q = q_f + \sum_{c=1}^C q_c = O = \sum_{s=1}^S o_s$  and  $p = \frac{B}{O} = \frac{b_f + \sum_{c=1}^C b_c}{\sum_{s=1}^S o_s}$ . All other model primitives, including utility and cost functions, are as in §5.

To examine the robustness of our results in this setting, we first characterize the equilibrium outcomes, including the wholesale price, production quantities, procurement budgets, cooperative sizes, and the retailer's aggregate demand before and after the merger of two cooperatives in §EC.1.2 of the Online Appendix. We then conduct a rigorous numerical analysis using 10,000 random instances of  $(\theta, t, S, a)$  to compare the average utility of member-consumers who shop at cooperatives in the pre-merger and post-merger equilibria. In particular, we randomly generate these parameters and verify that *in all of these 10,000 instances*, mergers of cooperatives harm member consumers if and only if the production scale-up cost  $r$  is below a certain threshold – consistent with our finding in Theorem 3(ii). We describe the details of the random number generation process in §EC.1.2. Figure 8(b) illustrates the results of our analysis for one such instance. In addition, Figure 8(a) highlights that cooperatives can attract a larger share of consumers compared to a for-profit retailer due to their non-profit structure, and this size advantage increases with  $r$ . However, consistent with our findings in Theorem 3(i), the size of the merged cooperative is less than twice the size of an individual cooperative before the merger.



(a) Pre- vs. post-merger cooperative sizes,  $t = 10$ . (b) Difference between post- and pre-merger utility.

**Figure 8** Impact of scale-up cost on merger outcomes. **Setting:**  $S = 5$ ,  $a = 1$ ,  $C = 2$ ,  $\theta = 0.8$ , and one retailer.

## 8. Conclusion

Consumer cooperatives make a substantial economic impact as they constitute some of the largest retail chains in the world and serve tens of millions of consumers. Consumer cooperatives aim to achieve buyer power and ultimately maximize their members' welfare. To achieve these goals, to increase their buyer power, and reduce wholesale prices, consumer cooperatives often merge. For instance, several major economies such as Italy, Switzerland, and the UK have witnessed mergers of major cooperatives since the turn of the millennium. Regulators, such as the Competition Authorities, the European Commission, and the Federal Trade Commission, oversee these mergers. However, there has been no reported case in the US or Europe where a merger of consumer cooperatives has been subject to merger-enforcement actions. This observation has motivated us to study the impact of mergers among consumer cooperatives on consumer welfare.

To study this problem, we build a two-tier supply chain model with multiple suppliers facing scale-up costs and multiple cooperatives aiming to maximize their member-consumers' welfare. Consumers act strategically in choosing their welfare-maximizing cooperative. Using the market-game mechanism that incorporates both suppliers' seller power and cooperatives' buyer power in determining the wholesale price, we investigate how mergers of cooperatives influence strategic decisions of suppliers, cooperatives, and consumers, and ultimately affect consumer welfare.

We find that although mergers of cooperatives increase buyer power and drive down the wholesale price as intended, they may end up reducing consumer welfare when the pre-merger number of cooperatives or the production scale-up cost is below a certain threshold. This is because the higher buyer power after the merger induces suppliers to reduce their production quantities. This underproduction is more pronounced when there are a few cooperatives or the production scale-up cost is low. Indeed, under decreasing marginal cost of production, we find that mergers of

cooperatives always harm consumers. However, underproduction is less detrimental to consumer welfare when there are many cooperatives or the production scale-up cost is high. In this case, mergers benefit consumers through lower prices and higher leftover income to procure other goods.

We also expand our analysis in several important dimensions. First, we consider horizontal differentiation among consumer cooperatives, such that strategic consumers incur a mismatch cost depending on how different a cooperative is from their “ideal” position. This model helps us capture factors such as locational convenience or societal contributions that may make different cooperatives more appealing to different consumers. We show that the merger helps cooperatives span a larger group of members than non-merged cooperatives in equilibrium. Importantly, our key result still holds: mergers of cooperatives reduce consumer welfare when the scale-up cost is below a certain threshold. We further show that this threshold is decreasing in the mismatch cost. Second, we consider vertical differentiation, where the merged cooperative provides additional value to its members due to factors such as cost synergies. The additional value helps the merged cooperative attract more members in equilibrium, even when consumers incur a switching cost. However, unless the additional value is very high, mergers of cooperatives still reduce consumer welfare when the production scale-up cost is below a certain threshold, where this threshold decreases with the additional value of the merger. Even if the merger benefits members of the merged cooperative, it can harm members of other cooperatives due to switching costs. Third, we verify that our main results remain valid when suppliers face capacity constraints, and show that a tight capacity has the same directional effect as a high production scale-up cost. Finally, we show that our results continue to hold in the presence of a for-profit retailer in the supply chain.

Our theory of cooperatives provides clear guidelines for cooperative managers (board members) and policymakers about when to facilitate or restrict cooperative mergers by considering two parameters: the number of cooperatives in the market and the cost of scaling-up production. Our results can guide cooperative managers in advancing their members’ welfare and inform policymakers to design effective antitrust regulations that promote healthy competition among cooperatives.

To obtain sharper insights and as a first step toward studying cooperative mergers, we have made some modeling choices. Expanding our work or considering other models could lead to interesting future research directions. First, we have considered identical suppliers for tractability, yet it might be of interest to extend our results to heterogeneous suppliers. Second, we assume that cooperatives can gauge their members’ preferences. Although this assumption is reasonable as long as cooperatives are managed by a healthy and representative portion of their members, it may be harder to achieve when cooperatives are very large. Thus, an interesting direction for future research is to analyze a case where cooperatives have some uncertainty about their members’ preferences. We conjecture that our main results would be directionally the same, but considering such uncertainty

may lead to other interesting dynamics and new research questions. Finally, although we focus on the main objective of consumer cooperatives, maximizing their members' welfare, cooperatives may have other objectives, such as supporting local suppliers and improving sustainable retail practices. Considering these alternative objectives can be an interesting direction for future research.

## References

- An, J., S.-H. Cho, C. S. Tang. 2015. Aggregating smallholder farmers in emerging economies. *Production and Operations Management* **24**(9) 1414–1429.
- Anderson, R.K., P.K. Porter, S.C. Maurice. 1979. The economics of consumer-managed firms. *Southern Economic Journal* **46**(1) 119–130.
- Arifoglu, K., C.S. Tang. 2023. Luxury brand licensing: Competition and reference group effects. *Production and Operations Management* **32**(10) 3227–3245.
- Basu, S., J. G. Fernald. 1997. Returns to scale in US production: Estimates and implications. *Journal of Political Economy* **105**(2) 249–283.
- Bekenstein, A.L. 1943. A theoretical analysis of consumer cooperatives: The managerial problem. *Journal of Political Economy* **51**(3) 251–257.
- Bhattacharyya, S., A. Nain. 2011. Horizontal acquisitions and buying power: A product market analysis. *Journal of Financial Economics* **99**(1) 97–115.
- Bimpikis, K., S. Ehsani, R. Ilklic. 2019. Cournot competition in networked markets. *Management Science* **65**(6) 2467–2481.
- Carlton, D.W., J.M. Perloff. 2015. *Modern Industrial Organization*. Pearson Education Limited, England.
- Chen, G., C. G. Korpeoglu, S. E. Spear. 2017. Price stickiness and markup variations in market games. *Journal of Mathematical Economics* **72** 95–103.
- Cho, S.-H. 2014. Horizontal mergers in multi-tier decentralized supply chains. *Management Science* **60**(2) 356–379.
- Cho, S.-H., X. Wang. 2017. Newsvendor mergers. *Management Science* **63**(2) 298–316.
- Coop Alleanza. 2024. History and values of coop alleanza 3.0 <https://www.coopalleanza3-0.it/cooperativa/coop-alleanza-30/storia.html>. Accessed on 6 June 2024.
- Coop Italia. 2025. Who we are. <https://coopitalianfood.com/who-we-are/>. Accessed on July 23 2025.
- Coop Switzerland. 2023. Strategy. [https://report.coop.ch/pdfs/Coop\\_GB\\_23\\_Strategie\\_en\\_33cca946ee.pdf](https://report.coop.ch/pdfs/Coop_GB_23_Strategie_en_33cca946ee.pdf). Accessed on July 23 2025.
- Corbett, C., U. Karmarkar. 2001. Competition and structure in serial supply chains with deterministic demand. *Management Science* **47**(7) 966–978.
- Dubey, P., M. Shubik. 1977. A closed economic system with production and exchange modelled as a game of strategy. *Journal of Mathematical Economics* **4** 253–287.

- Enke, S. 1945. Consumer cooperatives and economic efficiency. *American Economic Review* **35**(1) 148–155.
- ESM. 2025. Top 10 supermarket retail chains in the UK. <https://www.esmmagazine.com/retail/top-10-supermarket-chains-in-the-uk-231802>. Accessed on July 23 2025.
- Euro Coop. 2023. Consumer coops: Sustainability frontrunners in times of crisis [https://mcusercontent.com/d2fed8e841f96a9b3de885aae/files/855d0044-a8ca-b103-90ff-cbccad2fdaf3/Euro\\_Coop\\_seminar\\_report.pdf](https://mcusercontent.com/d2fed8e841f96a9b3de885aae/files/855d0044-a8ca-b103-90ff-cbccad2fdaf3/Euro_Coop_seminar_report.pdf). Accessed on 17 February 2024.
- Federgruen, A., M. Hu. 2017. Competition in multi-echelon systems. *INFORMS Tutorials in Operations Research* 178–211.
- Federgruen, A., M. Hu. 2020. The price and variety effects of vertical mergers. Working Paper.
- Fee, C. E., S. Thomas. 2004. Sources of gains in horizontal mergers: evidence from customer, supplier, and rival firms. *Journal of Financial Economics* **74**(3) 423–460.
- Fudenberg, D., J. Tirole. 1991. *Game Theory*. MIT Press, Cambridge, MA.
- Gao, W., M. Kehrig. 2017. Returns to scale, productivity and competition: Empirical evidence from US manufacturing and construction establishments. Working paper.
- Hendrikse, G. 2011. Pooling, access, and countervailing power in channel governance. *Management Science* **57**(9) 1692–1702.
- Hu, C., M. Hu, Y. Xiao. 2024. Socially responsible newsvendor. Working Paper.
- Hu, M., M. Shi, J. Wu. 2013. Simultaneous vs. sequential group-buying mechanisms. *Management Science* **59**(12) 2805–2822.
- ICA. 2023. Cooperatives are building a better world <https://ica.coop/en>. Accessed on 28 May 2024.
- ICA. 2023. World cooperative monitor [https://monitor.coop/sites/default/files/2024-01/wcm\\_2023\\_3101.pdf](https://monitor.coop/sites/default/files/2024-01/wcm_2023_3101.pdf). Accessed on 24 May 2024.
- Jerath, K., S. Sajeesh, Z.J. Zhang. 2016. A model of unorganized and organized retailing in emerging economies. *Marketing Science* **35**(5) 756–778.
- Korpeoglu, C. G., E. Korpeoglu, S.-H. Cho. 2020. Supply chain competition: A market game approach. *Management Science* **66**(12) 5648–5664.
- Korpeoglu, C. G., E. Korpeoglu, C. S. Tang, J. J. Yu. 2024. Should an incumbent store deter entry of a socially responsible retailer? *Production and Operations Management* 1–21.
- Mas-Colell, A., M.D. Whinston, J.R. Green. 1995. *Microeconomic Theory*. Oxford Press, New York.
- McHugh, R. 2025. Top 10 supermarket retail chains in Switzerland. <https://www.esmmagazine.com/retail/top-10-supermarket-retail-chains-in-switzerland-238497>. Accessed on July 23 2025.
- Minaker, L. M., D. L. Olstad, M. E. Thompson, K. D. Raine, P. Fisher, L. D. Frank. 2016. Associations between frequency of food shopping at different store types and diet and weight outcomes: Findings from the newpath study. *Public Health Nutrition* **19**(12) 2268–2277.

- Nakkas, A., Y. Xu. 2019. The impact of valuation heterogeneity on equilibrium prices in supply chain networks. *Production and Operations Management* **28**(2) 241–257.
- OECD. 2008. Monopsony and buyer power. <http://www.oecd.org/daf/competition/44445750.pdf>. Accessed on July 23 2025.
- Pekic, B. 2025. Top 10 supermarket retail chains in Italy. <https://www.esmmagazine.com/retail/top-10-supermarket-retail-chains-in-italy-234367>. Accessed on July 24 2025.
- Porter, M. E. 1980. *Competitive Strategy*. The Free Press, New York.
- Privett, N., F. Erhun. 2011. Efficient funding: Auditing in the nonprofit sector. *Manufacturing & Service Operations Management* **13**(4) 471–488.
- Qian, X., T. L. Olsen. 2020. Operational and financial decisions within proportional investment cooperatives. *Manufacturing & Service Operations Management* **22**(3) 545–561.
- Saha, R. L., A. Seidmann, V. Tilson. 2019. The impact of custom contracting and the Infomediary role of healthcare GPOs. *Production and Operations Management* **28**(3) 650–667.
- Salop, S.C. 1979. Monopolistic competition with outside goods. *The Bell Journal of Economics* 141–156.
- Sexton, R.J. 1983. Economic considerations in forming consumer cooperatives and establishing pricing and financing policies. *Journal of Consumer Affairs* **17**(2) 290–314.
- Sexton, R.J., T.A. Sexton. 1987. Cooperatives as entrants. *RAND Journal of Economics* **18**(4) 581–595.
- Shapley, L.S., M. Shubik. 1977. Trade using one commodity as a means of payment. *Journal of Political Economy* **85** 937–968.
- Tyagi, R.K. 1999. On the effects of downstream entry. *Management Science* **45**(1) 59–73.
- UN. 2014. Measuring the size and scope of the cooperative economy: Global census on cooperatives <https://www.un.org/esa/socdev/documents/2014/coopsegm/grace.pdf>. Accessed on 10 April 2024.
- Zhang, H., G. Aydin, H.S. Heese. 2023. Curbing the usage of conflict minerals: A supply network perspective. *Decision Sciences* **54**(5) 535–553.
- Zhang, H., G. Aydin, R.P. Parker. 2022. Social responsibility auditing in supply chain networks. *Management Science* **68**(2) 1058–1077.

## Appendix

**Proof of Proposition 1. Unique Equilibrium Characterization.** Each cooperative  $c$ 's action is its procurement budget  $b_c \in \mathbb{R}_+$ , which is constrained by the cooperative's total income  $N_c I$ . Thus, its action set is  $[0, N_c I]$ , which is a non-empty, compact, and convex subset of Euclidean space. Each cooperative  $c$ 's objective function  $U_c = \gamma + \frac{1}{1-\theta} \left[ \left( \frac{q_c}{N_c} \right)^{1-\theta} - 1 \right] + I - \frac{b_c}{N_c} = \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N_c} \frac{b_c}{b_c + \widehat{B}_{-c}} \widehat{O} \right)^{1-\theta} - 1 \right] + I - \frac{b_c}{N_c}$  is continuous in  $b_c$ . The necessary first-order optimality condition with respect to  $b_c$  is

$$\left( \frac{1}{N_c} \frac{b_c}{b_c + \widehat{B}_{-c}} \widehat{O} \right)^{-\theta} \frac{\widehat{B}_{-c}}{(b_c + \widehat{B}_{-c})^2} \widehat{O} - 1 = 0, \quad (13)$$

which is also sufficient since  $U_c$  is concave in  $b_c$  (given  $\theta > 0$ ). Notice that as  $b_c \rightarrow 0$ , the left-hand side of the above condition converges to a strictly positive value and as  $b_c \rightarrow N_c I$ , the left-hand side converges to a strictly negative value for a sufficiently large  $I$  which we assume ( $I > \bar{I}$ ). Hence, the optimal  $b_c$  admits an interior solution.

*Symmetry of cooperative sizes and equilibrium procurement budgets.* The detailed proof that each cooperative contains  $1/C$  measure of consumers is provided in the proof of Theorem 1, steps 1 and 2, and is hence omitted here. Given the symmetry in cooperative sizes, we will prove that no asymmetric procurement budgets can exist in equilibrium. Suppose to the contrary that there exists an equilibrium with asymmetric procurement budgets. Then, there must be at least two cooperatives (cooperatives 1 and 2 without loss of generality) such that  $\widehat{b}_1 > \widehat{b}_2$ . Then, using (13) and  $N_c = 1/C$ , we obtain  $\left( \frac{C\widehat{b}_1}{\widehat{B}} \widehat{O} \right)^{-\theta} \frac{\widehat{B} - \widehat{b}_1}{\widehat{B}^2} \widehat{O} - 1 < \left( \frac{C\widehat{b}_2}{\widehat{B}} \widehat{O} \right)^{-\theta} \frac{\widehat{B} - \widehat{b}_2}{\widehat{B}^2} \widehat{O} - 1$ , which implies that either  $\widehat{b}_1$  or  $\widehat{b}_2$  cannot satisfy (13), and hence cannot be an equilibrium procurement budget; a contradiction.

Let  $\widehat{b}$  denote each cooperative's equilibrium procurement budget. By evaluating (13) we obtain

$$\widehat{B} = C\widehat{b} = \frac{C-1}{C} \widehat{O}^{1-\theta}. \quad (14)$$

Moving backward to the first stage, the action of each supplier  $s$  is its production quantity  $o_s \in \mathbb{R}_+$  to maximize its profit function  $\pi_s = p o_s - a o_s^r = \frac{o_s \widehat{B}}{o_s + \widehat{O}_{-s}} - a o_s^r = \frac{C-1}{C} o_s (o_s + \widehat{O}_{-s})^{-\theta} - a o_s^r$  which is continuous in  $o_s$ . Since  $\theta > 1 - r$ ,  $\pi_s < 0$  as  $o_s \rightarrow +\infty$ . Thus, the action set of each supplier is restricted from above. The necessary first-order optimality condition with respect to  $o_s$  is

$$\frac{\partial \pi_s}{\partial o_s} = \frac{C-1}{C} (o_s + \widehat{O}_{-s})^{-\theta} - \frac{C-1}{C} \theta o_s (o_s + \widehat{O}_{-s})^{-\theta-1} - a r o_s^{r-1} = 0, \quad (15)$$

which is also sufficient as shown in §EC.1.1 of the Online Appendix (see (EC.36) and (EC.37)).

*Symmetry of equilibrium production quantities.* Given the necessary condition above, we will prove that no asymmetric production quantities can exist in equilibrium. Suppose to the contrary that suppliers' equilibrium production quantities are asymmetric. Then, there must be at least two suppliers (suppliers 1 and 2 without loss of generality) such that  $\widehat{o}_1 > \widehat{o}_2$ . Observe that the function  $\frac{C-1}{C} \theta o \widehat{O}^{-\theta-1} + a r o^{r-1}$  is strictly increasing in  $o$  for  $r \geq 1$ . This implies that  $\frac{C-1}{C} \widehat{O}^{-\theta} - \frac{C-1}{C} \theta \widehat{o}_1 \widehat{O}^{-\theta-1} - a r \widehat{o}_1^{r-1} < \frac{C-1}{C} \widehat{O}^{-\theta} - \frac{C-1}{C} \theta \widehat{o}_2 \widehat{O}^{-\theta-1} - a r \widehat{o}_2^{r-1}$ . Thus, either  $\widehat{o}_1$  or  $\widehat{o}_2$  cannot satisfy (15) which is a contradiction. Therefore, production quantities in equilibrium should be symmetric.

Let  $\hat{o}$  denote each supplier's equilibrium production quantity. By evaluating (15) we obtain (7). We can verify that in equilibrium, each supplier earns a strictly positive profit given that  $S(r-1) + \theta > 0$ . Finally, the price can be obtained as  $\hat{p} = \frac{\hat{B}}{\hat{O}}$ . This completes the proof. ■

**Proof of Theorem 1.** In two steps, we shall prove a stronger result that shows both Theorem 1 and the symmetry of cooperative sizes in Proposition 1.

*Step 1.* We prove that there is no (pre-merger or post-merger) equilibrium in which  $m \geq 1$  cooperatives have size  $N' > \frac{1}{\tilde{C}}$  and the remaining  $(\tilde{C} - m)$  cooperatives have size  $\frac{1-mN'}{\tilde{C}-m} < \frac{1}{\tilde{C}}$ .

Suppose to the contrary that such an equilibrium exists. We already show in the proof of Proposition 1 that cooperatives of the same size spend symmetric procurement budgets in equilibrium. Let  $\hat{b}'$  and  $\hat{b}$  be the symmetric procurement budgets of cooperatives with size  $N'$  and  $\frac{1-mN'}{\tilde{C}-m}$ , respectively. Then, similar to (EC.3) and (EC.4), we can write

$$\left(\frac{\hat{b}'}{N'} \frac{\hat{O}_m}{\hat{B}_m}\right)^{-\theta} \frac{\hat{B}_m - \hat{b}'}{\hat{B}_m^2} \hat{O}_m - 1 = 0, \quad (16)$$

$$\left(\frac{\hat{b}(\tilde{C} - m)}{1 - mN'} \frac{\hat{O}_m}{\hat{B}_m}\right)^{-\theta} \frac{\hat{B}_m - \hat{b}}{\hat{B}_m^2} \hat{O}_m - 1 = 0. \quad (17)$$

From (16) and (17), we obtain

$$\frac{\hat{B}_m - \hat{b}'}{\hat{B}_m - \hat{b}} = \frac{(m-1)\hat{b}' + (\tilde{C} - m)\hat{b}}{m\hat{b}' + (\tilde{C} - 1 - m)\hat{b}} = \left(\frac{\hat{b}'(1 - mN')}{N'(\tilde{C} - m)\hat{b}}\right)^\theta.$$

Let  $\eta' = \frac{\hat{b}}{\hat{b}'}$ . Simplifying the above expression,  $\eta'$  solves

$$\frac{m-1 + (\tilde{C} - m)\eta'}{m + (\tilde{C} - 1 - m)\eta'} = \left(\frac{1 - mN'}{N'(\tilde{C} - m)\eta'}\right)^\theta. \quad (18)$$

We can rearrange the above expression and rewrite it as

$$\frac{m-1 + (\tilde{C} - m)\eta'}{m + (\tilde{C} - 1 - m)\eta'} [N'(\tilde{C} - m)\eta']^\theta - (1 - mN')^\theta = 0.$$

The derivative of the left-hand side of the above expression with respect to  $\eta'$  is

$$\frac{\tilde{C} - 1}{[m + (\tilde{C} - 1 - m)\eta']^2} [N'(\tilde{C} - m)\eta']^\theta + \theta N'(\tilde{C} - m) [N'(\tilde{C} - m)\eta']^{\theta-1} \frac{m-1 + \theta(\tilde{C} - m)\eta'}{m + (\tilde{C} - 1 - m)\eta'} > 0.$$

Observe that if  $\eta' \rightarrow 0$ , the left-hand side converges to  $-(1 - mN')^\theta < 0$  and if  $\eta' \rightarrow 1$ , the left-hand side converges to  $[N'(\tilde{C} - m)]^\theta - (1 - mN')^\theta > 0$  for  $N' > \frac{1}{\tilde{C}}$ . Hence,  $\eta' \in (0, 1)$  uniquely solves (18) for each  $\tilde{C}, m$  and  $N'$ . Following this observation, we can write

$$\frac{\partial \eta'}{\partial \tilde{C}} = -\frac{\frac{\eta'(1-\eta')}{[m+(\tilde{C}-1-m)\eta']^2} + \theta \left(\frac{N'(\tilde{C}-m)\eta'}{1-mN'}\right)^{-\theta-1} \frac{N'\eta'}{1-mN'}}{\frac{\tilde{C}-1}{[m+(\tilde{C}-1-m)\eta']^2} + \theta \left(\frac{N'(\tilde{C}-m)\eta'}{1-mN'}\right)^{-\theta-1} \frac{N'(\tilde{C}-m)}{1-mN'}} < 0, \quad (19)$$

by the implicit function theorem. In addition,  $\hat{B}_m = m\hat{b}' + (\tilde{C} - m)\hat{b} \Rightarrow \frac{\hat{b}'}{\hat{B}_m} = \frac{1}{m + (\tilde{C} - m)\eta'}$  and  $\frac{\hat{b}}{\hat{B}_m} = \frac{\eta'}{m + (\tilde{C} - m)\eta'}$ .

Using (16) and (17), we obtain

$$\begin{aligned} \hat{B}_m &= \left(\frac{1}{N'} \frac{1}{m + (\tilde{C} - m)\eta'}\right)^{-\theta} \frac{m-1 + (\tilde{C} - m)\eta'}{m + (\tilde{C} - m)\eta'} \hat{O}_m^{1-\theta} \\ &= \left(\frac{\tilde{C} - m}{1 - mN'} \frac{\eta'}{m + (\tilde{C} - m)\eta'}\right)^{-\theta} \frac{m + (\tilde{C} - 1 - m)\eta'}{m + (\tilde{C} - m)\eta'} \hat{O}_m^{1-\theta}. \end{aligned} \quad (20)$$

We now compare the utility that a consumer receives in these two types of cooperatives to show that it cannot form an equilibrium. Let  $\widehat{U}'$  and  $\widehat{U}$  represent the utilities that a consumer receives in cooperatives with size  $N'$  and  $\frac{1-mN'}{C-1-m}$ , respectively. Then, we have

$$\begin{aligned}\widehat{U}' - \widehat{U} &= \frac{1}{1-\theta} \left( \frac{1}{N'} \frac{1}{m + (\widetilde{C} - m)\eta'} \right)^{1-\theta} \widehat{O}_m^{1-\theta} - \frac{1}{N'} \frac{1}{m + (\widetilde{C} - m)\eta'} \widehat{B}_m \\ &\quad - \frac{1}{1-\theta} \left( \frac{\widetilde{C} - m}{1 - mN'} \frac{\eta'}{m + (\widetilde{C} - m)\eta'} \right)^{1-\theta} \widehat{O}_m^{1-\theta} + \frac{\widetilde{C} - m}{1 - mN'} \frac{\eta'}{m + (\widetilde{C} - m)\eta'} \widehat{B}_m \\ &= \left( \frac{1}{N'} \frac{1}{m + (\widetilde{C} - m)\eta'} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - m)\eta'} \right] \\ &\quad - \left( \frac{\widetilde{C} - m}{1 - mN'} \frac{\eta'}{m + (\widetilde{C} - m)\eta'} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{m + (\widetilde{C} - 1 - m)\eta'}{m + (\widetilde{C} - m)\eta'} \right] \\ &\propto \left( \frac{1}{N'} \frac{1}{m + (\widetilde{C} - m)\eta'} \right) \frac{m + (\widetilde{C} - 1 - m)\eta'}{m - 1 + (\widetilde{C} - m)\eta'} \left[ \frac{1}{1-\theta} - \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - m)\eta'} \right] \\ &\quad - \left( \frac{\widetilde{C} - m}{1 - mN'} \frac{\eta'}{m + (\widetilde{C} - m)\eta'} \right) \left[ \frac{1}{1-\theta} - \frac{m + (\widetilde{C} - 1 - m)\eta'}{m + (\widetilde{C} - m)\eta'} \right] < 0,\end{aligned}$$

where the left-hand side of the inequality is obtained by using (20) and after factoring out some positive common terms. To see the inequality, it is enough to prove that

$$\begin{aligned}& \frac{m + (\widetilde{C} - 1 - m)\eta'}{m - 1 + (\widetilde{C} - m)\eta'} \left[ \frac{1}{1-\theta} - \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - m)\eta'} \right] \\ & < \frac{N'(\widetilde{C} - m)\eta'}{1 - mN'} \left[ \frac{1}{1-\theta} - \frac{m + (\widetilde{C} - 1 - m)\eta'}{m + (\widetilde{C} - m)\eta'} \right] \\ \Leftrightarrow & \left( \frac{N'(\widetilde{C} - m)\eta'}{1 - mN'} \right)^\theta \left[ \frac{1}{1-\theta} - \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - m)\eta'} \right] \\ & < \frac{N'(\widetilde{C} - m)\eta'}{1 - mN'} \left[ \frac{1}{1-\theta} - \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - m)\eta'} \left( \frac{N'(\widetilde{C} - m)\eta'}{1 - mN'} \right)^\theta \right] \\ \Leftrightarrow & \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - m)\eta'} \left[ \frac{N'(\widetilde{C} - m)\eta'}{1 - mN'} - 1 \right] \\ & < \frac{1}{1-\theta} \left[ \left( \frac{N'(\widetilde{C} - m)\eta'}{1 - mN'} \right)^{1-\theta} - 1 \right],\end{aligned}$$

where the second inequality results from the expression for  $\eta'$  in (18) and the third inequality results from rearranging terms and dropping the term  $\left( \frac{N'(\widetilde{C} - m)\eta'}{1 - mN'} \right)^\theta$  from both sides. To see why the third inequality holds, consider the function  $H(\zeta) = \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - m)\eta'} (\zeta - 1) - \frac{1}{1-\theta} (\zeta^{1-\theta} - 1)$ , where  $\zeta \equiv \frac{N'(\widetilde{C} - m)\eta'}{1 - mN'}$  and note that we want to show that  $H(\zeta) < 0$ . To see this, we take the partial derivative of  $H(\zeta)$  with respect to  $\zeta$  as follows  $\frac{\partial H(\zeta)}{\partial \zeta} = \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - m)\eta'} - \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - 1 - m)\eta'} < 0$ , where we use the fact that  $\zeta^{-\theta} = \frac{m-1 + (\widetilde{C} - m)\eta'}{m + (\widetilde{C} - 1 - m)\eta'}$  by (18). Since  $\zeta > 1$ , we have  $H(\zeta) < H(1) = 0$ . This means  $\widehat{U}' < \widehat{U}$  and hence we cannot have an equilibrium with two cooperative sizes.

*Step 2. We prove that there is no (pre-merger or post-merger) equilibrium in which  $m \geq 3$  cooperatives have asymmetric sizes.*

Suppose to the contrary that such an equilibrium exists, that is there are at least three different equilibrium sizes in the post-merger equilibrium. Let  $N'_1 > N'_2 > N'_3$  be the cooperatives sizes and  $\widehat{b}_1$ ,  $\widehat{b}_2$ , and  $\widehat{b}_3$  be the

corresponding equilibrium procurement budgets for any of these cooperatives. Then, similar to (16) and (17) we can write

$$\left(\frac{\hat{b}_1 \hat{O}_m}{N'_1 \hat{B}_m}\right)^{-\theta} (\hat{B}_m - \hat{b}_1) = \frac{\hat{B}_m^2}{\hat{O}_m}, \quad (21)$$

$$\left(\frac{\hat{b}_2 \hat{O}_m}{N'_2 \hat{B}_m}\right)^{-\theta} (\hat{B}_m - \hat{b}_2) = \frac{\hat{B}_m^2}{\hat{O}_m}, \quad (22)$$

$$\left(\frac{\hat{b}_3 \hat{O}_m}{N'_3 \hat{B}_m}\right)^{-\theta} (\hat{B}_m - \hat{b}_3) = \frac{\hat{B}_m^2}{\hat{O}_m}. \quad (23)$$

Since the left-hand sides of (21), (22), and (23) are equal and  $N'_1 > N'_2 > N'_3$ , we must have  $\hat{b}_1 > \hat{b}_2 > \hat{b}_3$ . Also, since the left-hand sides of (21), (22), and (23) are equal and  $\hat{B}_m - \hat{b}_1 < \hat{B}_m - \hat{b}_2 < \hat{B}_m - \hat{b}_3$ , we conclude that  $\frac{\hat{b}_1}{N'_1} < \frac{\hat{b}_2}{N'_2} < \frac{\hat{b}_3}{N'_3}$ . Next, in equilibrium, we must have  $\hat{U}_1 = \hat{U}_2 = \hat{U}_3$  and hence

$$\begin{aligned} & \frac{1}{1-\theta} \left(\frac{\hat{b}_1 \hat{O}_m}{N'_1 \hat{B}_m}\right)^{1-\theta} + I - \frac{\hat{b}_1}{N'_1} = \frac{1}{1-\theta} \left(\frac{\hat{b}_1 \hat{O}_m}{N'_1 \hat{B}_m}\right) \left(\frac{\hat{b}_2 \hat{O}_m}{N'_2 \hat{B}_m}\right)^{-\theta} \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_1} + I - \frac{\hat{b}_1}{N'_1} \\ &= \frac{1}{1-\theta} \left(\frac{\hat{b}_2 \hat{O}_m}{N'_2 \hat{B}_m}\right)^{1-\theta} + I - \frac{\hat{b}_2}{N'_2} \\ &= \frac{1}{1-\theta} \left(\frac{\hat{b}_3 \hat{O}_m}{N'_3 \hat{B}_m}\right)^{1-\theta} + I - \frac{\hat{b}_3}{N'_3} = \frac{1}{1-\theta} \left(\frac{\hat{b}_3 \hat{O}_m}{N'_3 \hat{B}_m}\right) \left(\frac{\hat{b}_2 \hat{O}_m}{N'_2 \hat{B}_m}\right)^{-\theta} \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_3} + I - \frac{\hat{b}_3}{N'_3}, \\ &\Rightarrow \frac{1}{1-\theta} \frac{\hat{O}_m}{\hat{B}_m} \left(\frac{\hat{b}_2 \hat{O}_m}{N'_2 \hat{B}_m}\right)^{-\theta} \left[ \frac{\hat{b}_2}{N'_2} - \left(\frac{\hat{b}_1}{N'_1}\right) \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_1} \right] = \frac{\hat{b}_2}{N'_2} - \frac{\hat{b}_1}{N'_1}, \end{aligned} \quad (24)$$

by using (21), (22), and (23) in the first three lines and then rearranging the terms in the first and second lines. Similarly, by rearranging the terms in the second and third lines, we obtain

$$\frac{1}{1-\theta} \frac{\hat{O}_m}{\hat{B}_m} \left(\frac{\hat{b}_2 \hat{O}_m}{N'_2 \hat{B}_m}\right)^{-\theta} \left[ \left(\frac{\hat{b}_3}{N'_3}\right) \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_3} - \frac{\hat{b}_2}{N'_2} \right] = \frac{\hat{b}_3}{N'_3} - \frac{\hat{b}_2}{N'_2}. \quad (25)$$

Using (24) and (25), and after rearranging the terms, we obtain

$$\begin{aligned} & \left[ \frac{\hat{b}_2}{N'_2} - \frac{\hat{b}_1}{N'_1} \right] \left[ \left(\frac{\hat{b}_3}{N'_3}\right) \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_3} - \frac{\hat{b}_2}{N'_2} \right] = \left[ \frac{\hat{b}_3}{N'_3} - \frac{\hat{b}_2}{N'_2} \right] \left[ \frac{\hat{b}_2}{N'_2} - \left(\frac{\hat{b}_1}{N'_1}\right) \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_1} \right] \\ &\Rightarrow \frac{\hat{b}_2}{N'_2} = \frac{\frac{\hat{b}_1}{N'_1} \left(\frac{\hat{b}_3}{N'_3}\right) \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_3} - \frac{\hat{b}_1}{N'_1} \left(\frac{\hat{b}_3}{N'_3}\right) \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_1}}{\left(\frac{\hat{b}_3}{N'_3}\right) \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_3} - \frac{\hat{b}_3}{N'_3} + \frac{\hat{b}_1}{N'_1} - \frac{\hat{b}_1}{N'_1} \frac{\hat{B}_m - \hat{b}_2}{\hat{B}_m - \hat{b}_1}}. \end{aligned} \quad (26)$$

Next, note that we can rewrite the condition  $\hat{U}_1 = \hat{U}_2 = \hat{U}_3$  as follows

$$\begin{aligned} & \frac{1}{1-\theta} \left(\frac{\hat{b}_1 \hat{O}_m}{N'_1 \hat{B}_m}\right)^{1-\theta} + I - \frac{\hat{b}_1}{N'_1} = \frac{1}{1-\theta} \left(\frac{\hat{b}_1 \hat{O}_m}{N'_1 \hat{B}_m}\right) \left(\frac{\hat{b}_3 \hat{O}_m}{N'_3 \hat{B}_m}\right)^{-\theta} \frac{\hat{B}_m - \hat{b}_3}{\hat{B}_m - \hat{b}_1} + I - \frac{\hat{b}_1}{N'_1} \\ &= \frac{1}{1-\theta} \left(\frac{\hat{b}_2 \hat{O}_m}{N'_2 \hat{B}_m}\right)^{1-\theta} + I - \frac{\hat{b}_2}{N'_2} = \frac{1}{1-\theta} \left(\frac{\hat{b}_2 \hat{O}_m}{N'_2 \hat{B}_m}\right) \left(\frac{\hat{b}_3 \hat{O}_m}{N'_3 \hat{B}_m}\right)^{-\theta} \frac{\hat{B}_m - \hat{b}_3}{\hat{B}_m - \hat{b}_2} + I - \frac{\hat{b}_2}{N'_2}, \\ &= \frac{1}{1-\theta} \left(\frac{\hat{b}_3 \hat{O}_m}{N'_3 \hat{B}_m}\right)^{1-\theta} + I - \frac{\hat{b}_3}{N'_3} \\ &\Rightarrow \frac{1}{1-\theta} \frac{\hat{O}_m}{\hat{B}_m} \left(\frac{\hat{b}_3 \hat{O}_m}{N'_3 \hat{B}_m}\right)^{-\theta} \left[ \frac{\hat{b}_3}{N'_3} - \left(\frac{\hat{b}_1}{N'_1}\right) \frac{\hat{B}_m - \hat{b}_3}{\hat{B}_m - \hat{b}_1} \right] = \frac{\hat{b}_3}{N'_3} - \frac{\hat{b}_1}{N'_1}, \end{aligned} \quad (27)$$

by using (21), (22), and (23) in the first three lines and then rearranging the terms in the first and third lines. Similarly, rearranging the terms in the second and third lines, we obtain

$$\frac{1}{1-\theta} \frac{\hat{O}_m}{\hat{B}_m} \left(\frac{\hat{b}_3 \hat{O}_m}{N'_3 \hat{B}_m}\right)^{-\theta} \left[ \frac{\hat{b}_3}{N'_3} - \left(\frac{\hat{b}_2}{N'_2}\right) \frac{\hat{B}_m - \hat{b}_3}{\hat{B}_m - \hat{b}_2} \right] = \frac{\hat{b}_3}{N'_3} - \frac{\hat{b}_2}{N'_2}. \quad (28)$$

Using (27) and (28), and after rearranging the terms, we obtain

$$\left[ \frac{\widehat{b}_3}{N'_3} - \frac{\widehat{b}_1}{N'_1} \right] \left[ \frac{\widehat{b}_3}{N'_3} - \left( \frac{\widehat{b}_2}{N'_2} \right) \frac{\widehat{B}_m - \widehat{b}_3}{\widehat{B}_m - \widehat{b}_2} \right] = \left[ \frac{\widehat{b}_3}{N'_3} - \frac{\widehat{b}_2}{N'_2} \right] \left[ \frac{\widehat{b}_3}{N'_3} - \left( \frac{\widehat{b}_1}{N'_1} \right) \frac{\widehat{B}_m - \widehat{b}_3}{\widehat{B}_m - \widehat{b}_1} \right].$$

Substituting  $\frac{\widehat{b}_2}{N'_2}$  from (26) into the above expression, and simplifying the expression using straightforward algebra, we obtain  $\widehat{b}_1 = \widehat{b}_2$  which is a contradiction. Thus, we cannot have three or more cooperative sizes in equilibrium. This completes the proof of step 2.

Therefore, the unique equilibrium comprises equal-sized cooperatives, and the equilibrium outcomes are obtained using the expressions in Proposition 1 by setting  $C = \widetilde{C}$ . ■

**Proof of Proposition 3.** The proof directly follows from Proposition 1 and Theorem 1. ■

**Proof of Theorem 2.** In equilibrium, consumer utility  $\widehat{U}_c = \gamma + \frac{1}{1-\theta}[(S\widehat{\delta})^{1-\theta} - 1] + I - C\widehat{b}$ . Plugging in the values for  $\widehat{\delta}$  and  $\widehat{b}$  and ignoring the irrelevant terms, the derivative of  $\widehat{U}_c$  with respect to  $C$  can be determined by evaluating the derivative of  $\left[ \frac{C-1}{C} \right]^{\frac{1-\theta}{r+\theta-1}} \left[ \frac{1}{1-\theta} - \frac{C-1}{C} \right]$  with respect to  $C$ . This is proportional to  $\frac{1}{r+\theta-1} \left[ 1 - r \left( \frac{C-1}{C} \right) \right]$ . We now argue that  $\widehat{U}_c$  is unimodal in  $C$ , that is there exists  $C^*$  such that  $\frac{\partial \widehat{U}_c}{\partial C} > 0$  for all  $C < C^*$  and  $\frac{\partial \widehat{U}_c}{\partial C} < 0$  for all  $C > C^*$ . Observe that when  $r \geq 2$  (which implies  $r + \theta - 1 > 0$ ),  $1 - r \left( \frac{C-1}{C} \right) \leq 0$  for all  $C \geq 2$ . Hence,  $C^* = 2$ . In addition, when  $r \in (1, 2)$ ,  $C^* = \frac{r}{r-1}$  is the unique value above which  $\frac{\partial \widehat{U}_c}{\partial C} < 0$  and below which  $\frac{\partial \widehat{U}_c}{\partial C} > 0$ . Finally, when  $r = 1$ , we have  $r + \theta - 1 > 0$  and  $1 - r \left( \frac{C-1}{C} \right) > 0$ . Thus,  $C^* \rightarrow \infty$ . ■

## Online Appendix

### EC.1. Proofs

**Proof of Proposition 2.** (i) The necessary (and sufficient) first-order optimality condition of the merged cooperative utility-maximization problem given in (8) is

$$\left( \frac{C}{2} \frac{b_{c_{12}}}{b_{c_{12}} + \widehat{B}_{-c_{12}}} \widehat{O}_m \right)^{-\theta} \frac{\widehat{B}_{-c_{12}}}{(b_{c_{12}} + \widehat{B}_{-c_{12}})^2} \widehat{O}_m - 1 = 0. \quad (\text{EC.1})$$

As in the proof of Proposition 1, we can show that the optimal  $b_{c_{12}}$  admits an interior solution.

Each non-merged cooperative  $c \in \{3, \dots, C\}$  also best-responds by solving

$$\left( C \frac{b_{c_m}}{b_{c_m} + \widehat{B}_{-c_m}} \widehat{O}_m \right)^{-\theta} \frac{\widehat{B}_{-c_m}}{(b_{c_m} + \widehat{B}_{-c_m})^2} \widehat{O}_m - 1 = 0, \quad (\text{EC.2})$$

where subscript  $m$  represents post-merger outcomes. Using the exact same argument as in the proof of Proposition 1, one can verify that in any equilibrium, the procurement budgets of non-merged cooperatives are symmetric. Let  $\widehat{b}_m$  denote each non-merged cooperative's equilibrium procurement budget. Considering (EC.1) and (EC.2) yields the following simultaneous equations for the equilibrium procurement budgets  $\widehat{b}_{c_{12}}$  and  $\widehat{b}_m$ :

$$\left( \frac{C}{2} \frac{\widehat{b}_{c_{12}}}{\widehat{B}_m} \widehat{O}_m \right)^{-\theta} \frac{\widehat{B}_m - \widehat{b}_{c_{12}}}{\widehat{B}_m^2} \widehat{O}_m - 1 = 0, \quad (\text{EC.3})$$

$$\left( C \frac{\widehat{b}_m}{\widehat{B}_m} \widehat{O}_m \right)^{-\theta} \frac{\widehat{B}_m - \widehat{b}_m}{\widehat{B}_m^2} \widehat{O}_m - 1 = 0. \quad (\text{EC.4})$$

From (EC.3) and (EC.4), we obtain

$$\frac{\widehat{B}_m - \widehat{b}_{c_{12}}}{\widehat{B}_m - \widehat{b}_m} = \frac{(C-2)\widehat{b}_m}{\widehat{b}_{c_{12}} + (C-3)\widehat{b}_m} = \left( \frac{\widehat{b}_{c_{12}}}{2\widehat{b}_m} \right)^\theta.$$

Let  $\eta = \frac{\widehat{b}_m}{\widehat{b}_{c_{12}}}$ . Simplifying the above expression,  $\eta$  solves

$$1 + (C-3)\eta - (C-2)\eta(2\eta)^\theta = 0. \quad (\text{EC.5})$$

The derivative of the left-hand side of (EC.5) with respect to  $\eta$  is

$$(C-3) - (C-2)(1+\theta)(2\eta)^\theta = (C-3) - (C-2)(1+\theta) \frac{1+(C-3)\eta}{(C-2)\eta} = -\theta(C-3) - \frac{1+\theta}{\eta} < 0.$$

Observe that if  $\eta = \frac{1}{2}$ , the left-hand side of (EC.5) becomes  $\frac{1}{2} > 0$  and if  $\eta = 1$ , the left-hand side of (EC.5) becomes  $(C-2)(1-2^\theta) < 0$ . Hence,  $\eta \in (\frac{1}{2}, 1)$  uniquely solves (EC.5) for each  $C$ . Following this observation, we can write

$$\frac{\partial \eta}{\partial C} = - \frac{\eta[1 - (2\eta)^\theta]}{(C-3) - (C-2)(1+\theta)(2\eta)^\theta} = \frac{\eta(\eta-1)}{(C-2)[\theta(C-3)\eta + 1 + \theta]} < 0, \quad (\text{EC.6})$$

by the implicit function theorem and after substituting for  $(2\eta)^\theta$  from (EC.5). Letting  $C = 3$  and  $C \rightarrow \infty$  in (EC.5), we find that  $\frac{1}{2} < \eta \leq (\frac{1}{2})^{\frac{\theta}{1+\theta}}$ . In addition,  $\widehat{B}_m = \widehat{b}_{c_{12}} + (C-2)\widehat{b}_m = [1 + (C-2)\eta]\widehat{b}_{c_{12}} \Rightarrow \frac{\widehat{b}_{c_{12}}}{\widehat{B}_m} = \frac{1}{1+(C-2)\eta}$  and  $\frac{\widehat{b}_m}{\widehat{B}_m} = \frac{\eta}{1+(C-2)\eta}$ . Using (EC.3) and (EC.4), we obtain

$$\widehat{B}_m = \left( \frac{C}{2} \frac{1}{1+(C-2)\eta} \right)^{-\theta} \frac{(C-2)\eta}{1+(C-2)\eta} \widehat{O}_m^{1-\theta} = \left( \frac{C\eta}{1+(C-2)\eta} \right)^{-\theta} \frac{1+(C-3)\eta}{1+(C-2)\eta} \widehat{O}_m^{1-\theta}. \quad (\text{EC.7})$$

Anticipating this behavior by cooperatives, the action of each supplier  $s$  in the first stage is its production quantity  $o_s \in \mathbb{R}_+$  to maximize its profit function  $\pi_{s_m} = p_m o_{s_m} - a o_{s_m}^r = \frac{o_{s_m} \hat{B}_m}{o_{s_m} + \hat{O}_{-s_m}} - a o_{s_m}^r = \left(\frac{C}{2} \frac{1}{1+(C-2)\eta}\right)^{-\theta} \frac{(C-2)\eta}{1+(C-2)\eta} o_{s_m} (o_{s_m} + \hat{O}_{-s_m})^{-\theta} - a o_{s_m}^r$  which is continuous in  $o_{s_m}$ . The necessary first-order optimality condition with respect to  $o_{s_m}$  is

$$\frac{\partial \pi_{s_m}}{\partial o_{s_m}} = \left(\frac{C}{2} \frac{1}{1+(C-2)\eta}\right)^{-\theta} \frac{(C-2)\eta}{1+(C-2)\eta} \left[ (o_{s_m} + \hat{O}_{-s_m})^{-\theta} - \theta o_{s_m} (o_{s_m} + \hat{O}_{-s_m})^{-\theta-1} \right] - a r o_{s_m}^{r-1} = 0.$$

Using the exact same arguments as in the proof of Proposition 1, we can verify that production quantities are symmetric in any equilibrium and that the above condition is also sufficient for optimality. Thus, the equilibrium production quantity is given by

$$\begin{aligned} \hat{o}_m &= \left[ \left(\frac{C}{2} \frac{1}{1+(C-2)\eta}\right)^{-\theta} \frac{(C-2)\eta}{1+(C-2)\eta} \frac{1}{ar} S^{-\theta-1} (S-\theta) \right]^{\frac{1}{r+\theta-1}} \\ &= \left[ \left(\frac{C\eta}{1+(C-2)\eta}\right)^{-\theta} \frac{1+(C-3)\eta}{1+(C-2)\eta} \frac{1}{ar} S^{-\theta-1} (S-\theta) \right]^{\frac{1}{r+\theta-1}}. \end{aligned} \quad (\text{EC.8})$$

Finally, the price can be obtained as  $\hat{p}_m = \frac{\hat{B}_m}{\hat{O}_m}$ .

(ii) To compare the utility that a consumer receives in the merged cooperative with the utility in a non-merged cooperative, we need to evaluate the following expression

$$\begin{aligned} \hat{U}_{c_{12}} - \hat{U}_{c_m} &= \frac{1}{1-\theta} \left( \frac{C \hat{b}_{c_{12}} \hat{O}_m}{2 \hat{B}_m} \right)^{1-\theta} - \frac{C \hat{b}_{c_{12}}}{2} - \frac{1}{1-\theta} \left( C \frac{\hat{b}_{c_m} \hat{O}_m}{\hat{B}_m} \right)^{1-\theta} + C \hat{b}_{c_m} \\ &= \left( \frac{C}{2} \frac{1}{1+(C-2)\eta} \right)^{1-\theta} \hat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{(C-2)\eta}{1+(C-2)\eta} \right] \\ &\quad - \left( \frac{C\eta}{1+(C-2)\eta} \right)^{1-\theta} \hat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{1+(C-3)\eta}{1+(C-2)\eta} \right] \\ &= \left( \frac{C}{2} \frac{1}{1+(C-2)\eta} \right) \left( \frac{C\eta}{1+(C-2)\eta} \right)^{-\theta} \frac{1+(C-3)\eta}{(C-2)\eta} \hat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{(C-2)\eta}{1+(C-2)\eta} \right] \\ &\quad - \left( \frac{C\eta}{1+(C-2)\eta} \right)^{1-\theta} \hat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{1+(C-3)\eta}{1+(C-2)\eta} \right] \\ &\propto \left( \frac{C}{2} \frac{1}{1+(C-2)\eta} \right) \frac{1+(C-3)\eta}{(C-2)\eta} \left[ \frac{1}{1-\theta} - \frac{(C-2)\eta}{1+(C-2)\eta} \right] \\ &\quad - \left( \frac{C\eta}{1+(C-2)\eta} \right) \left[ \frac{1}{1-\theta} - \frac{1+(C-3)\eta}{1+(C-2)\eta} \right] < 0, \end{aligned}$$

where the third equality results from (EC.7). To see the inequality, it is enough to prove that

$$\begin{aligned} &\frac{1+(C-3)\eta}{(C-2)\eta} \left[ \frac{1}{1-\theta} - \frac{(C-2)\eta}{1+(C-2)\eta} \right] < 2\eta \left[ \frac{1}{1-\theta} - \frac{1+(C-3)\eta}{1+(C-2)\eta} \right] \\ \iff &(2\eta)^\theta \left[ \frac{1}{1-\theta} - \frac{(C-2)\eta}{1+(C-2)\eta} \right] < 2\eta \left[ \frac{1}{1-\theta} - \frac{(C-2)\eta}{1+(C-2)\eta} (2\eta)^\theta \right] \\ \iff &\frac{(C-2)\eta}{1+(C-2)\eta} (2\eta-1) < \frac{1}{1-\theta} \left[ (2\eta)^{1-\theta} - 1 \right], \end{aligned}$$

where the second line results from the expression for  $\eta$  in (EC.5) and the third line results from rearranging terms and dropping the term  $(2\eta)^\theta$  from both sides. To see why the third line holds, consider the function  $G(C) = \frac{(C-2)\eta}{1+(C-2)\eta} (2\eta-1) - \frac{1}{1-\theta} \left[ (2\eta)^{1-\theta} - 1 \right]$ , and note that we want to show

that  $G(C) < 0$  for all  $C \geq 3$ . To see this, we take the total derivative of  $G(C)$  with respect to  $C$ :

$$\begin{aligned} \frac{dG(C)}{dC} &= \frac{\partial G}{\partial C} + \frac{\partial G}{\partial \eta} \times \frac{\partial \eta}{\partial C} \\ &= \frac{\eta(2\eta-1)}{[1+(C-2)\eta]^2} + \left[ \frac{2\eta-1}{[1+(C-2)\eta]^2} + \frac{2\eta}{1+(C-2)\eta} - \frac{2\eta}{1+(C-3)\eta} \right] \frac{\eta(\eta-1)}{\theta(C-3)\eta+1+\theta} \\ &= \frac{\eta(2\eta-1)}{[1+(C-2)\eta]^2} \left[ \frac{\theta(C-3)\eta+\eta+\theta}{\theta(C-3)\eta+1+\theta} \right] + \left[ \frac{2\eta}{1+(C-2)\eta} - \frac{2\eta}{1+(C-3)\eta} \right] \frac{\eta(\eta-1)}{\theta(C-3)\eta+1+\theta} > 0 \end{aligned}$$

where in the second line we use (EC.5) and (EC.6). As a result,  $G(C)$  attains its maximum when  $C \rightarrow \infty$  which in that case  $\eta \rightarrow \frac{1}{2}$  by (EC.5). Observe that  $\lim_{C \rightarrow \infty} G(C) = 0$  and hence  $G(C) < 0$  for all  $C \geq 3$ . This means  $\widehat{U}_{c_{12}} < \widehat{U}_{c_m}$  for all  $C \geq 3$ . ■

**Proof of Proposition 4.** Notice that in choosing their procurement budgets, cooperatives take their size as given and try to optimize the average utility of their members. Hence, the existence of mismatch costs in the model only influences consumers' decisions in the first stage of the game and not the optimization problem of the cooperatives. This observation implies that the exact argument in the proof of Theorem 1 can be used to prove that the pre-merger market game has a unique equilibrium in which each cooperative contains  $1/C$  measure of consumers. ■

**Proof of Theorem 3.** Part (i). The existence of equilibrium and symmetry of production quantities follow from previous proofs and are hence omitted. Suppose that in equilibrium,  $N_{c_{12}}$  consumers join cooperative  $c_{12}$  and  $(1 - N_{c_{12}})$  consumers join cooperative  $c_3$ . Then, the merged cooperative  $c_{12}$  solves the following optimization problem:

$$\max_{b_{c_{12}}} \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N_{c_{12}}} \frac{b_{c_{12}}}{b_{c_{12}} + \widehat{b}_{c_3}} \widehat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{b_{c_{12}}}{N_{c_{12}}}. \quad (\text{EC.9})$$

Notice that each cooperative chooses its procurement budget given its size, where the size of each cooperative is determined by backward induction given the mismatch cost and anticipating the procurement strategy of cooperatives in equilibrium. Thus, the mismatch cost can be omitted from the cooperative's problem. The first-order optimality condition with respect to  $b_{c_{12}}$  is given by

$$\left( \frac{1}{N_{c_{12}}} \frac{b_{c_{12}}}{b_{c_{12}} + \widehat{b}_{c_3}} \widehat{O}_m \right)^{-\theta} \frac{\widehat{b}_{c_3}}{(b_{c_{12}} + \widehat{b}_{c_3})^2} \widehat{O}_m - 1 = 0, \quad (\text{EC.10})$$

which is both necessary and sufficient. Similarly, considering the optimization problem of the non-merged cooperative and deriving the first-order optimality condition with respect to  $b_{c_3}$ , we obtain

$$\left( \frac{1}{[1 - N_{c_{12}}]} \frac{b_{c_3}}{b_{c_3} + \widehat{b}_{c_{12}}} \widehat{O}_m \right)^{-\theta} \frac{\widehat{b}_{c_{12}}}{(b_{c_3} + \widehat{b}_{c_{12}})^2} \widehat{O}_m - 1 = 0. \quad (\text{EC.11})$$

The above two conditions imply that

$$\eta = \frac{\widehat{b}_{c_3}}{\widehat{b}_{c_{12}}} = \left( \frac{1 - N_{c_{12}}}{N_{c_{12}}} \right)^{\frac{\theta}{1+\theta}}. \quad (\text{EC.12})$$

Since  $\widehat{B}_m = \widehat{b}_{c_{12}} + \widehat{b}_{c_3} = (1 + \eta)\widehat{b}_{c_{12}}$ , we have  $\frac{\widehat{b}_{c_{12}}}{\widehat{B}_m} = \frac{1}{1+\eta}$  and  $\frac{\widehat{b}_{c_3}}{\widehat{B}_m} = \frac{\eta}{1+\eta}$ . Using (EC.10) and (EC.11),

$$\widehat{B}_m = \left( \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \right)^{-\theta} \frac{\eta}{1+\eta} \widehat{O}_m^{1-\theta} = \left( \frac{1}{[1 - N_{c_{12}}]} \frac{\eta}{1+\eta} \right)^{-\theta} \frac{1}{1+\eta} \widehat{O}_m^{1-\theta}. \quad (\text{EC.13})$$

In addition, each supplier  $s$  chooses its production quantity  $o_{sm}$  to maximize its profit  $\pi_{sm} = p_m o_{sm} - a o_{sm}^r = \frac{o_{sm} \widehat{B}_m}{o_{sm} + \widehat{O}_{-sm}} - a o_{sm}^r = \left(\frac{1}{N_{c_{12}}} \frac{1}{1+\eta}\right)^{-\theta} \frac{\eta}{1+\eta} o_{sm} (o_{sm} + \widehat{O}_{-sm})^{-\theta} - a o_{sm}^r$ . Taking the necessary (and sufficient) first-order optimality condition with respect to  $o_{sm}$ , the production quantity by each supplier solves:

$$\widehat{o}_m = \left[ \left( \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \right)^{-\theta} \frac{\eta}{1+\eta} \frac{1}{ar} S^{-\theta-1} (S-\theta) \right]^{\frac{1}{r+\theta-1}} = \left[ \left( \frac{1}{[1-N_{c_{12}]} \frac{1}{1+\eta}} \right)^{-\theta} \frac{1}{1+\eta} \frac{1}{ar} S^{-\theta-1} (S-\theta) \right]^{\frac{1}{r+\theta-1}}. \quad (\text{EC.14})$$

Now, let us derive the value of  $N_{c_{12}}$  in equilibrium. Note that in Figure 3(b), a consumer at the margin between  $c_3$  and  $c_{12}$  from left or right should be indifferent between joining the merged cooperative  $c_{12}$  or the non-merged one  $c_3$  in equilibrium. To satisfy this condition, we must have

$$\begin{aligned} & \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \widehat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \widehat{B}_m - t \left( \frac{N_{c_{12}}}{2} - \frac{1}{6} \right) \\ &= \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{[1-N_{c_{12}]} \frac{1}{1+\eta}} \widehat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{1}{[1-N_{c_{12}]} \frac{1}{1+\eta}} \widehat{B}_m - t \left( \frac{1-N_{c_{12}}}{2} \right) \\ &\iff \left( \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{\eta}{1+\eta} \right] - \left( \frac{1}{[1-N_{c_{12}]} \frac{1}{1+\eta}} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{1}{1+\eta} \right] \\ &= t \left( N_{c_{12}} - \frac{2}{3} \right), \end{aligned} \quad (\text{EC.15})$$

where in deriving the mismatch costs in the first equality, we use two facts: 1) in any equilibrium, the distance of the marginal consumers on both sides of  $c_3$  from  $c_3$ , must be equal; otherwise, these two consumers would not be receiving equal utilities (given different mismatch costs); and 2) the marginal consumer in any equilibrium cannot locate between  $c_1$  and  $c_2$ , as otherwise, any consumer between the marginal consumer and  $c_1$  or  $c_2$  would be better off joining the merged cooperative and paying lesser mismatch costs. Figure 3(b) depicts the market configuration.

Now, suppose  $t = 0$ . Then recall from the proof of Theorem 1, step 1, that if  $N_{c_{12}} \leq \frac{1}{2}$ , the utility of a consumer in the merged cooperative  $c_{12}$  would be higher than their utility in the other cooperative  $c_3$ . This makes the left-hand side of (EC.15) positive. However, under  $t > 0$  and if  $N_{c_{12}} \leq \frac{1}{2}$ , the right-hand side of (EC.15) would be strictly negative, which is a contradiction. Therefore, in order to satisfy (EC.15), we must have that  $N_{c_{12}} > \frac{1}{2}$ .

Following this observation, the left-hand side of (EC.15) is strictly negative, implying that  $N_{c_{12}} < \frac{2}{3}$  in order to make the right-hand side also strictly negative. Therefore,  $\frac{1}{2} < N_{c_{12}} < \frac{2}{3}$ .

Next, we prove the uniqueness of  $N_{c_{12}}$  that satisfies (EC.15). To see this, notice that the left-hand side of (EC.15) can be written as  $F(N_{c_{12}}) - F(1 - N_{c_{12}})$  where

$$\begin{aligned} F(1 - N_{c_{12}}) &= \left( \frac{1}{[1 - N_{c_{12}]} \frac{1}{1+\eta}} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{1}{1+\eta} \right] \propto \\ & \left[ \frac{(1 - N_{c_{12}})^{-\frac{1}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right]^{\frac{(1-\theta)(r-1)}{r+\theta-1}} \left[ \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right]^{\frac{1-\theta}{r+\theta-1}} \left[ \frac{1}{1-\theta} - \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right], \end{aligned}$$

after substituting for  $\eta$  from (EC.12) and  $\widehat{O}_m$  from (EC.14), and ignoring irrelevant terms. We claim that  $F(1 - N_{c_{12}})$  is strictly increasing in  $N_{c_{12}}$ . To prove this, we take its derivative with respect to  $N_{c_{12}}$ . After ignoring some positive common terms, the derivative simplifies to

$$\begin{aligned}
& \frac{(1-\theta)(r-1)}{r+\theta-1} N_{c_{12}}^{\frac{\theta}{1+\theta}} \left( (1-N_{c_{12}})^{-\frac{2}{1+\theta}} - \frac{\theta}{1+\theta} N_{c_{12}}^{-\frac{1}{1+\theta}} (1-N_{c_{12}})^{-\frac{1}{1+\theta}} + \frac{1}{1+\theta} N_{c_{12}}^{\frac{\theta}{1+\theta}} (1-N_{c_{12}})^{-\frac{2+\theta}{1+\theta}} \right) \\
& \times \left( \frac{1}{1-\theta} - \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1-N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right) \\
& + \frac{(1-\theta)}{r+\theta-1} \left( \frac{\theta}{1+\theta} \right) N_{c_{12}}^{-\frac{1}{1+\theta}} (1-N_{c_{12}})^{-\frac{2}{1+\theta}} \left( \frac{1}{1-\theta} - \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1-N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right) \\
& - \frac{\theta}{1+\theta} N_{c_{12}}^{-\frac{1}{1+\theta}} (1-N_{c_{12}})^{-\frac{2}{1+\theta}} \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1-N_{c_{12}})^{\frac{\theta}{1+\theta}}} \\
& > \left( \frac{1-\theta}{1+\theta} \right) N_{c_{12}}^{-\frac{1}{1+\theta}} (1-N_{c_{12}})^{-\frac{2}{1+\theta}} \left( \frac{1}{1-\theta} - \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1-N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right) \\
& - \frac{\theta}{1+\theta} N_{c_{12}}^{-\frac{1}{1+\theta}} (1-N_{c_{12}})^{-\frac{2}{1+\theta}} \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1-N_{c_{12}})^{\frac{\theta}{1+\theta}}} \\
& = \frac{1}{1+\theta} N_{c_{12}}^{-\frac{1}{1+\theta}} (1-N_{c_{12}})^{-\frac{2}{1+\theta}} \left( 1 - \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1-N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right) > 0,
\end{aligned}$$

where the first inequality is obtained by setting  $r = 1$  given that the expression on the first three lines above is positive and increasing in  $r$ . Now, since  $F(1 - N_{c_{12}})$  is strictly increasing in  $N_{c_{12}}$ , we conclude that  $F(N_{c_{12}})$  is strictly decreasing in  $N_{c_{12}}$  and hence  $F(N_{c_{12}}) - F(1 - N_{c_{12}})$  is strictly decreasing in  $N_{c_{12}}$ , whereas the right-hand side of (EC.15) is strictly increasing in  $N_{c_{12}}$ . Therefore, there exists a unique  $N_{c_{12}}$  that satisfies (EC.15). Next, if we bring all the terms in (EC.15) to the left-hand side, it can be seen that the partial derivative with respect to  $t$  is  $-(N_{c_{12}} - \frac{2}{3}) > 0$  given that  $N_{c_{12}} < \frac{2}{3}$ . The partial derivative with respect to  $N_{c_{12}}$  is strictly negative, as argued above. Thus, by applying the implicit function theorem to (EC.15), it can be verified that  $\frac{\partial N_{c_{12}}}{\partial t} > 0$ .

Part (ii). Considering the average utility received by members under the non-merged cooperative  $c_3$ , the difference between post-merger and pre-merger utility can be expressed as (a similar analysis can be applied to compare the utilities of members in  $c_{12}$ ):

$$\left( \frac{1}{[1 - N_{c_{12}}]} \frac{\eta}{1 + \eta} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{1}{1+\eta} \right] - O^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{2}{3} \right] - \frac{1}{2} t \left[ \frac{1}{3} - \frac{N_{c_{12}}}{2} \right], \quad (\text{EC.16})$$

where the term for the mismatch cost captures the difference between the expected mismatch costs incurred by members of cooperative  $c_3$  under these two settings. Notice that since  $N_{c_{12}} \in (\frac{1}{2}, \frac{2}{3})$ , consumers of  $c_3$  pay a higher mismatch cost on average post-merger (see, Figure 3(b)). Now,

suppose  $r \rightarrow 1$ . Then, (EC.16) simplifies to

$$S^{1-\theta} \left( \frac{1}{a} S^{-\theta-1} (S - \theta) \right)^{\frac{1-\theta}{\theta}} \left[ \left( \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right)^{\frac{1-\theta}{\theta}} \left( \frac{1}{1-\theta} - \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right) - \left( \frac{2}{3} \right)^{\frac{1-\theta}{\theta}} \left( \frac{1}{1-\theta} - \frac{2}{3} \right) \right] - \frac{1}{2} t \left[ \frac{1}{3} - \frac{N_{c_{12}}}{2} \right] < 0.$$

To see the inequality, note that the function  $x^{\frac{1-\theta}{\theta}} (\frac{1}{1-\theta} - x)$  is strictly increasing in  $x$  for  $x < 1$ , and  $\frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} = \frac{1}{1+\eta} < \frac{2}{3} \iff \eta > \frac{1}{2}$ , which holds. Therefore, the first bracket in the above expression is strictly negative. The second bracket is also strictly positive, and hence the entire expression is strictly negative. This implies that as  $r \rightarrow 1$ , the pre-merger utility is strictly higher than the post-merger utility.

Next, suppose  $r \rightarrow \infty$ , then (EC.16) simplifies to

$$\left( \frac{(1 - N_{c_{12}})^{-\frac{1}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right)^{1-\theta} \left( \frac{1}{1-\theta} - \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right) - \left( \frac{1}{1-\theta} - \frac{2}{3} \right) - \frac{1}{2} t \left[ \frac{1}{3} - \frac{N_{c_{12}}}{2} \right].$$

Applying the implicit function theorem to (EC.15), it can be verified that  $\frac{\partial N_{c_{12}}}{\partial r} > 0$  given the facts that  $\widehat{O}_m$  is strictly decreasing in  $r$  and the left-hand side of (EC.15) is a negative value. This implies that as  $r \rightarrow \infty$ ,  $N_{c_{12}} \rightarrow \frac{2}{3}$  (hence, no difference in mismatch cost compared to pre-merger). Therefore, the above expression simplifies to

$$\begin{aligned} & \left( \frac{(1 - N_{c_{12}})^{-\frac{1}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right)^{1-\theta} \left( \frac{1}{1-\theta} - \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right) - \left( \frac{1}{1-\theta} - \frac{2}{3} \right) \\ & > \left( \frac{1}{1-\theta} - \frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}} \right) - \left( \frac{1}{1-\theta} - \frac{2}{3} \right) = \frac{2}{3} - \frac{1}{1+\eta} > 0, \end{aligned}$$

where we use the fact that  $(1 - N_{c_{12}})^{-\frac{1}{1+\theta}} > N_{c_{12}}^{\frac{\theta}{1+\theta}} + (1 - N_{c_{12}})^{\frac{\theta}{1+\theta}}$ , and for any sign of  $1 - \theta$ , the first inequality holds.

Now, given the continuity of (EC.16) in  $r$ , there exists a value  $r^* \in (1, \infty)$  where the pre-merger utility is equal to the post-merger utility. We now claim that this  $r^*$  is unique where for all  $r < r^*$ , pre-merger utility is higher and for all  $r \geq r^*$ , post-merger utility is higher. To see this, recall that when  $r \rightarrow 1$ , pre-merger utility is higher. Let  $r^*$  be the smallest  $r$  at which pre-merger utility is equal to the post-merger utility. Then, we prove that if (EC.16) is positive at some  $r' \geq r^*$ , it remains strictly positive at  $r'' > r'$ . To see this, first notice that as  $N_{c_{12}}$  increases, the mismatch cost term in (EC.16) decreases. In addition, the first expression in (EC.16) which is  $F(1 - N_{c_{12}})$  also increases in  $N_{c_{12}}$ . Therefore, (EC.16) increases in  $N_{c_{12}}$ . Owing to the fact that  $\frac{\partial N_{c_{12}}}{\partial r} > 0$ , we conclude that the indirect derivative of (EC.16) with respect to  $r$  (through  $N_{c_{12}}$ ) is positive. Next, we investigate the direct derivative of (EC.16) with respect to  $r$ . (EC.16) can be re-written as

$$\frac{3}{4} \left( \frac{1}{[1 - N_{c_{12}}]} \frac{\eta}{1 + \eta} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{1}{1+\eta} \right] - O^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{2}{3} \right]$$

$$+\frac{1}{4}\left(\frac{1}{N_{c_{12}}}\frac{1}{1+\eta}\right)^{1-\theta}\widehat{O}_m^{1-\theta}\left[\frac{1}{1-\theta}-\frac{\eta}{1+\eta}\right], \quad (\text{EC.17})$$

where we substitute for the mismatch cost term using (EC.15). After factoring out the common term  $S^{1-\theta}\left(\frac{1}{ar}S^{-\theta-1}(S-\theta)\right)^{\frac{1-\theta}{r+\theta-1}}$ , the direct derivative of the above expression with respect to  $r$  is

$$\begin{aligned} & \frac{3(1-\theta)\theta}{4(r+\theta-1)^2}\left[\frac{(1-N_{c_{12}})^{-\frac{1}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]^{\frac{(1-\theta)(r-1)}{r+\theta-1}}\left[\frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]^{\frac{1-\theta}{r+\theta-1}} \\ & \times\left[\frac{1}{1-\theta}-\frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]\log\left[\frac{(1-N_{c_{12}})^{-\frac{1}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right] \\ & -\frac{3(1-\theta)}{4(r+\theta-1)^2}\left[\frac{(1-N_{c_{12}})^{-\frac{1}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]^{\frac{(1-\theta)(r-1)}{r+\theta-1}}\left[\frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]^{\frac{1-\theta}{r+\theta-1}} \\ & \times\left[\frac{1}{1-\theta}-\frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]\log\left[\frac{N_{c_{12}}^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right] \\ & +\frac{(1-\theta)\theta}{4(r+\theta-1)^2}\left[\frac{(N_{c_{12}})^{-\frac{1}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]^{\frac{(1-\theta)(r-1)}{r+\theta-1}}\left[\frac{(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]^{\frac{1-\theta}{r+\theta-1}} \\ & \times\left[\frac{1}{1-\theta}-\frac{(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]\log\left[\frac{(N_{c_{12}})^{-\frac{1}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right] \\ & -\frac{(1-\theta)}{4(r+\theta-1)^2}\left[\frac{(N_{c_{12}})^{-\frac{1}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]^{\frac{(1-\theta)(r-1)}{r+\theta-1}}\left[\frac{(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]^{\frac{1-\theta}{r+\theta-1}} \\ & \times\left[\frac{1}{1-\theta}-\frac{(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right]\log\left[\frac{(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}{N_{c_{12}}^{\frac{\theta}{1+\theta}}+(1-N_{c_{12}})^{\frac{\theta}{1+\theta}}}\right] \\ & +\frac{(1-\theta)}{(r+\theta-1)^2}\left[\frac{2}{3}\right]^{\frac{1-\theta}{r+\theta-1}}\left[\frac{1}{1-\theta}-\frac{2}{3}\right]\log\left[\frac{2}{3}\right]>0, \end{aligned}$$

given the facts that (EC.16) is positive at  $r$  and  $3\log\left[\frac{1}{1+\eta}\right]+\log\left[\frac{\eta}{1+\eta}\right]<4\log\left[\frac{2}{3}\right]$ . Putting these observations together, if (EC.16) is positive at some  $r'\geq r^*$ , it remains strictly positive at  $r''>r'$ .

Finally, to see why  $r^*$  is decreasing in  $t$ , consider an arbitrary  $t'>0$  and let  $r_{t'}$  be the value of  $r$  at which post-merger utility is equal to pre-merger utility given  $t'$ . Now, holding  $r=r_{t'}$  fixed, let  $t'$  increase to  $t''$ . Then,  $N_{c_{12}}''$  that solves (EC.15) increases. Accordingly, since (EC.16) is increasing in  $N_{c_{12}}$ , (EC.16) is strictly positive. This means post-merger utility is higher than pre-merger utility under  $t''$  at  $r=r_{t'}$ . Therefore,  $r_{t''}$  must be smaller than  $r_{t'}$ . This completes the proof of part (ii). ■

**Proof of Theorem 4.** Part (i). The existence of equilibrium and the derivation of the procurement budgets for the merged and non-merged cooperatives, as well as the suppliers' production quantities, follow from the proof of Theorem 3 and are hence omitted. Without loss of generality, assume that consumers decide to switch post-merger one at a time. Notice that immediately after the merger of cooperatives 1 and 2, the merged cooperative contains  $N_{c_{12}}=\frac{2}{3}$  measure of con-

sumers and the non-merged cooperative  $c_3$ , the remaining  $\frac{1}{3}$  measure. Therefore, the utilities that consumers receive in the merged and non-merged cooperatives upon merger are, respectively,

$$U_{c_{12}} = \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \widehat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \widehat{B}_m + v_M,$$

and

$$U_{c_3} = \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{[1-N_{c_{12}}]} \frac{\eta}{1+\eta} \widehat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{1}{[1-N_{c_{12}}]} \frac{\eta}{1+\eta} \widehat{B}_m + v,$$

with  $N_{c_{12}} = \frac{2}{3}$ . Define

$$\Delta U = U_{c_3} - U_{c_{12}} > 0, \quad (\text{EC.18})$$

where the inequality follows from Proposition 2(ii). Then, if  $\Delta v = v_M - v < \Delta U$ , consumers want to switch from the merged cooperative to the non-merged one  $c_3$ . Here, if  $\Delta v < \Delta U \leq \Delta v + \alpha$ , no switching occurs; otherwise, if  $\Delta v + \alpha < \Delta U$ , consumers switch. Thus, we can derive the value of  $N_{c_{12}} \in (\frac{1}{2}, \frac{2}{3})$  in equilibrium by setting  $\widehat{U}_{c_{12}} = \widehat{U}_{c_3} - \alpha$  as follows

$$\begin{aligned} & \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \widehat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \widehat{B}_m + v_M \\ &= \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{[1-N_{c_{12}}]} \frac{\eta}{1+\eta} \widehat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{1}{[1-N_{c_{12}}]} \frac{\eta}{1+\eta} \widehat{B}_m + v - \alpha \\ \Leftrightarrow & \left( \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{\eta}{1+\eta} \right] - \left( \frac{1}{[1-N_{c_{12}}]} \frac{\eta}{1+\eta} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{1}{1+\eta} \right] \\ &= v - v_M - \alpha = -\Delta v - \alpha < 0. \end{aligned} \quad (\text{EC.19})$$

Next, if  $\Delta v \geq \Delta U$ , consumers want to switch from the non-merged cooperative to  $c_{12}$ . Here, if  $\Delta v \geq \Delta U \geq \Delta v - \alpha$ , no switching occurs. Otherwise, if  $\Delta v - \alpha > \Delta U$ , consumers switch. Thus, we can derive the value of  $N_{c_{12}} \in (\frac{2}{3}, 1)$  in equilibrium by setting  $\widehat{U}_{c_{12}} - \alpha = \widehat{U}_{c_3}$  as follows

$$\begin{aligned} & \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \widehat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \widehat{B}_m + v_M - \alpha \\ &= \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{[1-N_{c_{12}}]} \frac{\eta}{1+\eta} \widehat{O}_m \right)^{1-\theta} - 1 \right] + I - \frac{1}{[1-N_{c_{12}}]} \frac{\eta}{1+\eta} \widehat{B}_m + v \\ \Leftrightarrow & \left( \frac{1}{N_{c_{12}}} \frac{1}{1+\eta} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{\eta}{1+\eta} \right] - \left( \frac{1}{[1-N_{c_{12}}]} \frac{\eta}{1+\eta} \right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[ \frac{1}{1-\theta} - \frac{1}{1+\eta} \right] \\ &= v - v_M + \alpha = -\Delta v + \alpha < 0. \end{aligned} \quad (\text{EC.20})$$

Because  $\Delta v < \bar{v}$ ,  $N_{c_{12}} < 1$ . The uniqueness of  $N_{c_{12}}$  in the above cases follows from the same arguments used in the proof of Theorem 3. Next, if we bring all the terms in (EC.19) or (EC.20) to the left-hand side, it can be seen that the partial derivative with respect to  $\Delta v$  is 1. The partial derivative with respect to  $N_{c_{12}}$  is strictly negative, as shown in the proof of Theorem 3. Therefore, by applying the implicit function theorem to (EC.19) or (EC.20), it can be verified that  $\frac{\partial N_{c_{12}}}{\partial \Delta v} > 0$ . Using the same argument, it can be verified that  $\frac{\partial N_{c_{12}}}{\partial \alpha} > 0$  in (EC.19) and  $\frac{\partial N_{c_{12}}}{\partial \alpha} < 0$  in (EC.20).

Part (ii). To compare post-merger utility with pre-merger utility in equilibrium, we consider the utility received by members under the non-merged cooperative  $c_3$  (given that  $\widehat{U}_{c_3} = \widehat{U}_{c_{12}} \pm \alpha$

post-merger). The difference between post-merger and pre-merger utility can then be expressed as

$$\left(\frac{1}{[1 - N_{c_{12}}]1 + \eta}\right)^{1-\theta} \widehat{O}_m^{1-\theta} \left[\frac{1}{1-\theta} - \frac{1}{1+\eta}\right] - O^{1-\theta} \left[\frac{1}{1-\theta} - \frac{2}{3}\right], \quad (\text{EC.21})$$

where we use the fact that consumers derive vertical value  $v$  from cooperative  $c_3$  before and after the merger. Now, let  $v^*$  be the unique value such that if  $\Delta v - \alpha = v^*$ , the value of  $N_{c_{12}}$  determined by (EC.20) makes  $\eta = \frac{1}{2}$  (according to (EC.12)). Then all the steps in the proof of Theorem 3, part (ii), can be applied to this case to prove the results.

Part (iii). When  $\Delta v - \alpha > \Delta U$ , in equilibrium we have  $\widehat{U}_{c_{12}} - \alpha = \widehat{U}_{c_3}$ . Now suppose  $r^*$  (and  $r_1^*$ ) are the unique thresholds above which post-merger utility is higher than pre-merger utility for the members of the merged (non-merged) cooperative. Since  $\widehat{U}_{c_{12}} - \alpha = \widehat{U}_{c_3}$ , there exists a region  $(r^*, r_1^*)$  where a merger benefits its members but harm other consumers. ■

**Proof of Proposition 5.** *Existence and Characterization of Unique Equilibrium.* Each cooperative  $c$ 's action is its procurement budget  $b_c \in \mathbb{R}_+$  to maximize utility function  $U_c$ . The necessary first-order optimality condition with respect to  $b_c$  is

$$u' \left( \frac{1}{N} \frac{b_c}{b_c + \widehat{B}_{-c}} \widehat{O} \right) \frac{\widehat{B}_{-c}}{(b_c + \widehat{B}_{-c})^2} \widehat{O} - 1 = 0. \quad (\text{EC.22})$$

Utility function  $u(\cdot)$  is concave, so  $u'(\cdot)$  is a decreasing function. Moreover,  $\frac{1}{N} \frac{b_c}{b_c + \widehat{B}_{-c}} \widehat{O}$  is increasing in  $b_c$  and  $\frac{\widehat{B}_{-c}}{(b_c + \widehat{B}_{-c})^2} \widehat{O}$  is decreasing in  $b_c$ . Thus,  $\frac{\partial(U_c)}{\partial b_c}$  is decreasing in  $b_c$ , and hence  $U_c$  is concave in  $b_c$  (so it is also quasi-concave in  $b_c$ ) and the above necessary condition is also sufficient for optimality. Also note that as  $b_c \rightarrow 0$ , the left-hand side of the above condition converges to a strictly positive value and as  $b_c \rightarrow NI$ , the left-hand side converges to a strictly negative value for a sufficiently large  $I$ , which we assume. Hence, the optimal  $b_c$  admits an interior solution.

*Symmetry of equilibrium procurement budgets.* We will prove that no asymmetric procurement budgets can exist in equilibrium. Suppose to the contrary that there exists an equilibrium with asymmetric procurement budgets. Then, there must be at least two cooperatives (cooperatives 1 and 2 without loss of generality) such that  $\widehat{b}_1 > \widehat{b}_2$ . Then, we obtain  $u' \left( \frac{1}{N} \frac{\widehat{b}_1 \widehat{O}}{\widehat{B}} \right) \frac{(\widehat{B} - \widehat{b}_1) \widehat{O}}{\widehat{B}^2} - 1 < u' \left( \frac{1}{N} \frac{\widehat{b}_2 \widehat{O}}{\widehat{B}} \right) \frac{(\widehat{B} - \widehat{b}_2) \widehat{O}}{\widehat{B}^2} - 1$ , where  $u'$  is a decreasing function. Thus, either  $\widehat{b}_1$  or  $\widehat{b}_2$  cannot satisfy (EC.22), and hence cannot be an equilibrium procurement budget, which is a contradiction.

Let  $\widehat{b}$  denote each cooperative's equilibrium procurement budget. From (EC.22) we obtain

$$\widehat{B} = C\widehat{b} = \frac{C-1}{C} u'(\widehat{O}) \widehat{O}. \quad (\text{EC.23})$$

Moving backward to the first stage, the action of each supplier  $s$  is its production quantity  $o_s \in \mathbb{R}_+$  which is constrained by the capacity constraint  $\kappa$ . Thus, its action set is  $[0, \kappa]$ , which is a non-empty, compact, and convex subset of Euclidean space. Each supplier  $s$  aims to maximize its profit function  $\pi_s = p o_s - \psi(o_s) = \frac{o_s \widehat{B}}{o_s + \widehat{O}_{-s}} - \psi(o_s) = \frac{C-1}{C} o_s u'(o_s + \widehat{O}_{-s}) - \psi(o_s)$  which is continuous in  $o_s$ . The first derivative of the profit function with respect to  $o_s$  is  $\frac{\partial \pi_s}{\partial o_s} = \frac{C-1}{C} u'(o_s + \widehat{O}_{-s}) + \frac{C-1}{C} o_s u''(o_s +$

$\widehat{O}_{-s} - \psi'(o_s)$ . Notice that a sufficiently convex cost function  $\psi''(o_s) \geq \underline{\psi}_1 \geq 0$  makes  $\pi(o_s)$  concave in  $o_s$  (which we assume), and hence it is also quasi-concave in  $o_s$ . Because all conditions of Theorem 1.2 in [Fudenberg and Tirole \(1991\)](#) are satisfied, there exists a pure-strategy Nash equilibrium. Moreover, because each supplier has a concave profit function, the Kuhn-Tucker conditions of each supplier's optimization problem are sufficient for equilibrium. The Lagrangian function of each supplier  $s' \in \{1, 2, \dots, S\}$  profit-maximization problem is

$$\mathcal{L}(o_s, \mu_s, \lambda_s) = \frac{C-1}{C} o_s u'(o_s + \widehat{O}_{-s}) - \psi(o_s) + \mu_s(\kappa - o_s) + \lambda_s o_s,$$

where  $\mu_s \geq 0$  is the Lagrange multiplier of the capacity constraint and  $\lambda_s \geq 0$  is the Lagrange multiplier of the non-negativity constraint  $o_s \geq 0$ . The Kuhn-Tucker conditions are

$$\frac{\partial \mathcal{L}}{\partial o_s} = \frac{C-1}{C} u'(\widehat{O}) + \frac{C-1}{C} \widehat{o}_s u''(\widehat{O}) - \psi'(\widehat{o}_s) - \widehat{\mu}_s + \widehat{\lambda}_s = 0, \forall s \in \{1, \dots, S\} \quad (\text{EC.24})$$

$$\frac{\partial \mathcal{L}}{\partial \mu_s} = \kappa - \widehat{o}_s \geq 0, \forall s \in \{1, 2, \dots, S\} \quad (\text{EC.25})$$

$$\frac{\partial \mathcal{L}}{\partial \lambda_s} = \widehat{o}_s \geq 0, \forall s \in \{1, 2, \dots, S\} \quad (\text{EC.26})$$

$$\widehat{\mu}_s(\kappa - \widehat{o}_s) = 0, \forall s \in \{1, 2, \dots, S\} \quad (\text{EC.27})$$

$$\widehat{\lambda}_s \widehat{o}_s = 0, \forall s \in \{1, 2, \dots, S\}. \quad (\text{EC.28})$$

*Symmetry of equilibrium production quantities.* We will prove that no asymmetric production quantities can exist in equilibrium. Suppose to the contrary that suppliers' equilibrium production quantities are asymmetric. Then, there must be at least two suppliers (suppliers 1 and 2 without loss of generality) such that  $\widehat{o}_1 > \widehat{o}_2$ . In this case, [\(EC.25\)](#) implies that  $\widehat{o}_2 < \kappa$ , so we have  $\widehat{\mu}_2 = 0$  from [\(EC.27\)](#). Because  $\widehat{\lambda}_2 \geq 0$ , we have  $\frac{C-1}{C} u'(\widehat{O}) + \frac{C-1}{C} \widehat{o}_2 u''(\widehat{O}) - \psi'(\widehat{o}_2) \leq 0$ . Similarly, because  $\widehat{o}_1 > \widehat{o}_2$ , we have  $\widehat{o}_1 > 0$  from [\(EC.26\)](#), which implies that  $\widehat{\lambda}_1 = 0$ . Because  $\widehat{\mu}_1 \geq 0$ , we have  $\frac{C-1}{C} u'(\widehat{O}) + \frac{C-1}{C} \widehat{o}_1 u''(\widehat{O}) - \psi'(\widehat{o}_1) \geq 0$ . Moreover,  $\frac{C-1}{C} u'(\widehat{O}) + \frac{C-1}{C} \widehat{o}_s u''(\widehat{O}) - \psi'(\widehat{o}_s)$  is strictly decreasing in  $\widehat{o}_s$ , so  $\widehat{o}_1 > \widehat{o}_2$  implies that  $\frac{C-1}{C} u'(\widehat{O}) + \frac{C-1}{C} \widehat{o}_1 u''(\widehat{O}) - \psi'(\widehat{o}_1) < \frac{C-1}{C} u'(\widehat{O}) + \frac{C-1}{C} \widehat{o}_2 u''(\widehat{O}) - \psi'(\widehat{o}_2) \leq 0$ . However,  $\frac{C-1}{C} u'(\widehat{O}) + \frac{C-1}{C} \widehat{o}_1 u''(\widehat{O}) - \psi'(\widehat{o}_1) < 0$  contradicts with  $\frac{C-1}{C} u'(\widehat{O}) + \frac{C-1}{C} \widehat{o}_1 u''(\widehat{O}) - \psi'(\widehat{o}_1) \geq 0$ . Therefore, the equilibrium should be symmetric.

Let  $\widehat{o}$  denote each supplier's equilibrium production quantity. Evaluating [\(EC.24\)](#)-[\(EC.28\)](#) at the symmetric equilibrium yields the following equations for the equilibrium production quantity  $\widehat{o}$

$$\frac{C-1}{C} \left[ u'(S\widehat{o}) + \widehat{o} u''(S\widehat{o}) \right] - \psi'(\widehat{o}) - \widehat{\mu} + \widehat{\lambda} = 0, \quad (\text{EC.29})$$

$$\kappa - \widehat{o} \geq 0, \quad (\text{EC.30})$$

$$\widehat{o} \geq 0, \widehat{\mu}(\kappa - \widehat{o}) = 0, \widehat{\lambda} \widehat{o} = 0. \quad (\text{EC.31})$$

Now, if the capacity constraint is binding, we have  $\widehat{o} = \kappa$  which uniquely pins down  $\widehat{b}$  by [\(EC.23\)](#). Otherwise, suppose the capacity constraint is not binding, i.e.,  $0 < \widehat{o} < \kappa$ . Then,  $\widehat{\mu} = \widehat{\lambda} = 0$ . Using a similar argument as in the proof of symmetry of production quantities, one can verify that

$\hat{\delta} = \kappa$  cannot be an equilibrium production quantity in this case, so the equilibrium production quantity,  $\hat{\delta}$ , is unique which also uniquely pins down  $\hat{b}$  by (EC.23). Observe that  $\hat{\delta}$  in this case solves  $\frac{C-1}{C} \left[ u'(S\hat{\delta}) + \hat{\delta}u''(S\hat{\delta}) \right] = \psi'(\hat{\delta}) > 0$  which implies that  $u'(S\hat{\delta}) + \hat{\delta}u''(S\hat{\delta}) = u'(S\hat{\delta}) \left[ 1 - \frac{R(S\hat{\delta})}{S} \right] > 0 \iff R(S\hat{\delta}) < S$ , where  $R(x) = -\frac{xu''(x)}{u'(x)}$  captures each consumer's coefficient of relative risk aversion. Moreover, we assume that  $\frac{C-1}{C}u'(0) > \psi'(0)$  to ensure that  $\hat{\delta} > 0$  by (EC.29). Finally, the price can be obtained as  $\hat{p} = \frac{\hat{B}}{\hat{\delta}}$ . This completes the proof. ■

**Proof of Proposition 6.** When the capacity constraint is not binding, we have

$$\frac{C-1}{C}u'(S\hat{\delta}) + \frac{C-1}{C}\hat{\delta}u''(S\hat{\delta}) - \psi'(\hat{\delta}) = 0, \quad (\text{EC.32})$$

$$\hat{B} = C\hat{b} = \frac{C-1}{C}u'(\hat{\delta})\hat{\delta}. \quad (\text{EC.33})$$

Using (EC.32) and by the implicit function theorem, we have

$$\frac{\partial \hat{\delta}}{\partial C} = -\frac{\frac{1}{C^2} \left[ u'(S\hat{\delta}) + \hat{\delta}u''(S\hat{\delta}) \right]}{\frac{C-1}{C}Su''(S\hat{\delta}) + \frac{C-1}{C}u''(S\hat{\delta}) + \frac{C-1}{C}S\hat{\delta}u'''(S\hat{\delta}) - \psi''(\hat{\delta})} > 0,$$

for a sufficiently convex cost function  $\psi(\hat{\delta})$  which we assume. This implies that  $\hat{\delta} < \kappa$  is increasing in  $C$ . Moreover, when  $\hat{\delta} = \kappa$ , it is non-decreasing in  $C$ . Next, when  $\hat{\delta} < \kappa$ ,  $\hat{B}$  is given by (EC.33). Thus,  $\hat{p} = \frac{\hat{B}}{\hat{\delta}} = \frac{C-1}{C}u'(\hat{\delta}) = \frac{\psi'(\hat{\delta})u'(S\hat{\delta})}{u'(S\hat{\delta}) + \hat{\delta}u''(S\hat{\delta})}$  after substituting for  $\frac{C-1}{C}$  from (EC.32). Because  $\frac{u'(S\hat{\delta})}{u'(S\hat{\delta}) + \hat{\delta}u''(S\hat{\delta})} \geq 0$ , one can verify that for a sufficiently convex cost function  $\psi(\hat{\delta})$  (i.e.,  $\psi''(\hat{\delta}) \geq \underline{\psi}_1$ ),  $\frac{d\hat{p}}{dC} = \frac{\partial \hat{p}}{\partial \hat{\delta}} \frac{\partial \hat{\delta}}{\partial C} \geq 0$ , implying that  $\hat{p}$  is increasing in  $C$ . Finally, when  $\hat{\delta} = \kappa$ , from (EC.23),  $\hat{p} = \frac{\hat{B}}{\hat{\delta}} = \frac{C-1}{C}u'(S\kappa)$ . Since  $u'(S\kappa) > 0$  is constant in  $C$  and  $\frac{C-1}{C}$  is increasing in  $C$ , we have  $\hat{p}$  increasing in  $C$ . ■

**Proof of Theorem 5.** (i) In equilibrium, consumer utility  $\hat{U}_c = u(S\hat{\delta}) + I - \hat{B}$ . We first show that  $U_c$  is unimodal in  $C$ , i.e., there exists  $C^*$  such that  $\frac{d\hat{U}_c}{dC} > 0$  for all  $C < C^*$  and  $\frac{d\hat{U}_c}{dC} < 0$  for all  $C > C^*$ . When  $\hat{\delta} = \kappa$  is constant in  $C$ ,  $\hat{B} = \frac{C-1}{C}u'(S\kappa)S\kappa$  is increasing in  $C$ , so  $\hat{U}_c$  decreases with  $C$ . If  $\hat{\delta} = \kappa$  even for  $C = 2$ , then because  $\hat{\delta}$  is non-decreasing in  $C$ ,  $C^* = 2$ . Next, suppose that  $\hat{\delta} < \kappa$  for  $C = 2$ . Then because  $\hat{\delta}$  is increasing in  $C$ , there exists  $C_0 \in (2, +\infty]$  such that for all  $C < C_0$ , we have  $\hat{\delta} < \kappa$  and for all  $C \geq C_0$ , we have  $\hat{\delta} = \kappa$ . For  $C < C_0$ ,  $\hat{\delta} < \kappa$ , so  $\hat{b}$  is given by (EC.33). Thus,  $\hat{U}_c = u(S\hat{\delta}) + I - \frac{C-1}{C}u'(S\hat{\delta})S\hat{\delta} = u(S\hat{\delta}) + I - \frac{\psi'(\hat{\delta})u'(S\hat{\delta})S\hat{\delta}}{u'(S\hat{\delta}) + \hat{\delta}u''(S\hat{\delta})}$  after substituting for  $\frac{C-1}{C}$  from (EC.32). The derivative of  $\hat{U}_c$  with respect to  $C$  is  $\frac{d\hat{U}_c}{dC} = \phi(\hat{\delta}) \frac{\partial \hat{\delta}}{\partial C}$ , where  $\phi(\hat{\delta}) \equiv Su'(S\hat{\delta}) - \psi''(\hat{\delta})G(\hat{\delta}) - \psi'(\hat{\delta})G'(\hat{\delta})$  where  $G(\hat{\delta}) \equiv \frac{u'(S\hat{\delta})S\hat{\delta}}{u'(S\hat{\delta}) + \hat{\delta}u''(S\hat{\delta})} > 0$ . Noting that  $\frac{\partial \phi(\hat{\delta})}{\partial \hat{\delta}} = S^2u''(S\hat{\delta}) - \psi'''(\hat{\delta})G(\hat{\delta}) - 2\psi''(\hat{\delta})G'(\hat{\delta}) - \psi'(\hat{\delta})G''(\hat{\delta})$  and  $u(S\hat{\delta})$  is concave, a sufficiently convex function  $\psi'(\hat{\delta})$  (which we assume by  $\psi'''(\hat{\delta}) \geq \underline{\psi}_2$ ) implies that  $\phi(\hat{\delta})$  is decreasing in  $\hat{\delta}$  and hence  $C$ . Following this observation, we have three cases. First, if  $\phi(\hat{\delta}) \leq 0$  even under  $C = 2$ , then because  $\phi(\hat{\delta})$  is decreasing in  $C$ ,  $\phi(\hat{\delta}) < 0$  for all  $C > 2$ . Thus,  $C^* = 2$ . Second, if  $\phi(\hat{\delta}) \geq 0$  under  $C = C_0$ , because  $\phi(\hat{\delta})$  is decreasing in  $C$ ,  $\phi(\hat{\delta}) > 0$  for all  $C < C_0$ . Thus,  $C^* = C_0$ . Finally, if  $\phi(\hat{\delta}) > 0$  even under  $C = 2$  and  $\phi(\hat{\delta}) < 0$  under  $C = C_0$ , because  $\phi(\hat{\delta})$  is continuous and decreasing in  $C$ , there should exist  $C^* \in (2, C_0)$  such that  $\phi(\hat{\delta}) > 0$  for all  $C < C^*$  and  $\phi(\hat{\delta}) < 0$  for all  $C > C^*$ . Because  $\frac{d\hat{U}_c}{dC} = \phi(\hat{\delta}) \frac{\partial \hat{\delta}}{\partial C}$  and  $\frac{\partial \hat{\delta}}{\partial C} > 0$ , we have  $\frac{d\hat{U}_c}{dC} > 0$  for all  $C < C^*$

and  $\frac{d\hat{U}_c}{dC} < 0$  for all  $C > C^*$ . (ii) Note that when  $\kappa$  increases, it is more likely that  $\hat{\delta} < \kappa$  so  $C_0$  is non-decreasing in  $\kappa$ . In the first and third cases discussed above,  $C^*$  is less than  $C_0$  so it does not change with  $\kappa$ . In the second case discussed above,  $C^* = C_0$  which is non-decreasing in  $\kappa$ . Thus,  $C^*$  is non-decreasing in  $\kappa$ . Finally, when  $\kappa$  is sufficiently small,  $\hat{\delta} = \kappa$ , even under  $C = 2$ . Thus, as discussed above  $C^* = 2$  in that case. ■

### EC.1.1. Decreasing Marginal Cost of Production

**Proof of Theorem 6.** We first extend the proof of Proposition 1 to characterize the pre-merger equilibrium under decreasing marginal cost of production (i.e.,  $r \in (0, 1)$ ). The equilibrium analysis for characterizing cooperatives' procurement budgets is unaffected in this case, and hence we focus on characterizing suppliers' production quantities. The action of each supplier  $s$  is its production quantity  $o_s \in \mathbb{R}_+$  to maximize its profit function  $\pi_s = po_s - ao_s^r = \frac{o_s \hat{B}}{o_s + \hat{O}_{-s}} - ao_s^r = \frac{C-1}{C} o_s (o_s + \hat{O}_{-s})^{-\theta} - ao_s^r$  (after substituing  $\hat{B}$  from (14)) which is continuous in  $o_s$ . Towards the goal of characterizing a symmetric pure-strategy equilibrium in which all suppliers produce positive production quantities, the necessary first-order optimality condition with respect to  $o_s$  can be expressed as

$$\frac{\partial \pi_s}{\partial o_s} = \frac{C-1}{C} (o_s + \hat{O}_{-s})^{-\theta} - \frac{C-1}{C} \theta o_s (o_s + \hat{O}_{-s})^{-\theta-1} - ar o_s^{r-1} = 0. \quad (\text{EC.34})$$

Observe that since  $\theta > 1 - r$ ,  $\pi_s < 0$  as  $o_s \rightarrow +\infty$ . In addition,  $\pi_s = 0$  and  $\frac{\partial \pi_s}{\partial o_s} < 0$  as  $o_s \rightarrow 0$ . Therefore, the optimal production quantity should admit an interior solution. By invoking symmetry, (EC.34) admits a unique solution as given in (7).

To verify that (7) forms an equilibrium and that the second-order optimality condition is met, we can examine the second derivative of the supplier's optimization problem as follows:

$$-\theta \frac{C-1}{C} (o_s + \hat{O}_{-s})^{-\theta-2} \left[ 2(o_s + \hat{O}_{-s}) - (1 + \theta)o_s \right] - ar(r-1)o_s^{r-2}. \quad (\text{EC.35})$$

We now claim that the above expression is strictly negative (implying that the sufficiency condition is met) for any candidate production quantity  $o_s$  that satisfies the necessary condition in (EC.34) and generates a positive profit for supplier  $s$ . To see this, we can rewrite (EC.35) as follows:

$$\begin{aligned} & -\theta \frac{C-1}{C} (o_s + \hat{O}_{-s})^{-\theta-1} \left[ 1 - \theta \frac{o_s}{o_s + \hat{O}_{-s}} + 1 - \frac{o_s}{o_s + \hat{O}_{-s}} \right] - ar(r-1)o_s^{r-2} \\ \propto & -\theta \frac{C-1}{C} (o_s + \hat{O}_{-s})^{-\theta-1} o_s \left[ 1 - \theta \frac{o_s}{o_s + \hat{O}_{-s}} + 1 - \frac{o_s}{o_s + \hat{O}_{-s}} \right] \\ & - (r-1) \frac{C-1}{C} (o_s + \hat{O}_{-s})^{-\theta} \left[ 1 - \theta \frac{o_s}{o_s + \hat{O}_{-s}} \right] \\ \propto & -\theta \frac{o_s}{o_s + \hat{O}_{-s}} \left[ 1 - \theta \frac{o_s}{o_s + \hat{O}_{-s}} + 1 - \frac{o_s}{o_s + \hat{O}_{-s}} \right] - (r-1) \left[ 1 - \theta \frac{o_s}{o_s + \hat{O}_{-s}} \right] \\ = & - \left[ 1 - \theta \frac{o_s}{o_s + \hat{O}_{-s}} \right] \left[ r-1 + \theta \frac{o_s}{o_s + \hat{O}_{-s}} \right] - \theta \frac{o_s}{o_s + \hat{O}_{-s}} \left[ 1 - \frac{o_s}{o_s + \hat{O}_{-s}} \right] < 0, \quad (\text{EC.36}) \end{aligned}$$

where the second and third lines are obtained by multiplying the first line by  $o_s$  and substituting  $ar o_s^{r-1}$  from (EC.34), and the fourth line is obtained by dropping some common positive terms. To see why the last expression is strictly negative, it is enough to show that the first two brackets are positive. The first bracket must be positive to hold (EC.34) equal to zero, as shown below

$$\frac{C-1}{C}(o_s + \widehat{O}_{-s})^{-\theta} \left[ 1 - \theta \frac{o_s}{o_s + \widehat{O}_{-s}} \right] - ar o_s^{r-1} = 0.$$

In addition, given that the supplier must earn a positive profit at any candidate  $o_s$ , we can write

$$\begin{aligned} \pi_s &= \frac{C-1}{C} o_s (o_s + \widehat{O}_{-s})^{-\theta} - ar o_s^r \geq 0 \\ \iff & \frac{C-1}{C} o_s (o_s + \widehat{O}_{-s})^{-\theta} - \frac{C-1}{C^r} o_s (o_s + \widehat{O}_{-s})^{-\theta} \left[ 1 - \theta \frac{o_s}{o_s + \widehat{O}_{-s}} \right] \geq 0 \\ \iff & r - 1 + \theta \frac{o_s}{o_s + \widehat{O}_{-s}} \geq 0, \end{aligned}$$

where the second line is obtained by substituting  $ar o_s^r$  from (EC.34). Therefore, we prove our claim.

Next, we show that there is only one candidate production quantity  $o_s$  that satisfies the necessary condition in (EC.34) and generates a positive profit for supplier  $s$ . To see this, we can multiply (EC.34) by  $o_s^{1-r}$  and rearrange terms to obtain

$$\frac{C-1}{C} o_s^{1-r} (o_s + \widehat{O}_{-s})^{-\theta} \left[ 1 - \theta \frac{o_s}{o_s + \widehat{O}_{-s}} \right] = ar, \quad (\text{EC.37})$$

for any candidate production quantity that satisfies the necessary optimality condition. As shown above, the term in the brackets above cannot be negative for any candidate optimum, so we can restrict our attention to such production quantities. In this case, the term in the brackets strictly decreases with such  $o_s$ . In addition,  $o_s^{1-r} (o_s + \widehat{O}_{-s})^{-\theta}$  also decreases in  $o_s$  if  $r - 1 + \theta \frac{o_s}{o_s + \widehat{O}_{-s}} \geq 0$  which holds given that the supplier must earn a positive profit at any candidate  $o_s$  (as shown above). Therefore, the left-hand side of (EC.37) strictly decreases in  $o_s$  values of focus, whereas its right-hand side remains constant. As a result, (EC.34) admits a unique solution as long as the profit function is positive, and that solution is the global maximum.

Lastly, we verify that each supplier earns a strictly positive profit by producing the candidate symmetric production quantity than by producing nothing (in which case the supplier's profit would be zero). Plugging in the value of the candidate solution from (7) in the supplier's profit function, it can be verified that this condition holds given that  $\theta > S(1-r)$ .

The price can also be obtained as  $\widehat{p} = \frac{\widehat{B}}{\widehat{O}}$ . Therefore, our equilibrium in Proposition 1 is the unique symmetric equilibrium under decreasing marginal cost of production.

Subsequent results in §4 follow similarly and still hold with an exception in Proposition 3 where we can show that the price is decreasing in  $C$  under decreasing marginal cost of production

$$\widehat{p} = \frac{C\widehat{b}}{S\widehat{O}} \propto \left[ \frac{C-1}{C} \right]^{\frac{r-1}{r+\theta-1}}$$

which is decreasing in  $C$  if  $r < 1$ . Finally, the proof of Theorem 2 can be extended to this case by verifying that when  $r \in (1 - \theta, 1)$ , we have  $r + \theta - 1 > 0$  and  $1 - r \left(\frac{C-1}{C}\right) > 0$ . Thus,  $C^* \rightarrow \infty$ . ■

### EC.1.2. Downstream Competition with a For-profit Retailer

**Pre-merger Equilibrium.** The existence of equilibrium and symmetry of suppliers' production quantities follow from previous proofs and are hence omitted. As in our base model, strategic consumers first choose whether to join one of the two cooperatives or buy from the retailer. To keep the focus on the retailer's presence and its impact on consumers' gain or loss from the mergers of cooperatives, we focus on equilibria where  $N_c > 0$  (to be determined endogenously) measure of consumers joins each cooperative and the remaining  $1 - 2N_c > 0$  measure opts to buy from the retailer. Specifically, the marginal consumer who is indifferent between joining a cooperative or buying from the retailer will be determined endogenously by anticipating the corresponding utility under each strategy in equilibrium. Given  $N_c$ , cooperative  $c$  solves

$$\max_{b_c} \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N_c} \frac{b_c}{b_c + \widehat{B}_{-c}} \widehat{O} \right)^{1-\theta} - 1 \right] + I - \frac{b_c}{N_c}. \quad (\text{EC.38})$$

The necessary (and sufficient) optimality condition solves

$$\left( \frac{1}{N_c} \frac{b_c}{b_c + \widehat{B}_{-c}} \widehat{O} \right)^{-\theta} \frac{\widehat{B}_{-c}}{(b_c + \widehat{B}_{-c})^2} \widehat{O} - 1 = 0. \quad (\text{EC.39})$$

In addition, each consumer who buys from the retailer solves (not considering the mismatch cost as it won't change the consumption):

$$\max_x \gamma + \frac{1}{1-\theta} [x^{1-\theta} - 1] + I - p_f x. \quad (\text{EC.40})$$

The necessary and sufficient optimality condition with respect to  $x$  is  $x^{-\theta} - p_f = 0$ . Notice that as  $x \rightarrow 0$ , the left-hand side of this condition converges to a strictly positive value and as  $x \rightarrow (I/p_f)$ , the left-hand side converges to a strictly negative value for a sufficiently large  $I$  which we assume as in the base model ( $I > \bar{I}$ ). Hence, the optimal  $x$  admits an interior solution in the form of  $\widehat{x} = p_f^{-\frac{1}{\theta}}$ . Therefore, the aggregate demand of the retailer  $q_f = (1 - 2N_c) p_f^{-\frac{1}{\theta}}$ . This implies that  $q_f^{-\theta} = (1 - 2N_c)^{-\theta} p_f$ . Moreover,  $q_f = \frac{b_f}{p} = \frac{b_f}{B} O = \frac{b_f}{b_f + \widehat{B}_{-f}} O$ . Then, given  $N_c$ , the retailer solves

$$\max_{b_f} (p_f - p) q_f \equiv \max_{b_f} (p_f q_f - b_f), \quad (\text{EC.41})$$

where  $p_f q_f = q_f^{1-\theta} (1 - 2N_c)^\theta = \left( \frac{b_f}{b_f + \widehat{B}_{-f}} O \right)^{1-\theta} (1 - 2N_c)^\theta$ . The first-order optimality condition with respect to  $b_f$  must satisfy

$$(1 - \theta) \left( \frac{1}{[1 - 2N_c]} \frac{b_f}{b_f + \widehat{B}_{-f}} \widehat{O} \right)^{-\theta} \frac{\widehat{B}_{-f}}{(b_f + \widehat{B}_{-f})^2} \widehat{O} - 1 \leq 0. \quad (\text{EC.42})$$

Observe that if  $1 - \theta \leq 0$ , the above condition holds with strict inequality and hence  $b_f = 0$ . This is because when  $\theta \geq 1$ , consumers are extremely risk averse and prefer to join a non-profit cooperative rather than buy from a for-profit retailer. In this case, the retailer would be better off not spending any procurement budget and serving no consumers, as the net profit would be negative. This

implies that when  $\theta \geq 1$ , the results are similar to our base model where the retailer does not exist in the market. Therefore, suppose,  $1 - \theta > 0$  and hence  $b_f > 0$  satisfies the above necessary and sufficient condition with equality. (EC.39) and (EC.42) together imply that  $\eta = \frac{\widehat{b}_c}{\widehat{b}_f}$  solves

$$\frac{2(1-\theta)\eta^{1+\theta}}{1+\eta} = \left( \frac{N_c}{1-2N_c} \right)^\theta. \quad (\text{EC.43})$$

Rearranging the terms, we obtain  $N_c = \frac{\omega}{1+2\omega}$  where  $\omega = \left( \frac{2(1-\theta)\eta^{1+\theta}}{1+\eta} \right)^{\frac{1}{\theta}}$ . Since  $\widehat{B} = 2\widehat{b}_c + \widehat{b}_f = (1+2\eta)\widehat{b}_f$ , we have  $\frac{\widehat{b}_f}{\widehat{B}} = \frac{1}{1+2\eta}$  and  $\frac{\widehat{b}_c}{\widehat{B}} = \frac{\eta}{1+2\eta}$ . Using (EC.39) and (EC.42), we obtain

$$\widehat{B} = \left( \frac{1}{N_c} \frac{\eta}{1+2\eta} \right)^{-\theta} \frac{1+\eta}{1+2\eta} \widehat{O}^{1-\theta} = (1-\theta) \left( \frac{1}{[1-2N_c]} \frac{1}{1+2\eta} \right)^{-\theta} \frac{2\eta}{1+2\eta} \widehat{O}^{1-\theta}. \quad (\text{EC.44})$$

In addition, each supplier  $s$  chooses its production quantity  $o_s$  to maximize its profit  $\pi_s = p o_s - a o_s^r = \frac{o_s \widehat{B}}{o_s + \widehat{O}_{-s}} - a o_s^r = \left( \frac{1}{N_c} \frac{\eta}{1+2\eta} \right)^{-\theta} \frac{1+\eta}{1+2\eta} o_s (o_s + \widehat{O}_{-s})^{-\theta} - a o_s^r$ . Taking the necessary (and sufficient) first-order optimality condition with respect to  $o_s$ , the production quantity by each supplier solves:

$$\begin{aligned} \widehat{o} &= \left[ \left( \frac{1}{N_c} \frac{\eta}{1+2\eta} \right)^{-\theta} \frac{1+\eta}{1+2\eta} \frac{1}{ar} S^{-\theta-1} (S-\theta) \right]^{\frac{1}{r+\theta-1}} \\ &= \left[ (1-\theta) \left( \frac{1}{[1-2N_c]} \frac{1}{1+2\eta} \right)^{-\theta} \frac{2\eta}{1+2\eta} \frac{1}{ar} S^{-\theta-1} (S-\theta) \right]^{\frac{1}{r+\theta-1}}. \end{aligned} \quad (\text{EC.45})$$

Now, we can derive the value of  $N_c$  in equilibrium. For a consumer who is indifferent between joining a cooperative or buying from the retailer, we must have

$$\begin{aligned} \widehat{U}_c - t \left( N_c - \frac{1}{6} \right) &= \widehat{U}_f - t \left( \frac{1}{2} - N_c \right) \\ \iff \widehat{U}_c - \widehat{U}_f &= 2t \left( N_c - \frac{1}{3} \right) \\ \iff \frac{1}{1-\theta} \left[ \left( \frac{1}{N_c} \frac{\eta}{1+2\eta} \widehat{O} \right)^{1-\theta} - 1 \right] - \frac{1}{N_c} \frac{\eta}{1+2\eta} \widehat{B} \\ &\quad - \frac{1}{1-\theta} [\widehat{x}^{1-\theta} - 1] + p_f \widehat{x} = 2t \left( N_c - \frac{1}{3} \right), \end{aligned} \quad (\text{EC.46})$$

where  $\widehat{U}_c$  and  $\widehat{U}_f$  indicate the utility a consumer receives in equilibrium from joining a cooperative or visiting the retailer, respectively.

**Post-merger Equilibrium.** As in §5, consider a post-merger setting where cooperatives 1 and 2 merge to form cooperative  $c_{12}$  and compete with the retailer downstream in the supply chain. Let  $N'_c$  be the size of merged cooperative  $c_{12}$  in equilibrium. Then, cooperative  $c_{12}$  solves

$$\max_{b'_c} \gamma + \frac{1}{1-\theta} \left[ \left( \frac{1}{N'_c} \frac{b'_c}{b'_c + \widehat{B}'_{-c}} \widehat{O}' \right)^{1-\theta} - 1 \right] + I - \frac{b'_c}{N'_c}. \quad (\text{EC.47})$$

The necessary (and sufficient) optimality condition solves

$$\left( \frac{1}{N'_c} \frac{b'_c}{b'_c + \widehat{B}'_{-c}} \widehat{O}' \right)^{-\theta} \frac{\widehat{B}'_{-c}}{(b'_c + \widehat{B}'_{-c})^2} \widehat{O}' - 1 = 0. \quad (\text{EC.48})$$

In addition, those consumers who buy from the retailer solve:

$$\max_{x'} \gamma + \frac{1}{1-\theta} [x'^{1-\theta} - 1] + I - p'_f x'. \quad (\text{EC.49})$$

The necessary first-order optimality condition with respect to  $x'$  is  $x'^{-\theta} - p'_f = 0$  which is also sufficient. Thus,  $\widehat{x}' = p'_f{}^{-\frac{1}{\theta}}$ . Thus the aggregate demand of the retailer  $q'_f = (1 - N'_c)p'_f{}^{-\frac{1}{\theta}}$ . This implies that  $q'_f{}^{-\theta} = (1 - N'_c)^{-\theta}p'_f$ . Moreover,  $q'_f = \frac{b'_f}{p'} = \frac{b'_f}{\widehat{B}'_f}O' = \frac{b'_f}{b'_f + \widehat{B}'_{-f}}O'$ . Then, the retailer solves

$$\max_{b'_f} (p'_f - p')q'_f \equiv \max_{b'_f} (p'_f q'_f - b'_f), \quad (\text{EC.50})$$

where  $p'_f q'_f = q'_f{}^{1-\theta}(1 - N'_c)^\theta = \left(\frac{b'_f}{b'_f + \widehat{B}'_{-f}}O'\right)^{1-\theta}(1 - N'_c)^\theta$ . The first-order optimality condition with respect to  $b'_f$  must satisfy

$$(1 - \theta) \left( \frac{1}{[1 - N'_c] b'_f + \widehat{B}'_{-f}} \widehat{O}' \right)^{-\theta} \frac{\widehat{B}'_{-f}}{(b'_f + \widehat{B}'_{-f})^2} \widehat{O}' - 1 \leq 0. \quad (\text{EC.51})$$

As in the pre-merger case, we assume that  $1 - \theta > 0$  and hence  $b'_f > 0$  satisfies the above condition (which is also sufficient) with equality. (EC.48) and (EC.51) together imply that  $\eta' = \frac{\widehat{b}'_c}{\widehat{b}'_f}$  solves

$$(1 - \theta)\eta'^{1+\theta} = \left( \frac{N'_c}{1 - N'_c} \right)^\theta \Rightarrow N'_c = \frac{\omega'}{1 + \omega'}, \quad (\text{EC.52})$$

where  $\omega' = ((1 - \theta)\eta'^{1+\theta})^{\frac{1}{\theta}}$ . Since  $\widehat{B}' = \widehat{b}'_c + \widehat{b}'_f = (1 + \eta')\widehat{b}'_f$ , we have  $\frac{\widehat{b}'_f}{\widehat{B}'} = \frac{1}{1 + \eta'}$  and  $\frac{\widehat{b}'_c}{\widehat{B}'} = \frac{\eta'}{1 + \eta'}$ . Using (EC.48) and (EC.51), we obtain

$$\widehat{B}' = \left( \frac{1}{N'_c} \frac{\eta'}{1 + \eta'} \right)^{-\theta} \frac{1}{1 + \eta'} \widehat{O}'^{1-\theta} = (1 - \theta) \left( \frac{1}{[1 - N'_c] 1 + \eta'} \right)^{-\theta} \frac{\eta'}{1 + \eta'} \widehat{O}'^{1-\theta}. \quad (\text{EC.53})$$

In addition, solving each supplier's maximization problem as before, the production quantity by each supplier solves:

$$\begin{aligned} \widehat{\sigma}' &= \left[ \left( \frac{1}{N'_c} \frac{\eta'}{1 + \eta'} \right)^{-\theta} \frac{1}{1 + \eta'} \frac{1}{ar} S^{-\theta-1} (S - \theta) \right]^{\frac{1}{r+\theta-1}} \\ &= \left[ (1 - \theta) \left( \frac{1}{[1 - N'_c] 1 + \eta'} \right)^{-\theta} \frac{\eta'}{1 + \eta'} \frac{1}{ar} S^{-\theta-1} (S - \theta) \right]^{\frac{1}{r+\theta-1}}. \end{aligned} \quad (\text{EC.54})$$

Now, we can derive the value of  $N'_c$  in equilibrium. To satisfy the indifference condition for the marginal consumer,  $N'_c$  must solve

$$\widehat{U}'_c - t \left( \frac{N'_c}{2} - \frac{1}{6} \right) = \widehat{U}'_f - t \left( \frac{1}{2} - \frac{N'_c}{2} \right) \iff \widehat{U}'_c - \widehat{U}'_f = t \left( N'_c - \frac{2}{3} \right). \quad (\text{EC.55})$$

Finally, we are interested in comparing the difference between post-merger and pre-merger member-consumer utility which is given by  $\widehat{U}'_c - \widehat{U}_c - \frac{1}{4}t(2N_c - N'_c)$ . Here, the term for the mismatch cost captures the difference between the expected mismatch costs incurred by the members of cooperatives under these two settings. To answer this question, we conduct a rigorous numerical analysis with 10,000 random instances of  $(\theta, t, S, a)$ . In particular, at each instance, we randomly select the number of suppliers  $S$  from  $U[2, 10]$ , the supplier cost function coefficient  $a$  from  $U[0.5, 1]$ , consumer utility coefficient  $\theta$  from  $U(0, 1)$ , and the mismatch cost  $t$  from  $U[0, 10]$ . In all of these 10,000 random instances, we verify that mergers of cooperatives harm member consumers if and only if the production scale-up cost  $r$  is lower than a threshold. Figure 8 in the main body illustrates the results for one such instance and shows that our results in Theorem 3 are robust in this case. ■