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Cooperation among competitors: A comparison of cost-sharing mechanisms

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ABSTRACT

In this paper, we investigate the consequences of using outcome-based versus ex ante-based cost-sharing mechanisms in terms of competing firms' profitability and total welfare. We consider two firms making a joint expenditure, which can positively affect firms' demand and/or unit operating costs, while competing in the final market by setting either price or quantity. We compare two outcome-based cost-sharing mechanisms, i.e., Quantity Proportional (QP) and Total Margin proportional (TM), with the more competitive Fixed Share (FS) mechanism where cost-sharing is set up on an ex ante basis. We show that outcome-based mechanisms, and even a fully collusive behavior induced by the optimal cost-sharing mechanism, might actually enhance total welfare as compared with the more competitive FS mechanism. We also find that, although the FS mechanism is never more preferable than the TM mechanism, it can lead to higher profits than the QP mechanism when competition is mild. These results can support firms cooperating with competitors in the choice of the cost-sharing mechanism as well as provide important implications to policy makers.

1. Introduction

Cooperation among competitors can take the most disparate forms, such as alliances, consortia, cooperatives, joint production, marketing or R&D agreements, across the most disparate industries, e.g., aerospace, agri-food, automotive, financial, IT and electronics, pharmaceutical, and retail (Hansmann, 1996; Rochet and Tirole, 2002; Akcay and Tan, 2008; Rodriguez Monroy and Vilana Arto, 2010; Chen and Roma, 2011; Ghosh and Morita, 2012; Lo Nigro et al., 2013; Tomlinson and Fai, 2013).

In this context, one important, yet understudied, question relates to the profit and welfare implications of different mechanisms that competing firms may use to share joint expenditures or investments. Cost sharing is indeed one of the most common reasons behind firms' cooperation (Cassiman and Veugelers, 2002). Real examples suggest that cost sharing is usually set up on an ex ante basis in many R&D joint ventures. Consider, for instance, firms investing in a joint venture to develop a new technology, and then competing independently in the product market. In these cases, firms often decide the shares of the joint investment before they engage in market competition and do not allow any ex post adjustment based on market outcomes such as margins or sales. For instance, the contribution to the R&D investment was set up on an ex ante fixed basis for the R&D agreement between Sony and Samsung to develop new LCD technology (Gnyawali and Park, 2011). The ex ante fixed sharing rule is also utilized by the Blu-ray Disc Association, i.e., the R&D consortium consisting of all major consumer electronics manufacturers that developed the Blu-ray technology (Blu-ray Disc Association, 2015). Similarly, product design and other R&D costs for memory technologies are split based on a fixed share by Intel and Micron in their joint venture IM Flash Technologies (Micron, 2014).

In some other cases, firms might leave room for ex post adjustments or entirely base the joint expenditure allocation on market outcomes. The latter situations may arise in case of stable research consortia. For instance, R&D activities of Sematech, the worldwide R&D consortium of semi-conductor manufacturers, have been financed through members' contributions proportionally to their sales (Katz et al., 1990). Similarly, in the joint production alliance between car manufacturers PSA and Toyota, the capital expenses related to the common plant are divided proportionally to the production output of the two companies (ATZ online, 2004). Outcome-based allocation mechanisms are even more popular in agri-food and retail cooperatives/consortia, where firms cooperate for certain activities but still compete in the product market (Albaek and Schultz, 1997). The US Department of Agriculture explains that manufacturing and marketing operations are usually financed by cooperatives' members through mechanisms, such as patronage refunds or per-unit retains, which are indeed outcome-based mechanisms (US Department of

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Agriculture, 1994). For instance, big dairy cooperatives such as Land O'Lakes or Dairy Farmers of America adopt such mechanisms (Chaddad and Cook, 2004). In Europe, numerous cooperatives and consortia utilize allocation schemes based on firms' output (in quantity or in value) to share costs of their regular activities of production quality control and product promotion. Examples include Arla Foods, a Denmark-based dairy cooperative with operations worldwide (Arla Foods, 2015). Furthermore, outcome-based mechanisms are utilized to finance retail cooperatives and buying groups. For instance, Spar, one of the largest retail co-ops worldwide, explains that all joint marketing and supply chain management activities are financed through members' contributions based on their sales (Spar, 2015). In these cooperative settings, the entity established to manage the cooperation (e.g., cooperative, consortium or category association) is usually responsible for joint expenditures, such as quality assurance programs or generic advertising campaigns. However, members still remain competitors in the final market, and thus choose the price of their products or the relative level of output independently (Crespi and Marette, 2002). In this case, members' annual contributions to finance the joint activities often depend on output marketed during the year and adjustments may occur at the end of the year.

Our study is motivated by the fact that a direct comparison of ex ante-based vs. outcome-based mechanisms has not been conducted in the extant literature in spite of the highlighted popularity of these mechanisms. In this paper, we fill this gap by investigating the competitive effects of outcome-based vs. ex ante-based cost-sharing mechanisms in a variety of economic settings. This allows us to understand how different cost-sharing mechanisms shape firms' operational (price or quantities) and cooperative (joint expenditure) decisions and thus influence their profitability. At the same time, it allows us to shed light on their economic viability in terms of total welfare. Hence, our analysis helps increase firms' understanding about the role of outcome-based vs. ex ante-based cost-sharing mechanisms, and thus provide a better support for their decisions of cooperation with competitors. Moreover, our analysis offers a more complete view in terms of policy by shedding light on the reasonableness of the conventional argument provided by previous literature (Grossman and Shapiro, 1986; Katz, 1986; Katz et al., 1990) that outcome-based mechanisms have a negative influence on total welfare.[1]

We model a game where two identical firms cooperate by sharing a joint expenditure, which can positively affect firms' demand and/or unit operating costs. For instance, cooperation can be in the form of production, marketing, and/or R&D expenditures. Still, firms compete with each other in the final market deciding upon a competitive variable independently. The competitive variable can be either the price or the quantity. Therefore, firms face a Bertrand competition or a Cournot competition, respectively. We model firms' cooperative and competitive decisions under both one-stage and two-stage games. In the first case, all decisions are made simultaneously. Specifically, the entity established by the firms to manage the cooperation (e.g., consortium, cooperative, joint venture) is responsible for choosing the level of the joint expenditure, whereas firms independently set their own prices or quantities. In the second case, the decisions are sequential. In other words, the joint expenditure is chosen first, and firms compete in setting prices or quantities in the second stage. We initially develop the analysis under the one-stage game as it is analytically tractable. Afterwards, we extend the study to a two-stage game with the support of both analytical derivation and numerical analysis and show that the key messages of the paper still hold.[2]

We compare profit and welfare implications of using two outcome-based mechanisms, namely Quantity Proportional (QP) and Total Margin proportional (TM), versus a mechanism where the joint expenditure is allocated to firms on an ex ante basis, which we refer to as Fixed Share (FS). As discussed above, both types of mechanisms are common in a wide range of business settings. The FS mechanism reflects the case where the joint expenditure is split based on bargaining before firms engage in market competition and firms' shares are never changed. Several studies have considered a fixed share mechanism for sharing joint costs of R&D projects (Katz, 1986; Aloysius and Rosenthal, 1999). In contrast, under the QP and TM mechanisms joint expenditures are allocated to firms based on the marketed output and realized profit margins, respectively. Food processing and retail cooperatives are examples of cooperation where these mechanisms are popular (US Department of Agriculture, 1994; Spar, 2015). Also, the logic of QP and TM mechanisms closely reflects that of stable R&D or manufacturing collaborations (Grossman and Shapiro, 1986; ATZ online, 2004). Particularly, the TM mechanism can be implemented in R&D joint ventures when there are no big issues of observability among partners (Lambertini et al., 2008). Finally, we also derive the optimal cost-sharing mechanism, i.e., the mechanism that maximizes firms' total profit, which is itself an outcome-based mechanism, and compare it with the FS mechanism in terms of total welfare.

Our results show that firms' profits are never the highest under the FS mechanism. Indeed, this mechanism is always dominated by the TM mechanism. However, interestingly, under both Bertrand and Cournot competition, the QP mechanism is the preferable mechanism to firms in the presence of fierce competition, whereas it can be dominated by both FS and TM mechanisms when competition is absent or sufficiently mild. Moreover, the findings about welfare comparison suggest that outcome-based mechanisms might have the merit of enhancing the total welfare as compared with a more competitive mechanism, e.g., the FS mechanism. Under the one-stage game, this can hold under Bertrand competition and demand-increasing expenditure. The extension to the two-stage game confirms and further strengthens this result. In this case, the positive effect of outcome-based mechanisms on welfare can emerge under both Bertrand and Cournot types of competition, irrespective of whether the joint expenditure is demand-increasing or cost-reducing. Our findings are robust also when extending our model to non-identical firms via numerical investigation.

The rest of the paper is organized as follows. In Section 2 we present a literature overview. In Section 3 we set up the model. In Section 4 we compare the different cost-sharing mechanisms under the one-stage game. We then analyze the two-stage game in Section 5. Finally, in Section 6 we discuss the implications and conclude.

2. Literature overview

In economics literature, a plethora of studies have shown that cooperation among competitors might be beneficial to both firms

[1] Note that, in deriving our managerial and policy implications, we consider total welfare rather than consumer surplus. The potential conflict between consumer and society preferences recalls the historical economic debate on the actual goal of antitrust agencies and the appropriateness of total surplus or consumer surplus as welfare standards, which has recently been reawakened by numerous economists (Carlton, 2007). As argued by these researchers, in an economy pursuing total welfare maximization, antitrust agencies should focus on total welfare, leaving to other bodies the task of resolving distributional questions. While an in-depth analysis of the practical issues tackled in this current debate is beyond the scope of this paper, it should be clear that, in line with most of the previous literature on cooperation among competitors (Grossman and Shapiro, 1986; Katz, 1986; d'Aspremont and Jacquemin, 1988; Katz et al., 1990), we espouse the arguments in favor of total welfare throughout the paper.

[2] As explained later in greater detail, we consider both Bertrand and Cournot types of competition and both one-stage and two-stage games to better reflect real business settings, and thus deliver a more general message.