Minority Share Ownership and Price leadership in duopoly markets

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Abstract

In this paper we are interested in exploring whether a Bertrand competitor may have an incentive to acquire Minority Share Ownership in a competitor of a Bertrand duopoly market when both firms produce differentiated products and choose their prices in order to maximize their profits. Given the said acquisition the "acquiring firm" possesses a leading role in the market while the competitor presents the characteristics of a follower. The two different strategic environments enable us to analyze the possible effects of Minority Share Ownership on strategic variables, such as prices, quantities and profits. We show that Firm's profits are higher with Minority Share Ownership than without it, while the said partial ownership causes anticompetitive effects. We also compare the results we derive here with the results which are derived from a Stackelberg duopoly market where a Leader acquires Minority Share Ownership in Follower's capital equity.

Keywords: Minority Share Ownership, Price Leadership, Bertrand competition, First – mover advantage, Second – mover advantage, Barometric Leadership

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1. Introduction

The importance of Minority Interests (*MIS*) in Competition Policy (*CP*) for mergers has been stressed by European Commission (*EC*) since 2007 (Ryanair/Aer Lingus merger).[1] The need to explore the economics of *MIs* has been announced by *EU* since 2011 (Ignjatovic & Ridyard 2012).[2]

The EC recently launched another public consultation on future modifications to European Union (*EU*) merger control law in view, *inter alia*, of increasing oversight over Minority Share Ownerships (*MSOs*).[3] Particularly, this latest consultation focuses on two main issues: a) whether to expand merger control rules to address the anticompetitive effects arising from certain acquisitions of *MSOs* and b) enhancing the speed and effectiveness of the case referral system for the transfer of cases from Member States to the Commission, both before and after notification.

Minority interests «may be described as an interest in the performance of a firm for the holder without affording the holder of that interest the ability materially to influence policy relevant to the behaviour of the firm in the marketplace. The holder of a minority interest may in addition also receive some information about the firm's operations than would normally be available to the public at large» (OFT, 2010, p. 15).

There are mainly four types of minority interests: *MSOs*, Interlocking Directorships (*IDs*), Loans (*Ls*) and Contract for Differences (*CfDs*). *MSOs* arises when the portion of equity held by a shareholder in a competitor is less than the critical amount of the voting shares in issue that allows the holder to control it. However, the minority shareholder may influence competitor's strategic behavior in the product market, either by receiving information regarding competitors product's policy, or through positions of responsibility that possess in both firms. The latter constitutes the notion of *IDs*.

The *CfDs* are more complex minority interests. The holder owns derivative products associated with *MSOs* in the competitor and therefore is more interest in the financial performance of the competitor rather than the holder of *MSOs*. The same holds when a competitor finances another competitor through Loans. In this case, the lender is mainly interested in the probability of the borrower to face the risk of bankruptcy.

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[1] See http://ec.europa.eu/competition/mergers/cases/decisions/m4439_20070627_20610_en.pdf.
[2] See also http://ec.europa.eu/competition/calls/tenders_closed.html.
[3] See European Commission (2013) available at http://ec.europa.eu/competition/consultations/2013_merger_-control/merger_control_en.pdf. The closing day of the public consultation is 12.09.2013.

The scope of this paper is twofold: firstly, we analyze unilateral *MSO* in Bertrand duopoly markets. That is, we are interesting in exploring whether a Bertrand competitor may have an incentive to hold *MSO* in the other competitor of a Bertrand duopoly market where both firms produce differentiated products and choose their prices in order to maximize their profits. Given this acquisition of *MSO*, the "acquiring firm" possesses a leading role in the market while the competitor presents the characteristics of a follower. The intuition behind this is as follows: the minority shareholder by receiving information regarding competitor's product policy has the first - mover advantage in the market, while the other competitor follows it.[4] Alternatively, the minority shareholder may become a barometric leadership by buying information through the position of responsibility that possess in competitor's firm, which enable it to set its price before the price setting of its competitor (Cooper, 1996).[5]

We compare two game settings: in the first game none of the Bertrand competitors acquire a *MSO* and both of them are engaged in a Bertrand – Nash equilibrium with differentiated products (*BNEDP without MSO*). In the second game one of the Bertrand's competitors holds a portion of equity in the other Bertrand competitor's equity capital and both of them are engaged in a Stackelberg – Nash equilibrium with differentiated products (*SNEDP with MSO*). The intuition behind competitor's with *MSO* strategic policy is as follows: it aims to increase its profits by its share in the competitor's without *MSO* equity capital, while it does not have an obligation to notify the acquisition of *MSO* in the Competition Authority (CA). The competitor with *MSO* has an incentive to acquire an *MSO* in the other competitor in the market if its profits in *BNEDP with MSO* are greater than its profits in *BNEDP without MSO*.

Secondly, we compare the results we derive from the Bertrand duopoly market with the results which are derived from a Stackelberg duopoly market where a Leader acquires *MSO* in Follower's equity capital (Fotis & Athanasiou, 2013a).[6]

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[4] Amir & Stepanova (2006) derive endogenously the result of first & second – mover advantage. More precisely, when the unit costs of the two firms are sufficiently different (close), the low cost firm has the first (second)-mover advantage, while the second firm has always the second – mover advantage. Additionally, in Ryanair/Aer Lingus merger case Aer Lingus "argued that Ryanair uses the minority stake to get access to Aer Lingus' confidential strategic plans and business secrets, to block special resolutions, and to request extraordinary general meetings with a view to attempting to reverse already adopted strategic decisions. As a result, Aer Lingus could have been weakened as an effective competitor of Ryanair….." (European Commission, 2013, p. 4).

[5] Cooper (1997) derives this result in pure strategies equilibrium.

[6] In Fotis & Athanasiou (2013a) we compare two game settings: in the first game the Leader does not acquire a *MSO* in the Follower's equity capital and both of them are engaged in a Stackelberg – Nash equilibrium with differentiated products. In the second game the Leader holds a portion of equity in Follower's equity capital and

The remainder of the paper is organized in the following way: in section 2 we review the literature and in section 3 we present the models under scrutiny and we discuss their results. Section 4 compares the results which are derived from the Bertrand and Stackelberg markets and section 5 concludes and offers some policy implications.

2. Literature review

Fotis & Athanasiou (2013a) explore a Stackelberg market with or without *MSO* and conclude that in equilibrium, a Stackelberg Leader has an incentive to hold *MSO* in a Follower since its profits are higher than the profits of a Leader without *MSO*. *MSO* also positively affects Follower's profits. Regarding the effects of *MSO* on Leader & Follower's strategic variables the authors state that the existence of *MSO* results in less total quantity supplied in the market and higher prices and therefore, market equilibrium may lower consumer surplus. So, in Stackelberg markets with *MSO* the market may become less competitive than in Stackelberg markets without *MSO*.

To the best of our knowledge the remaining research so far has been focused on the possible unilateral effects of *MSOs* on firms' strategic variables (prices, quantities, profits), assuming that firms are engaged in Cournot or Bertrand competition. More precisely, Reynolds and Snapp (1986), Farrell and Shapiro (1990) and Rodriguez (1991) indicate that when two firms acquire long portion of equities (cross holdings) in competitors that produce substitute products, the market equilibrium lowers consumer surplus (less quantity[7], higher prices and profits for both firms), that is, the market becomes less competitive than when there are no *MSOs*. Also, Bresnahan and Salop (1986) consider the possibility that two competitors may create a joint venture whose gains may be divided in proportion to the shareholders' interests. The authors conclude that an independent joint venture enhance more the competitive structure of the market instead of *MSOs*, while *MSOs* are more competitive than limited joint control or full ownership/control by one competitor.

Under product competition Flath (1991) concludes that if two firms begin without cross holdings, then neither firm will acquire long portion of equities in competitors.

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both of them are engaged in a Stackelberg – Nash equilibrium with differentiated products. The Leader has an incentive to acquire an *MSO* in the Follower if its profits in SNEDP with *MSO* are greater than its profits in SNEDP without *MSO*.

[7] See also Flath (1992).

Hansen and Lott (1995) demonstrate that a future entrant earns profits by holding *MSOs* in incumbent's equity capital before entering the market since it has private information about its future stock price. Yi (1996) explores the situation where a large firm acquires assets from a small firm. He concludes that equilibrium price rises if the common production technology is homogeneous of degree *t,* where $0 < t \leq 1$.

Dietzenbacher et al. (2000) explore an *n* firm market in which firms possess *MSOs* in one another. They analyse the effects of *MSOs* on the firms' markups in a Cournot and a Bertrand setting. The authors conclude that in all game settings the *MSOs* are anti competitive. O'Brien and Salop (2000) point out that welfare is reduced if a firm obtaining control in a competitor through *MSOs* instead of fully merging with it.

Clayton and Jorgensen (2005) determine the optimal cross holdings endogenously. They state that optimality depends on the effect of cross holdings on competitors' marginal profits and conclude that firms hold long portion of equities when firms produce complements, while they hold short portion of equities when firms produce substitute products. The authors imply that exogenous cross holdings reduce consumer welfare with substitute products, while endogenous cross holdings are consumer welfare enhancing with both substitute and complements products.

OFT (2010) shows that the effects of *MSOs* on firms' strategic variables depend on the type of prevailing competition in the market. If there are three firms in the market (A, B and C), which are engaged in Cournot competition and firm A acquires *MSO* in firm B, while firm C remains the outsider in the market (unilateral *MSOs*), then firm A optimally reduces its quantity, firm C increases its quantity as a response to firm A acquiring a *MSO* in firm B and market price increases as *MSO* increases. However, since profits of firm A is maximized when its *MSO* in firm B is zero, it is optimal for firm A not to acquire a *MSO* in firm B.[8]

When firms engaged in Cournot competition with differentiated products the results are not analogous. It is shown that a small *MSO* may maximize joint profits of firms A & B, while the portion of equities is an increasing function of the degree of product differentiation. The acquisition of *MSO* by firm A in firm B may not be optimal if the market share of the outsiders becomes too large (OFT 2010, p.47).

If firms engaged in Bertrand competition with differentiated products, prices of firms A, B and C are increasing functions of firm A's *MSO* in firm B, while the optimal *MSO* is

[8] The same results are obtained in the case where firm A acquires a MSO in firm B and vice versa (multilateral MSOs). However, price increase further than in the case of unilateral *MSOs*.

positive. In a n firm market where firms A & B acquire *MSOs* in each other, the equilibrium *MSO* is positive and its optimal level increases with the number of competitors in the market and the level of product differentiation, which is lower than in the case of unilateral *MSOs* (OFT 2010, p.50).

Willig (2011) assumes that in Bertrand markets with differentiated products firms may acquire *MSOs* instead of fully merging with competitors. He demonstrates that when firm A owns a *MSO* in firm B then the portion of diverted sales from an increase of firm's A product price, that is, the UPP, accrues to firm A only to the present of *MSO* that holds in firm B. Foros et al. (2011) explore a two firms oligopoly and compare the profitability of a full merger between firms A & B with the profitability of a *MSO* in which firm A acquires passive investment[9] in firm B and obtains the corporate control over all firm's B pricing decisions. The authors conclude that joint profits with *MSO* are greater than the joint profits of a merger since the market is less competitive in the former than in the latter case.

Brito et al. (2011) consider an industry with two firms and n shareholders. They elaborate the effect of *MSOs* on competition by exploring different types of them (i.e. passive or active investment). The authors state that *MSOs* through passive investment increase consumer surplus, while selling the active investment (voting shares) to a large shareholder is better than selling it to a small shareholder.

3 The model

We consider the standard model of duopolistic price competition with differentiated products. Each firm faces a linear demand of the form (Schoonbeek 1990, Amir and Stepanova 2006).

$$D_i(p_i, p_j) = x_i = a_i - p_i + d_{ij}p_j \text{, where } i \neq j \quad (1)$$

where p_i is the price which firm i charges, a_i is a constant for firm i and d_{ij} is a parameter which measures the Diversion Ratio from the product of firm i to the product of j (Willig 1991, Shapiro 1996, Hausman et al. 2010), i.e. the fraction of sales lost by firm i,

[9] A passive investment is purely financial, that is, without control rights.

when it raises the price of its product, that are captured by firm j , for $i, j = 1,2, i \neq j$, where 1 stands for Firm 1 and 2 stands for Firm 2.

In addition it is assumed that firm i has linear production cost $C_i(x_i) = c_i x_i$, with marginal cost c_i, for $i = 1,2$. The profit of firm i is given by:

$$\pi_i(p_i, p_j) = (p_i - c_i)D_i(p_i, p_j) \quad (2)$$

First we explore Bertrand – Nash equilibrium with differentiated products without *MSO* (*BNEDP without MSO*) and then we consider the Stackelberg – Nash equilibrium with differentiated products with *MSO* (*SNEDP with MSO*).

3.1 BNEDP without MSO

In a Bertrand duopoly game with differentiated products, each firm solves the following problem:

$$\max_{p_i} \pi \left(p_i, p_j^*\right) = (p_i - c_i)D \left(p_i, p_j^*\right) \; i = 1,2 \; and \; i \neq j \;\; (3)$$

Solving the above problems we obtain the equilibrium price and quantity of the Firm 1 ($_b\boldsymbol{P}_1^*$ and $_b\boldsymbol{Q}_1^*$, respectively), the equilibrium price and quantity of Firm 2 ($_b\boldsymbol{P}_2^*$ and $_b\boldsymbol{Q}_2^*$, respectively) and the equilibrium profits of Firm 1 and Firm 2 ($_b\boldsymbol{\pi}_1^*$ and $_b\boldsymbol{\pi}_2^*$, respectively) (see Appendix A.1).

3.2 SNEDP with MSO

Let us now assume that Firm 1 acquires a *MSO* in Firm's 2 equity capital. Firm 1 becomes the firm with the first – mover advantage, that is the Leader and Firm 2 becomes the firm with the second – mover advantage, that is the Follower. Therefore, we examine a Stackelberg duopoly game with differentiated products with *MSO*. Firm 2 solves its maximization problem, where the reaction function of the Firm 1 is taken as given (Clayton & Jorgensen 2005), i.e.:

$$\pi_1(p_1, p_2^*) = \max_{p_1} \ (p_1 - c_1)D(p_1, p_2^*) + m \cdot \pi_2(p_1, p_2^*) \ - K \quad (4)$$

where $m \in (0,1)$ is the minority shareholding of the leader to the follower and $K \in \Re^+$ is the cost of this acquisition/investment.

The reaction function of the Firm 2 is derived by solving the following problem:

$$\pi_2\left(p_1 \ , p_2\right) = \max_{p_2} (p_2 - c_2)D \ \ \left(p_1 \ , p_2\right) \quad (5)$$

Solving the above problems we obtain the equilibrium price and quantity of Firm 1 (${}_s\boldsymbol{P}_1^*$ and ${}_s\boldsymbol{Q}_1^*$, respectively), the equilibrium price and quantity of Firm 2 (${}_s\boldsymbol{P}_2^*$ and ${}_s\boldsymbol{Q}_2^*$, respectively) and the equilibrium profits of both firms (${}_s\boldsymbol{\pi}_1^*$ and ${}_s\boldsymbol{\pi}_2^*$, respectively) (see Appendix A.2).

3.3 Profit comparison of Firm 1 and 2 before and after the existence of MSO

Let us now compare the profits from the above mentioned cases. We are interested in the following problem:

"*whether a firm that acts in a Bertrand setting is better off in profitability terms when it acquires a MSO in the other firm which renders it a Follower*".

Proposition 1: The differences

$${}_{s-b}\boldsymbol{\Delta\Pi}_1^* = \ {}_s\boldsymbol{\pi}_1^* - \ {}_b\boldsymbol{\pi}_1^* \ \text{and} \ {}_{s-b}\boldsymbol{\Delta\Pi}_2^* = \ {}_s\boldsymbol{\pi}_2^* - \ {}_b\boldsymbol{\pi}_2^* \quad (6)$$

are positive under certain conditions.

Proposition 1 shows that Firm 1 has an incentive to hold a *MSO* in Firm 2 since its profits are higher than the corresponding profits without *MSO*. Also, Firm's 1 *MSO* in Firm's 2 equity capital positively affects Firm's 2 profits. Therefore, both firms enhance their profitability (see Appendix A.3).

3.4 The effect of MSO on Firm's 1 equilibrium prices and quantities

Let us now compare the prices and quantities of Firm 1 with and without *MSO*. We are interested in the following problem:

"*whether a MSO in a firm that acts in a Bertrand setting may decrease consumer welfare*".

Proposition 2: The difference

$$_{s-b}\boldsymbol{\Delta P_1^*} = \ _s\boldsymbol{P_1^*} - \ _b\boldsymbol{P_1^*} \quad (7)$$

is positive, whereas the difference

$$_{s-b}\boldsymbol{\Delta Q_1^*} = \ _s\boldsymbol{Q_1^*} - \ _b\boldsymbol{Q_1^*} \quad (8)$$

is negative under certain conditions.

Proposition 2 shows that *MSO* positively (negatively) affects Firm's 1 price (quantity). That is, the market may become less competitive with the existence of *MSO* than without it and this in turn implies that consumers may be worse – off (see Appendix A.4).

3.5 The effect of MSO on Firm's 2 equilibrium prices and quantities

Let us now compare the prices and quantities of Firm 2 before and after the existence of *MSO*.

Proposition 3: The difference

$$_{s-b}\boldsymbol{\Delta P_2^*} = \ _s\boldsymbol{P_2^*} - \ _b\boldsymbol{P_2^*} \quad (9)$$

equals the difference

$$_{s-b}\boldsymbol{\Delta Q_2^*} = \ _s\boldsymbol{Q_2^*} - \ _b\boldsymbol{Q_2^*} \quad (10)$$

and both are positive under certain conditions.

Proposition 3 states that *MSO* positively affects Firm's 2 price & quantity. Since Firm 2 acts as a Follower in the market, it behaves as a monopolist with respect to the fraction of consumers not satisfied by Firm 1, which acts as a Leader in the market (Boyer & Moreaux 1987). Its quantity increases since it serves the quantity demanded without *MSO* plus the quantity demanded by the consumers not satisfied by Firm 1 with *MSO*.

Firm's 2 price also increases but less than the reservation price of consumers not satisfied by Firm 1 (see Appendix A.5).

3.6 The effect of MSO on the prices of Firms 1 & 2.

Proposition 4: In the Stackelberg setting with *MSO* the price difference between the two firms is positive under certain condition for m:

$$_{s}\boldsymbol{\Delta P}^{*} = {}_{s}\boldsymbol{P}_{\mathbf{1}}^{*} - {}_{s}\boldsymbol{P}_{\mathbf{2}}^{*} > 0 \quad (11)$$

Proposition 4 states that Firm 2 or the Follower after the existence of *MSO* sets a price slightly below the price of Firm 1 or the Leader and sells to the fraction of consumers not satisfied by the latter. Therefore, Firm 2 satisfies the residual demand or the fraction of consumers with lower reservation price than Firm's 1 equilibrium price $_{s}\boldsymbol{P}_{\mathbf{1}}^{*}$. If the Follower sets a higher price than $_{s}\boldsymbol{P}_{\mathbf{1}}^{*}$ then serves nothing.

Alternatively, Firm 1 may be a high cost firm, which cannot reduce its price below the price of Firm 2. So, it is preferable for it to redirect part of the demand which cannot satisfy to the Firm 2 and recover part of its lost profit through the *MSO* in Firm's 2 equity capital (see Appendix A.6).

3.7 The effect of MSO on total supply

Let us now examine the effect of *MSO* on the total quantity supplied by Firm 1 and Firm 2.

Proposition 5: The difference

$$_{(\boldsymbol{s_1}+\boldsymbol{s_2})-(\boldsymbol{b_1}+\boldsymbol{b_2})}\boldsymbol{\Delta TQ}^{*} = ({}_{s}\boldsymbol{Q}_{\mathbf{1}}^{*} + {}_{s}\boldsymbol{Q}_{\mathbf{2}}^{*}) - ({}_{b}\boldsymbol{Q}_{\mathbf{1}}^{*} + {}_{b}\boldsymbol{Q}_{\mathbf{2}}^{*}) \quad (12)$$

is negative under certain conditions.

Proposition 5 states that *MSO* decreases the available quantity in the market. Even though $_{s-b}\boldsymbol{\Delta Q}_{\mathbf{2}}^{*}$ from Proposition 3 is positive, the increase of Firm's 2 quantity after Firm's 1 *MSO* is not large enough in order to increase the total quantity supplied in the market. Put it differently, the decrease of the latter's quantity dominates the increase of former's quantity and therefore after Firm's 1 *MSO*, the total quantity in the market decreases (see Appendix A.7).

4. The magnitude of the effect of MSO on strategic variables in different market environments

In this section we are interested in examining the magnitude of the effect of *MSO* on strategic variables such as prices, firms' quantities and profits, as well as total quantity supplied in the market, comparing the results we derive here with the results which are derived from a Stackelberg duopoly market where a Leader acquires *MSO* in Follower's equity capital.

Particularly, we firstly compare the effect of *MSO* on the total quantity supplied by the two firms in both strategic environments.

Proposition 6: The difference

$$_{(s_1+s_2)-(b_1+b_2)}\boldsymbol{\Delta TQ^*_{(1+2)}} - {}_{sm-s}\boldsymbol{\Delta TQ^*_{(L+F)}} = [({}_{s}\boldsymbol{Q^*_1} + {}_{s}\boldsymbol{Q^*_2}) - ({}_{b}\boldsymbol{Q^*_1} + {}_{b}\boldsymbol{Q^*_2})] - [({}_{sm}\boldsymbol{Q^*_L} + {}_{sm}\boldsymbol{Q^*_F}) - ({}_{s}\boldsymbol{Q^*_L} + {}_{s}\boldsymbol{Q^*_F})] \quad (13)$$

is negative under certain conditions.

We denote ${}_{sm}\boldsymbol{Q^*_L} + {}_{sm}\boldsymbol{Q^*_F}$ as the total quantity supplied in a Stackelberg market after Leader's acquisition of *MSO* in Follower's equity capital. Also, we denote ${}_{s}\boldsymbol{Q^*_L} + {}_{s}\boldsymbol{Q^*_F}$ as the total quantity supplied in a Stackelberg market before Leader's acquisition of *MSO* in Follower's equity capital. Therefore, ${}_{sm-s}\boldsymbol{\Delta TQ^*_{(L+F)}}$ is the change of total quantity supplied in a Stackelberg market before and after Leader's acquisition of *MSO* in Follower's equity capital.

Since ${}_{sm-s}\boldsymbol{\Delta TQ^*_{(L+F)}} < 0$[10] and ${}_{(s_1+s_2)-(b_1+b_2)}\boldsymbol{\Delta TQ^*_{(1+2)}} < 0$, Proposition 6 states that the decrease of total quantity supplied in the market where Firm 1 has the first – mover advantage after the acquisition of *MSO* in Firm's 2 equity capital, is lower than the decrease of total quantity supplied in the Stackelberg market where the Leader acquires *MSO* in Follower's equity capital. Alternatively, an acquisition of *MSO* by a Stackelberg Leader in

[10] See Fotis & Athanasiou (2013a), Proposition 5.

Follower's equity capital causes a higher decrease in total quantity supplied in the market than a corresponding acquisition by a competitor in another competitor's equity capital of a Bertrand duopoly market (see Appendix B.1).

Let us now compare the effect of *MSO* on the quantities supplied by Firm 1 and the Leader in both strategic environments.

Proposition 7: The difference

$$ {}_{s-b}\boldsymbol{\Delta Q_1^*} - {}_{sm-s}\boldsymbol{\Delta Q_L^*} = ({}_{s}\boldsymbol{Q_1^*} - {}_{b}\boldsymbol{Q_1^*}) - ({}_{sm}\boldsymbol{Q_L^*} - {}_{s}\boldsymbol{Q_L^*}) \quad (14) $$

is negative under certain conditions.

We denote ${}_{sm}\boldsymbol{Q_L^*}$ as the quantity supplied by the Leader in a Stackelberg market after its acquisition of *MSO* in Follower's equity capital. Also, we denote ${}_{s}\boldsymbol{Q_L^*}$ as the quantity supplied by the Leader in a Stackelberg market before its acquisition of *MSO* in Follower's equity capital. Therefore, ${}_{sm-s}\boldsymbol{\Delta Q_L^*}$ is the change of quantity supplied by the Leader in a Stackelberg market before and after its acquisition of *MSO* in Follower's equity capital.

Since ${}_{sm-s}\boldsymbol{\Delta Q_L^*} < 0$[11] and ${}_{s-b}\boldsymbol{\Delta Q_1^*} < 0$, proposition 7 states that the decrease of the quantity supplied by the Leader in the Stackelberg market after the acquisition of *MSO* in Follower's equity capital, is higher than the decrease of quantity supplied by Firm 1 which has the first – mover advantage after the acquisition of *MSO* in Firm's 2 equity capital (see Appendix B.2).

Proposition 8 states that Firm 1, which has the first – mover advantage after the acquisition of *MSO* in firm's 2 equity capital, increases more its price than Leader's equilibrium price after the *MSO* in Follower's equity capital.

Proposition 8: The difference

$$ {}_{s-b}\boldsymbol{\Delta P_1^*} - {}_{sm-s}\boldsymbol{\Delta P_L^*} = ({}_{s}\boldsymbol{P_1^*} - {}_{b}\boldsymbol{P_1^*}) - ({}_{sm}\boldsymbol{P_L^*} - {}_{s}\boldsymbol{P_L^*}) \quad (15) $$

is positive under certain conditions [12] (see Appendix B.3)

The effect of *MSO* on quantities supplied by Firm 2 and the Follower in both strategic environments is given by the following proposition:

Proposition 9: The difference

[11] See Fotis & Athanasiou (2013a), Proposition 2.

[12] We denote ${}_{sm}\boldsymbol{P_L^*}$ as the equilibrium price by the Leader in a Stackelberg market after its acquisition of *MSO* in Follower's equity capital. Also, we denote ${}_{s}\boldsymbol{P_L^*}$ as the equilibrium price by the Leader in a Stackelberg market before its acquisition of *MSO* in Follower's equity capital. Therefore, ${}_{sm-s}\boldsymbol{\Delta P_L^*}$ is the change of equilibrium price by the Leader in a Stackelberg market before and after its acquisition of *MSO* in Follower's equity capital. Proposition 2 in Fotis & Athanasiou (2013a) shows that ${}_{(sm-s)}\boldsymbol{\Delta P_L^*} = {}_{sm}\boldsymbol{P_L^*} - {}_{s}\boldsymbol{P_L^*} > 0$.

$${}_{s-b}\boldsymbol{\Delta Q}_2^* - {}_{sm-s}\boldsymbol{\Delta Q}_F^* = ({}_s\boldsymbol{Q}_2^* - {}_b\boldsymbol{Q}_2^*) - ({}_{sm}\boldsymbol{Q}_F^* - {}_s\boldsymbol{Q}_F^*) \quad (16)$$

is positive under certain conditions.

We denote ${}_{sm}\boldsymbol{Q}_F^*$ as the quantity supplied by the Follower in a Stackelberg market after the acquisition of *MSO* in its equity capital by the Leader. Also, we denote ${}_s\boldsymbol{Q}_F^*$ as the quantity supplied by the Follower in a Stackelberg market before the acquisition of *MSO* in its equity capital by the Leader. Therefore, ${}_{sm-s}\boldsymbol{\Delta Q}_F^*$ is the change of quantity supplied by the Follower in a Stackelberg market before and after the acquisition of *MSO* in its equity capital by the Leader.

Since ${}_{sm-s}\boldsymbol{\Delta Q}_F^* > 0$[13] and ${}_{s-b}\boldsymbol{\Delta Q}_2^* > 0$, proposition 9 states that the increase of the quantity supplied by the Follower in the Stackelberg market after the acquisition of *MSO* in its equity capital by the Leader, is lower than the corresponding increase by Firm 2 which has the second – mover advantage after the acquisition of *MSO* in its equity capital (see Appendix B.4).

Proposition 10 states that Firm 2, which behaves as a Follower after the acquisition of *MSO* in its equity capital by Firm 1, increases more its price than Follower's equilibrium price after the *MSO* in its equity capital by the Leader.

Proposition 10: The difference

$${}_{s-b}\boldsymbol{\Delta P}_2^* - {}_{sm-s}\boldsymbol{\Delta P}_F^* = ({}_s\boldsymbol{P}_2^* - {}_b\boldsymbol{P}_2^*) - ({}_{sm}\boldsymbol{P}_F^* - {}_s\boldsymbol{P}_F^*) \quad (17)$$

is positive under certain conditions[14] (see Appendix B.5).

Lastly, we compare the effect of *MSO* on both firms' profits. Let us first ask the following question:

"who gains more from the existence of MSO, Firm 1 which has the first – mover advantage or the Leader?".

Proposition 11: The difference

$${}_{s-b}\boldsymbol{\Delta \Pi}_1^* - {}_{sm-s}\boldsymbol{\Delta \Pi}_L = ({}_s\boldsymbol{\pi}_1^* - {}_b\boldsymbol{\pi}_1^*) - ({}_{sm}\boldsymbol{\pi}_L^* - {}_s\boldsymbol{\pi}_L^*) \quad (18)$$

is positive under certain conditions.

[13] See Fotis & Athanasiou (2013a), Proposition 3.

[14] We denote ${}_{sm}\boldsymbol{P}_F^*$ as the equilibrium price by the Follower in a Stackelberg market after the acquisition of *MSO* in its equity capital by the Leader. Also, we denote ${}_s\boldsymbol{P}_F^*$ as the equilibrium price by the Follower in a Stackelberg market before the acquisition of *MSO* in its equity capital by the Leader. Therefore, ${}_{sm-s}\boldsymbol{\Delta P}_F^*$ is the change of equilibrium price by the Follower in a Stackelberg market before and after the acquisition of *MSO* in its equity capital. Proposition 3 in Fotis & Athanasiou (2013a) shows that ${}_{(sm-s)}\boldsymbol{\Delta P}_F^* = {}_{sm}\boldsymbol{P}_F^* - {}_s\boldsymbol{P}_F^* > 0$.

We denote ${}_{sm}\boldsymbol{\pi}_L^*$ as the profit of the Leader in a Stackelberg market after the acquisition of *MSO* in Follower's equity capital. Also, we denote ${}_{s}\boldsymbol{\pi}_L^*$ as the profit of the Leader in a Stackelberg market before the acquisition of *MSO* in Follower's equity capital. Therefore, ${}_{sm-s}\boldsymbol{\Delta\Pi}_L$ is the change of Leader's profit in a Stackelberg market after the acquisition of *MSO* in Follower's equity capital.

Since ${}_{sm-s}\boldsymbol{\Delta\Pi}_L > 0$[15] and ${}_{s-b}\boldsymbol{\Delta\Pi}_1^* > 0$, proposition 11 states that Firm 1 which has the first – mover advantage gains more from the acquisition of *MSO* in Firm's 2 equity capital than the Leader in the Stackelberg market after the acquisition of *MSO* in Follower's equity capital. This is true since propositions 7 & 8 above indicate that Firm 1 increases (decreases) more (less) its price (quantity) than the Leader after the existence of *MSO* (see Appendix B.6).

Let us now ask the same question with respect to Follower's and the firm's 2 profits: "*who gains more from the existence of MSO, Firm 2 which has the second – mover advantage or the Follower?*".

Proposition 12: The difference

$${}_{s-b}\boldsymbol{\Delta\Pi}_2^* - {}_{sm-s}\boldsymbol{\Delta\Pi}_F = \left({}_{s}\boldsymbol{\pi}_2^* - {}_{b}\boldsymbol{\pi}_2^* \right) - \left({}_{sm}\boldsymbol{\pi}_F^* - {}_{s}\boldsymbol{\pi}_F^* \right) \quad (19)$$

is positive under certain conditions.

We denote ${}_{sm}\boldsymbol{\pi}_F^*$ as the profit of the Follower in a Stackelberg market after the acquisition of *MSO* in its equity capital by the Leader. Also, we denote ${}_{s}\boldsymbol{\pi}_F^*$ as the profit of the Follower in a Stackelberg market before the acquisition of *MSO* in its equity capital. Therefore, ${}_{sm-s}\boldsymbol{\Delta\Pi}_F$ is the change of Follower's profit in a Stackelberg market after the acquisition of *MSO* in its equity capital.

Since ${}_{sm-s}\boldsymbol{\Delta\Pi}_F > 0$[16] and ${}_{s-b}\boldsymbol{\Delta\Pi}_2^* > 0$, proposition 12 states that Firm 2 which has the second – mover advantage gains more from the acquisition of *MSO* in its equity capital than the Follower in the Stackelberg market after the acquisition of *MSO* in its equity capital. This is true since propositions 9 & 10 above indicate that Firm 2 increases more the equilibrium price and quantity than the Follower after the existence of *MSO* (see Appendix B.7).

Summarizing the results we state that the acquisition of unilateral *MSO* by a Bertrand competitor in a Bertrand duopoly market is anticompetitive since a) it lowers the

[15] See Fotis & Athanasiou (2013a), Proposition 1.
[16] See Fotis & Athanasiou (2013a), Proposition 1.

total quantity supplied in the market, b) increases the product price and c) enhances the profitability of both firms.

Particularly, Firm 1, the firm that has a first – mover advantage after the acquisition of *MSO*, has an incentive to hold a *MSO* in Firm 2, the firm that has a second – mover advantage after the acquisition of *MSO*, since its profits are higher than the corresponding profits without *MSO*. Also, Firm's 1 *MSO* in Firm's 2 equity capital positively affects Firm's 2 profits. Therefore, both firms enhance their profitability. The existence of *MSO* positively (negatively) affects Firm's 1 price (quantity), while it positively affects Firm's 2 price & quantity. However, *MSO* decreases the total quantity in the market since the decrease of Firm's 1 quantity dominates the increase of Firm's 2 quantity supplied in the market.

Regarding the comparison of the magnitude of the effect of *MSO* in Bertrand and Stackelberg strategic environments we conclude that a) the firm with the first – mover advantage gains more from the existence of *MSO* than a Leader, b) the firm with the second – mover advantage gains more from the existence of *MSO* than a Follower, c) a Leader decreases (increases) more (less) its quantity (price) than the firm with the first – mover advantage, d) a Follower increases less its price and quantity than the Firm with the second – mover advantage, e) total quantity supplied by Leader and Follower is less than the corresponding quantity supplied by Firms 1 & 2.

6 Conclusions and Policy implications

In this paper we are interested in exploring whether a Bertrand competitor may have an incentive to hold a unilateral *MSO* in the other competitor of a Bertrand duopoly market where both firms produce differentiated products and choose their prices in order to maximize their profits. We are also interested in scrutinizing the results we derive from the Bertrand duopoly market with the results derived from a Stackelberg duopoly market where a Leader acquires *MSO* in Follower's equity capital.

From the analysis so far we conclude that the acquisition of the partial proportion in competitor's equity capital, either in the Bertrand duopolistic price setting or the Stackelberg duopolistic price setting, causes anticompetitive effects since it negatively affects the total quantity supplied in both markets, while it positively affects the product price. A Leader reacts less aggressively than the firm with the first – mover advantage with respect to the product price and a Follower increases less their product price and quantity supplied in the market than the firm with the second – mover advantage.

Therefore, we imply that antitrust authorities should be skeptical when scrutinizing Bertrand & Stackelberg markets in which firms hold unilateral *MSO* in competitor's equity capital, since the said *MSO* may be capable of harming consumers. Acquiring an *MSO* of a competitor changes the competitive incentives of the acquiring firm. As a result, the latter chooses to increase its price unilaterally.

Future research could move in the direction of increasing the number of market players and introducing nonlinear demand schedules and/or quadratic cost functions. Also, the calculation of optimum *MSO*, consumer surplus and the introduction of multilateral *MSO* could enrich the results and highlight key aspects of competition policy.

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Appendix A

For simplicity we define the quantities $\varphi = a_1 + c_1,\ \gamma = a_1 - c_1,\ \psi = a_2 + c_2,\ \lambda = a_2 - c_2$, $\zeta = 2 - d_{12}d_{21}, \omega = 4 - d_{12}d_{21}$.

A.1 BNEDP without MSO

Solving the Bertrand problem for the duopoly game with differentiated products we obtain the equilibrium prices and quantities:

$${}_b\boldsymbol{P}_1^* = \frac{2\varphi+\psi\cdot d_{12}}{\omega} > 0 \quad \text{if } d_{ij} \in (0,1) \tag{A1}$$

$${}_b\boldsymbol{Q}_1^* = \frac{2\gamma+\psi\cdot d_{12}+c_1\cdot d_{12}d_{21}}{\omega} > 0 \quad \text{if } \gamma > 0 \text{ and } d_{ij} \in (0,1) \tag{A2}$$

$${}_b\boldsymbol{P}_2^* = \frac{2\psi+\varphi\cdot d_{12}}{\omega} > 0 \quad \text{if } d_{ij} \in (0,1) \tag{A3}$$

$${}_b\boldsymbol{Q}_2^* = \frac{2\cdot\lambda+\varphi\cdot d_{21}+c_2\cdot d_{12}d_{21}}{\omega} > 0 \quad \text{if } \lambda > 0 \text{ and } d_{ij} \in (0,1) \tag{A4}$$

After algebraic manipulation, the respective equilibrium profits are:

$${}_b\boldsymbol{\pi}_1^* = \frac{(2+\psi d_{12}-\zeta\cdot c_1)^2}{\omega^2} > 0 \tag{A5}$$

$${}_b\boldsymbol{\pi}_2^* = \frac{(2\cdot\lambda+\varphi d_{21}+c_2\cdot d_{12}d_{21})^2}{\omega^2} > 0 \tag{A6}$$

A.2 SNEDP with MSO

Solving the Stackelberg duopoly game with differentiated products and MSOs problem we obtain the equilibrium prices and quantities:

$$ {}_{s}\boldsymbol{P}_{\mathbf{1}}^{*} = \frac{2a_1+\zeta\cdot c_1+\psi\cdot d_{12}+\lambda\cdot m\cdot d_{21}}{2\zeta-md_{21}^2} > 0 \text{ if } \lambda > 0 \text{ and } d_{ij} \in (0,1) \quad \text{(A7)} $$

$$ {}_{s}\boldsymbol{Q}_{\mathbf{1}}^{*} = \frac{2mc_2d_{21}(1-d_{12}d_{21})+\zeta\cdot\psi\cdot d_{12}+2a_1(\zeta-md_{21}^2)+\omega\cdot c_1d_{12}d_{21}}{4\zeta-2md_{21}^2} - \frac{4c_1+2m\cdot a_1d_{21}}{4\zeta-2md_{21}^2} > 0 $$

if $d_{ij} \in (0,1)$ and the first part is greater than the second part. (A8)

$$ {}_{s}\boldsymbol{P}_{\mathbf{1}}^{*} = \frac{\zeta\cdot a_2+c_2(2\zeta-2md_{21}^2)+2a_1d_{21}+\zeta\cdot c_1d_{21}}{4\zeta-2md_{21}^2} > 0 \text{ if } d_{ij} \in (0,1) \quad \text{(A9)} $$

$$ {}_{s}\boldsymbol{Q}_{\mathbf{1}}^{*} = \frac{\omega\cdot\lambda+\zeta\cdot c_1d_{21}+2c_2d_{12}d_{21}+2a_1d_{21}}{4\zeta-2md_{21}^2} > 0 \text{ if } d_{ij} \in (0,1) \quad \text{(A10)} $$

After algebraic manipulation, the respective equilibrium profits are:

$$ {}_{s}\boldsymbol{\pi}_{\mathbf{1}}^{*} = \frac{4m(\lambda+c_1d_{21})(\lambda+c_2d_{12}d_{21})+(\psi\cdot d_{12}-\zeta\cdot c_1)^2+4a_1(\psi\cdot d_{12}+m\cdot\lambda\cdot d_{21}+c_1d_{21}(d_{12}+m\cdot d_{21}))+4a_1(a_1-2c_1)}{8\zeta-4md_2^2} - K > 0 $$

if $d_{ij} \in (0,1)$, $a_1 > 2c_1$, $\lambda > 0$ and

$$ 4m(\lambda+c_1d_{21})(\lambda+c_2d_{12}d_{21})+(\psi\cdot d_{12}-\zeta\cdot c_1)^2+4a_1(\psi\cdot d_{12}+m\cdot\lambda\cdot d_{21}+c_1d_{21}(d_{12}+m\cdot d_{21}))+ $$

$$ +4a_1(a_1-2c_1) > K \quad \text{(A11)} $$

$$ {}_{s}\boldsymbol{\pi}_{\mathbf{2}}^{*} = \frac{(4c_2-2\varphi\cdot d_{21}+d_{12}d_{21}(-3c_2+c_1d_{21})-\zeta\cdot a_2)^2}{4(-2\zeta+m\cdot d_{21}^2)^2} > 0 \quad \text{(A12)} $$

A.3 Profit comparison with or without MSO

After algebraic manipulation we obtain the following expressions:

$$ {}_{s-b}\boldsymbol{\Delta\Pi}_{\mathbf{1}}^{*} = {}_{s}\boldsymbol{\pi}_{\mathbf{1}}^{*} - {}_{b}\boldsymbol{\pi}_{\mathbf{1}}^{*} = $$

$$ \frac{(2a_1+\psi\cdot d_{12}-\zeta\cdot c_1)^2(d_{12}^2d_{21}^2+4md_{21}^2)}{(8\zeta+d_{12}^2d_{21}^2)(8\zeta-4md_{21}^2)} + \frac{4a_1(\lambda\cdot md_{21}+mc_1d_{21}^2)+4m(\lambda+c_1d_{21})(\lambda+c_2d_{12}d_{21})}{(8\zeta-4md_{21}^2)} - K > 0 $$

if $d_{ij} \in (0,1)$, $\lambda > 0$ and

$$\frac{(2a_1+\psi\cdot d_{12}-\zeta\cdot c_1)^2(d_{12}^2d_{21}^2+4md_{21}^2)}{(8\zeta+d_{12}^2d_{21}^2)(8\zeta-4md_{21}^2)}+\frac{4a_1(\lambda\cdot md_{21}+mc_1d_{21}^2)+4m(\lambda+c_1d_{21})(\lambda+c_2d_{12}d_{21})}{(8\zeta-4md_{21}^2)}>K \qquad \text{(A13)}$$

$$_{s-b}\boldsymbol{\Delta\Pi_1^*}=\ _s\boldsymbol{\pi_2^*}-\ _b\boldsymbol{\pi_2^*}=\frac{\left[2\lambda+(\varphi+c_2d_{12})d_{21}-\frac{1}{2}d_{12}d_{21}(\lambda+c_1d_{21})\right]^2}{\left(\omega+d_{12}d_{21}+md_{21}^2\right)^2}-\frac{[2\lambda+(\varphi+c_2d_{12})d_{21}]^2}{\omega^2}>0$$

if $d_{ij}\in(0,1)$ and $\frac{\left[2\lambda+(\varphi+c_2d_{12})d_{21}-\frac{1}{2}d_{12}d_{21}(\lambda+c_1d_{21})\right]^2}{\left(\omega+d_{12}d_{21}+md_{21}^2\right)^2}>\frac{[2\lambda+(\varphi+c_2d_{12})d_{21}]^2}{\omega^2}$. (A14)

A.4 The effect of MSO on Leader's equilibrium prices and quantities

After algebraic manipulation we obtain the following expressions:

$$_{s-b}\boldsymbol{\Delta P_1^*}=\ _s\boldsymbol{P_1^*}-\ _b\boldsymbol{P_1^*}=\frac{d_{21}(4\lambda m+2md_{21}(a_1+c_1+c_2d_{12})+d_1(2\gamma+\psi d_{12}+c_1d_{12}d_{21}))}{\omega(2\zeta-md_{21}^2)}>0$$

if $d_{ij}\in(0,1)$, $\gamma>0$, $\lambda>0$. (A15)

$$_{s-b}\boldsymbol{\Delta Q_1^*}=\ _s\boldsymbol{Q_1^*}-\ _b\boldsymbol{Q_1^*}=\frac{-\zeta d_{21}(4\lambda m+2md_{21}(a_1+c_1+c_2d_{12})+d_{12}(2\gamma+\psi d_{12}+c_1d_{12}d_{21}))}{2\omega(2\zeta-md_{21}^2)}<0$$

if $d_{ij}\in(0,1)$, $\gamma>0$, $\lambda>0$. (A16)

A.5 The effect of MSO on Follower's equilibrium prices and quantities

After algebraic manipulation we obtain the following expression:

$$_{s-b}\boldsymbol{\Delta P_2^*}=\ _s\boldsymbol{P_2^*}-\ _b\boldsymbol{P_2^*}=\frac{d_{21}^2\left(4\lambda m+2md_{21}(a_1+c_1+c_2d_{12})+d_1(2\gamma+\psi d_{12}+c_1d_{12}d_{21})\right)}{2\omega(2\zeta-md_{21}^2)}$$

$_{s-b}\boldsymbol{\Delta Q_2^*}=\ _s\boldsymbol{Q_2^*}-\ _b\boldsymbol{Q_2^*}>0$ if $d_{ij}\in(0,1)$, $\gamma>0$, $\lambda>0$. (A17)

A.6 The effect of MSO on the prices of Firms 1 & 2

After algebraic manipulation we obtain the following expression:

$$_s\boldsymbol{\Delta P^*}=\ _{sm}\boldsymbol{P_1^*}-\ _{sm}\boldsymbol{P_2^*}=\psi(\omega-2d_{12})+4\gamma+2\varphi d_{21}+c_1d_{12}d_{21}-2md_{21}(\lambda+c_2d_{21})$$

which is positive if $d_{ij}\in(0,1)$ and $m<\frac{\psi(\omega-2d_{12})+4\gamma+2\varphi d_{21}+c_1d_{12}d_{21}}{2d_{21}(\lambda+c_2d_{21})}$ (A18)

A.7 The effect of MSO on total supply

After algebraic manipulation we obtain the following expression:

$$_{(s_1+s_2)-(b_1+b_2)}\boldsymbol{\Delta TQ}^* = -\frac{d_{21}(2-d_{21}-d_{12}d_{21})(4\lambda m+2md_{21}(a_1+c_1+c_2d_{12})+d_{12}(2\gamma+\psi d_{12}+c_1d_{12}d_{21}))}{2\omega(2\zeta-md_{21}^2)} < 0$$

which is negative if $d_{ij} \in (0,1)$, $\gamma > 0$, $\lambda > 0$. (A19)

Appendix B

For simplicity we define the quantities $\varphi = a_1 + c_1,\ \gamma = a_1 - c_1,\ \psi = a_2 + c_2,\ \lambda = a_2 - c_2$, $\zeta = 2 - d_{12}d_{21},\ \omega = 4 - d_{12}d_{21},\ \varepsilon = 2\lambda + \varphi d_2 + c_2 d_1 d_2,\ \theta = 4 - 4\kappa - \kappa^2,\ \kappa = 2 - d_1 d_2,$ $\mu = \left(\frac{d_1 d_2 \lambda}{2} + \frac{c_1 d_1 d_2}{2}\right)^2$

B.1 Comparison of total quantity supplied in both strategic environments after the existence of MSO

After algebraic manipulation we obtain the following expression:

$$_{(s_1+s_2)-(b_1+b_2)}\boldsymbol{\Delta TQ}^*_{(1+2)} - {}_{sm-s}\boldsymbol{\Delta TQ}^*_{(L+F)} = -\frac{d_1d_2(2-d_2-d_1d_2)(2\gamma+d_1\psi+c_1d_1d_2)}{4(8-6d_1d_2+d_1^2d_2^2)} < 0$$

which is negative if $d_{ij} \in (0,1)$ and $\gamma > 0$ (B1)

B.2 Comparison of equilibrium quantities supplied by Firm 1 and Leader after the existence of MSO

After algebraic manipulation we obtain the following expression:

$$_{s-b}\boldsymbol{\Delta Q}_1^* - {}_{sm-s}\boldsymbol{\Delta Q}_L^* = -\frac{d_1d_2(2\gamma+d_1\psi+c_1d_1d_2)}{4(2+2\kappa)} < 0$$

which is negative if $d_{ij} \in (0,1)$ and $\gamma > 0$ (B2)

B.3 Comparison of equilibrium prices by Firm 1 and Leader after the existence of MSO

After algebraic manipulation we obtain the following expression:

$$ {}_{s-b}\boldsymbol{\Delta P_1^*} - {}_{sm-s}\boldsymbol{\Delta P_L^*} = \frac{d_1 d_2 (2\gamma + d_1\psi + c_1 d_1 d_2)}{4(8 - 6d_1 d_2 + d_1^2 d_2^2)} > 0 $$

which is negative if $d_{ij} \in (0,1)$ and $\gamma > 0$ (B3)

B.4 Comparison of equilibrium quantitıes supplied by Firm 2 and Follower after the existence of MSO

After algebraic manipulation we obtain the following expression:

$$ {}_{s-b}\boldsymbol{\Delta Q_2^*} - {}_{sm-s}\boldsymbol{\Delta Q_F^*} = \frac{d_1 d_2^2 (2\gamma + d_1\psi + c_1 d_1 d_2)}{4(8 - 6d_1 d_2 + d_1^2 d_2^2)} > 0 $$

which is negative if $d_{ij} \in (0,1)$ and $\gamma > 0$ (B4)

B.5 Comparison of equilibrium prices by Firm 2 and Follower after the existence of MSO

After algebraic manipulation we obtain the following expression:

$$ {}_{s-b}\boldsymbol{\Delta P_2^*} - {}_{sm-s}\boldsymbol{\Delta P_F^*} = \frac{d_1 d_2 (2\gamma + d_1\psi + c_1 d_1 d_2)}{4(8 - 6d_1 d_2 + d_1^2 d_2^2)} > 0 $$

which is negative if $d_{ij} \in (0,1)$ and $\gamma > 0$ (B5)

B.6 Comparison of firm's 1 and Leader's profits after the existence of MSO

After algebraic manipulation we obtain the following expression regarding the change of profits of Leader and Firm 1 which has the first – mover advantage:

$$ {}_{s-b}\boldsymbol{\Delta \Pi_1^*} - {}_{sm-s}\boldsymbol{\Delta \Pi_L} = \frac{d_1^2 d_2^2}{(2 - d_1 d_2)(-4 + d_1 d_2)^2} > 0 $$

which is positive if $d_{ij} \in (0,1)$ (B6)

B.7 Comparison of firm's 2 and Follower's profits after the existence of MSO

After algebraic manipulation we obtain the following expression regarding the change of profits of Follower and Firm 2 which has the second – mover advantage:

$$_{s-b}\boldsymbol{\Delta\Pi}_2^* - {}_{sm-s}\boldsymbol{\Delta\Pi}_F = -\frac{(2a_2-2c_2+(\varphi+c_2d_1)d_2)^2}{(-2-\kappa)^2} + \frac{(4c_2-2\varphi d_2+d_1d_2(-3c_2+c_1d_2)+a_2(-2-k))^2}{16(-\kappa)^2} > 0$$

which is positive if $d_{ij} \in (0,1)$, $\lambda > 0$, $\kappa \in \left(1, \frac{2}{3}\right)$ and $\varepsilon \in (0, \varepsilon_1) \cup (\varepsilon_2, \max \varepsilon)$, where $\varepsilon_1, \varepsilon_2 = \frac{2\theta\mu \pm \sqrt{\theta}(4\kappa\mu)}{2(\theta-4\kappa^2)}$. (B7)