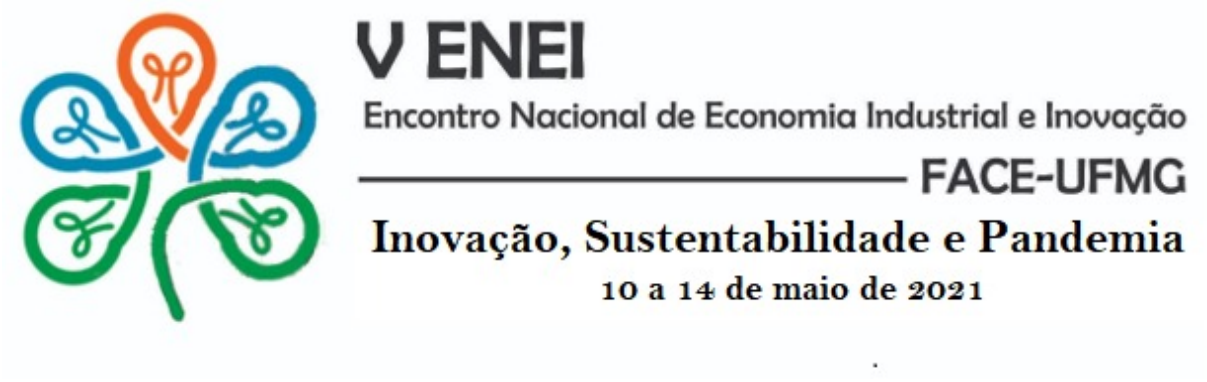


# Horizontal Merger and Upward Pricing Pressure in a Bertrand-Cournot Model

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**Abstract:** The upward pricing pressure (UPP) proposed by Farrell and Shapiro (2010a) is a significant advance in the horizontal merger literature and practice. However, the indicator is designed for a particular pre-merger scenario: the Bertrand-type competition. Here, we propose an indicator for a Bertrand-Cournot duopoly pre-merger scenario, shedding light on this assumption's role in the UPP. Besides, we assess the effect of the degree of product differentiation on UPP. Results indicated that the upward pricing pressure caused by a merger depends on the pre-merger competition, with the Bertrand-Cournot having a higher UPP than the Bertrand scenario. The degree of product differentiation also matters for the UPP – merged firms that produce more homogeneous products have a higher probability of causing upward pricing pressure in post-merger. Our findings help the antitrust authority analyze firms' mergers, indicating that these two features need to be better observed: the pre-merger competition scenario and firms' product differentiation.

**Keywords:** Product differentiation; Bertrand-Cournot model; Horizontal merger; Upward pricing pressure.

**Código JEL:** L10; L13; L22; L40.

**Área Temática:** 9.1 Discussão teórico-metodológica.

# 1 Introduction

Antitrust authorities worldwide often receive requests for acquisitions or mergers. The investigations resulting from the initial applications have a single and challenging objective: to predict whether the merger (or acquisition) is anticompetitive (Dutra and Sabarwal, 2020). The task's difficulty lies in predicting which of the opposing price merge effects will prevail. An upward pricing force due to loss of direct competition between merged firms – sales lost by an increase in prices can be captured by the merged firm. Or a downward pricing force due to efficiency gains from merger (Farrell and Shapiro, 2010a).

Previously, the traditional horizontal merger analysis practice was based on the relevant market definition and the merging firms' combined market share. Antitrust authorities did not allow the merger when the firms belong to the same market, and the merger causes substantial increases in market shares and concentration (Bjornerstedt and Verboven, 2016).

Both criteria can be widely discussed. Merging parties usually argue that the relevant market is much broader, reducing merger effects measured by concentration indexes. In a famous example, the merge between Whole Foods and Wild Oats, defining the market as "premium natural organic markets" or as "all traditional markets" changes drastically how the merge impacts market shares. While Federal Trade Commission (FTC) argued that the two firms were the two biggest players in the premium natural organic markets, the understanding of DOJ was that they are players of traditional markets. The merger between Coca-Cola and Dr. Pepper also involves defining whether the relevant market is the "carbonated soft drinks" or in the "soft drinks" market (Young and Crews, 2019).

Tools used in this horizontal merger literature and practice had a turning point in 2010. Professors Joseph Farrell and Carl Shapiro that at the time were chief economists at the FTC and Department of Justice (DOJ), respectively (Moresi, 2010), joined their outstanding positions in the Antitrust Authorities with an interesting theoretical proposal. Their Upward Pricing Pressure (UPP) Approach[1] was included in the Federal Trade Commission Horizontal Merger Guidelines (2010), United States, and was considered an essential tool in other countries guides for mergers, *e.g.* United Kingdom (2010), France (2013), and Brazil (2016)[2].

Besides the spread of Farrell-Shapiro UPP over the literature, it was often used in court to justify decisions and motivate further investigations – *e.g.*, the merger between Sysco and US Foods (US)[3], and the merger between Hutchison 3G and Orange (Europe)[4]. UPP does not fundamentally rely on defining the relevant antitrust market and uses only merging firms' information, being less data demanding than the approach based on concentration. So, it is straightforward to handle since data from the entire industry is not necessary. This simplicity does not come at the expense of a loss of accuracy[5]. Also, in UPP, there is the possibility of mergers that substantially increase market shares can be considered pro-competitive (Farrell and Shapiro, 2010a).

About its limitations, UPP does not predict post-merger prices, just a price direction. The model also assumes a specific type of competition in the pre-merger scenario – the Bertrand competition. Thus, all the framework in Farrell and Shapiro (2010a) is well suited for this type of competition. We are trying to advance how the merger environment impacts post-merger

[1] Hereafter called by Farrell-Shapiro UPP and only UPP.

[2] See (Dutra and Sabarwal, 2020) for more details on including the UPP in Guides.

[3] See Miller et al. (2017) for more details.

[4] See Wiethaus and Nitsche (2014) for more details.

[5] Garmon (2017), in a study about the accuracy of screening tools in hospital mergers, says that: UPP is "more accurate than traditional concentration measures at flagging potentially anticompetitive hospital mergers for further review."

equilibrium with two main contributions. First, we investigated the possibility of a Bertrand-Cournot duopoly with differentiated products in the pre-merger scenario and its implications on upward pricing pressure predictions. Second, the effect of the degree of product differentiation on upward price pressures will be examined.

The rest of the paper is organized as follows. Section 1 continues with a review of the literature on the notion of upward price pressure. Section 2 describes the demand systems that characterize horizontally differentiated products. Section 3 describes the development of the upward price pressure (UPP) proposed by Farrell and Shapiro (2010a) and the effect of the degree of product differentiation on the UPP. Section 4 develops the upward pricing pressure in a Bertrand-Cournot model and the effects of degree of product differentiation on this UPP. Finally, Section 5 presents the conclusions of the research proposal.

## 1.1 Related Literature

This work is related to the literature on the measurement of the upward pricing pressure (UPP) indicator in the Bertrand duopoly model with horizontally differentiated products, the Bertrand-Cournot mixed strategic interaction model with horizontally differentiated products, and the effect of the degree of differentiation of products on the upward pricing pressure in both models.

The model described in Farrell and Shapiro (2010a) is based on a Bertrand model, indicating that the products sold are somehow distinct and the main variable of choice by the firms is the price. Some criticisms based on the assumption of Bertrand's model were made by (Epstein and Rubinfeld, 2010). Although a significant advance, the authors argued that it is just a particular case of merge simulation. Farrell and Shapiro (2010b) replayed, showing that basically UPP does not need post-merge assumptions and can be successfully used to preview the price effect in mergers Farrell and Shapiro (2010b).

The applied approach was made by Miller et al. (2017), using monte-carlo simulations to predict price-setting after the merger. The result showed that Farrell and Shapiro (2010a) UPP's were reliable. The level within the results found are reliable about concerning or the the competitive authority, based on the the cases judged by the FTC was made in coate2011benchmarking. The potential to be used by the European Comission was suggested by Oldale and Padilla (2013).

The author also develops a Gross Upward Market Power Pressure Index (GUMPPI), which includes the output and not only the price effect. The possibility of finding a significant UPP that will not result in price growing when firms are significantly asymmetric was shown by mathiesen2012note and in an empirical approach by Cheung (2016).

After that, some extensions were made. Moresi (2010) extend the UPP for merging firms that competition was driven by price (Cournot) and bidding competition also. Also, Willig (2011) show the results when using products that change the merger and partial mergers' quality. The inclusion of feedback effects in the UPP was made by Neurohr (2017). The inclusion of cost-efficiencies and some application were made by Dutra and Sabarwal (2020).

More recent extensions are being developed for two-sided markets Affeldt et al. (2013) and Affeldt et al. (2018) for UPP and for UPP and other indicators Pontual Ribeiro and Golovanova (2020). Also, the incorporation of feedback effects in these models were made, Cosnita-Langlais et al. (2018), and re-balancing effects Cosnita-Langlais et al..

# 2 Model

The spatial competition models incorporated by Hotelling (1929) and Salop (1979) have the peculiarity of characterizing a market structure with differentiated products and correcting the famous Bertrand paradox, but they are the only ones. For our purposes, we will use a linear demand system that characterizes horizontally differentiated products derived from the quadratic utility function of Dixit (1979).

Consider a representative consumer who wants two goods, $q_1$ and $q_2$, with a quadratic utility function defined as:

$$U(q_1, q_2) = aq_1 + aq_2 - \frac{bq_1^2 + 2dq_1q_2 + bq_2^2}{2}. \tag{1}$$

Assuming that the budget is $M$ and the prices of goods, $q_1$ and $q_2$, are $p_1$ and $p_2$ respectively. The optimal quantity that maximizes the level of consumer welfare produces the following system of demand functions with differentiated products

$$p_1 = a - b(q_1 + \theta q_2), \quad p_2 = a - b(q_2 + \theta q_1), \tag{2}$$

where $\frac{d}{b} = \theta \in (0, 1)$ indicates the degree of product differentiation. Firms that serve the demand system 2 are monopolists if $\theta = 0$. On the other hand, if $\theta = 1$ then we say that the products are homogeneous. The demand system for type for the Bertrand competition scenario can be expressed as:

$$q_1 = \frac{a(1-\theta) - p_1 + \theta p_2}{b(1-\theta^2)}, \quad q_2 = \frac{a(1-\theta) - p_2 + \theta p_1}{b(1-\theta^2)}. \tag{3}$$

In an environment of Bertrand-Cournot competition, the strategic interaction is mixed, one firm chooses price (Bertrand-type firm) and the other firm chooses quantity (Cournot-type firm). To calculate the equilibrium price and quantity, the system is composed of the demand function for firm 1 and the inverse demand function for firm 2 respectively.

$$q_1 = \frac{a - p_1 - b\theta q_2}{b}, \quad p_2 = a(1-\theta) + \theta p_1 - bq_2(1-\theta^2). \tag{4}$$

The ways of expressing the system of demand functions make it possible to calculate the equilibrium that is dependent on the competition scenario.

# 3 UPP in Bertrand Model

Here we describe the development of the upward pricing pressure indicator incorporated by Farrell and Shapiro (2010a) and analyze the effects of the degree of product differentiation on the merger of a duopoly.

Let us consider two firms 1 and 2 that serve a market with horizontally differentiated products defined by an demand system

$$D_1(p_1, p_2), \quad D_2(p_1, p_2). \tag{5}$$

Both firms operating at constant marginal cost $\bar{c} > 0$, define their profit functions as:

$$\pi_1 = (p_1 - \bar{c})D_1(p_1, p_2), \quad \pi_2 = (p_2 - \bar{c})D_2(p_1, p_2). \tag{6}$$

The competition of these two firms in the market leads to a process of individual maximization (strategic game) of their profits. Then the best response functions for both firms can be written as:

$$\frac{\partial \pi_i}{\partial p_i} = D_i(p_i, p_j) + (p_i - \bar{c}_i)\frac{\partial D_i(p_i, p_j)}{\partial p_i} = 0, \quad \text{for all,} \quad i \in \{1, 2\}, \quad \text{with} \quad i \neq j. \tag{7}$$

Case in which one of the firms wants to merge with the other or wants to acquire the other firm. Assuming that firm 1 wants to merge with firm 2, then the profit function for firm 1 is:

$$\pi = \pi_1 + \pi_2 = [p_1 - \bar{c_1}(1 - e_1)]D_1(p_1, p_2) + [p_2 - \bar{c_2}(1 - e_2)]D_2(p_1, p_2), \tag{8}$$

where $c_i = \bar{c_i}(1 - e_i)$ represent the marginal cost post-merger of the product $i \in \{1, 2\}$, and $\bar{c_i}$ the marginal cost pre-merger of the product $i \in \{1, 2\}$. Maximizing the merger profit function, by first order conditions we have.

$$\frac{\partial \pi}{\partial p_1} = D_1(p_1, p_2) + [p_1 - \bar{c_1}(1 - e_1)]\frac{\partial D_1(p_1, p_2)}{\partial p_1} + [p_2 - \bar{c_2}(1 - e_2)]\frac{\partial D_2(p_1, p_2)}{\partial p_1}. \tag{9}$$

Then using the condition 7 and rearranging terms we find the upward price pressure (UPP) for product 1.

$$UPP_1 = \Delta_{12}(p_2 - c_2) - e_1\bar{c}_1, \tag{10}$$

where $\Delta_{12} = -\left(\frac{\partial D_1(p_1,p_2)}{\partial p_1}\right)^{-1}\left(\frac{\partial D_2(p_1,p_2)}{\partial p_1}\right)$ is the migration rate of consumers from product 1 to product 2 due to price variation in product 1. The criterion to diagnose whether the merger generates upward pricing pressure is the indicator developed by Farrell and Shapiro (2010a). So we say that the merger of firm 1 with firm 2 causes upward pricing pressure if $UPP_1 > 0$, this means that,

$$\Delta_{12}(p_2 - c_2) > e_1\bar{c}_1. \tag{11}$$

The following are alternative forms and conditions necessary to observe when a pre-merger competition of firms was Bertrand and post-merger causes upward pricing pressure.

**Proposition 1.** *Consider that firms 1 and 2 serve demand system 5. If firms 1 and 2 are asymmetric, the merger of firm 1 with firm 2 causes upward pricing pressure if*

$$\Delta_{12} > \frac{p_1}{p_2}\frac{(1 - M_1)e_1}{M_2}. \tag{12}$$

*Similarly, the merger of firm 2 with firm 1 causes upward pricing pressure if*

$$\Delta_{21} > \frac{p_2}{p_1}\frac{(1 - M_2)e_2}{M_1}.$$

*Proof.* Since the equation 10 is positive, we divide the expression by $p_1$ and use the equality $\frac{c_1}{p_1} = 1 - \frac{p_1 - c_1}{p_1} = 1 - M_1$ we find that

$$UPP_1^* = \Delta_{12}\frac{p_2}{p_1}M_2 - e_1(1 - M_1) = GUPPI - e_i(1 - M_1),$$

where $M_i = \frac{p_i - c_i}{p_i}$ is the Lerner index, $GUPPI = \Delta_{12}\frac{p_2}{p_1}M_2$ is the gross upward pricing pressure index find by Salop and Moresi (2009). Then since $UP_1^*$ is still positive we conclude that

$$\Delta_{21} > \frac{p_2}{p_1}\frac{(1 - M_2)e_2}{M_1}.$$

Analogous form is demonstrated the merger of the firm 2 with the firm 1. Therefore, the conjecture is demonstrated. □

As a consequence of the Proposition 1, we have a particular case of upward pricing pressure when two symmetric firms merge.

**Corollary 1.** *Consider that firms 1 and 2 serve demand system 5. If firms 1 and 2 are symmetric, the merger of firm 1 with firm 2 causes upward pricing pressure if*

$$\Delta_{12} > \frac{(1 - M)e_1}{M}. \tag{13}$$

*Similarly, the merger of firm 2 with firm 1 causes upward pricing pressure if*

$$\Delta_{21} > \frac{(1 - M)e_2}{M}.$$

*Proof.* Since the firms are symmetric, and identifying the parameters that characterize symmetry such as equilibrium prices $p_1 = p_2$ and Lerner index $M_1 = M_2$. From the inequality 12 we have:

$$\Delta_{12} > \frac{(1 - M)e_1}{M}.$$

Analogous form is demonstrated the fusion of the firm 2 with the firm 1. Therefore, the conjecture is demonstrated. □

Farrell and Shapiro (2010a) to illustrate the upward pricing pressure makes a simulation on this indicator. Given a efficiency credit $e_1 = 0.1$ and pre-merger margins $M = 0.25$, the merger would generate upward pricing pressure if the deviation index is greater than $\Delta_{12} = 03$.

The following result characterizes the effect of the degree of product differentiation on the upward pricing pressure.

**Corollary 2.** *Consider that firms 1 and 2 serve demand system 2. If firms 1 and 2 are symmetric, the merger of firm 1 with firm 2 causes upward pricing pressure if*

$$\theta > \frac{(1 - M)e_1}{M}. \tag{14}$$

*Similarly, the merger of firm 2 with firm 1 causes upward pricing pressure if*

$$\theta > \frac{(1 - M)e_2}{M}.$$

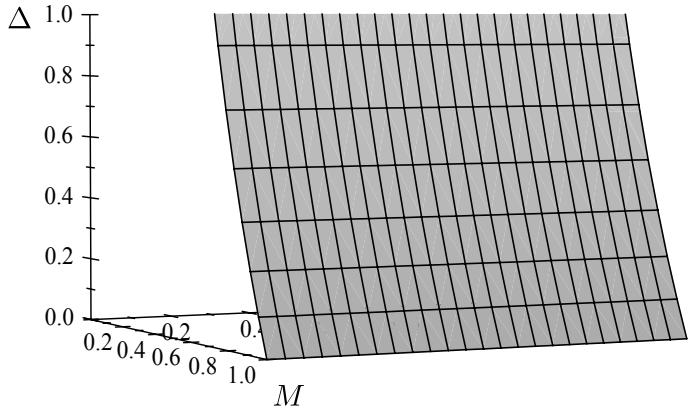


Figure 1: Effect of the degree of product differentiation on the upward pricing pressure.

*Proof.* Since $\frac{dq_2}{dp_1} = \frac{\theta}{1-\theta^2}$ and $\frac{dq_1}{dp_1} = -\frac{1}{1-\theta^2}$, then for each degree of product differentiation $\theta \in (0,1)$ we have that migration taxa of consumer migration from product 1 to product 2 is $\Delta_{12} = \theta \in (0,1)$. Then from the inequality 1 it is implied that

$$\theta > \frac{(1-M)e_1}{M}.$$

Analogous form is demonstrated the fusion of the firm 2 with the firm 1. Therefore, the conjecture is demonstrated. □

Figure 1 illustrates Corollary 1 where the compensatory levels between the consumer migration rate, the Lerner index, and the efficiency for a merger to cause upward pricing pressure is observed. It is observed that the critical trade-off for the merger to cause upward pricing pressure is that the migration rate of consumers is decreasing concerning the Lerner index, that for any level of efficiency.

On the other hand, it can be observed in the Corollary 2 that the degree of product differentiation is an indication of the consumer migration rate. Therefore, the higher the Lerner index, the more homogeneous products cause upward pricing pressure with greater ease, for all levels of efficiency.

# 4 UPP Bertrand-Cournot Model

Extending the idea of upward pricing pressure incorporated by Farrell and Shapiro (2010a), we propose an analysis of upward pricing pressure in a horizontally differentiated Bertrand-Cournot duopoly model.

Let us consider two firms 1 (Bertrand-type firm) and 2 (Cournot-type firm) that serve a market with horizontally differentiated products defined by an demand system

$$D_1(p_1, q_2), \quad P_2(p_1, q_2). \tag{15}$$

Both firms operating at constant marginal cost $\bar{c} > 0$, define their profit functions as:

$$\pi_1(p_1, q_2) = (p_1 - \bar{c})D_1(p_1, q_2), \quad \pi_2(p_1, q_2) = (P_2(p_1, q_2) - \bar{c})q_2. \tag{16}$$

In a competitive environment, firms individually maximize their profits. The equilibrium price and quantity can be written as functions of the best response functions for firms 1 and 2

respectively

$$\frac{\partial \pi_1(p_1, q_2)}{\partial p_1} = D_1(p_1, q_2) + (p_1 - \bar{c})\frac{\partial D_1(p_1, q_2)}{\partial p_1} = 0, \tag{17}$$

$$\frac{\partial \pi_2(p_1, q_2)}{\partial p_1} = P_2(p_1, q_2) - \bar{c} + \frac{\partial P_2(p_1, q_2)}{\partial q_2} q_2 = 0. \tag{18}$$

In the scenario of merger or acquisition between these firms, suppose that firm 1 acquires firm 2. The profit function of firm 1 is the sum of the profit functions 1 and 2, consequently, the objective of firm 1 is to maximize the following profit function

$$\pi = \pi_1 + \pi_2 = [p_1 - \bar{c_1}(1 - e_1)]D_1(p_1, q_2) + [P_2(p_1, q_2) - \bar{c_2}(1 - e_2)]q_2, \tag{19}$$

where $c_1 = \bar{c_1}(1 - e_1)$ and $c_2 = \bar{c_2}(1 - e_2)$ are the marginal cost after merger of the product 1 and 2. Maximizing the merger profit function, by first order conditions we have

$$\frac{\partial \pi}{\partial p_1} = D_1(p_1, q_2) + [p_1 - \bar{c_1}(1 - e_1)]\frac{\partial D_1(p_1, p_2)}{\partial p_1} + \frac{\partial P_2(p_1, q_2)}{\partial p_1} q_2 = 0. \tag{20}$$

Then using the condition 17 and rearranging terms we find the upward price pressure (UPP) for product $i \in \{1, 2\}$

$$UPP_1 = \Delta_{12} q_2 - e_1 \bar{c}_1. \tag{21}$$

where $\Delta_{12} = -\left(\frac{\partial D_1(p_1, q_2)}{\partial p_1}\right)^{-1}\left(\frac{\partial P_2(p_1, q_2)}{\partial p_1}\right)$ is the trade-off between the price of product 2 and the quantity of demand of the product 1 given the variation of product price 1. The criterion to diagnose whether the merger generates upward pricing pressure is the indicator developed by Farrell and Shapiro (2010a). Then we say that the merger generates an upward price pressure if $UPP_1 > 0$, this means that,

$$\Delta_{12} q_2 > e_1 \bar{c}_1. \tag{22}$$

The following are alternative forms and conditions necessary to observe when a pre-merger competition of firms was Bertrand-Cournot and post-merger causes upward pricing pressure.

**Proposition 2.** *Consider that firms 1 and 2 serve demand system 15. If firms 1 and 2 are asymmetric, the merger of firm 1 with firm 2 causes upward pricing pressure if*

$$\Delta_{12} > \frac{p_1}{q_2}(1 - M_1)e_1, \tag{23}$$

*Proof.* Since the equation 10 is positive, we divide the expression by $p_1$ and use the equality $\frac{c_1}{p_1} = 1 - \frac{p_1 - c_1}{p_1} = 1 - M_1$ we find that

$$UPP_1^* = \Delta_{12}\frac{q_2}{p_1} - e_1(1 - M_1),$$

where $M_i = \frac{p_i - c_i}{p_i}$ is the Lerner index, $GUPPI = \Delta_{12}\frac{q_2}{p_1}$ is the gross upward pricing pressure index find by Salop and Moresi (2009) (for the Bertrand-Cournot pre-merger competitive case). Then since $UPP_1^*$ is still positive we conclude that

$$\Delta_{12} > \frac{p_1}{q_2}(1 - M_1)e_1.$$

Therefore, the conjecture is proven. □

The following result characterizes the effect of the degree of product differentiation on the upward pricing pressure. The Bertrand-Cournot competition of the firms 1 and 2, attending to the demand system 4 at constant marginal cost $c$ with $0 < c < a$, have price and quantity equilibrium $p_1 = \dfrac{2(a+c) - \theta(a-c) - \theta^2(a-2c)}{4-3\theta^2}$, $q_2 = \dfrac{2(a+c) - \theta(a-c)}{4-3\theta^2}$. While in a collusive environment with maximum profit the optimal price and quantity is $p_1 = \dfrac{(a+c)}{2}$, $q_2 = \dfrac{(a-c)}{2(1+\theta)}$.

**Corollary 3.** *Consider that firms 1 and 2 serve demand system 4. If firms 1 and 2 are asymmetric, the merger of firm 1 with firm 2 causes upward pricing pressure if*

$$\Delta_{12} > \frac{p_1(\theta)}{q_2(\theta)}(1 - M_1)e_1,$$

*Proof.* Since $\dfrac{dp_2}{dp_1} = \theta$ and $\dfrac{dq_1}{dp_1} = -1$, then for each degree of product differentiation $\theta \in (0,1)$ we have that migration rate of consumer migration from product 1 to product 2 is $\Delta_{12} = \theta \in (0,1)$. Then from the inequality 1 it is implied that

$$\theta > \frac{p_1(\theta)}{q_2(\theta)}(1 - M_1)e_1.$$

Therefore, the conjecture is proven. □

Finally, we examine how the competition prior to the merger affects the upward upward pricing pressure indicator caused by a merger of firms. We compare the upward pricing pressure caused by a merger of firms with Bertrand pre-merger competition and Bertrand-Cournot pre-merger competition.

**Proposition 3.** *Consider that firms 1 and 2 serve demand systems 3 and 4. The merger of firms attending demand system 4 causes greater upward pricing pressure than attending demand system 3.*

*Proof.* Since the consumer migration rates are $\Delta_{12} = \theta$ and $\Delta_{12} = \theta$ serving the demand system 3 and 4 respectively. On the other hand, since the Counrot-Bertrand competitive equilibrium quantity of firm 2 is greater than the competitive Bertrand price of firm 1, subtract the marginal cost, for every degree of horizontal product differentiation $\theta \in (0,1)$. Then we have the following inequality:

$$q_2 > p_1 - c_1.$$

Then, using the equations 10 and 21 we have that

$$\theta q_2 - e_1 c_1 > \theta(p_1 - c_1) - e_1 c_1.$$

Therefore, the conjecture is proven. □

# 5 Conclusion

This paper's contribution is twofold. First, it develops a new upward pricing pressure indicator based on the Bertrand-Cournot pre-merger competition duopoly model. Second, it analyzes the effect of the degree of horizontal product differentiation on the upward pricing pressures developed in this research.

We find that the upward pricing pressure caused by firms' mergers depends on the type of competition pre-merger. Furthermore, we show that if the pre-merger competition of firms is the Bertrand-Cournot type, then a merger causes upward pricing pressure more easily than in the Bertrand scenario. Hence, using tools that diagnose the type of competition in the pre-merger is important.

On the other hand, it is observed that the degree of horizontal product differentiation impacts on the upward pricing pressure caused by a merger: under Farrell and Shapiro (2010a) assumption, if the products tend to be more homogeneous then the merger of firms causes upward pricing pressure more easily. As a guide to the antitrust authority activity, it is to analyze more carefully when the merged firms tend to produce homogeneous products.

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