E C O N O M I C S B U L L E T I N

Horizontal mergers in the circular city: a note

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Abstract

Two−firm horizontal Cournot mergers give rise to multi−plant firms in spatial markets. We study location equilibria on the circle for competition between a two−store merged entity and one then two single−store competitors. Several results turn up. First of all, we get equilibrium location patterns that could not have been obtained on the segment. Secondly, we investigate the profitability of such mergers and find that they turn out to be unprofitable much earlier.

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1. **Introduction**

Horizontal mergers have long been known to raise puzzling questions on their profitability. In the widely used standard Cournot model (linear, symmetric, homogenous good, simultaneous game), horizontal mergers are simply not profitable, as shown by Salant, Switzer and Reynolds (1983). However, changing certain hypotheses of the standard model does yield different results. Assuming strategic complementarity instead (as in the Bertrand model) is enough to restore the internal profitability. Dropping the constant identical marginal costs also helps, just like assuming enough differentiation among the products.

Introducing a spatial framework basically preserves the conclusions obtained in the non spatial setting. More precisely, horizontal mergers in shipping spatial linear models with homogeneous good and Cournot competition cannot be profitable unless firms relocate. McAffee, Simmons and Williamson (1992) suggested the contrary, since the transport cost induces a marginal delivery cost asymmetry between firms at any location in the market. The merged firm keeps then open both outlets (in contrast with the non spatial model), and potentially benefits from its bigger size. Nevertheless, Norman and Pepall (1998) show that this is not enough to restore internal profitability, since spatial markets are segmented in a standard linear shipping model with quantity competition. Without arbitrage on behalf of consumers, independent Cournot equilibria obtain at each local market due to local constant returns to scale, and therefore the merger paradox is present on each of these spatially separated markets. Marginal delivery cost asymmetry is not enough to reverse the unprofitability result: simple output reallocation between affiliates does not generate a sufficient cost advantage to the merged entity, and this was already the case in the non-spatial models.

In turn, if relocation is allowed for, the delivery cost asymmetry can endogenously increase. Norman and Pepall (2000) show that the endogenous location in the post-merger game does make a merger profitable if the *segment* market is sufficiently concentrated (less than eight firms initially). Actually, they argue that besides the endogenous location, it is the behavioral asymmetry between the insiders and the outsiders at this stage of the game that makes the merger profitable.

We may briefly remind here that the two main reasons behind the merger paradox in Cournot models are the strategic substitution and the incapacity of the merged entity to commit to a higher level of output in the post-merger game[1].

[1] The importance of commitment was revealed by Daughety (1990), who allowed the merged

In their paper, Norman and Pepall (2000) stick with the spatial Cournot competition but model a Stackelberg-in-location stage before the quantity stage. The location first mover advantage is presented as a key factor leading to a bigger and better firm, thus enjoying a net absolute advantage over its competitors w.r.t. a certain group of consumers who become its captive demand (in their setting, a merger allows the two stores to coordinate their relocation choices in order to better adjust them to consumer locations). However, they acknowledge that their Stackelberg-in-location outcome can be replicated by a simultaneous relocation stage, on condition that the merged entity chooses two distinct locations for its affiliates so as to prevent overlapping of their respective market areas. Therefore, the simultaneous location game and the sequential one can give identical outcomes. We conclude then that the location sequentiality assumption is not essential for their profitability result, and go on to look for an alternative explanation.

Basically, we raise the question of how the scope for profitable spatial horizontal mergers depends on the type of underlying location model. Our work builds on the framework of Norman and Pepall (2000), up to the space circularity. We argue that the shape of the space is a supplementary yet essential condition to be taken into account, because their result of internal profitability on the segment is actually due to the border effect present on such an exogenously bounded market, and not to the behavioral asymmetry assumption. We claim that the incentives to merge are higher in the linear city than in the circular one, and put this down to the fact that the segment is an asymmetric location structure to the extent that locations are not homogenous as on the circle. It is this asymmetry that leads to minimum differentiation (as shown by Anderson and Neven (1991)), since everybody's preferred location is the mid-point of the segment[2]. Merging gives the opportunity to reach at lower cost the distant demand, and to lower the competitive pressure on the mid-segment location. We show here that despite relocation, mergers on the circle become unprofitable much earlier (starting with four firms on the market). Lack of a unique most-preferred location lets the competition effect dominate, and firms never agglomerate at the same location on the circle[3]. Merging brings rival outlets closer together, so post-merger competition is

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entity to act as a Stackelberg leader and thus restored the merger's internal profitability.

[2]Firms are optimally located when total quantity delivered to the right equals that on the left (the quantity median property, in the terms of Pal and Sarkar (2002)). When all firms are single-store, the quantity median location is the same and unique for all, the mid-point of the segment. This is due to the presence of exogenous endpoints which limit the market areas of all firms in the same way.

[3]On the circle there is no single median point. All locations are *a priori* alike, and they can

more intense than on the segment. A larger increase in market power is therefore required to make the merger profitable, which actually happens when firms merge to form a duopoly. In return, the outsiders' free-riding dominates in a merger to triopoly, making it unprofitable. Our model examines these two particular cases in detail, in order to point out that a certain degree of asymmetry or heterogeneity on the market (of which merged firms may take advantage of) is necessary to have sufficient incentives to merge.

Our paper has a double purpose. First of all, we wish to remind that conclusions might largely differ once the linear space assumption is replaced by the circular one. Location models often concluded that Bertrand competition yielded spatial dispersion, as compared with Cournot, which actually gave the opposite result, before counter examples revealed the importance of the assumption on the shape of the market. Likewise, we bring froward the possibility for the profitability of spatial mergers to depend essentially on the same assumption. After all, even if the largest part of the literature on spatial competition builds on the unitary segment hypothesis, certain real situations are better approximated by the circular city framework.

We recall for instance that any spatial model is supposed to be a tractable way to model firms' choice of product specification. Typical examples include circular towns spreading around lakes, for which consumers cannot generally afford to cross the lake when going shopping, and therefore department stores take up locations around the lake. Also, in the case of traffic-jammed cities, shopping malls are located on the outskirts, on the circular belt-way, so as to avoid consumers the downtown traffic. Finally, choosing firms' locations on the circle equally approximates the mechanism of flexible manufacturing, where the basic product (standing for the location of the firm) is then customized at a certain cost (here, the shipping cost) so as to make it available to consumers[4].

At the same time, we also remind that a set of consumers with preferences defined on a set of goods can normally be represented by such a location model, which actually was in the beginning the very purpose of the analogy between the spatial setting and the product differentiation framework. As far as the linear rep-

all potentially satisfy the quantity median property, it all depends on competitors' locations. There is no exogenous border constraint for fims to take up the same location, therefore by not clustering all at the same point, firms are able to reduce competitive pressure.

[4]Other examples of the circular framework modeling firm's choice of product specification include television networks choosing time slots for their programmes, or rival airlines choosing the arrival and departure times for their flights.

resentation is concerned, it applies to single-peaked consumer's preferences[5]. No such analogy is available for preferences represented by the circular model, which might be considered as a drawback when making the choice of a particular spatial representation over another. Moreover, the linear structure is characterized by the presence of a unique median consumer, which is contradicted on the circle[6]. The circular representation appears particularly special in light of all this. Perfect symmetry in locations mirrors the multiplicity of median consumers, and this is what gives rise to the partial clustering result of Gupta et al. (2004), as well as to our intuition on the relation between merger incentives and market (a)symmetry. Last but not least, Horstmann and Slivinski (1985) also note that consumer preference restrictions imply that in the case of the circular representation, products that are no individual's least preferred good simply do not exist (they would be located inside the circumference), whereas they abound in the linearly representable structure. In other words, *all* varieties on the circle are someone's most preferred commodity and someone else's least preferred commodity, which is not the case for varieties on the segment.

We might therefore venture the following remarks on the choice between the circular framework and the linear one: the former might be more appropriate for global markets, where border effects are virtually inexistent, and where different varieties may more easily satisfy the above conditions. The latter might approximate regional or national markets, where border effects may be more powerful. Informally, if we interpret the existence of borders as giving rise to opportunities for obtaining some captive demand (exploiting commercial niches, for instance), then the circular framework might be more useful for modelling steady, mature markets, where such opportunities have disappeared, whereas the linear setting would represent expanding markets, where such niches still exist.

Second of all, this paper contributes to the question of location choices of multi-store firms. On the segment, location equilibria for multi-store firms have already been worked out. Pal and Sarkar (2002) exhaustively analyze competition between multi-store firms on the segment, and prove that the complex problem of determining equilibrium store locations can be approximated by a lot simpler one. Note that this is also entirely possible thanks to the existence of endpoints. On

[5] See for instance Black (1948) for this well-known result in social choice literature.

[6] Actually, given any pair of goods over which consumers' preferences are defined, on the circle there are always two such median consumers indifferent between them, whose preference orderings are exactly opposite one another. See Horstmann and Slivinski (1985) for more details on this median consumer and consumers' preferences represented by location models.

the circle, where all locations are *a priori* homogeneous, Chamorro-Rivas (2000) chooses a certain perfectly symmetric framework, i.e. a two-plant duopoly, to obtain the 'equidistance result'. We contribute by solving out for the location equilibria between a two-plant firm and one or two single-plant competitors. The 'equidistance result' can be obtained only in the latter case. In turn, it is obvious that as compared with the linear framework, multiplicity is likely to characterize the multi-plant location equilibria, also due to the lack of a unique median consumer. More insight is necessary w.r.t. the circular space assumption - we conjecture for instance that the number of firms and that of plants are important parameters.

The paper is organized as follows: we begin by introducing the base model, then we discuss in order mergers to duopoly and triopoly. Each time we identify first location equilibria after merger, then establish the (un)profitability result.

2. **Model**

An infinite number of consumers are uniformly located on the unit circle. Three identical single-store firms (we discuss later the four-firm case) produce a homogeneous good with the same technology characterized by constant marginal costs, normalized to zero. Firm's i location is denoted by x_i, $i = 1, 2, 3$. At any consumer location x on the circle, demand is given by $p(x) = a - Q(x)$, $a > 0$, where $p(x)$ is the product price at that location and $Q(x)$ is the total output supplied at x. Firms incur transport costs $t\,|x - x_i|$, linear in distance and quantity, in order to ship output to consumers[7]. Consumers have a prohibitive costly transport cost, preventing arbitrage, so firms can and will price discriminate across the set of spatially differentiated markets. Given constant marginal delivery costs, a set of independent Cournot equilibria obtains for each location x on the circle. There are no set-up or (re)location costs, and there is neither entry on nor exit from the market (each firm supplies a positive quantity at every local market). Starting from an initial location equilibrium, two firms merge (an exogenous decision). A two-period post-merger game takes place: first firms relocate simultaneously and then they simultaneously play Cournot. The equilibrium concept used is the subgame perfect Nash equilibrium.

[7] t is a positive constant, and the norm stands for the shorter distance of the two possible ways to ship goods along the circumference. Since the transport cost parameter enters as a multiple in the profits expression, for our profitability analysis we will assume $t = 1$ without loss of generality.

2.1 **Merger to duopoly**

Two among the three firms on the circle decide to merge. We identify the location equilibria both before and after merger, so as to compare profits. In contrast with the linear market, the merger to duopoly on the circle exhibits a lower profitability range and multiple location equilibria.

Using the analysis of Shimizu and Matsumura (2003), we can list *all* location equilibria on the pre-merger market. There can be no more than three distinct locations. Actually, all firms clustering at the same point is never an equilibrium on the circle, so firms choose either two or three distinct locations. In the two-location equilibrium, firms locate diametrically, whereas the three distinct locations pattern is the equidistant one. To sum up, there are only two equilibria before merger: two firms in 0 and the third in 1/2 (diametrical pattern), and one firm in 0, the second in 1/3 and the third in 2/3 (equidistant pattern)[8].

Insert Figure 1.

In order to get the optimal locations after merger, denote now by r ($r \in [0, 1/2]$) the location of the single-store firm, and by d and $1-d$ those of the two affiliates[9] (where $d \in (0, 1/2)$). The equilibrium profits write as follows:

$$9 \times \Pi_{\text{merged}} = \int_0^{1/2} \left[a + |r-x| - 2\,|d-x|\right]^2 dx + \int_{1/2}^{1} \left[a + |r-x| - 2\,|1-d-x|\right]^2 dx \quad (1)$$
$$9 \times \Pi_{\text{single-store}} = \int_0^{1/2} \left[a + |d-x| - 2\,|r-x|\right]^2 dx + \int_{1/2}^{1} \left[a + |1-d-x| - 2\,|r-x|\right]^2 dx \quad (2)$$

The optimal locations result from profits' maximization w.r.t. d and r respectively. Depending on the relative position of the single-store firm w.r.t. the two affiliates, the discussion is divided in three subcases[10]. In the end only two equilibrium patterns turn up: the first one is like a degenerate segment, with the

[8] This is obtained alternatively by solving out explicitly for the location equilibrium game, which is much more time- and space-consuming. Proof is of course available on request. (A sample resolution of a circular Cournot model is available in Matsushima (2001).)

[9] Following Pal and Sarkar (2002), we know that the two affiliates will never share the same location. Moreover, on each side of an affiliate, its market area extends up to the midpoint between itself and the other affiliate. There is no market area overlapping, and basically each outlet supplies on half a circle. We can always denote the two midpoints by 0 and 1/2, for ease of computation and exposition, and without any loss of generality.

[10] Actually, we need to consider both the position of the single-store and that of the point opposite to it, because both locations enter the profit expression. Say for instance that $r \in [0, 1/2 - d]$ (the resolution for the two other cases is similar and available on request): then optimal $r = 0$ and optimal $d = a - \frac{1}{4}\sqrt{16a^2 - 8a + 2}$.

outsider at mid-distance between the two insiders[11]. We call this Type 1 equilibrium. In return, *the second pattern could not have been obtained on the segment*: the affiliates locate as a two-store monopoly (i.e. diametrically), but the outsider and one of the insiders share the same location. We call this Type 2 equilibrium.

Insert Figure 2

The two pre-merger equilibria yield different equilibrium profits. Firms obviously make identical profits in the equidistant case, but in the diametrical one, firms at 0 get a lower profit than the one at $1/2$. Similarly, *post-merger patterns are not equivalent*, with the merged firm performing better on the so-called degenerate segment. We summarize next the profit comparison (six subcases), where $\Delta\Pi$ denotes the profit differential (i.e. $\Pi_{\text{merged}} - \sum_{\text{before}} \Pi^{\text{firms}}_{\text{merging}}$). Following Norman and Pepall (2000), we look for the range of values of a (the demand parameter, maximum reservation price) satisfying the condition for positive quantities (that is $a > n/2$, which becomes here $a > 1.5$.) and allowing for a profitable merger.

Insert Table 1

The profitability range is smaller on the circle, regardless of the subcase we discuss. On the segment[12], the (unique) profitability interval was $(1.5, 4.4089]$. Merger to duopoly is actually less profitable on the circle, because starting from less rivalry before merger, we end up with more competition afterwards, due to the location pattern that results from post-merger relocation. The unique initial equilibrium on the segment had all firms in the middle (see Anderson and Neven (1991)). On the circle, at most two firms share the same location before merger, so initial individual profits are higher than on the segment. Afterwards, the merged firm is better off in the segment-like pattern (Type 1), but even then the profitability range is smaller than on the segment. There, the merged entity enjoyed some captive demand between its stores and the line's ends, since the outsiders remained in the middle. This captive demand effect still exists on the circle in the segment-like case, but is weaker because of the cannibalization risk between the two outlets in the region of $1/2$. Exogenous borders lower this risk to zero on the segment. Conversely, in Type 2 equilibrium the affiliates do choose monopoly locations, but this location advantage is shared with the outsider, so the profitability range is even smaller than in the segment-like case.

[11] The equilibrium locations are exactly what they were on the segment, since we find the same expression for the optimal d (see footnote 4) as Norman and Pepall (2000).

[12] See Norman and Pepall (2000).

2.2 Merger to triopoly

We start again with the pre-merger location analysis and go on to determine the location post-merger equilibria, so as to compare profits. This merger turns out to be unprofitable.

A qualitative analysis of the pre-merger market gives all initial location equilibria. The four-firm location equilibrium may exhibit two, three or four *distinct* locations. Following Shimizu and Matsumura (2003), we know that the two-location equilibrium has two firms at each end of a diameter. Rather tedious computations show that we cannot have an equilibrium with three distinct locations (proof available on request). Finally, there are an infinity of four-location equilibria, with firms at the ends of any two diameters, as shown by Gupta et al. (2004). However, it is straightforward to show that all these equilibria (both with two and four distinct locations) are equivalent in terms of profits for all firms. To sum up, we have two pre-merger equilibrium patterns: two firms at 0 and the other two at 1/2, and each time a firm at the end of a diameter. For ease of computation we shall nevertheless use two perpendicular diameters, without any loss of generality whatsoever.

Insert Figure 3.

Denote by p and r respectively the two outsiders' locations, and again by d and $1-d$ the locations of the two affiliates (where $d \in (0, 1/2)$). Profits in location equilibrium write as follows:

$$16 \times \Pi_p = \int_0^{1/2} \left[a + |r-x| + |d-x| - 3|p-x|\right]^2 dx + \int_{1/2}^{1} \left[a + |r-x| + |1-d-x| - 3|p-x|\right]^2 dx \quad (3)$$

$$16 \times \Pi_r = \int_0^{1/2} \left[a + |p-x| + |d-x| - 3|r-x|\right]^2 dx + \int_{1/2}^{1} \left[a + |p-x| + |1-d-x| - 3|r-x|\right]^2 dx \quad (4)$$

$$16 \times \Pi_{merged} = \int_0^{1/2} \left[a + |r-x| + |p-x| - 3|d-x|\right]^2 dx + \int_{1/2}^{1} \left[a + |r-x| + |p-x| - 3|1-d-x|\right]^2 dx \quad (5)$$

We obtain the candidates to optimal locations by solving the simultaneous system formed by the first order conditions in p, r and d respectively on the above profits[13]. Checking for the second order conditions gives us the equilibrium locations. The bottom line is that both the two affiliates and the two outsiders locate

[13] Twelve cases need to be discussed, depending on the relative positions of the two single-store competitors w.r.t. the two affiliates. Computations are tedious and take much space, but are of course available on request.

diametrically[14]. Basically, either the two affiliates locate at $1/4$ and $3/4$ and the two outsiders locate either at 0 and $1/2$ respectively, or the latter share each the location of an affiliate, i.e. $1/4$ and $3/4$.

Insert Figure 4.

It can be easily checked that after merger all location equilibria are equivalent, i.e. they yield the same profits for each and every firm. Remember that we had the same remark applying to equilibria before merger. Consequently, the profit comparison is quite simple:

$$2 \times \Pi_{\text{before}}^{\text{firms}} - \Pi_{\text{merged}} = 2 \times \left(\frac{a^2}{25} - \frac{a}{50} + \frac{7}{300}\right) - \left(\frac{a^2}{16} + \frac{a}{64} + \frac{1}{256}\right) > 0, \forall a > 2$$

The conclusion is straightforward: the merger to triopoly is not profitable. Note that this time there is no captive demand available at all, since in both equilibrium patterns, each affiliate faces an outsider on each side. Consequently, despite relocation, the merged entity cannot isolate itself from outsiders' competition[15].

3. Conclusion

To sum up, this paper basically claims that incentives to merge are higher when there is some form of market asymmetry that firms may benefit from. We show here by two examples that on the circle, horizontal Cournot mergers with endogenous location become unprofitable much "earlier" than on the segment, that is for a lower number of firms on the market. On the circle, a merger to *triopoly* is not profitable, whereas on the segment the profitability result was valid up to *initially eight firms*. This suggests that the circular market is much more subject to the merger paradox than the segment, and that for more than four firms all mergers may well not be profitable. This conjecture still wants formal proof for the time being.

The second point we make in this paper concerns spatial competition between multi-plant firms. On the circle, this analysis is yet incomplete, and we contribute by working out two particular cases. We argue that the number of plants of the merged firm, as well as the number of single-store competitors are essential parameters in presence of the circularity assumption. Remember that with a single competitor, we obtained a partial agglomeration equilibrium pattern that

[14] For instance, in the case where $p \in [d, 1/2]$ and $r \in [1/2, 1-d]$, we obtain the following optimal locations: $p = 1/4$, $r = 3/4$, $d = 1/4$.

[15] Remember that without relocation, such mergers are not profitable, and here the post-merger location patterns merely replicate those from before merger.

was impossible on the segment: an affiliate and the single-store competitor sharing the same location. Similarly, a two-store merged entity may share exactly the same locations as its two single-store competitors, which again could not happen on the segment[16].

More insight is needed on the spatial competition between multi-store firms. So far, completely asymmetric firms in their number of affiliates (more than one) have not been considered. It would be though quite necessary, in order to better assess the implications of merger control in spatial markets and to infer effects of divestiture injunctions.

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[16]See Pal and Sarkar (2002) - the same number of firms and affiliates yields there a unique equilibrium. On the segment, two-store firms locate their affiliates symmetrically w.r.t. the middle point of the segment, where all the single-store firms are always located.

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Table I : Profit comparison for merger to duopoly

$\Delta\Pi \geq 0$	a∈( ]
$\sum$profits equidistant firms - Type 1 merged profit	a∈(1.5, 3.6]
$\sum$profits equidistant firms - Type 2 merged profit	a∈(1.5, 3.61]
$\sum$profits 'diametrical' firms (firms at 0 and 1/2) - Type 1 merged profit	a∈(1.5, 3.57]
$\sum$profits 'diametrical' firms (firms at 0 and 1/2) - Type 2 merged profit	a∈(1.5, 3.53]
$\sum$profits 'common location' firms (firms at 0) - Type 1 merged profit	a∈(1.5, 4.01]
$\sum$profits 'common location' firms (firms at 0) - Type 2 merged profit	a∈(1.5, 4.023]

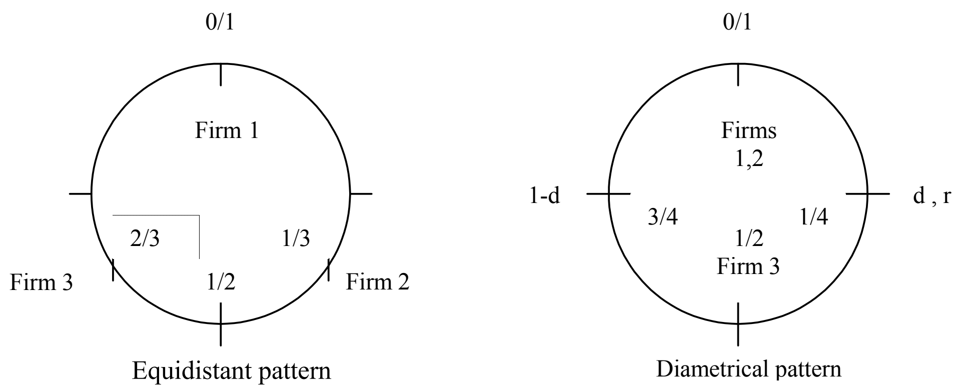
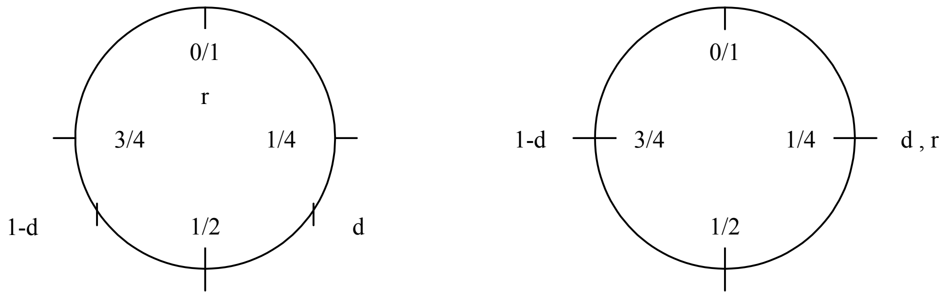


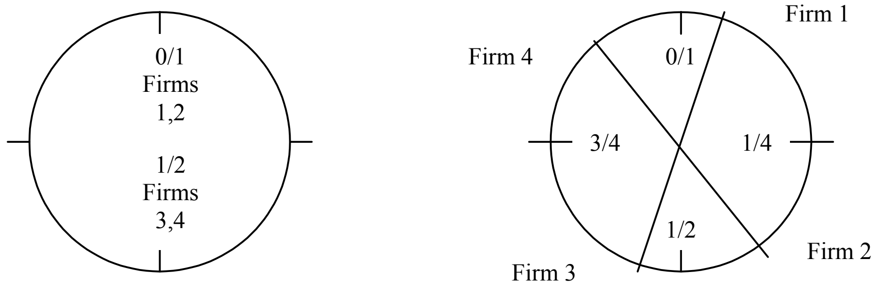
Figure 1 : Location equilibria before merger to duopoly



Type 1 : Outsider at mid-distance between the affiliates

Type 2 : Outsider sharing one of the diametrical locations of the affiliates

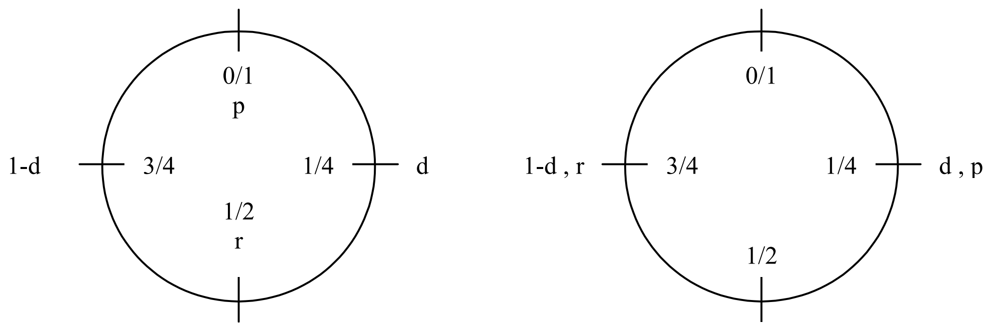
Figure 2 : Location equilibria after merger to duopoly



Two distinct locations pattern

Four distinct locations pattern

Figure 3 : Location equilibria before merger to triopoly



Outsiders and affiliates located equidistantly

Diametrical pairs of one outsider and one affiliate

Figure 4 : Location equilibria after merger to triopoly