Keeping Your Enemies Closer

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Abstract

We present an analytical framework for understanding why and when firms who compete aggressively in an existing market, decide to enter a new market via a strategic alliance as opposed to entering independently. Specifically, we investigate conditions under which an alliance mode of entry for two competing firms does better than each firm entering the new market independently. We characterize these conditions in terms of the relative levels of competition and size of the two markets. Our findings suggest that accessing a new market as an alliance dominates independent entry (i) when the competition in the existing market is strong relative to the new market; *and* (ii) when the new market is large relative to the existing market. We also show how there exists a trade-off between competition and market size under which an alliance does better. Using propensity score matching, we estimate the causal effect of entering a market through an alliance as opposed to entering independently, and have reason to believe that an alliance mode of entry can result in an increase in performance of a firm, under certain conditions of competition and market size. We then extend our theoretical analysis by allowing for asymmetry between the two competing firms, and showing that there is a smaller set of conditions under which an alliance mode of entry does better.

Keywords: Strategic Alliances; Competition; Non-Cooperative Game Theory; Propensity Score Matching

1. Introduction

In 1996, two separate strategic alliances were charted across different continents. On the east of the Atlantic, BP and Mobil announced their intention to form an alliance to compete more effectively against strong competitors, Shell and Exxon, in the European oil market (Robson & Dunk 1999). On the west of the Atlantic, GE Aviation and Pratt & Whitney – fierce competitors in the aircraft engine market – formed a joint venture called Engine Alliance to challenge Rolls-Royce's then-monopoly of engines that power the largest aircraft in the world, and subsequently overtook Rolls-Royce in market share (Engine Alliance 2011).

Both cases involve an alliance between two firms who compete in an existing market, but have interests in a new market. Both competitors can enter the new market independently – yet, they choose to do so as an alliance. Borrowing the words of GE Aviation and Pratt & Whitney (Engine Alliance 2011), why would a strategic alliance be a "logical solution" among "aggressive competitors"?

There has been a fair amount of research on strategic alliances in both the fields of strategic management and economics. A substantial portion of the former deals with the management of strategic alliances (Kale & Singh 2009), and the latter – specifically the sub-field of industrial organization – has evolved from the theory of the firm to organizational economics, providing us with insights in the area of "transaction costs, contracts, principal-agent relationships, incentives, information, and many other aspects of firm organization" (Gomes-Casseres 2006).

Here, we pose a more granular question that is motivated by specific phenomena in the business world. The focal question is – "why and when do competitors in an existing market form an alliance to access a new market, as opposed to entering independently?" We also seek to answer: (i) How much should the competitors contribute to the alliance? (ii) How will the level of contribution to the alliance depend on the relative size of the two markets (new and existing), and the relative strength of the competition in the two markets? (iii) How much better can the firms achieve via an alliance mode of entry? (iv) How do the results change when competitors are asymmetric?

Recent numbers reveal that more than 2,000 strategic alliances are launched worldwide each year, and this number grows by 15% each year (Steinhilber 2008). A proposed reason for this phenomenon is the rapid change that is taking place in the competitive business environment (Harrigan 1986). Despite the increasing popularity of alliances in the business environment, past studies have shown that between 30% and 70% of these alliances fail (Kale & Singh 2009). In light of this paradox, many studies have proposed ways to increase the success rate of strategic alliances. To the interested readers, we refer them to the comprehensive coverage of this issue by our colleagues in the field of strategic management. Our objective is more modest. We hope to shed some light on strategic alliances by presenting a non-cooperative game theoretic model, in which two competing firms have to consider the tension between competition and cooperation as they approach entry into the new market.

We approach this problem using the following framework. We assume that there are two focal firms competing in an existing market with another firm. The two focal firms now have an opportunity to enter a new market which is currently dominated by another player. Each firm can do so either independently or as a strategic alliance, and has to make this decision in the first stage of a two-stage non-cooperative game with complete information. Following that, each firm then decides how much of its endowment to allocate across the existing and new market, and finally receives a payoff in each market based on the decision in both stages. Under what circumstances will two competing firms enter the new market as an alliance, as opposed to entering independently? And how different are their payoffs in both modes of entry?

Our results are as follows. By solving for the pure-strategy Nash equilibrium in the second stage of the non-cooperative game under each mode of entry, we obtain the optimal allocation and payoff as a function of relative competition between both markets, and the relative size of both markets. Using backwards-induction, we can then solve for the subgame-perfect Nash equilibrium for the game. We obtain the following two conditions under which an alliance mode of entry dominates an independent mode of entry: (i) when the competition in the existing market is strong, relative to the new market; *and* (ii) when the new market is large, relative to the existing market. We also show that (iii) there exists a trade-off between competition and market size under which an alliance does better.

We hope that our findings will provide researchers as well as practitioners with some new insights as they consider the possibility of entry into a new market via an alliance with a competitor. We now proceed to describe the model in detail.

2. Model

2.1 General Setup

Consider two markets – existing and new. Consider also two firms, A and B, who compete in an existing market and are now interested in entering a new market. To do so, A and B have to decide how much of their endowment, which we assume to be c for each firm, to allocate between the existing and the new market. Let a and b represent A and B's respective input in the existing market, and the balance $(c_A - a)$ and $(c_B - b)$ represent A and B's respective input in the new market. In our model, a and b are the only respective decision variable that each firm has to make. There are thus three assumptions made here about A and B: (i) both are symmetric in their endowments; and (ii) both are considering inputs in both markets. We relax the first assumption in a later section, where we allow for asymmetry of the players.

Besides *A* and *B*, there are other firms in both the existing and new market. Let *X* and *Y* represent the aggregation of other independent firms in the existing and new market respectively. We further assume that *X* is only interested in the existing market, and *Y* is only interested in the new market, i.e. they are not considering entry into each other's market. Let *x* and *y* represent *X* and *Y*'s respective inputs in the existing and new market. Figure 1 represents the status quo arrangement.

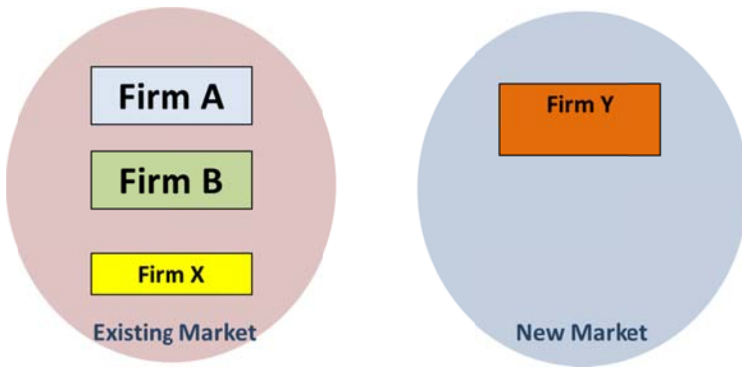


Figure 1: Representing the Status Quo

At this point, we consider two modes of entry by *A* and *B* into the new market – one in which *A* and *B* enter independently, and the other in which *A* and *B* enter as an alliance. We represent these two alternatives diagrammatically in Figure 2.

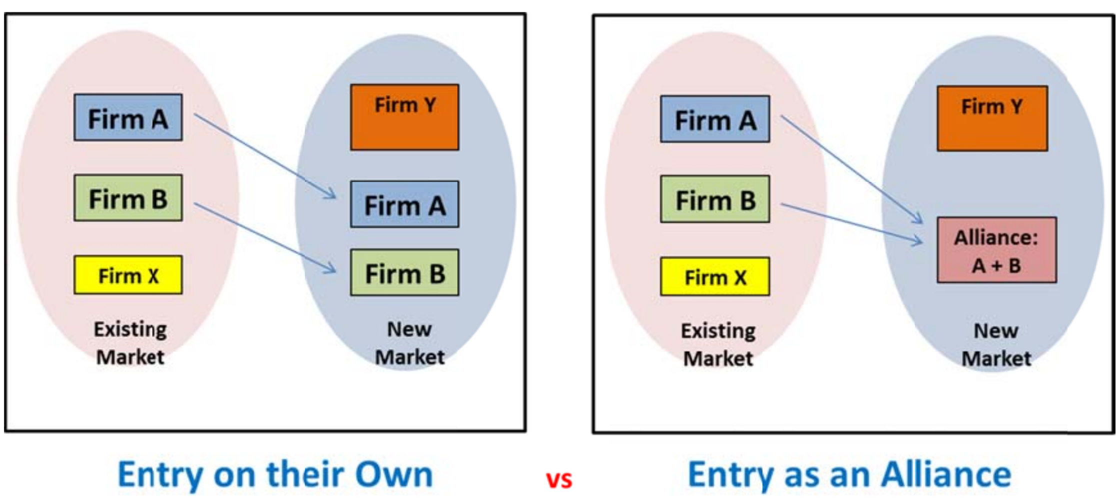


Figure 2: Two Modes of Entry for *A* and *B*

In our model, a firm's share of the payoff in a market is determined by its share of the total inputs in that particular market, i.e. a firm's share of payoff in each market depends on its input relative to combined inputs of *all* firms in the market. This has similarities to the steady-state market share model (Little, 1979), traditionally known as the Lanchester model, which has been used in the competitive marketing literature primarily in the context of advertising competition.

Letting $M_{Existing}$ and M_{New} represent the payoff potential of the existing and new market respectively, we represent the total net payoff of *A* and *B* under the independent mode of entry in (1) and (2), where *k* is a scaling factor:

$$\pi_{A,indep} = k\left\{\left[\frac{a}{a+b+x} \cdot M_{Existing}\right] + \left[\frac{c_A - a}{(c_A - a)+(c_B - b)+y} \cdot M_{New}\right]\right\} - c_A. \tag{1}$$

$$\pi_{B,indep} = k\left\{\left[\frac{b}{a+b+x} \cdot M_{Existing}\right] + \left[\frac{c_B - b}{(c_A - a)+(c_B - b)+y} \cdot M_{New}\right]\right\} - c_B. \tag{2}$$

Alternatively, *A* and *B* can enter the new market as a strategic alliance. If so, we assume that *A* and *B* pool their inputs into a single entity for entry into the new market, and given their symmetry, split the payoff from the new market equally. In this case, the expressions for the total payoff for each firm are:

$$\pi_{A,alliance} = k\left\{\left[\frac{a}{a+b+x} \cdot M_{Existing}\right] + \frac{1}{2}\left[\frac{(c_A - a)+(c_B - b)}{(c_A - a)+(c_B - b)+y} \cdot M_{New}\right]\right\} - c_A\,. \tag{3}$$

$$\pi_{B,alliance} = k\left\{\left[\frac{b}{a+b+x} \cdot M_{Existing}\right] + \frac{1}{2}\left[\frac{(c_A - a)+(c_B - b)}{(c_A - a)+(c_B - b)+y} \cdot M_{New}\right]\right\} - c_B\,. \tag{4}$$

Our setup is as follows. Firms *A* and *B* are in a two-period non-cooperative game with complete information. In the first period, both firms have to simultaneously decide whether to enter the new market independently or as an alliance. Both firms enter into an alliance only if they simultaneously choose to do so; in all other cases, both firms enter the new market independently. In the second period, both firms will decide how much of its endowment to allocate in each market, based on the mode of entry determined in the first period. (1) to (4) thus describe the payoff to each firm under each mode of entry, based on decision variables *a* and *b*.

We thus solve the game using backwards-induction. In other words, *A* and *B* know the values of *x*, *y*, $M_{Existing}$ and M_{New}, and thus solve for the optimal payoff under both modes of entry at the second stage of the game. They then decide whether to enter the new market as an alliance or independently, depending on which mode of entry yields a higher payoff[1]. The subgame-perfect Nash equilibrium for the game will thus be the equilibrium that is associated with the backwards-induction outcome.

2.2 Specific Setup

To reduce the number of parameters in the model for analytical tractability, we normalize the input of A, B, X and Y against c_A (and by symmetry, c_B), and redefine a, b, x and y respectively as normalized decision variables and parameters. In other words, we assume the initial endowment of firms A and B to be 1, and redefine $a, b \in (0, 1)$ to be the normalized inputs of A and B respectively. In a similar spirit, x and y are the normalized endowments of the aggregate competition X and Y respectively. We also redefine k as the normalized scaling factor, without loss of generality.

Furthermore, let $w \in (0, 1)$ be the proportion of x to the sum of x and y, i.e. w reflects the proportion or weight of the total competition coming from the existing market:

$$w = \frac{x}{x+y}\,, \tag{5}$$

The assumption is that the *sum* of the aggregate competition from X and Y is equivalent in magnitude to the initial endowment of firms A and B.

Also, without loss of generality, let $M \in (0, 1)$ be the proportion of $M_{Existing}$ to the sum of $M_{Existing}$ and M_{New}, i.e. M reflects the proportion or weight of the total market size coming from the existing market:

$$M = \frac{M_{Existing}}{M_{Existing} + M_{New}}\,. \tag{6}$$

With the normalization described above, and together with (5) and (6), we can simplify (1) to (4):

$$\pi_{A,indep} = k\left\{\left[\frac{a}{a+b+w} \cdot M\right] + \left[\frac{1-a}{(1-a)+(1-b)+(1-w)} \cdot (1-M)\right]\right\} - 1. \tag{7}$$

$$\pi_{B,indep} = k\left\{\left[\frac{b}{a+b+w} \cdot M\right] + \left[\frac{1-b}{(1-a)+(1-b)+(1-w)} \cdot (1-M)\right]\right\} - 1. \tag{8}$$

$$\pi_{A,alliance} = k\left\{\left[\frac{a}{a+b+w} \cdot M\right] + \frac{1}{2}\left[\frac{(1-a)+(1-b)}{(1-a)+(1-b)+(1-w)} \cdot (1-M)\right]\right\} - 1\,. \tag{9}$$

[1] Due to symmetry of the firms, there is less concern with the notion of pairwise stability proposed by Jackson and Wolinsky (1996).

$$\pi_{B,alliance} = k\left\{\left[\frac{b}{a+b+w}\cdot M\right] + \frac{1}{2}\left[\frac{(1-a)+(1-b)}{(1-a)+(1-b)+(1-w)}\cdot(1-M)\right]\right\} - 1. \quad (10)$$

The parameters and the decision variables of the model setup are in Table 1, and the sequence of events for alliance formation towards new market entry are in Figure 3 (Bradlow & Coughlan, 2009). The following parameters and decision variables are all constrained to be strictly positive, in order for our analysis to be meaningful.

Symbol	**Definition**
a	Firm A's input in the existing market
b	Firm B's input in the existing market
w	Relative weight of competition in existing market to total competition
M	Relative weight of existing market size to total market size
k	Scaling factor of payoffs
$\pi_{A,indep}$	Sum of A's payoff under independent mode of entry
$\pi_{B,indep}$	Sum of B's payoff under independent mode of entry into new market
$\pi_{A,alliance}$	Sum of A's payoff under alliance mode of entry into new market
$\pi_{B,alliance}$	Sum of B's payoff under alliance mode of entry into new market

Table 1: Parameters and Decision Variables

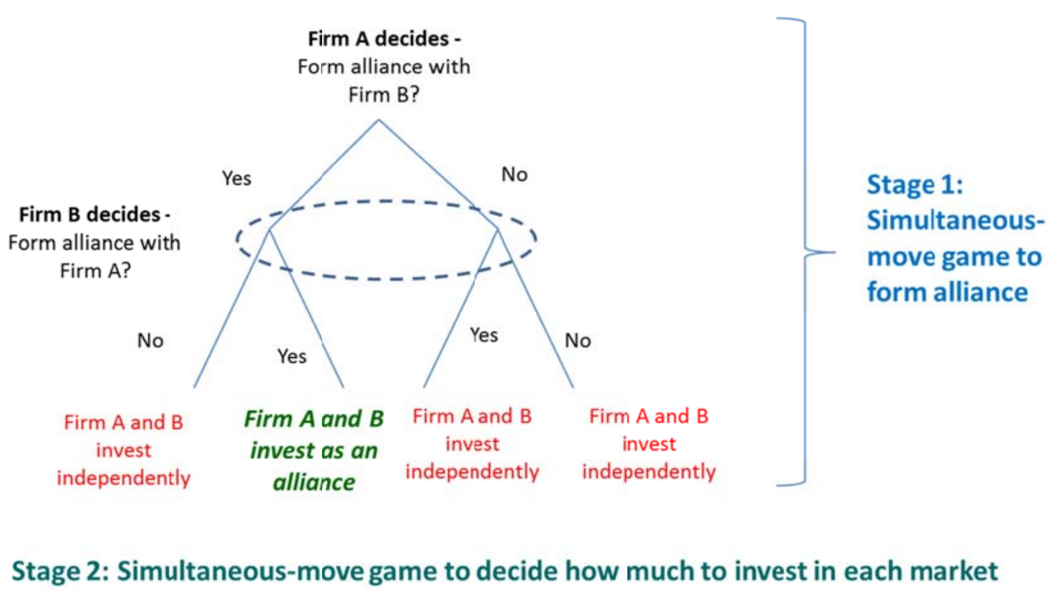


Figure 3: Sequence of Events: A Two-Stage Non-Cooperative Game

Moving forward, we will always assume that k is sufficiently large to ensure that payoffs under both modes of entry will always be positive, and thus the return to the firms in allocating its entire fixed endowment will always be worthwhile.

3. Analysis

In this section, we show when A and B will jointly prefer to enter the new market as an alliance, as opposed to entering independently. In other words, under certain conditions of M and w, both firms receive a higher payoff when they enter the new market as an alliance. We also show how the optimal input for each firm in either market changes under both modes of entry as a function of competition and size of markets.

We first present the analytical result for $M = 1/2$, i.e. the case in which the size of the new market is the same as the size of the existing market in subsection 3.1, and then extend our analysis for different values of M in subsection 3.2. In subsection 3.3, we study the effects of asymmetry between A and B on the alliance mode of entry using a computational approach, as doing so analytically would be difficult.

3.1 Setting Size of New Market to be Equal to Size of Existing Market

We solve for the symmetric pure-strategy Nash equilibrium solution for both modes of entry into the new market based on the setup in (7) to (10). For the independent mode of entry, we take the first-order conditions of (7) and (8) with respect to the decision variable for each firm, and setting $M = 1/2$ for the special case in which the size of both markets are equal, we obtain:

$$\frac{\partial(\pi_{A,indep})}{\partial a} = \frac{k}{2}\left[\frac{1-a}{(3-a-b-w)^2} - \frac{1}{3-a-b-w} - \frac{a}{(a+b+w)^2} + \frac{1}{a+b+w}\right]. \tag{11}$$

$$\frac{\partial(\pi_{B,indep})}{\partial b} = \frac{k}{2}\left[\frac{1-b}{(3-a-b-w)^2} - \frac{1}{3-a-b-w} - \frac{b}{(a+b+w)^2} + \frac{1}{a+b+w}\right]. \tag{12}$$

Solving (11) and (12) for a symmetric optimal solution[2], with a, b and w to be constrained between 0 and 1, we obtain a unique pure-strategy solution, $a*$. The solution in (13) is given by the second root of the following implicit function:

$$9w - 8w^2 + 2w^3 + (9 - 26w + 10w^2)\boldsymbol{a}^* + (-20 + 16w)\boldsymbol{a}^{*2} + 8\boldsymbol{a}^{*3} = 0. \tag{13}$$

We also verify that $a*$ is a maxima by checking that the second-order condition is negative for $0 < w < 1$. By symmetry, the same applies for $b*$. Going forward, we will present only the results for $a*$ in the case of symmetric firms.

We follow the same procedure to solve for the symmetric pure-strategy Nash equilibrium solution for the alliance mode of entry into the new market. (14) and (15) represent the first-order conditions, and (16) represents the symmetric optimal solution for alliance mode of entry. Once again, we verify that $a*$ is the unique pure-strategy solution, and that it is a maxima given that the second-order condition is negative for $0 < w < 1$.

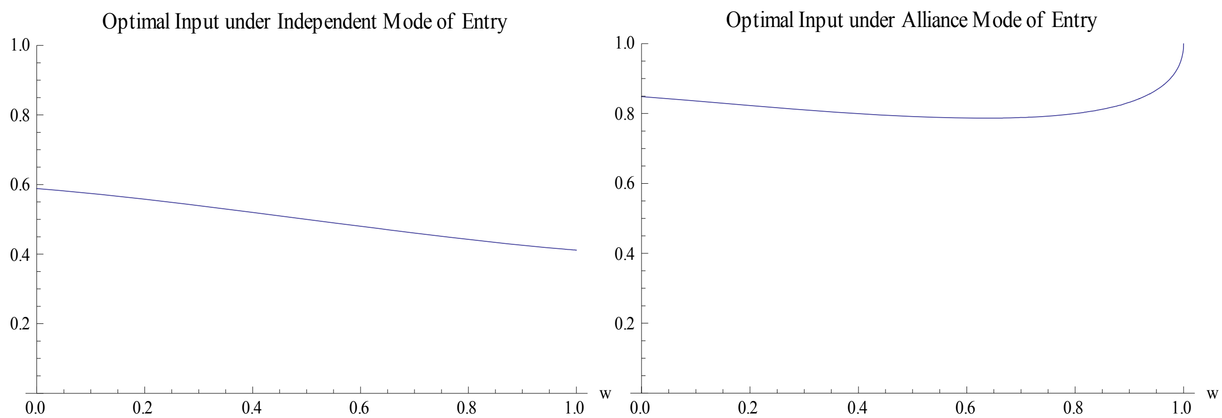
$$\frac{\partial(\pi_{A,alliance})}{\partial a} = \frac{k}{2}\left[\frac{2-a-b}{2(3-a-b-w)^2} - \frac{1}{2(3-a-b-w)} - \frac{a}{(a+b+w)^2} + \frac{1}{a+b+w}\right]. \tag{14}$$

$$\frac{\partial(\pi_{B,alliance})}{\partial b} = \frac{k}{2}\left[\frac{2-a-b}{2(3-a-b-w)^2} - \frac{1}{2(3-a-b-w)} - \frac{b}{(a+b+w)^2} + \frac{1}{a+b+w}\right]. \tag{15}$$

$$18w - 13w^2 + 3w^3 + (18 - 40w + 14w^2)\boldsymbol{a}^* + (-28 + 20w)\boldsymbol{a}^{*2} + 8\boldsymbol{a}^{*3} = 0. \tag{16}$$

To visualize the firm's optimal input in the existing market ($a*$ and $b*$) under both modes of entry, we plot the optimal input against w in Figures 4a and 4b[3]. Observe that in the independent mode of entry, optimal input is monotonically decreasing as relative competition in the existing market (w) increases. In other words, when both markets are equal in size, the optimal strategy is to decrease one's input in the existing market (and correspondingly increase one's input in the new market) as competition in the existing market intensifies.

[2] Observe that in solving for (11) and (12) as a system of equations for independent mode of entry, and also (14) and (15) for the alliance mode of entry, the scaling factor k will drop out, i.e. the Nash equilibrium solutions in both are not dependent on k.
[3] We used $k = 4$ for the plots here, which is more than sufficient to ensure that payoffs under mutual best response is positive.



Figures 4a and 4b:
Optimal Input in Existing Market when Both Market Sizes are Equal

In the alliance mode of entry, two observations about the optimal input in the alliance mode of entry are worth highlighting. First, for all values of w, the optimal input in the existing market under the alliance mode of entry is always higher than that of independent entry. Second, the optimal input in the alliance mode of entry – while decreasing at first – is actually non-monotonic, and that there is a turning point at a high value of w, with the optimal input a^* approaching 1 as w approaches 1.

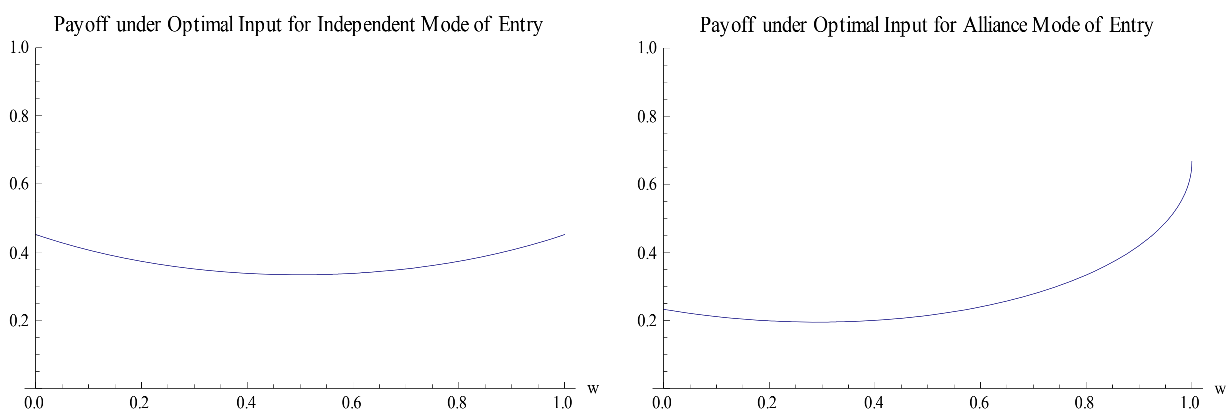
The intuition for the first observation is that either firm in the alliance has an incentive to allocate more to the existing market as compared to the new market, as the firm is the sole recipient of the payoff in the former, but has to share the payoff of the latter with the other firm. Going a step further, there are also tensions in the alliance mode of entry – the firm is evaluating its private marginal gain in the existing market and the shared marginal gain in the new market.

This tension gives rise to the second observation. The turning point arises because as relative competition in the existing market (w) increases in the initial stage and as relative competition in the new market (1-w) decreases correspondingly, the resulting increase in attractiveness of the new market is sufficiently large for either firm to allocate inputs to the new market through the alliance relative to the private gain, even after having to share half of the new market payoff with the other firm. In other words, the shared marginal attractiveness of the new market outweighs the private marginal attractiveness of the existing market.

However, there comes a certain point when the latter starts to outweigh the former (turning point in Figure 4b is approximately $w = 0.63$ when $M = 1/2$). From this point on, the firm in an alliance mode of entry can now do better by refocusing its inputs towards the existing market. The optimal input in the existing market then converges to 1 as w approaches 1. This phenomenon arises because as relative competition continues to ease in the new market, less is needed by the alliance in the new market to overcome the weakening competition in the new market. Having contributed "enough" to the alliance, and having gained sufficiently from the share of the "spoils", the "battle" now shifts back to the existing market, where both firms attempt to "ward off" the intensifying competition.

Notice that the abovementioned tension does not exist in the independent mode of entry into the new market as either firm is making an independent decision in both markets and neither firm has its "hands tied" as in an alliance mode of entry. Furthermore, under independent mode of entry, there is symmetry in the existing and new market – and so, we see a monotonically decreasing optimal input in the existing market in Figure 4a that is a function of increasing relative competition in the existing market.

This point is further illustrated in Figure 5 which show the plots of $\pi_{A,indep}$ and $\pi_{A,alliance}$ against w [4]. Observe that the payoff for the independent mode of entry is symmetric, but not the case for the alliance mode of entry. In the latter, payoff increases asymmetrically as w approaches 1. Put simply, when both markets are of equal size, there is no difference between the two markets under independent mode of entry – the firm optimizes its input across each market in a symmetric manner, and thus we observe a symmetric payoff due to both markets being of equal size. The same cannot be said, however, for the alliance mode of entry, in which there is an opportunity to tacitly "coordinate" a lower input into the new market. As we observe later, this effect works in favor for the firms if the relative competition in the new market is weaker, i.e. the alliance does better when w is high.



Figures 5a (left) and 5b (right):
Payoff under Optimal Input in Existing Market when Both Market Sizes are Equal

[4] Similar to previous footnote.

This difference in payoff is clearer in Figure 6, where we see how much more each firm can achieve under the two modes of entry. As the expression for the function in Figure 6 is itself a function of several implicit functions, we are unable to solve for a closed-form expression of *w* for the case when an alliance mode of entry does better. However, we can numerically approximate the point where the curve crosses the abscissa to be slightly less than 0.88. This result is summarized below.

RESULT 1. *If M = 1/2 and w > 0.88, then an alliance mode of entry does better than an independent mode of entry.*

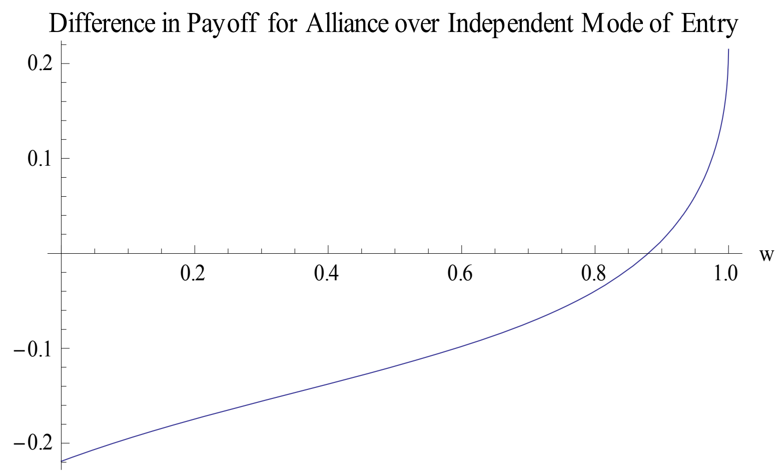


Figure 6: Firms Do Better under Alliance Mode of Entry as Relative Competition in Existing Market Gets Stronger

3.2 Allowing for Different Values of *M*

We extend the analysis for different values of *M*. Solving for (7) and (8) as a system of equations, and constraining the decision variables and parameters to be between 0 and 1, we obtain the symmetric pure-strategy Nash equilibrium. The optimal input in the independent mode of entry is given by the second root of the implicit function in (17). We do the same for (9) and (10), and obtain the optimal input in the alliance mode of entry, given by the second root of the implicit function in (18). Both (17) and (18) come with additional constraints on *M*.

$$\begin{gathered} 9Mw - 2w^2 - 4Mw^2 + w^3 + (9M - 8w - 10Mw + 5w^2)\boldsymbol{a}^* + \\ (-8 - 4M + 8w)\boldsymbol{a}^{*2} + 4\boldsymbol{a}^{*3} = 0, \\ \frac{-2w+w^2}{-9+4w} < M < \frac{4+4w+w^2}{5+4w}. \end{gathered} \tag{17}$$

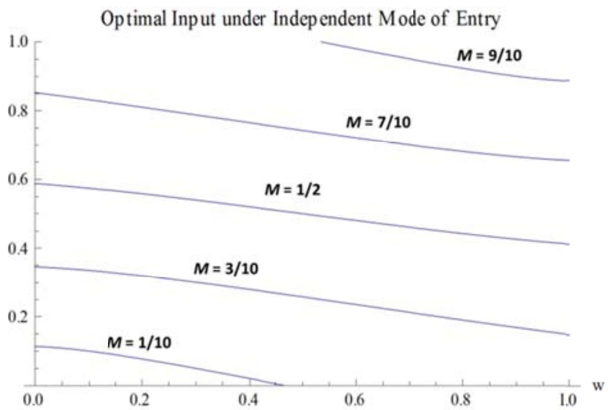
$$\begin{gathered} 18Mw - w^2 - 11Mw^2 + w^3 + Mw^3 + (18M - 4w - 32Mw + 4w^2 + 6Mw^2)\boldsymbol{a}^* \\ + (-4 - 20M + 4w + 12Mw)\boldsymbol{a}^{*2} + 8M\boldsymbol{a}^{*3} = 0, \\ \frac{w-w^2}{18-11w+w^2} < M < \frac{-4-4w-w^2}{-6-4w+w^2}. \end{gathered} \tag{18}$$

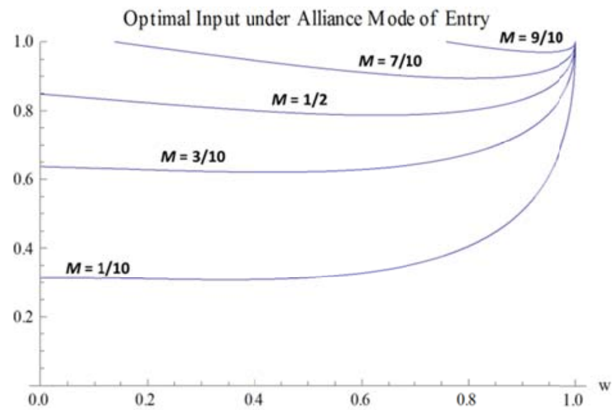
To convey the intuition on how the optimal inputs change as we vary *M*, we show in Figures 7a and 7b the respective optimal input under both modes of entry for several values of *M*.

In Figure 7a, we observe a downward shift in the optimal input under independent mode of entry as *M* decreases. In other words, as the existing market becomes less attractive relative to the new market, the optimal strategy will be to allocate less input to the existing market, and correspondingly more input to the new market. This makes intuitive sense, given the symmetry of the two markets under independent mode of entry. Note that as *M* approaches 0, the optimal input a^* will hit the lower bound of a for higher values of *w*. Likewise, as *M* approaches 1, the optimal input a^* will hit the upper bound of a for lower values of *w*. In the former, *A* (and also *B*) will invest – for the upper range of *w* – none in the existing market and everything in the new market. The reverse holds in the latter case for the lower range of *w*. These constraints on *M* are given in (17).

In Figure 7b, we also observe the general downward shift in the optimal input under alliance mode of entry as *M* decreases, while retaining the general shape that we observed earlier in Figure 4b. Again, there is first a slight dip in optimal input in the existing market for the various values of *M*, and then a convergence towards 1 as *w* approaches 1. The intuition which we provided earlier explains the general shape of the optimal input under alliance mode of entry, although the magnitude of the tension arising from the marginal attractiveness in each market now depends on the size of *M*. In terms of the optimal input hitting the bounds, we observe that each firm will hit the upper bound of 1 for the lower range of w for high values of M, but at a smaller magnitude for low values of M. Again these constraints on M are given in (18). The general result is summarized below.

RESULT 2. *As M decreases, there is a downward shift in the optimal input towards the existing market for both modes of entry.*





Figures 7a (left) and 7b (right):
Optimal Input in Existing Market for Different Market Sizes under Both Modes of Entry

Plugging in (17) and (18) into the respective payoff functions in (7) and (9), and accounting for the constraints on M, we can then take the difference in payoff between the alliance and independent mode of entry into the new market. We then obtain the following plot in Figure 8, which describes the set of conditions under which either mode of entry does better, or when there is no difference between both modes of entry. Notice that there is no difference in both modes of entry when M is very small, as both firms will invest entirely in the new market. Similarly, when M is fairly large and w is small, both firms will invest entirely in the existing market.

Our main focus is on the region in which the alliance mode of entry into the new market does better. Note that the region labeled "Alliance Mode of Entry Does Better" in Figure 8 is a density plot, where the lighter gray portions toward the right represent higher values of the payoff difference between the alliance and independent mode of entry.

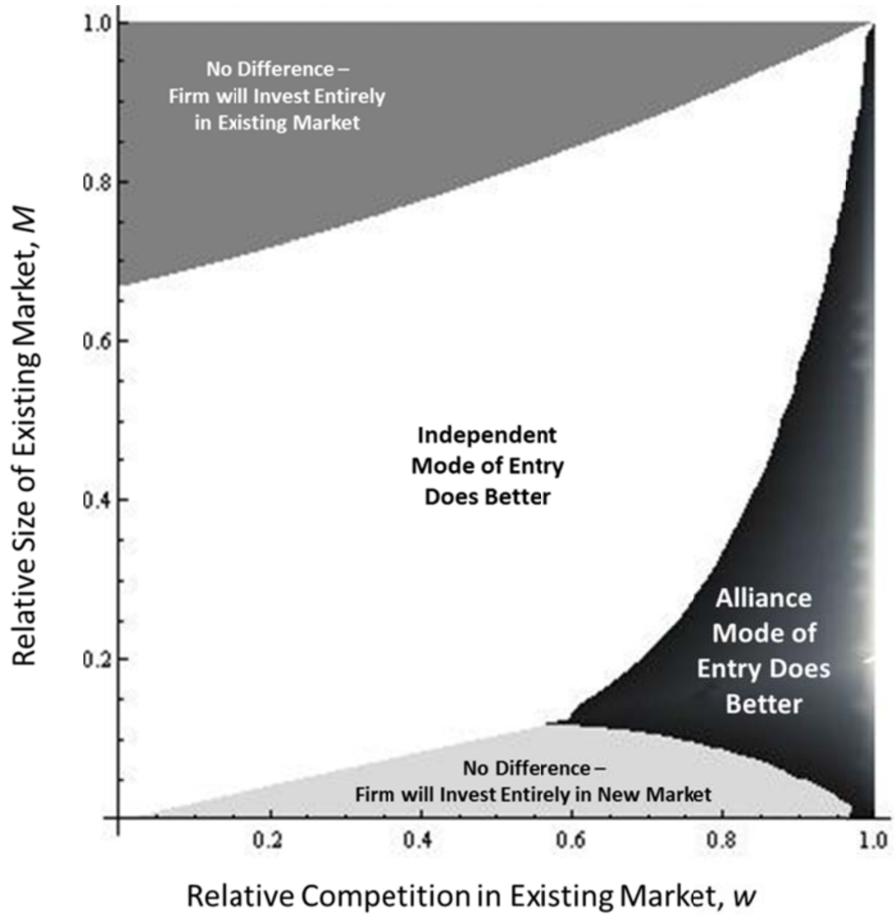


Figure 8: Different Regions under which Either Mode of Entry Does Better

First, Figure 8 corroborates Result 1 in the previous section – observe that when M = 1/2, an alliance mode of entry does better when w > 0.88. Second, using a numerical approximation, we find that for $0 < M < 1$, there exists a minimum threshold of 0.57 for w, below which an alliance always does worse. In other words, the competition in the existing market needs to be at least 1.33 times that of the new market for an alliance to form, below which the size of the new market is irrelevant[5]. The corresponding value of M is 0.13, i.e. the new market is about 6.69 times the size of the existing market[6]. This result is summarized below.

RESULT 3. *For* $0 < M < 1$*, there exists a minimum threshold of* 0.57 *for the relative competition in the existing market (*$w > 0.57$*), below which an alliance always does worse.*

[5] 0.57/(1-0.57) ≈ 1.33
[6] (1-0.13)/0.13 ≈ 6.69

Third, we find that as w increases from 0.57 to 1, there is an increasing range, or a "fanning out" of M in Figure 8, which is asymmetrically larger for higher values of M. Thus, as w gets larger, there is greater admissibility for M towards the formation of an alliance, and this admissibility is skewed towards a higher M (i.e. a smaller relative size of the new market). In other words, an alliance can do better for a greater range of new market size – and more so for smaller new markets – as competition in the existing market gets stronger. This result is summarized below.

RESULT 4. *As w increases, there is a "fanning out" of M, which is asymmetrically larger for higher values of M.*

Our findings thus suggest that there are two conditions – each necessary but not by itself sufficient – for which an alliance mode of entry dominates: (i) the competition in the existing market is strong, relative to the new market; *and* (ii) the new market is large, relative to the existing market. We also observe a (iii) trade-off in conditions – for both larger and smaller relative market size – as relative competition increases. We summarize this key result below.

RESULT 5. *An alliance mode of entry dominates when the competition in the existing market is strong relative to the new market, and when the new market is large relative to the existing market. There is also a trade-off for both larger and smaller relative market size as relative competition increases.*

3.3 Allowing for Asymmetry Between Firms

We now relax the assumption of symmetry between A and B, and examine how the results change. We will use a computational approach to overcome the difficulties of doing so analytically. To demonstrate when an alliance mode of entry does better, we examined $\pi_{A,indep}$, $\pi_{B,indep}$, $\pi_{A,alliance}$, and $\pi_{B,alliance}$ under a discretized parameter space for w and M. Specifically, we looked at $w \in (0,1)$ in steps of 0.02, and $M \in (0,1)$ in steps of 0.02. To find the pure-strategy Nash equilibrium for each combination of w and M, we also discretized the decision variables $a \in (0,1)$ and $b \in (0,1)$ in steps of 0.02, and then searched for the pair of strategies such that both firm's strategy are mutual best responses[7].

[7] In our computational algorithm, we also assume that $k = 4$. The highest payoff for the mutual best responses is always positive for the entire discretized parameter space of w and M, even though $k = 4$ might not guarantee positive payoffs for every single pairwise strategy for the entire discretized parameter space. We also assume that there exists a unique pure-strategy Nash equilibrium for every combination of w and M in the discretized parameter

First, we replicate the conditions in which an alliance mode of entry does better than independent mode of entry from our computational analysis. As seen in Figure 9, the region of the conditions for symmetric firms looks similar to the results using an analytical approach[8]. We then study the effects of asymmetry by allowing firm *A*'s endowment to be larger than firm *B*'s endowment, but ensuring that both sum up to the same level as in the symmetric case. This allows us to study the effects of asymmetry without introducing any effects of dominance relative to competition from *X* and *Y*.

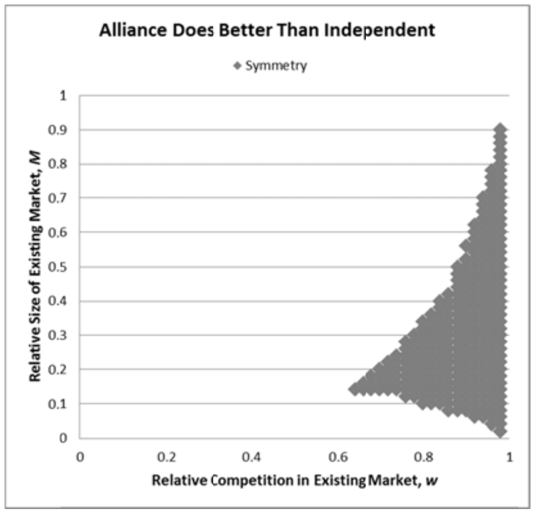


Figure 9: Conditions under which an Alliance Does Better for Symmetric Firms

First, we perturb the symmetry slightly such that relative size of *A* and *B* is in the proportion 51-49, i.e. *A* has 1.02 units of input endowment, while *B* has 0.98 units of input endowment. We observe in Figure 10a that there is a shrinkage in the area (shown in the lighter shade of gray) when we introduce 51-49 asymmetry between the two firms. This shrinkage continues when we introduce 52-48 asymmetry between the two firms (shown in the lightest shade of gray). In both Figure 10a and 10b, we contrast this shrinkage with the original set of conditions (shown in darkest shade of gray) for symmetric firms. We also find that this shrinkage continues up to the proportion 57-43. Thereafter, we observe no cases of an alliance doing better when the relative size of *A* and *B* is in the proportion 58-42 and beyond.

Notice that as asymmetry between *A* and *B* increases, the region in which an alliance does better retreats towards the region of higher payoffs (previously observed in Figure 8), and the minimum

---

space under both modes of entry, and subsequently checked the simulation results that this was a reasonable assumption.

[8] There is a slight difference in the computational result regarding the minimum threshold set of conditions for *w* and *M*, as compared to the result from an analytical approach. This arises because the granularity (steps of 0.02) that we have chosen for the discretization of parameters. This, however, does not affect the intuition of the results that we present here.

threshold for *w* increases accordingly. In summary, the set of conditions narrows as asymmetry between the two firms increases, and it will thus be increasingly difficult to support an alliance of widening asymmetry. The intuition here is that *A*, the larger of the two firms, has a larger endowment and thus can obtain an asymmetrically higher payoff in the independent mode of entry as compared to the case of symmetric firms. In other words, *A* has less of an incentive across the board to enter into the new market through an alliance. As a result, only the region of sufficiently high payoff (located towards the right of Figure 8) can support an alliance of asymmetric firms.

Our model thus predicts that as asymmetry between the two firms increases, there is a smaller set of *w* and *M* for which the alliance does better. This theoretical prediction is in fact consistent with empirical findings by Chung, Singh and Lee (2000), who find that "status similarity" of firms (which can be likened to symmetry of the firms in our model) can increase the likelihood of alliance formation[9]. The above result is summarized below.

RESULT 6. *As asymmetry between the two firms increases, there is a narrower set of conditions for which the alliance does better. If the two firms are vastly different in endowments, then an alliance cannot do better.*

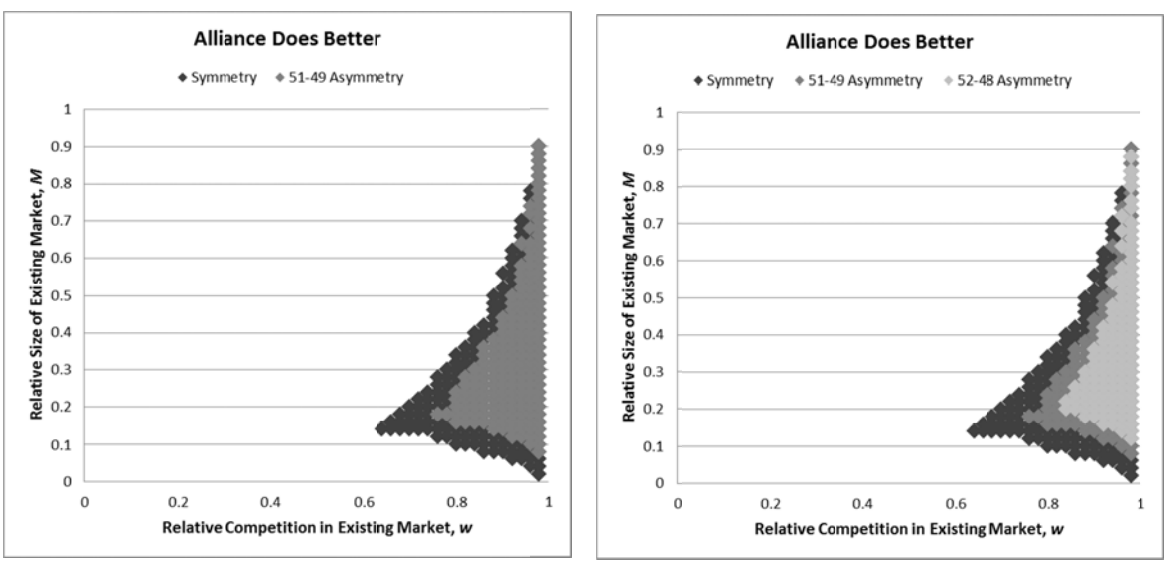


Figure 10a (left) & 10b (right):
Conditions Under Which an Alliance Does Better For Asymmetric *A* and *B*

[9] Chung, Singh and Lee (2000) proposes many reasons why status similarity of firms can increase the likelihood of alliance formation. One reason similar to the arguments which we present above is that dissimilarity of status (or asymmetry in our model) is likely to discourage firms from committing the same level of resources to an alliance because of a mismatch between contribution and expected commitment towards the costs and benefits of an alliance.

4. Conclusion

4.1 Summary and Managerial Implications

We motivated our research with phenomena observed in the business environment – two competing firms in an existing market forming an alliance to enter a new market as opposed to entering independently – and asked ourselves when and why this is optimal. Using a stylized model of two firms and two markets, we find that firms are more likely to enter the new market as an alliance when the competition in the existing market (relative to the new market) is intense, and when the size of the new market (relative to the existing market) is not as attractive.

We carried out an empirical validation of the above results on field data from the shopping mall industry. Using propensity score matching, and in particular an optimal full matching, we estimate the causal effect of entering a market through an alliance, as opposed to entering independently. Given the statistical significance of our results from the optimal full matching, we have reason to believe that an alliance mode of entry can result in an increase in performance of the mall, under certain conditions of competition and market size. Details of the empirical test are provided in Appendix A.

4.2 Future Research

Several extensions could be valuable for further study. First, our setup does not allow for anything inherently different between the existing and new market. In fact, our analysis can be generalized to any two markets, in which two firms have to compete in one market, but have the option to be compete in another market as an alliance. A possible extension – to better reflect the realities of new market entry – is to draw a distinction in our definition of the two markets. For example, one could assume that an existing market is more likely to be a mature market, whose size is independent of the inputs put in by the firms in the existing market, while the size of the new market depends on the inputs put in by the firms in the new market.

Another extension is to study the effect of different sharing rules besides the equal sharing rule which we proposed here. Some possibilities include a proportional sharing rule of the payoff in which alliance partners split the gains from the alliance in proportion to their individual inputs (Amaldoss et al. 2000). Future research may also consider how an alliance mode of entry is influenced by a winner-takes-all payoff function, which is relevant to markets in which the dominant firm (in terms of technological standard or patents) captures the entire market.

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Appendix A: Empirical Test of Theoretical Results using Propensity Score Matching

We carry out an empirical test of the theoretical results using propensity score matching. The hypothesis here is that firms which enter a new market via an alliance, for the above conditions, will do better in performance than firms which enter a new market independently. While the motivation for the theoretical results stemmed from the aerospace engine industry and the oil industry, we will carry out an empirical test of the theoretical results on the shopping mall industry for two reasons: (i) the availability of data on alliance mode of entry into different markets, together with the size of market and competition that a shopping mall faces, and (ii) that shopping malls have been the strongest area in real estate in the recent years, but largely overlooked in the marketing literature (Vitorino 2011).

A.1 Description

(i) Data

We carry out the analysis on a dataset consisting of large shopping malls in the US (N=4702). To test the hypothesis above, we focus on the attributes that give some measure of the market size and competition that each shopping mall faces. Out of the 4702 shopping malls in the dataset, 1036 shopping malls contain data for all the variables of interest, which we will describe in detail below. By focusing on these 1036 shopping malls, we assume that there is no systematic variation in the way that the other shopping malls had missing data. While one might assume that malls which are not publicly listed will tend to have less information about sales, we do observe reasonable effort in the data collection process such that there are no owners which are systematically left out of the dataset due to missing data for any of the variables.

(ii) Focusing on Key Owners

The shopping mall industry has a smaller market concentration compared to the aerospace engine and oil industries. Around thirty consolidated companies own more than half of the shopping malls for which we had complete data. For our analysis, we focus on the top three shopping mall owners, which have a presence across more than forty out of fifty states in the US. These are Developers Diversified Realty Corporation, General Growth Properties, and Simon Property Group[10]. Together, these three owners, which will call *A*, *B* and *C* (no relation to the notation used in the main portion of the paper), have a total of 141 shopping malls[11] for which we have complete data on. To have a decent number of alliances

[10] Other smaller but significant players which have more of a regional (rather than national) presence are Macerich, Pennsylvania Real Estate Investment Trust, and CBL & Associates Properties.

[11] *A* owns 17 malls, *B* owns 112 malls, and *C* owns 12 malls. Using the earlier-described definition of a market, there is an overlap of 7 malls between *A* and *B*, an overlap of 0 malls between *A* and *C*, and an overlap of 7 malls between *B* and *C*. It will be ideal – for purposes of testing the theory – to focus only on the 14 malls in which there

to analyze, we will also consider alliances which *A*, *B* and *C* form with other owners. Out of these 141 malls, there are 16 instances of alliances.

(iii) Variables of Interest

Definition of a Market: We define a market as the area covered by a twenty-mile radius around the particular shopping mall. Using the geo-coordinates of every available shopping mall, we can then determine – using a pairwise comparison across all shopping malls – which of the *other* shopping malls are considered to be within the same market as the focal shopping mall[12].

Performance of shopping mall: To evaluate the performance of the shopping mall, we will use annual sales. Ideally, profit of the shopping mall will be a more precise measure to use, although there is no information regarding cost structure in the dataset. We are thus assuming that the level of sales is a good proxy to profitability.

Market Size: For market size, the attributes of interest are household average income and the number of households in a twenty-mile radius. The product of these two variables gives me an upper bound to the potential market size that the shopping mall can serve. We assume that market size for the shopping mall is some fraction of the upper bound, and that this fraction is homogenous across all markets[13].

Competition: For competition, we focus on the number of stores and the total area of the *other* shopping malls that fall within the twenty-mile radius of a focal shopping mall. In other words, for the 141 malls of interest, we do consider competition from all 1036 malls, as long as they fall within the twenty-mile radius of a particular shopping mall. These two attributes proxy for the intensity of the competition that a shopping mall faces.[14]

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is an overlap between any of the three owners, although to do so will also mean that we overly narrow the sample size from 141 to 14 malls.

[12]First, we generated latitude and longitude in radians (i.e. multiply degrees by π/180), and used acos(sin(Lat1)*sin(Lat2)+cos(Lat1)*cos(Lat2)*cos(Lon2-Lon1))*3959 to get distance in miles. We then generated a distance matrix of malls to store the distances between every mall, and considered them to be in the same market if they are less than 20 miles apart.

[13] For example, if consumers tend to spend around ten percent of their income at large shopping malls, then actual market size would be ten percent of the product between household average income and the number of households in a twenty-mile radius.

[14]In the main portion of the paper, competition is defined as the ratio of the investment dollars that a firm puts into a market, relative to other firms competing in the same market. Market share is determined using the Lanchester model. Here, we do not observe the investment dollars in the dataset, and so, we proxy competition using the abovementioned attributes.

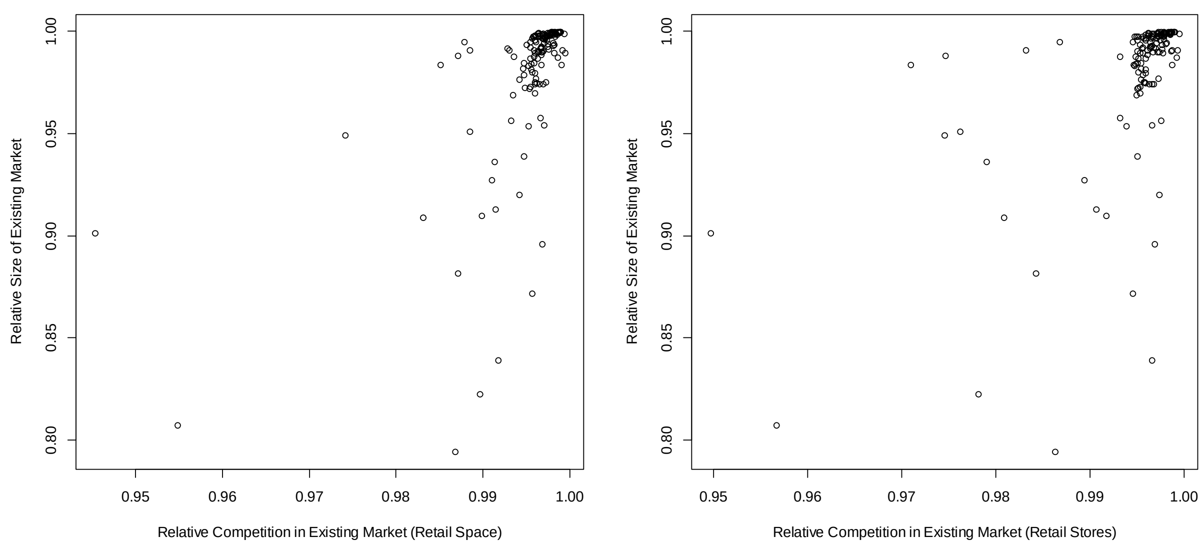
(iv) Treatment and Control

The treatment here will be whether the shopping mall is owned by an alliance. In other words, the control is a shopping mall that is solely owned.

A.2 Results from Propensity Score Matching

The objective of the analysis is to estimate the causal effect of entering a market through an alliance, as opposed to entering independently[15], on the performance of the shopping mall. To test the theoretical prediction, there are two possible questions one might ask: Do shopping malls that fall into the zone of "alliance mode of entry does better" in Figure 8 do better in an alliance? Do shopping malls that fall into the zone of "independent mode of entry does better" in Figure 8 do worse in an alliance?

From the dataset, we find that owners *A*, *B*, and *C* faced substantial relative competition in their existing markets– both in retail space and in number of stores (perhaps by nature that these owners all had a national presence). In addition, the size of the existing markets for these owners is large relative to their current market. Putting the two together, this explains a large clustering of data points in the upper corners of Figure 11a and 11b.



Figures 11a & 11b: Relative Size of Existing Market and Relative Competition (a. Retail Space, b. Number of Retail Stores) for the 141 malls

[15]There can be a possibility that an owner of a shopping mall center might never want to enter an alliance, in which case it will be better to control for owner effects. In this analysis, there exist instances in which the three focal owners have entered a market as an alliance.

Comparing this with the theoretical prediction from Figure 8, this means that an alliance mode of entry should do better for these malls. Given the nature of the market size and competition for the shopping malls data, we will focus on a single question for the rest of the analysis: *do these shopping malls do better if it is owned by an alliance?*

As explained earlier, our dependent variable is sales, which we use as a proxy for profitability. Sales, however, is highly skewed. Thus, we use the natural log of sales as our dependent variable. Figure 12 is a histogram showing the distribution of the dependent variable.

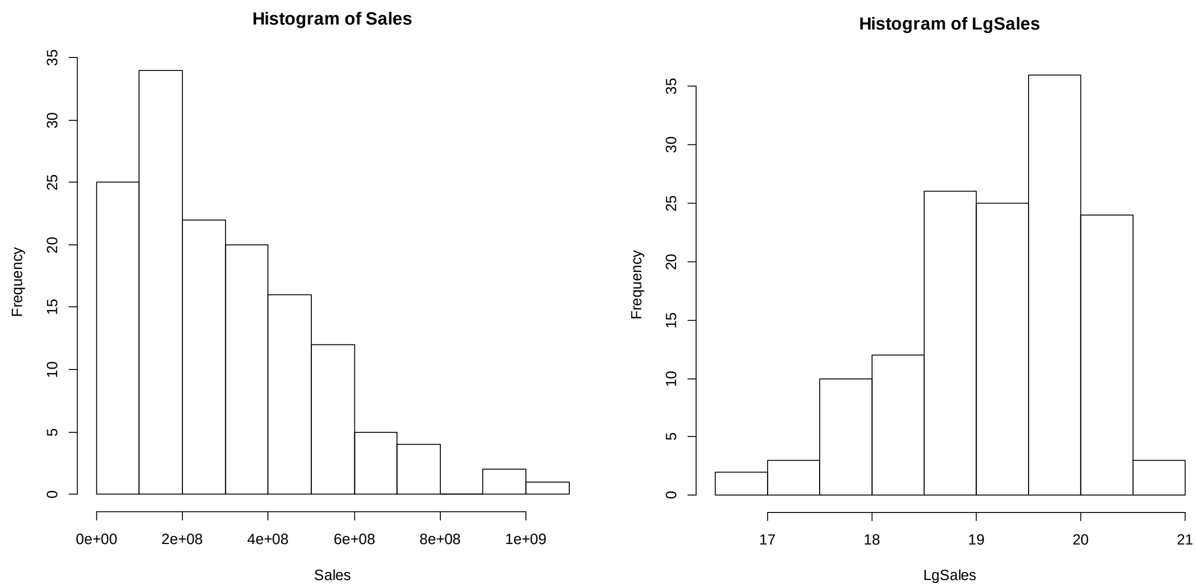


Figure 12a & 12b: Sales and Log(Sales) for the 141 malls

(i) Assessing the Balance

One might argue that malls that are owned by alliances serve a larger market size, or face less competition. To address these concerns, we assess the balance on the covariates between the treated and control groups. Table 1 shows a baseline comparison of the treated and control groups. We find that there is actually good balance on the covariates between the treated and control groups to begin with.

Covariate	**Treatment Group**	**Control Group**	**p-value for testing null hypothesis that means in treatment and control groups are same**
MKT20 (Market size in 20-mile radius of shopping mall[16])	34.5M	32.0M	0.75
StAll (Total number of competing stores in 20-mile radius of shopping mall)	442	346	0.42
SqAll (Total competing retail space in 20-mile radius of shopping mall)	3.71M Sqft	2.77M Sqft	0.33
ExMKT20 (Total market size of the owner's other existing malls[17])	2,730B	2,880B	0.66
ExStAll (Total number of competing stores in 20-mile radius of owner's other existing malls)	28,800	30,500	0.64
ExSqAll (Total competing retail space in 20-mile radius of owner's other existing malls)	229M Sqft	243M Sqft	0.64

Table 1: Baseline Comparison of the Treated and Control Groups

To examine the balance on the covariates between the treated and control groups, we can examine the standardized differences, which is the difference in the mean between treated and control group in standard deviation units. Following Cochran (1968), we will like to have absolute standardized differences to be less than 0.1 in the ideal case. Absolute standardized differences between 0.1 and 0.2 are not ideal, but acceptable. However, absolute standardized differences greater than 0.2 indicate substantial imbalance. We observe from Table 2 that "StAll" (total number of competing stores that a particular mall faces in a 20-mile radius) and "SqAll" (total retail space that a particular mall faces in a 20-mile radius)

[16]This is the upper cap of the market size, assuming k=1.
[17]This is the upper cap of the market size, assuming k=1.

have absolute standardized differences that are greater than 0.2. This shows that there are substantial imbalances on some of the variables.

```
            stand.diff.before
(Intercept)               NaN
MKT20              0.07665082
StAll              0.22104990
SqAll              0.27031834
ExMKT20           -0.12137648
ExStAll           -0.13078195
ExSqAll           -0.13394731
```

Table 2: Standardized Differences of the Covariates

(ii) Fitting a Propensity Score Model

We then fit a propensity score model, and show the results in Table 3:

```
Call:
glm(formula = Alliance ~ MKT20 + StAll + SqAll + ExMKT20 + ExStAll +
    ExSqAll, family = binomial, x = TRUE)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.8701  -0.5286  -0.4285  -0.3659   2.3786

Coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)  2.041e+00  4.147e+00   0.492    0.622
MKT20        1.008e-10  1.154e-10   0.874    0.382
StAll       -3.846e-02  3.823e-02  -1.006    0.314
SqAll        3.670e-06  3.436e-06   1.068    0.285
ExMKT20      1.076e-10  1.141e-10   0.943    0.346
ExStAll     -3.477e-02  3.781e-02  -0.920    0.358
ExSqAll      3.075e-06  3.381e-06   0.910    0.363

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 99.749  on 140  degrees of freedom
Residual deviance: 95.860  on 134  degrees of freedom
AIC: 109.86

Number of Fisher Scoring iterations: 5
```

Table 3: Results of Propensity Score Model

(iii) Finding Units with Overlap

To find a subset of the units with overlap, we follow the procedure of Dehejia and Wahba (1999). We exclude from further analysis any treated unit whose propensity score is greater than the maximum propensity score of the control units, and exclude any control unit whose propensity score is less than the minimum propensity score of the treated units. The boxplots of the propensity scores are shown in Figure 13. We find that 11 control units had propensity scores that are smaller than the minimum propensity score of the treated units. Thus, we exclude 11 out of 141 malls by this procedure.

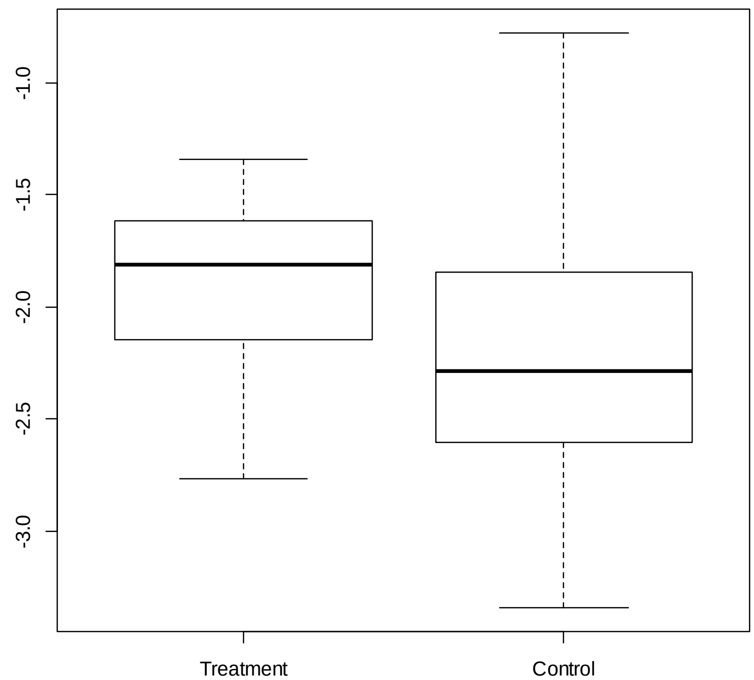


Figure 13: Boxplots of the Propensity Score

A.3 Optimal Full Matching

Next, we carry out optimal full matching, which in some sense is the optimal design for an observational study (Rosenbaum 2002). In a full matching of the treated and control groups, the sample is divided into a collection of matched sets consisting either of a treated subject and any positive number of controls, or a control unit and any positive number of treated units. Here, we define a stratification to be a partitioning of the units into groups or strata based on the covariates with the one requirement that each stratum must contain at least one treated unit and at least one control unit.

We use the optmatch R package developed by Hansen and Klopfer (2006) to construct an optimal full matching. We find that there are two matched sets with 1 treated and 1 control, 1 matched set with 1 treated and 2 controls, 1 matched set with 1 treated and 3 controls, 3 matched sets with 1 treated and 4 controls, 1 matched set with 1 treated and 5 controls, 3 matched sets with 1 treated and 6 controls, 2 matched sets with 1 treated and 8 controls, 1 matched set with 1 treated and 14 controls, 1 matched set with 1 treated and 19 controls, and 1 matched set with 1 treated and 23 controls. The effective sample size in matched pairs is 25.7.

(i) Assessing the Balance on Covariates for Full Matching

We then assess the balance on the covariates for the full matching, and observe that the standardized differences after the full matching are generally smaller than those before the full matching. Ideally, we will like to have absolute standardized differences that are less than 0.1 Here, we have to settle for absolute standardized differences that are between 0.1 and 0.2, which is not ideal, but still acceptable (Cochran 1968). While the covariate “StAll” is an exception, it is just slightly above 0.2, and so we do not concern ourselves too much with this exception.

	std.diff.before	std.diff.after
MKT20	0.19853364	0.1715092
StAll	0.27486152	0.2099811
SqAll	0.29964370	0.1955544
ExMKT20	-0.07777490	0.1229539
ExStAll	-0.08615859	0.1236300
ExSqAll	-0.08881452	0.1252153

Table 4: Standardized Differences of the Covariates for Full Matching

(ii) Aligned Rank Test

We use the aligned rank test to test whether there is evidence that an alliance caused an increase in performance of the mall. The aligned rank test is an analogue of the signed rank test for a stratified study in which there can be more than two units per strata. In this case of a full matching, the strata are the matched sets. The null hypothesis here is that an alliance did not cause an increase in the performance of the mall. We obtain a p-value of 0.01, and thus reject the null hypothesis that an alliance did not increase the performance of the mall. In other words, there is reason to believe that entering a market through an alliance might actually boost performance of the mall.