Do new competitors, new customers, new suppliers,... sustain, destroy or create competitive advantage?[1]

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Abstract

A new player, e.g., an entrant, joining an existing game generally allows more value to be created, but also creates new alternatives for existing players. Greater value expands the range of equilibrium appropriation levels for an existing player, in particular, lowering the minimum equilibrium appropriation. The emergence of new alternatives has the opposite effect.

We say a player has *competitive advantage* if the player's minimum equilibrium appropriation is strictly greater than the player's outside alternative. That is, the forces of competition alone, as embodied in the conditions defining equilibrium, suffice to guarantee a player appropriates more than the best alternative to being in the game, i.e., a sustainable performance advantage.

When a player has competitive advantage pre-entry, but not post-entry, we say entry *destroys* competitive advantage; likewise for *creating* and *sustaining* competitive advantage. Our results provide complete characterizations (i.e., if and only if statements) of the features of a game that cause the addition of a new player to destroy, create or sustain competitive advantage in a general coalitional game.

These results are of importance for strategy issues since – as argued by proponents of value-based business strategy, e.g., Brandenburger and Stuart (1996) – many of the economic interactions of interest in strategy are well-described as coalitional games.

1 Introduction

Many of the subjects of interest in strategy and industrial organization involve augmenting the agents in a game. Some examples: (*i*) a firm entering an industry with a new substitute or complementary product, or a new technology, or simply more capacity; (*ii*) a firm developing the capability to imitate an incumbent's activities, and contemplating entry; (*iii*) a new customer or segment changing demand for some product; (*iv*) an entrepreneurial venture altering the game incumbents are playing; (*v*) a spin-off or divestiture; (*vi*) a new source of supply for inputs; (*vii*) the transition from profitable short run to zero profit long run in a competitive market; (*viii*) a patent expiring and allowing others to produce; etc.

This paper explores how increasing the number of agents in a game affects the equilibrium payoffs of existing agents.[1] Specifically, we study a general coalitional game (within which any of the examples just mentioned can be described), and ask how adding an agent changes an existing agent's *minimum* equilibrium payoff. We focus primarily on whether that minimum payoff is *zero*, or more generally, equal to the agent's next best alternative to being in the game. There is nothing about our methodology that requires this focus on the minimum and whether it is zero; indeed, the same sort of reasoning can be applied to whether the minimum takes on some other value, or whether the maximum does so, etc. Instead, as we argued elsewhere (MacDonald and Ryall, 2004b), whether the minimum is positive is a question of special interest since it describes whether the forces of compe-

[1] Our results cover decreasing the number of agents by, e.g., firm exit, simply by treating the game with the larger number of agents as the initial condition.

tition *alone* suffice to *guarantee* supra-normal profit, an outcome we equate with the familiar term *competitive advantage*.[2]

In our earlier work (MacDonald and Ryall (2004a) and (2204b)), we provided a complete characterization of an agent's having a competitive advantage in a general coalitional game, i.e., a firm's minimum equilibrium payoff is positive if and only if certain conditions involving agents' alternatives are satisfied. Loosely, the basic result from that work (formally restated below) was that there are precisely two opposing entities that shape how value must be distributed in equilibrium: (*i*) the value ultimately produced by the agents; and (*ii*) the value that *could* be generated via alternative activities available to agents. The value produced must ultimately be distributed among agents, and the more there is to distribute, the more ways there are to distribute it and still dominate agents' alternative opportunities (i.e., alternatives the agents must be dissuaded from pursuing if they are to participate in the contemplated value generating activities). Thus, more value to distribute widens the range of payoffs an agent can earn in equilibrium, including lowering the minimum. On the other hand, agents' alternatives constrain the ways in which the value produced can be distributed so as to dominate those alternatives. More/better alternatives make this effect more powerful, thereby narrowing the range of equilibrium payoffs for an agent, including increasing the minimum.[3]

[2] "Competitive advantage" is traditionally synonymous with "profitable". In our view, this definition obscures an important distinction in that it lumps competitive reasons for profitability together with others such as luck, connections to regulators, negotiating skill, etc. Thus we restrict the term competitive advantage to a narrower meaning, viz. profitable as a consequence of competitive alternatives.

[3] In what follows we will refer to the impact of agents' alternatives as "competition". That is, an agent's having alternatives means there are groups competing to engage the

We focus on comparing a firm's (generally, any agent's) pre- and post-entry competitive advantage. The result described above suggests that one way to proceed is to analyze the agent's appropriation in a pre-entry game, and then compare this to appropriation in the corresponding post-entry game, including the entrant of interest. This approach, which we adopt, allows us to develop propositions of the following form: a firm has competitive advantage pre-entry, but not post entry, if and only if condition X is satisfied in the pre-entry game, but not in the post-entry game; i.e., a complete description of the features of the pre-and post-entry games that lead to entry *destroying* competitive advantage. The features of the game that lead to the firm not having competitive advantage pre-entry, but having competitive advantage post-entry, are described in an analogous fashion; i.e., entry *creates* competitive advantage. Entry *sustaining* competitive advantage is defined and characterized similarly.

A simple, but important, insight that underlies our analysis is that the pre- and post-entry situations have much in common. That is, the two games are not simply a pair of games with differing numbers of agents. Instead, adding an agent brings new value creation opportunities while leaving others unchanged. By specifying the post-entry game fully, then, to analyze the pre-entry game, suppressing all value creation involving the entrant, we are able to provide a complete description of the features of the pre- and post-entry environments that result in entry destroying, creating, or sustaining competitive advantage; see Proposition 1. (The remaining case, in which the firm lacks competitive advantage pre- and post-entry, is described

agent in other activities.

by "none of the above conditions".) Loosely, an entrant generally brings additional value to the economic activities in which agents ultimately engage, tending to widen the range of possible equilibrium payoffs for agents, including lowering their minimum payoffs. But the entrant also creates new alternatives in which agents might engage, which has the opposite effect. Whether entry creates, destroys or sustains competitive advantage depends on the interplay of these forces. Propositions 2-5 provide more perspective on entry's impact on competitive advantage by stating these conditions in terms of the entrant's "added value".

Entry's impact on an incumbent's minimum payoff comes via exactly three avenues. First, pre-entry, the aggregate value that all agents could create without the entrant is exactly the value that can be distributed in the pre-entry game. Post-entry, obtaining this value becomes one of the alternatives that the set of all agents other than the entrant might act upon. Second, entry opens up a specific alternative for the incumbent; i.e., to create value by interacting with just the entrant. Third, entry creates new opportunities for groups of agents that may or may not include the incumbent; i.e., to create value by interacting with the entrant. Alternatives of each variety have different effects. Our second set of results, Propositions 6-8, extends our understanding of how entry impacts competitive advantage by exploring the operation of these three effects one at a time.

One specific form of entry that has received much attention in strategy is imitation. Indeed, if there is one idea that is not controversial, it is that to enjoy a sustained performance advantage, a firm must possess value-producing resources that are difficult to imitate. For example, Saloner et.

al. (2001, page 49) say, "If a firm's competitive advantage is based on its capabilities, a sustainable advantage requires either that imitation is difficult or that the firm can improve its capabilities (learn) before its rivals catch up." The intuition is as follows. Imitation permits a competitor to provide new, equally attractive alternatives to customers. In order to persuade those customers not to act on those alternatives, the incumbent firm must allow its customers to keep a greater share of the gains from trading with it than they had previously enjoyed. As a result, its payoff is diminished and possibly eliminated altogether. In MacDonald and Ryall (2004b), we formalized and explored two versions of this idea, and found that the impact of imitation varies greatly with what one has in mind by "ability to imitate." One version is what we called *capability imitation*: the imitator can do anything the incumbent can do, viz., a clone of the incumbent. More precisely, the entrant is a capability imitator if in every economic interaction involving the firm, replacing the firm with the imitator results in the same value created. We showed that (*i*) capability imitation might or might not eliminate competitive advantage, and (*ii*) entry forces both the firm and the entrant to earn the same range of payoffs (not necessarily zero). Our second version of imitation, *unlimited product imitation* describes the situation in which the firm and its imitator can supply an identical product at the same constant marginal cost, i.e., no capacity constraints, no diminishing returns to scale, no limited managerial talent,... Unlimited product imitation invariably both eliminates competitive advantage and forces both the firm and entrant to earn zero payoff. These are special cases of the more general phenomenon of entry studied in this paper.

The use of coalitional game theory to study issues in strategy is growing rapidly. The coalitional approach to strategy was first suggested by Brandenburger and Stuart (1996) who, in particular, discussed the utility of the "value-added" concept in analyzing business strategy; also see Brandenburger and Stuart (2006), and MacDonald and Ryall (2004b). Lippman and Rumelt (2003) explore the benefits of coalitional game theory for strategy research and compare various well-known equilibrium concepts for coalitional games. Gans, MacDonald and Ryall (2005) show how the coalitional framework can be used in practice and elaborate on the interpretation of the mathematical primitives of the coalitional model. Adner and Zemsky (2006) use value-added concepts to analyze the sustainability of competitive advantage. De Fontenay and Gans (2004) use coalitional game theory to analyze the strategic implications of outsourcing. Ryall and Sorenson (2006) use these methods to analyze positional advantage in productive networks.

We begin with examples illustrating the basics of the methodology and some of our results, then develop the formal notation, review the basic characterization result, and discuss the new results.

2 Examples

2.1 Pre-entry game

The pre-entry game includes a firm, f, and two buyers. The firm has one unit of production capacity, and can costlessly produce either one of two goods, which we will think of as components of a system of some sort. For example, the goods might be a video device and a plasma TV. Buyer 1 has some use for one of the goods, valuing it at $10, but also values the whole system, at $30. Buyer 2 has no use for either good on its own, but also values the system at $30.

Let π_i denote the appropriation of buyer $i = 1, 2$ and π_f that of the firm. In all that follows, we assume $\pi_f, \pi_1, \pi_2 \geq 0$. Then, the conditions describing competitive appropriations, π_f, π_1 and π_2 are

$$\pi_f + \pi_1 \geq 10, \pi_f + \pi_2 \geq 0, \pi_1 + \pi_2 \geq 0,$$

and

$$\pi_f + \pi_1 + \pi_2 = 10.$$

(Since there is just one unit of capacity, the $30 value of the system cannot be achieved.) Observe that buyer 2's added value (i.e., the aggregate value the whole group can generate, less the value f and buyer 1 can generate on their own) is zero. Thus, since an agent's appropriation is bounded above by his/her added value, $\pi_2 = 0$. Excluding redundant constraints, we have

$$\pi_f + \pi_1 \geq 10,$$

and

$$\pi_f + \pi_1 = 10.$$

It follows immediately that $0 \leq \pi_f \leq 10$ and $\pi_1 = 10 - \pi_f$. In particular, f does not have competitive advantage under our definition since $\pi_f = 0$ is consistent with these conditions. The remaining examples illustrate how entry might eliminate or create competitive advantage.

2.2 Entry eliminates competitive advantage

Now assume an entrant, e, joins the game, and that e has precisely the same capabilities as f in the sense that buyers do not care whether they purchase from f or e. However, in this example, we assume that compatibility issues mean that a system must be purchased from one firm, i.e., a buyer could purchase one unit from each firm, but buyer 1 would generate \$10 buy doing so, and buyer 2 would generate \$0. Excluding redundant constraints, the conditions describing competitive appropriations, π_f, π_e, π_1 and π_2 are

$$\pi_f + \pi_1 \geq 10, \pi_e + \pi_1 \geq 10,$$

$$\pi_f + \pi_e + \pi_1 \geq 10, \pi_f + \pi_1 + \pi_2 \geq 10, \pi_e + \pi_1 + \pi_2 \geq 10,$$

and

$$\pi_f + \pi_e + \pi_1 + \pi_2 = 10.$$

Suppose f appropriates, i.e., $\pi_f > 0$. Then, there is strictly less than \$10 left to be distributed among e and the buyers. But e's entering and having the same capabilities as f means that generating \$10 is always an option for e and the buyers. This implies that they can improve on any distribution of value that leaves them appropriating less than \$10. Thus e's entry guarantees f cannot appropriate.

In this example, entry brought more capacity, but, as a result of the incompatibility, not in a way that allowed any more value to be achieved. Moreover, entry did not create any valuable alternative for the f and e pair alone, since buyer 1 is needed to create value. Further, as a result of the incompatibility, entry did not open up any new alternatives for groups of agents including f, e.g. by including e, the group of f and either buyer can create the same value they could without e. The only new alternatives created by e's entry involve groups not including f, i.e., e with buyer 1, or buyer 1 and buyer 2. Under these circumstances entry can never create competitive advantage for f, and, indeed, forces f's appropriation to zero (see Proposition 6 for the general statement).

This example, while very special, typifies the kind of outcome that motivates much concern about entry. That is, entry merely creates new opportunities for agents other than f, thereby creating competition that restricts or eliminates the possibility of f appropriating. The next examples show that the situation need not be much different for entry to have a very different impact.

2.3 Entry creates competitive advantage

In this example we continue to assume e's product is not compatible with f's, but in a less extreme manner. That is, buyer 2 continues to value the incompatible products at \$0, but buyer 1 can achieve \$11 in value from both goods, and \$10 from just one. We also suppose that a system, but neither good individually, has some alternative use outside the game, valued at \$2. Excluding redundant constraints, the conditions describing competitive appropriations become[4]

$$\pi_e + \pi_f \geq 2, \pi_f + \pi_1 \geq 10, \pi_e + \pi_1 \geq 10,$$

$$\pi_f + \pi_e + \pi_1 \geq 11, \pi_f + \pi_1 + \pi_2 \geq 10, \pi_e + \pi_1 + \pi_2 \geq 10,$$

and

$$\pi_f + \pi_e + \pi_1 + \pi_2 = 11.$$

Suppose $\pi_f = 0$. Then, if the outside alternative available to f and e is to be unattractive, e must appropriate at least \$2, leaving at most \$9 for the buyers. But this makes buyer 1's option of buying one unit from f quite attractive. Thus, f must appropriate. In fact, in this example the unique competitive appropriations are $\pi_f = \pi_e = 1$, $\pi_1 = 9$ and $\pi_2 = 0$. That is, f and e must appropriate at least \$2 between them, leaving at most \$9 for buyer 1. But each of f and buyer 1, and f and buyer 2, can appropriate \$10 between them. f and e receiving exactly \$1 is the only way to divide \$11 in the required fashion.

In this example, entry allowed more value to be achieved, but also opened up a new opportunity for e and f. On net, the tension between extra value to be distributed and better alternatives to the equilibrium activities result in f having competitive advantage where none existed before. (This case is generalized in Proposition 7.)

[4] The value 0 on the right hand side of $\pi_f + \pi_e + \pi_2 \geq 0$, along with $\pi_e + \pi_f \geq 2$, implies that this game is not "superadditive." The value can be changed to 2 without altering any of what follows. The zero value makes the example exactly consistent with the hypotheses of Proposition 7. Likewise, $\pi_f + \pi_e + \pi_1 \geq 11$ is required for the interpretation of the example, but does create an inconsistency with the hypotheses of Proposition 2; however, this inequality plays no role in determining the minimum appropriation for f.

2.4 Entry creates even greater competitive advantage

Finally, we assume that entry does not yield a new outside use for the system, but that the goods are fully compatible. The nonredundant conditions describing competitive appropriations are

$$\pi_f + \pi_1 \geq 10, \pi_e + \pi_1 \geq 10,$$

$$\pi_f + \pi_e + \pi_1 \geq 30, \pi_f + \pi_e + \pi_2 \geq 30, \pi_f + \pi_1 + \pi_2 \geq 10, \pi_e + \pi_1 + \pi_2 \geq 10,$$

and

$$\pi_f + \pi_e + \pi_1 + \pi_2 = 30.$$

Post-entry, since either buyer values the whole system, both have zero added value, and so $\pi_1 = \pi_2 = 0$. Conditions describing competitive appropriations simplify to

$$\pi_f \geq 10, \pi_e \geq 10, \pi_f + \pi_e \geq 30,$$

and

$$\pi_f + \pi_e = 30,$$

i.e., $10 \leq \pi_f \leq 20$ and $\pi_e = 30 - \pi_f$.

Pre-entry, f's appropriation lay between 0 and \$10; post-entry, f's appropriation lies between \$10 and \$20, i.e., entry not only created competitive advantage but actually shifted the incumbent's entire range of appropriation for the better. The intuition is as follows. Pre-entry, there is not enough capacity to produce anything buyer 2 values, so f and buyer 1 are effectively in a pure bargaining situation. Thus, whatever f appropriates is not a consequence of competition, and f does not have competitive advantage. Post entry, there is sufficient capacity to produce the system, which both buyers value at \$30. Specifically, f and e each produce to capacity, and one buyer purchases a system. Buyers have become intense competitors – each having zero added value – and so the \$30 must be shared between f and e. The sole constraint is that this sharing is such that neither f nor e could improve by selling one good to buyer 1 instead of being part of formation of a system.

In this example (consistent with the generalization in Proposition 8), an entrant both allows more value to be created (i.e., \$30 versus \$10) and opens up new alternatives (f and e *together* have capacity to create \$30 total with *either* buyer). The former tends to lower f's minimum equilibrium payoff, whereas the latter tends to increase it. In this example, the latter dominates, and entry creates competitive advantage.

3 Preliminaries

3.1 Notation and assumptions

Our goal is to study the value appropriation possibilities for an agent, for example, an incumbent firm, before and after the entry of another agent. The entering agent could be an imitating firm, but there are lots of other possibilities – a new supplier, a new customer, a firm offering a complementary product,... The coalitional game framework we employ is general enough to accommodate any kind of entry.[5]

The simplest and most transparent way to carry out the analysis involves specifying the *post*-entry game in detail, and then comparing pre-and post-entry appropriation possibilities for the agent of interest by treating the pre-entry case as the special one in which (in a way that will be made precise shortly) the entering agent has been "suppressed". To that end, we assume the game has $n+1$ agents, indexed by i; $i = 1, ..., n+1 < \infty$. Given the players, the balance of the specification of any coalitional game involves a description of the value that is expected ultimately to be created by the agents – the aggregate value that will be appropriated by the agents in the game – as well as the value of the alternatives that are available to subgroups of the agents. The idea is that the value any group of agents will ultimately appropriate must exceed or equal what that same group could obtain by acting on alternatives available to it. Otherwise, why would that group not act on its alternative instead? We begin by describing all the possible groups of agents in a way that facilitates analysis of the pre- and post-entry games. Then, we specify the value that will ultimately be distributed and the value subgroups of agents can obtain from available alternatives.

We employ $(n+1)$-length vectors of zeros and ones to describe the groups, where a vector with a 1 in the i^{th} position means the group includes agent i; a "generic" vector will be labelled g, and entities associated with g will have a g-subscript. It will be clear from the context whether g is a row or a column. The agent whose appropriation we will focus on will

[5]The basics of this framework are explained at length in MacDonald and Ryall (2004); also see Brandenburger and Stuart (2003).

be the first in any such vector, and the entrant the last. For concreteness, we will call the first agent the "incumbent firm," f, and the last agent the "entrant," e.

The analysis of the pre- and post-entry games is facilitated by organizing all the possible groups of agents in a particular way. The group of *all* agents is

$$\mathbf{I} \equiv (1, 1, ..., 1) \, .$$

The group including *only* f is

$$\mathbf{I}_f \equiv (1, 0, ..., 0) \, ,$$

whereas the group of all agents *other than* f is

$$\mathbf{I}_{-f} \equiv (0, 1, ..., 1) \, .$$

Analogously, the group including *only* e is

$$\mathbf{I}_e \equiv (0, ..., 0, 1) \, ,$$

and the group of all agents *other than* e is

$$\mathbf{I}_{-e} \equiv (1, ..., 1, 0) \, .$$

The group including *only* f *and* e is

$$\mathbf{I}_{fe} \equiv (1, 0, ..., 0, 1) \, ,$$

and the group including all agents *other than* f *and* e is

$$\mathbf{I}_{-fe} \equiv (0, 1, ..., 1, 0)\,.$$

This leaves $2^{n+1} - 8$ groups that include *at least one, but not every*, agent other than f and e, and possibly one or both of f and e. These groups can be divided into four subsets, each consisting of $2^{n-1} - 2$ groups. The first subset is the collection of groups that *include* f *but not* e. This collection can be described by the $\left(2^{n-1} - 2\right) \times (n+1)$ matrix

$$[\mathbf{1}G\mathbf{0}]\,, \tag{1}$$

where $\mathbf{1}$ ($\mathbf{0}$) is a column vector of ones (zeros) of length $\left(2^{n-1} - 2\right)$ and G is the $\left(2^{n-1} - 2\right) \times (n-1)$ matrix in which no two rows are the same and no row is either all zeros or all ones. Similarly, the collections of groups that include *neither* f *nor* e is described by

$$[\mathbf{0}G\mathbf{0}]\,; \tag{2}$$

those including e but not f are

$$[\mathbf{0}G\mathbf{1}]\,; \tag{3}$$

and those including both e and f are

$$[\mathbf{1}G\mathbf{1}]\,. \tag{4}$$

Any of the groups can produce value "on its own" in the sense that agents in the group can engage in whatever transactions are technically and institutionally feasible. For any group, g, v_g denotes the value that can be generated by g. Hence, the aggregate value anticipated in the post-entry industry is $v_{\mathbf{I}}$; the value available to agent i acting alone is $v_{\mathbf{I}_i}$, and so on. We assume, without loss of generality, that $v_{\mathbf{I}_i} = 0$ (a normalization).

There are $2^{n+1} - 1$ distinct and nonempty groups of players that can be formed from $n + 1$ players. Let v be the $\left(2^{n+1} - 1\right)$-vector of nonnegative numbers in which each component corresponds to a nonempty group; i.e., v is a vector including the v_g values, for all g. Consistent with the group-identification scheme introduced above, $v_{\mathbf{I}_f}$ is the value that can be produced by the firm on its own, $v_{\mathbf{I}_{-f}}$ the value that can be produced by all the agents without the firm, and so on. Similarly $v_{\mathbf{10}}$ is the $\left(2^{n-1} - 2\right)$-length vector that includes the components of v corresponding to the rows of (1); $v_{\mathbf{00}}$ is the vector that includes the components of v corresponding to the rows of (2); etc.

Note that v includes all information on the value creation opportunities available to the agents in both the pre- and post-entry games. That is, $v_{\mathbf{I}}$ is the aggregate value that will be produced in the industry post-entry. The other components of v (including $v_{\mathbf{I}_{-e}}$) are the values that any subgroup g could obtain on its own in the post-entry game. Likewise $v_{\mathbf{I}_{-e}}$ is the aggregate value that will be produced in the industry pre-entry, i.e., e is not "active" in the pre-entry game. Other components of v, corresponding to groups g that *do not include* e, are the values that these groups could obtain on their own in the pre-entry game.

Finally, to avoid trivial cases, we assume that any group g is no less productive when either f or e is included: *for all groups g not including f*

$$v_{g+\mathbf{I}_f} \geq v_g, \tag{5}$$

and *for all groups g not including e*

$$v_{g+\mathbf{I}_e} \geq v_g. \tag{6}$$

3.2 Competitive distributions and appropriation

Whatever economic activity ultimately transpires – either pre- or post-entry – the resulting value will be appropriated by the participating agents. Let π be an $(n+1)$-vector describing each agent's appropriation; π is called a *distribution of value.* We will refer to f's (e's) appropriation as π_f (π_e). A distribution of value, π, is *feasible and stable* in the pre-entry game if:

$$\mathbf{I} \cdot \pi \leq v_{\mathbf{I}_{-e}}, \tag{7}$$

and,

$$\begin{aligned}
\mathbf{I}_f \cdot \pi &\geq 0, & (8)\\
\mathbf{I}_{-e} \cdot \pi &\geq v_{\mathbf{I}_{-e}}, & (9)\\
\mathbf{I}_{-fe} \cdot \pi &\geq v_{\mathbf{I}_{-fe}}, & (10)\\
[\mathbf{1}G\mathbf{0}]\, \pi &\geqq v_{\mathbf{10}}, & (11)\\
[\mathbf{0}G\mathbf{0}]\, \pi &\geqq v_{\mathbf{00}}. & (12)
\end{aligned}$$

Condition (7) is the feasibility condition, requires that only the value agents can produce without the entrant, $v_{\mathbf{I}_{-e}}$, be distributed among the other agents. The other conditions, (8) – (12), are the stability conditions. They are necessary if, given π, agents are assumed to participate voluntarily in producing $v_{\mathbf{I}_{-e}}$. The logic behind this is that, if any of (8) – (12) fail, there is some group, g, not including e, for which $g \cdot \pi < v_g$. That is, the agents in g could all be made strictly better off by not participating in the contemplated transactions (i.e., whatever produces value $v_{\mathbf{I}_{-e}}$) and, instead, producing v_g via some other activity. (8) – (12) is a complete description of the competitive opportunities and alternatives players have that *do not involve e*.

In all that follows, including both pre- and post-entry games, we assume that the game is such that feasible and stable distributions exist. Conditions on v that are necessary and sufficient for existence are well-known; see the discussion in, e.g., MacDonald and Ryall (2004a). In this paper, these conditions amount to both $v_{\mathbf{I}}$ and $v_{\mathbf{I}_{-e}}$ not being "too small", which is why, for example, (7) is the appropriate feasibility condition in the pre-entry game.

For what follows, it is useful to recall a some basics about competitive distributions in coalitional games. One is that for any agent, say f, the levels of appropriation for that agent that are consistent with competition (i.e., π is a feasible and stable distribution) form a closed interval, i.e., a lowest possible value, a highest possible value, and everything between. We denote this interval by $[\pi_f^{\min}, \pi_f^{\max}]$. Generally, $\pi_f^{\min} < \pi_f^{\max}$, i.e., competition does not normally determine the firm's appropriation uniquely. To determine the firm's appropriation when $\pi_f^{\min} < \pi_f^{\max}$, additional assumptions are required regarding the resolution of super-competitive factors.[6] Second, if there is more value to distribute – e.g., $v_{\mathbf{I}_{-e}}$ is larger – the interval of appropriation for f consistent with competition cannot shrink, and generally grows. Third, if the alternatives available to agents improve – e.g., any of the components of $v_{\mathbf{I}_{-fe}}, v_{\mathbf{10}}$ or $v_{\mathbf{00}}$ increase – the interval of appropriation for f consistent with competition cannot grow, and generally shrinks. Finally, and more specific to the pre- and post-entry setup studied here, (7) and (9) imply that exactly $v_{\mathbf{I}_{-e}}$ is distributed among the agents in the pre-entry industry, and that $\pi_e = 0$. (If $\pi_e > 0$, (7) requires that strictly less than $v_{\mathbf{I}_{-e}}$ be distributed among the agents in the pre-entry game, violating (9).)[7]

A distribution of value, π, is *feasible and stable* in the post-entry game if (7) is *replaced* by

$$\mathbf{I} \cdot \pi \leq v_{\mathbf{I}}, \tag{13}$$

[6] See Brandenburger and Stuart (2004) for a very intuitive and applicable approach. Since we are concerned only with the effects of competition on the value appropriated by industry participants, we leave open the question of how extra-competitive issues are resolved.

[7] The last conclusion is straightforward, but important in the sense that it would be hard to interpret (7)-(12) as describing a competitive situation where the entrant plays no role if $\pi_e > 0$ were possible.

and, *in addition to* (8) – (12), π satisfies

$$\mathbf{I}_e \cdot \pi \geq 0, \tag{14}$$

$$\mathbf{I} \cdot \pi \geq v_{\mathbf{I}}, \tag{15}$$

$$\mathbf{I}_{-f} \cdot \pi \geq v_{\mathbf{I}_{-f}}, \tag{16}$$

$$\mathbf{I}_{fe} \cdot \pi \geq v_{\mathbf{I}_{fe}}, \tag{17}$$

$$[\mathbf{1}G\mathbf{1}]\,\pi \geqq v_{\mathbf{11}}, \tag{18}$$

$$[\mathbf{0}G\mathbf{1}]\,\pi \geqq v_{\mathbf{01}}. \tag{19}$$

Condition (13) replacing (7) accounts for the fact that post-entry, $v_{\mathbf{I}}$ is available for distribution instead of $v_{\mathbf{I}_{-e}}$. Including (14) – (19) takes account of the fact that the entrant opens up new alternatives for players, while removing none, and that if a distribution, π, is to survive competition, these new alternatives must not offer any group the prospect of improvement over what π offers.[8] Let $\left[\hat{\pi}_f^{\min}, \hat{\pi}_f^{\max}\right]$ be the range of appropriation for f that is consistent with competition post entry.

That (13) replaces (7), and (14)-(19) are in addition to (8) – (12), foreshadows the two general effects that an entrant has on an incumbent's appropriation possibilities. First, since (6) implies $v_{\mathbf{I}} \geq v_{\mathbf{I}_{-e}}$, there is no less, and generally more, value to distribute post entry. This, by itself, tends to *expand* the range of appropriation for f that is consistent with competition. On the other hand, post-entry, agents have many alternatives – i.e., those involving e – that were unavailable pre-entry; this, by itself, has the same

[8]Notice that (13) and (15) imply $\mathbf{I} \cdot \pi = v_{\mathbf{I}}$.

sort of impact as improving agents' alternatives pre-entry, i.e., it *narrows* the range of appropriation for f that is consistent with competition. The net effect of e's presence on f reflects the relative strength of these two forces; our results explain how this relative strength is determined.

4 Competitive advantage

If every feasible and stable distribution has f appropriating more than its next-best alternative (here normalized to 0), then f is guaranteed an economic profit, i.e., $\pi_f^{\min} > 0$. In this case the forces of competition *alone* guarantee f economic profit no matter how the extra-competitive forces mentioned above operate. Whenever $\pi_f^{\min} > 0$, we will say that the incumbent has a *competitive advantage,* where we emphasize that f's value appropriation is guaranteed by competition. When f does not have a competitive advantage, defined in this way, f might still appropriate, provided $\pi_f^{\max} > 0$; however, any value f appropriates in this case will be a consequence of some supra-competitive activity like bargaining, fairness or luck, and not the consequence of competition.

It helps to have some notation to keep track of whether and when f has a competitive advantage. So CA^{pre} means $\pi_f^{\min} > 0$, and CA^{post} means $\hat{\pi}_f^{\min} > 0$. In earlier work (MacDonald and Ryall (2004)), we provided a complete characterization of when a player in an arbitrary coalitional game has a competitive advantage as just defined. Since this basic result applies to f and to both the pre- and post-entry games, it will be helpful briefly to review that result, since it necessarily plays a key role in what follows.

4.1 Characterization (MacDonald & Ryall, (2004))

Agent f failing to have a competitive advantage in the pre-entry game is equivalent to the existence of a distribution, π, satisfying (7)-(12), and for which $\pi_f = 0$. This observation allows us to characterize CA^{pre}; a characterization of CA^{post} follows analogously.

To see how the characterization works, assume $\pi_f = 0$. Then (8) is always satisfied; using (5), if (9) is satisfied then (10) is too; and, again employing (5), if (11) is satisfied then (12) is too. Combining (7) and (9), the conditions whose satisfaction is equivalent to f *not* having a competitive advantage in the pre-entry game are simply

$$\mathbf{I}_{-e} \cdot \pi = v_{\mathbf{I}_{-e}}$$

and

$$[\mathbf{0}G\mathbf{0}]\, \pi \geqq v_{\mathbf{10}}, \tag{20}$$

where the latter is (11), taking account of the fact that when $\pi_f = 0$, $[\mathbf{1}G\mathbf{0}]\, \pi = [\mathbf{0}G\mathbf{0}]\, \pi$.

Inequalities (20) require that π, with $\pi_f = 0$, distributes value so that no group of agents (where e is not a member of any such group, since we are considering the pre-entry game) could appropriate more value by acting on some alternative including f. These are the most attractive alternatives since f would be no worse off by being included, and every such alternative is at least as valuable when f is included (i.e., (5)). Now notice that if there is sufficient value to distribute, i.e., $v_{\mathbf{I}_{-e}}$ is large enough, then (20) can always be satisfied, i.e., CA^{pre} does not hold. Thus, CA^{pre} holds if and only if $v_{\mathbf{I}_{-e}}$ is not too large. More precisely, let

$$mv^{pre} \equiv \min_{\pi \in \mathbb{R}_+^{n+1}} \{\mathbf{I} \cdot \pi \mid [\mathbf{0}G\mathbf{0}]\, \pi \geqq v_{\mathbf{10}}\}\,. \tag{21}$$

mv^{pre} is called f's *minimum value* in the pre-entry game, and is the least value that can be distributed to players other than f and e, while simultaneously making none of the alternatives described by (20) attractive.[9] If mv^{pre} is larger than the value available for distribution, $v_{\mathbf{I}_{-e}}$, there is no feasible way to distribute value, with f receiving nothing, without making some alternative attractive to some group including f; thus, f must appropriate. Conversely, if f appropriates in *every* feasible and stable distribution, then the available resources must be too meagre to distribute without making some alternative attractive to some group including f if $\pi_f = 0$.

Theorem 1. (MacDonald and Ryall) CA^{pre} if and only if $mv^{pre} > v_{\mathbf{I}_{-e}}$.

Analogous reasoning can be applied to f failing to have a competitive advantage in the post-entry game. If this is the case, there is a distribution, π, satisfying (8)-(19) and that has $\pi_f = 0$. To develop the equivalent to Theorem 1, assume, again, that $\pi_f = 0$. Then, as above, (8) is satisfied. Also, (10) is satisfied if (9) is, which, since $\mathbf{I}_{-e} \cdot \pi = \mathbf{I}_{-fe} \cdot \pi$ when $\pi_f = 0$, we will write

$$\mathbf{I}_{-fe} \cdot \pi \geq v_{\mathbf{I}_{-e}}. \tag{22}$$

Similarly, (11) and (12) can be combined, exactly as above, to yield (20).

[9] As stated, the minimation problem does not require $\pi_f = \pi_e = 0$; however, any minimizing π will have this feature.

Next, (16) is satisfied if (15) is, and (13) and (15) together imply that, post entry, exactly $v_{\mathbf{I}}$ will be distributed:

$$\mathbf{I} \cdot \pi = v_{\mathbf{I}}. \tag{23}$$

Also, (14) is satisfied if (17) is, which, using $\mathbf{I}_{fe} \cdot \pi = \mathbf{I}_e \cdot \pi$, we write as

$$\mathbf{I}_e \cdot \pi \geq v_{\mathbf{I}_{fe}}. \tag{24}$$

Finally, using (5), (19) is met if (18) is:

$$[\mathbf{0}G\mathbf{1}]\,\pi \geqq v_{\mathbf{11}}, \tag{25}$$

where, as above, we note the fact that when $\pi_f = 0$, $[\mathbf{1}G\mathbf{1}]\,\pi = [\mathbf{0}G\mathbf{1}]\,\pi$. Thus, the question of whether f has a competitive advantage in the post-entry game can be answered by determining whether the value that might be distributed, as described by (23) are sufficient to allow (20), (22), (24) and (25) to be satisfied. Define

$$mv^{post} \equiv \min_{\pi \in \mathbb{R}_+^{n+1}} \left\{ \mathbf{I} \cdot \pi \mid \mathbf{I}_{-fe} \cdot \pi \geq v_{\mathbf{I}_{-e}}, \mathbf{I}_e \cdot \pi \geq v_{\mathbf{I}_{fe}}, [\mathbf{0}G\mathbf{1}]\,\pi \geqq v_{\mathbf{11}} \text{ and } [\mathbf{0}G\mathbf{0}]\,\pi \geqq v_{\mathbf{10}} \right\}. \tag{26}$$

Theorem 2. (MacDonald and Ryall) CA^{post} if and only if $mv^{post} > v_{\mathbf{I}}$.

Note that the minimization problems (21) and (26) have the same objective, and that the constraints in the former are a subset of those in the latter; thus $mv^{pre} \leq mv^{post}$. Moreover, in (26) the aggregate value distributed to agents other than f or e must be at least $v_{\mathbf{I}_{-e}}$; thus $mv^{post} \geq v_{\mathbf{I}_{-e}}$.

Lemma 1. $mv^{post} \geq \max\{mv^{pre}, v_{\mathbf{I}_{-e}}\}$.

Finally, observe that (6) implies $v_{\mathbf{I}} \geq v_{\mathbf{I}_{-e}}$. Define e's *added value* by

$$av_e \equiv v_{\mathbf{I}} - v_{\mathbf{I}_{-e}};$$

(6) implies $av_e \geq 0$.

5 The impact of entry on competitive advantage

5.1 Basic result

Given Theorems 1 and 2, Lemma 1, and the fact that $v_{\mathbf{I}} \geq v_{\mathbf{I}_{-e}}$, we can be specific about the impact of entry on f's competitive advantage. There are exactly four entities that, together, determine this effect: $mv^{pre}, mv^{post}, v_{\mathbf{I}_{-e}}$ and $v_{\mathbf{I}}$.

Proposition 1. Given the pre- and post-entry games, entry

1. *destroys* competitive advantage – CA^{pre} and *not* CA^{post} – if and only if both $mv^{pre} > v_{\mathbf{I}_{-e}}$ and $mv^{post} \leq v_{\mathbf{I}}$;

2. *creates* competitive advantage – *not* CA^{pre} and CA^{post} – if and only if $mv^{pre} \leq v_{\mathbf{I}_{-e}}$ and $mv^{post} > v_{\mathbf{I}}$; and

3. *sustains* competitive advantage – CA^{pre} and CA^{post} – if and only if $mv^{pre} > v_{\mathbf{I}_{-e}}$ and $mv^{post} > v_{\mathbf{I}}$.

Remark 1. *Given the pre- and post-entry games, entry does not sustain, create, or destroy competitive advantage – neither* CA^{pre} *nor* CA^{post} *– if and only if* $mv^{pre} \leq v_{\mathbf{I}_{-e}}$ *and* $mv^{post} \leq v_{\mathbf{I}}$.

Given Proposition 1, there are two sources of insights about how entry impacts f's competitive advantage. One is further exploration of Proposition 1 itself. The other is exploration of the sources of the different patterns of values and minimum values that lead to the different cases in Proposition 1. We examine these in turn.

5.2 Examination of proposition 1, part 1

Since result (1) implies $mv^{post} \geq mv^{pre}$, the inequalities in part 1 of Proposition 1 can be combined to yield

$$v_{\mathbf{I}} \geq mv^{post} \geq mv^{pre} > v_{\mathbf{I}_{-e}}.$$

Subtracting $v_{\mathbf{I}_{-e}}$ throughout, then applying the definition of av_e, yields the following proposition.

Proposition 2. Given the pre- and post-entry games, entry *destroys* competitive advantage if and only if

$$av_e \geq mv^{post} - v_{\mathbf{I}_{-e}} \geq mv^{pre} - v_{\mathbf{I}_{-e}} > 0.$$

Two observations follow immediately. First, an entrant whose added value is sufficiently large *always* destroys f's competitive advantage. The intuition is straightforward. Entry provides agents both new alternatives – which, as discussed earlier, tends to increase $\pi_f^{\min}$ – along with more value, which has the opposite effect. If av_e is large enough, the latter effect always outweighs the former. Second, if the entrant is to destroy competitive advantage, a strictly positive av_e is necessary (the theoretically smallest possible value for av_e is zero). The argument is easy. If f has a competitive advantage in the pre-entry game, the reason is that, assuming f does not appropriate, the alternatives available to agents are too valuable to be dominated with the available resources. Entry produces even more alternatives. So if the entrant brings no new value to the game, i.e., $av_e = 0$, the same forces that gave f competitive advantage pre-entry are augmented by entry. Since the resources available to oppose these forces are no greater, f must continue to appropriate post-entry.

The necessity of $av_e > 0$ for entry to destroy f's competitive advantage provides an interesting perspective on a familiar situation in which entry is thought to eliminate competitive advantage. Consider a monopolist, f, with a constant returns production technology, and a collection of customers, at least some of whom value the monopolist's product at more than its (constant) marginal cost. Now assume another firm enters, offering the same product, and having the identical constant returns technology. Given identical costs and constant returns, the entrant has $av_e = 0$, and so, according to Proposition 2, *cannot* destroy competitive advantage. But given the identical products and costs, it is immediate that $\hat{\pi}_f^{\min} = \hat{\pi}_f^{\max} = 0$, i.e., f has no competitive advantage post-entry. These conclusions are mutually consistent only if f had no pre-entry competitive advantage. That is, the forces of competition in the pre-entry game did not guarantee the monopolist could appropriate. This is exactly correct. Given constant marginal cost, the monopolist is effectively in a pure bargaining game with every consumer, where the bargaining is over the surplus (value less production cost) from that one transaction. Thus $\pi_f^{\min} = 0$ and $\pi_f^{\max} = S$, where S is the aggregate surplus from consumption of the good by all consumers who value it at marginal cost or more. In this situation any profit the monopolist extracts from consumers pre-entry is purely the result of bargaining/negotiation, and not a consequence of the competitive alternatives available to it or to consumers.[10] The forces of competition are very weak pre-entry, and, in particular, f has no competitive advantage. Entry does nothing to make competition to transact with f more attractive, and creates an alternative for consumers that makes bargaining with f unnecessary, and, in fact, forces $\pi_f = \pi_e = 0$. Entry did not destroy the ability of alternatives to guarantee appropriation for f. Instead, it eliminated the possibility of f appropriating via bargaining.

5.3 Examination of proposition 1, part 2

Since (6) implies $v_{\mathbf{I}} \geq v_{\mathbf{I}_{-e}}$,the inequalities in part 2 of 1 can be combined to yield

$$mv^{post} > v_{\mathbf{I}} \geq v_{\mathbf{I}_{-e}} \geq mv^{pre}.$$

Subtract $v_{\mathbf{I}_{-e}}$ throughout and, as before, apply the definition of av_e.

Proposition 3. Given the pre- and post-entry games, entry *creates* com-

[10]Specifically, the textbook monopoly model assumes the firm has all the bargaining power. However, given constant returns, the monopolist's threatening, for example, to exclude one customer and sell to another is not credible, and there is no obvious justification for the bargaining power assumption. With increasing marginal cost or capacity constraints, this assumption has greater justification. At the same time, with increasing marginal cost, entry generally does not remove competitive advantage.

petitive advantage if and only if

$$mv^{post} - v_{\mathbf{I}_{-e}} > av_e \geq 0 \geq mv^{pre} - v_{\mathbf{I}_{-e}}.$$

Using result (1) and the fact that f has no pre-entry competitive advantage, the theoretically smallest value mv^{post} can take on is $v_{\mathbf{I}_{-e}}$, so $mv^{post} - v_{\mathbf{I}_{-e}}$ is mv^{post} measured relative to its smallest possible value. Two observations follow from Proposition 3. First, if entry generates new alternatives for groups including f that are sufficiently valuable, in the sense that $mv^{post} - v_{\mathbf{I}_{-e}}$ is large, then f always has competitive advantage post-entry. In this case, although the additional resources entry brings make it easier for given alternatives involving to f to be dominated, entry also offers new alternatives. And if these alternatives are valuable enough, f must appropriate post-entry even if failing to do so was possible pre-entry. Second, for entry to create competitive advantage, it is necessary that mv^{post} be strictly greater than its smallest possible value, $v_{\mathbf{I}_{-e}}$. If $mv^{post} = v_{\mathbf{I}_{-e}}$, then the resources available to render unattractive the new alternatives entry brings, i.e., $v_{\mathbf{I}}$, are ample and f need not appropriate.

Return to the example of monopoly with entry. In that example, $mv^{post} = S(= v_{\mathbf{I}_{-e}} = v_{\mathbf{I}})$. So, consistent with what we found before, entry has no prospect of creating competitive advantage for f. Altogether, in the monopoly with entry example, entry neither creates nor destroys competitive advantage.

5.4 Examination of proposition 1, part 3

Since (6) implies $v_{\mathbf{I}} \geq v_{\mathbf{I}_{-e}}$, the second inequality in part 3 of Proposition 1 gives

$$mv^{post} > v_{\mathbf{I}} \geq v_{\mathbf{I}_{-e}}.$$

Subtracting $v_{\mathbf{I}_{-e}}$ throughout, then applying the definition of av_e, gives

$$mv^{post} - v_{\mathbf{I}_{-e}} > av_e \geq 0.$$

The first inequality in part 3 of Proposition 1 is equivalent to

$$v_{\mathbf{I}_{-e}} - mv^{pre} < 0.$$

This, with the previous inequalities, yields the following result.

Proposition 4. Given the pre- and post-entry games, entry *sustains* competitive advantage if and only if

$$mv^{post} - v_{\mathbf{I}_{-e}} > av_e \geq 0 > v_{\mathbf{I}_{-e}} - mv^{pre}.$$

The intuition for Proposition 4 is as follows. The forces of competition pre-entry were strong enough to allow f competitive advantage. Post-entry there is more value to distribute, but the existing and new alternatives involving f continue to be too attractive for f's not appropriating to be stable.

Finally, we present a proposition demonstrating that the two opposing forces that we have emphasized thus far are indeed all the forces determining entry's impact on competitive advantage. If entry affects competitive advantage, it either creates it or destroys it. In the former, both

$$mv^{pre} \leq v_{\mathbf{I}_{-e}} \text{ and } mv^{post} > v_{\mathbf{I}},$$

or

$$mv^{post} - mv^{pre} > av_e.$$

In the latter both

$$mv^{pre} > v_{\mathbf{I}_{-e}} \text{ and } mv^{post} \leq v_{\mathbf{I}},$$

or

$$mv^{post} - mv^{pre} < av_e.$$

We combine these to conclude the following.

Proposition 5. Given the pre- and post-entry games, *if entry affects competitive advantage*, it *creates* it if and only if

$$mv^{post} - mv^{pre} > av_e,$$

and *destroys* it if and only if

$$mv^{post} - mv^{pre} < av_e.$$

The left hand side of each inequality measures the impact of increased competition to create value with f that entry brings, and the right hand side describes the additional resources that might be used to resolve this competition.

5.5 Impact of the new alternatives entry brings

Earlier we showed that minimum value – i.e., the least value that can be distributed to agents other than f (i.e., f receives zero) without making some alternative including f preferable for some group – was one of the two factors determining whether f had comparative advantage; the minimization problems (21) and (26) yield minimum value in the pre- and post entry games, respectively. Compared to the pre-entry game, entry introduces exactly three new kinds of alternatives, described by (22), (24) and (25), that influence minimum value. In this subsection we explore, one at a time, how these new alternative work, or fail, to influence f's competitive advantage.

As discussed earlier, entry impacts f's competitive advantage through bringing new resources, and also changing the competition for f's participation. Our focus in this subsection is solely on the latter, i.e., how and whether the new alternatives work to increase competition for f, and thus f's minimum value and competitive advantage.

The first new alternative, (22), is the one that involves all agents other than e, including f, simply acting on their own and sharing $v_{\mathbf{I}_{-e}}$. Whereas the agents other than e ultimately (i.e., a requirement of equilibrium) had to share $v_{\mathbf{I}_{-e}}$ with f pre-entry, post-entry, doing this is simply one of the available alternatives. Does this new choice, *by itself*, have any particular effect on f's competitive advantage? Intuitively, the answer must be no. That is, when the entrant does not make any group including f more valuable, it does nothing to make the alternatives involving f any harder to dominate, which leaves f's minimum appropriation, at best, unchanged. So if f lacks competitive advantage pre-entry, e's participation cannot create competitive advantage. On the other hand, if f has competitive advantage pre-entry, the fact that the entrant generally has a positive added value means there are more resources available, which, for the reasons set out earlier, tends to erode f's competitive advantage. If these additional resources are great enough, f's competitive advantage might be destroyed. Overall, sharing $v_{\mathbf{I}_{-e}}$ with f becoming an alternative rather than a necessity can never create competitive advantage. Indeed, entry allowing f's competitive advantage to persist is the best f can hope for.

More formally, assume both $v_{\mathbf{I}_{fe}} = 0$ and $v_{\mathbf{11}} = v_{\mathbf{10}}$. That is, the alternatives available to to any group including f (other than the group of all agents except e) are not improved by including e. Under these assumptions, (26) becomes[11]

$$mv_1^{post} \equiv \min_{\pi \in \mathbb{R}_+^{n+1}} \left\{ \mathbf{I} \cdot \pi \mid \mathbf{I}_{-fe} \cdot \pi \geq v_{\mathbf{I}_{-e}} \text{ and } [\mathbf{0}G\mathbf{0}]\, \pi \geqq v_{\mathbf{10}} \right\}, \tag{27}$$

i.e., comparing (27) to (21), $\mathbf{I}_{-fe} \cdot \pi \geq v_{\mathbf{I}_{-e}}$ is the sole additional constraint that has any bearing on the magnitude of mv_1^{post}, and thus on the mv_1^{post} versus $v_{\mathbf{I}}$ comparison that determines whether f has competitive advantage post-entry.

Proposition 6. Given the pre- and post-entry games, if $v_{\mathbf{I}_{fe}} = 0$ and $v_{\mathbf{11}} = v_{\mathbf{10}}$, entry

[11] To see this, observe that when $v_{\mathbf{11}} = v_{\mathbf{10}}$, any π satisfying $[\mathbf{0}G\mathbf{0}]\, \pi \geqq v_{\mathbf{10}}$ also satisfies $[\mathbf{0}G\mathbf{1}]\, \pi \geqq v_{\mathbf{11}}$, but not the converse. Thus the latter set of inequalities can be eliminated from (26).

1. Does not create competitive advantage;

2. Destroys competitive advantage if and only if $v_{\mathbf{I}_{-e}} < mv^{pre} \leq v_{\mathbf{I}}$;and

3. Sustains competitive advantage if and only if $v_{\mathbf{I}} < mv^{pre}$.

The argument is as follows. For part 1, suppose f does not have competitive advantage pre-entry, i.e., $mv^{pre} \leq v_{\mathbf{I}_{-e}}$. Then there is at least one distribution π that satisfies $[\mathbf{0}G\mathbf{0}]\,\pi \geqq v_{\mathbf{10}}$ and $\mathbf{I}_{-fe} \cdot \pi \leq v_{\mathbf{I}_{-e}}$. Thus the minimum value in (27) can be achieved by some distribution satisfying $[\mathbf{0}G\mathbf{0}]\,\pi \geqq v_{\mathbf{10}}$ and also $\mathbf{I}_{-fe} \cdot \pi = v_{\mathbf{I}_{-e}}$, i.e., $mv_1^{post} = v_{\mathbf{I}_{-e}}$. Since $v_{\mathbf{I}_{-e}} \leq v_{\mathbf{I}}$, f has no competitive advantage post-entry. For part 2, suppose f has competitive advantage pre-entry, i.e., $mv^{pre} > v_{\mathbf{I}_{-e}}$. It follows that any minimizing distribution in (27) also has $\mathbf{I}_{-fe} \cdot \pi > v_{\mathbf{I}_{-e}}$, in which case (21) and (27) are the same problem, i.e., $mv_1^{post} = mv^{pre}$. Thus, whether f also has competitive advantage post-entry hinges on a comparison of $v_{\mathbf{I}}$ and mv^{pre}. This also settles whether entry sustains competitive advantage, i.e., part 3.

An example to which Proposition 6 applies is as follows. Imagine that the pre-entry game describes a collection of firms, including f, that have formed a joint venture to develop some technology, and whose capabilities are such that no subgroup of the agents can develop the technology completely. Assume that the entrant joining the game permits greater value to be achieved from the fully developed technology, but no more to be derived than a partially-developed version; e.g., the entrant introduces a new or enhanced use for the technology. Then, the arrival of the new agent cannot create competitive advantage for f, and might even destroy it, even if f has some capability that is central to developing the technology. A similar example follows if the pre-entry agents are engineering teams assigned to develop the next generation of a microprocessor and the entrant is a software developer whose work can make the fully-functioning microprocessor more productive.

Next, what happens when e's entry provides a valuable alternative for f, but does not improve alternatives for any groups including f and other existing agents (except possibly the group of f and *all* existing agents, i.e., $av_e > 0$). That is, f is missing something that e can provide, but other agents might also fill this gap, so that adding e is only impactful absent other agents. How will this affect f's competitive advantage? Intuitively, e's participation provides an alternative that might be attractive to the *pair* f and e. This will improve the total appropriation possibilities for that pair. But it may not create competitive advantage for f if it was not already present, since e doing most or all of the of the appropriating is a possibility. It follows that if e's entry creates a valuable alternative for the pair f and e, but it is not possible for e to appropriate much, then entry will either create, or at least sustain competitive advantage for f. What would stop e from appropriating much? Small av_e.

Proposition 7 formalizes and sharpens this intuition. To see how, consider the group including only f[12]. Pre-entry, this group's alternative is just

[12] To determine the impact on f's competitive advantage of the option of all players other than e, including f, simply acting on their own and sharing $v_{\mathbf{I}_{-e}}$, we set $v_{\mathbf{I}_{fe}} = 0$ and $v_{\mathbf{11}} = v_{\mathbf{10}}$, effectively prohibiting $v_{\mathbf{I}_{fe}}$ and $v_{\mathbf{11}}$ from having any impact. To examine their impact alternative by alternative, it is tempting to do so while prohibiting the constraint $\mathbf{I}_{-fe} \cdot \pi \geq v_{\mathbf{I}_{-e}}$ from having any impact, say by setting $v_{\mathbf{I}_{-e}} = 0$. This would be a mistake. Assuming $v_{\mathbf{I}_{fe}} = 0$ and $v_{\mathbf{11}} = v_{\mathbf{10}}$ simply structures how the pre- and post-entry games differ. Assuming $v_{\mathbf{I}_{-e}} = 0$ fundamentally changes the pre-entry game. Thus, the next two Propositions make no new assumption about $v_{\mathbf{I}_{-e}}$.

$v_{\mathbf{I}_f} = 0$, whereas post-entry f and e can share $v_{\mathbf{I}_{fe}}$. Once again assuming $v_{\mathbf{11}} = v_{\mathbf{10}}$, but allowing $v_{\mathbf{I}_{fe}} > 0$,

$$mv_2^{post} \equiv \min_{\pi \in \mathbb{R}_+^{n+1}} \left\{ \mathbf{I} \cdot \pi \mid \mathbf{I}_{-fe} \cdot \pi \geq v_{\mathbf{I}_{-e}}, \mathbf{I}_e \cdot \pi \geq v_{\mathbf{I}_{fe}} \text{ and } [\mathbf{0}G\mathbf{0}]\, \pi \geqq v_{\mathbf{10}} \right\}. \tag{28}$$

Proposition 7. Given the pre- and post-entry games, if $v_{\mathbf{11}} = v_{\mathbf{10}}$, entry

1. Creates competitive advantage if and only if

$$mv^{pre} - v_{\mathbf{I}_{-e}} \leq 0 \leq av_e < v_{\mathbf{I}_{fe}};$$

2. Destroys competitive advantage if and only if

$$0 < mv^{pre} - v_{\mathbf{I}_{-e}} \leq v_{\mathbf{I}_{fe}} + mv^{pre} - v_{\mathbf{I}_{-e}} \leq av_e;$$

and

3. Sustains competitive advantage if and only if

$$v_{\mathbf{I}} - mv^{pre} < av_e < v_{\mathbf{I}_{fe}} + mv^{pre} - v_{\mathbf{I}_{-e}}.$$

For the first part, observe that when f does not have a competitive advantage pre-entry,

$$mv_2^{post} = \min_{\pi \in \mathbb{R}_+^{n+1}} \left\{ \mathbf{I} \cdot \pi \mid \mathbf{I}_{-fe} \cdot \pi \geq v_{\mathbf{I}_{-e}} \text{ and } [\mathbf{0}G\mathbf{0}]\, \pi \geqq v_{\mathbf{10}} \right\} + v_{\mathbf{I}_{fe}} = v_{\mathbf{I}_{-e}} + v_{\mathbf{I}_{fe}}.$$

The first equality follows from the fact that π_e enters the minimization only via the constraint $\mathbf{I}_e \cdot \pi \geq v_{\mathbf{I}_{fe}}$, and so $\pi_e = v_{\mathbf{I}_{fe}}$ in any solution. The second equality follows from observing that given any distribution of value $(0, \pi_{-fe}, 0)$ that solves (21), if any component of π_{-fe} is increased so that $\mathbf{I}_{-fe} \cdot \pi \geq v_{\mathbf{I}_{-e}}$ is satisfied, and $\pi_e = v_{\mathbf{I}_{fe}}$, (29) is also solved, with the minimized value being $mv_2^{post} = v_{\mathbf{I}_{-e}} + v_{\mathbf{I}_{fe}}$. It follows that conditions describing entry creating competitive advantage when it did not exist pre-entry, i.e.,

$$mv^{pre} \leq v_{\mathbf{I}_{-e}} \leq v_{\mathbf{I}} < mv_2^{post},$$

can be written

$$mv^{pre} \leq v_{\mathbf{I}_{-e}} \leq v_{\mathbf{I}} < v_{\mathbf{I}_{-e}} + v_{\mathbf{I}_{fe}}.$$

Subtracting $v_{\mathbf{I}_{-e}}$ yields the result.

For part 2, f's having a competitive advantage pre-entry requires $mv^{pre} > v_{\mathbf{I}_{-e}}$. And competitive advantage is destroyed by entry if and only if $mv_2^{post} \leq v_{\mathbf{I}}$. That f has competitive advantage pre-entry implies $\mathbf{I}_{-fe} \cdot \pi > v_{\mathbf{I}_{-e}}$ in the minimization defining mv_2^{post}. Therefore

$$mv_2^{post} \equiv \min_{\pi \in \mathbb{R}_+^{n+1}} \left\{ \mathbf{I} \cdot \pi \mid \mathbf{I}_e \cdot \pi \geq v_{\mathbf{I}_{fe}}, \text{ and } [\mathbf{0}G\mathbf{0}]\, \pi \geqq v_{\mathbf{10}} \right\}.$$

It follows that for any $\pi = (0, \pi_{-fe}, 0)$ yielding mv^{pre}, $(0,\ \pi_{-fe}, v_{fe})$ yields mv_2^{post} and that $mv_2^{post} = mv^{pre} + v_{fe}$. Thus, $mv_2^{post} \leq v_{\mathbf{I}}$ is equivalent to $mv^{pre} + v_{fe} \leq v_{\mathbf{I}}$, or $v_{fe} + mv^{pre} - v_{\mathbf{I}_{-e}} \leq av_e$. Since $v_{\mathbf{I}_{fe}} \geq 0$, we have that competitive advantage exists pre-entry, and is destroyed by entry, if and only if

$$0 < mv^{pre} - v_{\mathbf{I}_{-e}} \leq v_{\mathbf{I}_{fe}} + mv^{pre} - v_{\mathbf{I}_{-e}} \leq av_e.$$

For part 3, f's having a competitive advantage pre-entry requires $mv^{pre} > v_{\mathbf{I}_{-e}}$, or $v_{\mathbf{I}} - mv^{pre} < av_e$. Also, as in part 2, that f has competitive advantage pre-entry implies $mv_2^{post} = mv^{pre} + v_{fe}$. Thus f continuing to have competitive advantage requires $mv^{pre} + v_{fe} > v_{\mathbf{I}}$, or $mv^{pre} + v_{fe} - v_{\mathbf{I}_{-e}} > av_e$. It follows that

$$v_{\mathbf{I}} - mv^{pre} < av_e < mv^{pre} + v_{\mathbf{I}_{fe}} - v_{\mathbf{I}_{-e}}.$$

Intuitively, when entry brings new value, but also opens up just one new alternative – namely an alternative for f and e – the issue of whether f must appropriate boils down to whether the new resources can be distributed in a way that causes e and f not to find it advantageous to act on that new alternative if $\pi_f = 0$. Part 1 says that when f does not have competitive advantage pre-entry, whether entry creates it is particularly easy to determine. Pre-entry, the value distributed among agents other than f is all the available value, $v_{\mathbf{I}_{-e}}$. And these agents always have the alternative of appropriating at least this much post-entry. Thus, if the most e can hope to appropriate, i.e., av_e, is strictly less than what e must appropriate if acting on its alternative with f is not to be attractive assuming $\pi_f = 0$, i.e., $v_{\mathbf{I}_{fe}}$, then f must appropriate. Parts 2 and 3 work similarly, except that the situation is slightly more complex since the resources that might be distributed to agents other than f, pre-entry, are too meagre to be consistent with f's not appropriating pre-entry. Thus, whether f appropriates post-entry depends on whether the extra resources entry brings are sufficient, assuming $\pi_f = 0$, to allow (i) the new alternative available to e and f to be dominated, and (ii) the alternatives involving f that could not be dominated with the available resources pre-entry, to be dominated post-entry.

There are two interesting examples that are suggested by Proposition 7. The first, mentioned earlier, is the one in which e brings something to the game that is useful to f, but other agents also have what f lacks, so that e has little to contribute unless others are absent. In this example, $av_e = 0$, in which case e cannot appropriate, and entry creates or sustains f's competitive advantage. This example is one in which entry of an agent for whom good substitutes exist can never harm f's appropriation, and might help, e.g., by generating competition to work with f where none existed previously. However, there is another, less obvious, example. Suppose that the pre-entry game consists of an inventor with no business skills, and that the other agents are suppliers of parts and materials each of whom has some skill; skills are needed for any value to be created. The entrant has ordinary business skills, plus experience that is particularly well-suited to managing large entities such as the inventor plus all the suppliers. If these large scale management skills are not of particular importance for intermediate sized entities such as the inventor and a subset of suppliers, then av_e might be large. In this case, the result says that entry, despite bringing skills that make the f and e pair more valuable, might bring extra value that actually blunts the competition to work with f, and even remove f's competitive advantage. That is, e's capabilities and activities might be strongly complementary with f's, but e's contribution to the large organization is so valuable that e's entry erodes f's competitive advantage.

To proceed, consider including e in groups including f and at least one other agent. Assuming $v_{\mathbf{I}_{fe}} = 0$,but allowing $v_{\mathbf{11}} \geqq v_{\mathbf{10}}$, but allowing $v_{\mathbf{I}_{fe}} > 0$,

$$mv_3^{post} \equiv \min_{\pi \in \mathbb{R}_+^{n+1}} \left\{ \mathbf{I} \cdot \pi \mid \mathbf{I}_{-fe} \cdot \pi \geq v_{\mathbf{I}_{-e}}, [\mathbf{0}G\mathbf{1}]\,\pi \geqq v_{\mathbf{11}} \text{ and } [\mathbf{0}G\mathbf{0}]\,\pi \geqq v_{\mathbf{10}} \right\}. \tag{29}$$

Proposition 8. Given the pre- and post-entry games, if $v_{\mathbf{I}_{fe}} = 0$, entry

1. Creates competitive advantage if and only if

$$mv^{pre} - v_{\mathbf{I}_{-e}} \leq 0 \leq av_e < mv_3^{post} - v_{\mathbf{I}_{-e}};$$

2. Destroys competitive advantage if and only if

$$0 < mv^{pre} - v_{\mathbf{I}_{-e}} \leq mv_3^{post} - v_{\mathbf{I}_{-e}} \leq av_e;$$

and

3. Sustains competitive advantage if and only if

$$v_{\mathbf{I}} - mv^{pre} < av_e < mv_3^{post} - v_{\mathbf{I}_{-e}}.$$

For the first part, recall that conditions describing entry creating competitive advantage when it did not exist pre-entry are

$$mv^{pre} \leq v_{\mathbf{I}_{-e}} \leq v_{\mathbf{I}} < mv_3^{post}.$$

For part 2, conditions describing entry removing competitive advantage are

$$v_{\mathbf{I}_{-e}} < mv^{pre} \leq mv_3^{post} < v_{\mathbf{I}}.$$

Subtracting $v_{\mathbf{I}_{-e}}$ yields the result.

For part 3, f's having a competitive advantage pre-entry again requires $mv^{pre} > v_{\mathbf{I}_{-e}}$, or $v_{\mathbf{I}} - mv^{pre} < av_e$. And the condition describing f's also having competitive advantage post-entry is $mv_3^{post} < v_{\mathbf{I}}$. Subtracting $v_{\mathbf{I}_{-e}}$ from this inequality, and combining it with the previous one, yields the result.

The intuition for this final result is very similar to that underlying Proposition 7, except that now entry yields not just one new alternative that must be dominated by the new resources entry brings, but possibly many new alternatives involving e, f and other agents. Examples of entry having this sort of impact are easy to come by. For example, suppose f is an entrepreneur whose product requires a great variety of tasks to be completed, the other agents are those who might perform these tasks, and that e has technology allowing these agents to do these tasks more easily (i.e., $v_{\mathbf{11}} \geqq v_{\mathbf{10}}$), although e cannot complete any of the tasks (i.e., $v_{\mathbf{I}_{fe}} = 0$). If a fine division of labor allows a large group of players to complete all the tasks highly efficiently, then e has small added value, and the main impact of entry will be to make smaller groups including f, e, and others more productive. This generates competition for the f and e pair that cannot be resolved by e appropriating much, since av_e is small. Entry then either creates or sustains competitive advantage for f. Alternatively, if e's capability comes from organizational skill, this will impact larger groups more than smaller ones. In this case e's added value will be large, and the impact on entry on competition for f will be less. In this case entry will destroy f's competitive advantage if it exists in the first place.

6 Summary

Entry creates *new alternatives* that work to create or sustain competitive advantage:

1. the agents can choose to create value without e, rather than having to do so because e is not in the game;
2. e and f can create value on their own; and
3. e, f and others can create value.

But entry brings *more resources*, making it easier for alternatives to be dominated, tending to destroy competitive advantage or not create it. Whether entry creates, destroys or sustains competitive advantage hinges on which of these two basic forces dominates.

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