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Greenfield Investment versus Acquisition: Alternative Modes of Foreign Expansion

by

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Abstract

Foreign direct investment (FDI) is in reality a heterogeneous flow of funds, composed of both greenfield-FDI ("greenfield investment") and acquisition-FDI (cross-border mergers and acquisitions), although previous game-theoretic analyses have tended to concentrate exclusively on one form of FDI. We aim to isolate the determinants of the equilibrium form of FDI and to compare the welfare properties of equilibria associated with each type of FDI. We model the equilibrium industrial structures of a concentrated (two-incumbent) global industry that spans two "national" product markets (i.e. an "international oligopoly"). Firms' FDI decisions (i.e. whether to produce abroad and what form of FDI to choose) and process R&D decisions are made endogenously, and potential entry into the industry is allowed for. Key positive findings are that acquisition-FDI arises in small markets (where entry does not occur) and that necessary conditions for greenfield-FDI are a large market and a small sunk cost of additional plants. The normative analysis shows that equilibria associated with acquisition-FDI generally exhibit higher total profits but lower consumer surplus than those associated with greenfield-FDI. However, the possibility of Pareto dominant acquisition-FDI is shown to exist in small markets, where acquisition prompts R&D investment that would not otherwise occur.

JEL classification: F21, F23, L12, O31.

Keywords: greenfield-FDI, acquisition-FDI, international oligopoly, equilibrium industrial structure, process R&D, social welfare.

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1. Introduction

In reality foreign direct investment (FDI) is a heterogeneous flow of funds, composed of both greenfield-FDI ("greenfield investment"), which represents a net addition to the host country's capital stock, and acquisition-FDI, which represents a change in the ownership of pre-existing production facilities in the host country. Two questions are provoked by this observation. First, what determines the form of FDI that arises in equilibrium? Second, what are the comparative welfare properties of equilibria associated with the alternative forms of FDI? (The positive analysis of section 3 tackles the first question, and the normative analysis of section 4 addresses the second.)

To explore these questions, we model the equilibrium industrial structures of a concentrated global industry that spans two national product markets (i.e. an "international oligopoly"). Firms' FDI decisions (i.e. whether to produce abroad and what form of FDI to choose) and process R&D decisions are made endogenously. A key contribution of this paper is its incorporation of acquisition-FDI into a model of equilibrium industrial structures in an international oligopoly: precursor models in this tradition (e.g. Horstmann and Markusen, 1992; Rowthorn, 1992; Petit and Sanna-Randaccio, 2000) identified FDI in general with greenfield-FDI in particular. This contribution is potentially significant because, empirically, acquisition-FDI is the dominant form of FDI: UNCTAD (2000, pp. 14-18) reports that "[o]ver the past decade, most of the growth in international production has been via cross-border M&As [mergers and acquisitions]... rather than greenfield investment: the value of completed cross-border M&As rose from less than $100 billion in 1987 to $720 billion in 1999... *[when t]he ratio of the value of cross-border M&As to world FDI flows reached over 80 per cent*" (italics added).

A number of contributions have analysed equilibrium acquisition-FDI (e.g. Barros and Cabral, 1994; Falvey, 1998; Horn and Persson, 2001a, 2001b). All build on the decision rule for equilibrium selection pioneered by Salant, Switzer and Reynolds (1983): for a given cross-border acquisition to arise in equilibrium, the equilibrium profits of the resulting multinational enterprise (MNE) must exceed the combined profits of the predator and target firms in product market equilibrium if the proposed cross-border acquisition does not occur. The equilibrium in the absence of acquisition provides a "threat point". However, none of the analyses of equilibrium acquisition-FDI include greenfield-FDI as an alternative to acquisition-FDI: a firm's only alternative means of serving the foreign product market is to export from its domestic production base.[1] This omission has two consequences. First, existing models of equilibrium acquisition-FDI cannot provide comparisons between greenfield- and acquisition-FDI: such comparisons require the development of a modelling structure where the *form* of FDI is endogenously selected. The current paper attempts to fill this gap. Second, the exclusion of greenfield-FDI as an alternative to acquisition-FDI implies that firms' profits at the threat point (i.e. their "disagreement profits" if no acquisition occurs) may be incorrectly represented relative to reality, where firms *do*

[1] Bjorvatn (2004) also considers the greenfield/ acquisition distinction. However, endogenous R&D investment is not included and the equilibrium concept is "national" (i.e. only firm strategies within a single host country are considered). Ferrett (2004) shows that the entry strategies of all firms across all possible host countries in the industry must be allowed to vary at equilibrium if firm-specific sunk costs (e.g. R&D) exist.

have recourse to greenfield-FDI. In turn, this will of course affect the validity of predictions concerning the emergence of acquisition-FDI in equilibrium (via the decision rule outlined above).[2]

The modelling structure we develop in section 2 captures the choice between greenfield- and acquisition-FDI formally; it also includes endogenous process R&D decisions. It is instructive to consider why these two innovations might be expected to produce interesting results. First, the greenfield/acquisition distinction is significant because FDI is likely to have different welfare effects depending on its form: insofar as foreign market entry via acquisition-FDI, rather than greenfield-FDI, results in a more concentrated market structure, acquisition-FDI will be associated with lower consumer welfare (i.e. higher prices) than greenfield-FDI. Furthermore, equilibrium outcomes if the foreign firm does not undertake FDI (but chooses instead to export to the host country) are not necessarily identical to those under entry via acquisition: the possibility of facing imports places a constraint on the indigenous firm's behaviour under the no-FDI (exporting) strategy, which is removed by acquisition.

Second, process R&D investments are determined endogenously within our modelling structure because the relationships between R&D and the two forms of FDI may be different, although it is unclear a priori whether acquiring firms or greenfield investors will have a greater propensity to undertake R&D. Investigating these relationships will allow us to test a hypothesis that frequently motivates public policy: an oft-cited benefit of inward investment in the form of acquisition-FDI is its ability to foster "technological development", both via the ability of firms in a more concentrated market to bear the sunk costs of R&D and via the injection of superior technologies into the moribund target firm (a "failing firm" defence).[3] Furthermore, the inclusion of endogenous R&D investment decisions implies that consumer welfare need not necessarily be lower in more concentrated market equilibria because the (logical) possibility exists that equilibrium R&D investment may increase with concentration.

The remainder of the paper is organised as follows. In section 2 we formally describe the modelling structure. Section 3 presents our positive results on equilibrium industrial structures. The key findings are that acquisition-FDI certainly arises in medium-sized markets and that greenfield-FDI arises in large markets if the sunk costs of greenfield-FDI and R&D are not "too large". In section 4 we analyse the comparative welfare properties of equilibria associated with greenfield- and acquisition-FDI (labelled G- and A-equilibria respectively). The welfare comparison of G- and A-equilibria generally involves a Williamson (1968) trade-off between profits and consumer surplus. Despite this general result, we do find (limited) circumstances where the A-equilibrium is socially Pareto dominant because acquisition-FDI increases consumer welfare: in small markets acquisition-FDI can be associated with equilibrium R&D that would not occur at the G-equilibrium, thus lowering market prices in spite of monopolization. In this special case the advocacy of acquisition-FDI in public policy is unambiguously justified. Finally, section 5 concludes.

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[2] It should be noted that the exclusion of greenfield-FDI *does not* imply that disagreement profits will be "too low". If rival firms non-co-operatively choose between exporting and greenfield-FDI as means of serving the foreign product market when acquisition-FDI is ruled out, then greenfield-FDI can arise in (Prisoner's Dilemma) equilibria where both firms would prefer exporting: see Ferrett (2004).

[3] See Schenk (1999) for examples of where these arguments have been used in policy debate.

2. The Modelling Structure

2.1. Sequence of Moves and Equilibrium Concepts

We assume that the world comprises two identical countries and that international shipping of goods incurs a specific trade cost, t. There initially exist four plants to produce the homogeneous product, two in each country. There are three firms, two of which (firms 1 and 2, the "incumbents") own one plant each in different countries (with a constant marginal production cost, c). The third firm (firm 3, the "potential entrant") owns one plant in each country. The potential entrant's plants are initially (drastically) productively inefficient relative to the incumbents' (their marginal production cost exceeds the monopoly price of an incumbent, denoted by $x^{M}(c)$). By undertaking process R&D the potential entrant can lower her marginal production cost and sell strictly positive output in product market equilibrium. Therefore, "entry" in our model occurs via R&D investment rather than via sunk investments in new plants, as in Gilbert and Newbery (1982).[4] This characterisation of the entry decision is consistent with entry by diversification: the potential entrant is an incumbent in a "related" industry.

Figure 1 illustrates the extensive form of our four-stage game.[5] The stage-one choice between the two subgames is determined by the co-operative greenfield/acquisition decision rule (GADR), which is formally equivalent to the Salant/ Switzer/ Reynolds (1983) decision rule. In stages two and three the incumbents and the potential entrant, respectively, make their sunk investments. In stage four market equilibrium is established in both countries via Bertrand competition. Firms maximize their expected profits.

Firms can establish additional plants (each with a constant marginal production cost) in either country at a sunk cost of G. Therefore, there are plant-level economies of scale, and neither the potential entrant nor the acquirer will optimally establish additional plants (note that via take-over the acquirer gains the rival incumbent's "home" plant). Moreover, each incumbent will optimally establish at most one additional plant abroad in the G subgame.

[INSERT FIGURE 1 HERE]

Technological progress occurs via process R&D investments in steps, and each step incurs a sunk cost of I. The technological laggard (the potential entrant) can purchase the industry's best-practice technology (i.e. a marginal production cost of c) in one step. For firms on the technological frontier (i.e. the incumbents initially, and the potential entrant after sinking an investment of I to catch up) I purchases a process R&D investment with a risky outcome. With probability p R&D investment "succeeds" and the firm's marginal production cost falls to 0; however, with probability $1 - p$ R&D investment "fails" and the firm's marginal production cost remains at c. The probability of success p is identical and independent across firms.

[4] We do not allow the potential entrant to enter via acquisition.

[5] As we show below, Figure 1 incorporates the simplification of firms' strategic choices given in Lemma 1.

Several aspects of the order of moves in Figure 1 require justification. First, Bertrand competition is modelled as the final stage after firms have taken production location and R&D investment decisions because decisions involving sunk investments entail more commitment than pricing decisions, which can be altered rapidly and at relatively little cost. It is thus natural (and conventional) to treat pricing policies as contingent on prior sunk investment decisions. Second, we assume that the incumbents (whether or not an acquisition occurs) make sunk investments before the potential entrant to capture the frequently-cited first-mover advantage of incumbency (e.g. Dixit, 1980): historical presence in the industry affords the incumbents earlier knowledge of, and ability to exploit, profitable investment opportunities created by the opening up of national markets to cross-border trade and investment flows. Third, the incumbents' merger decision (leading potentially to a flow of acquisition-FDI) occurs before their process R&D and greenfield-FDI decisions. We make this assumption to add significant interest to our investigation of the second motivating question set out in the Introduction ("What are the comparative welfare properties of equilibria associated with the alternative forms of FDI?"). By making R&D investments conditional on whether a merger has occurred, we are able to explore additional possible welfare consequences of merger to the "pricing effects" that have traditionally dominated the literature. Moreover, Petit and Sanna-Randaccio (2000, p. 341) cite several recent empirical studies which find that "to an ever greater degree, firms are concerned with how their international strategy will influence their innovative activity." This implies that firms' FDI decisions precede their R&D decisions (contrary to the "traditional" view of, e.g., Caves, 1971) perhaps – as Petit and Sanna-Randaccio suggest – because the FDI decision involves a longer term commitment than the R&D decision.

Given these characteristics of the firms' strategic choices, we can limit the strategy spaces of the acquirer in the A subgame and the potential entrant to $\{N, R\}$ and $\{\varnothing, E, R\}$ respectively. N and $\varnothing$ both represent decisions to invest nothing in process R&D. A choice of E by the potential entrant costs I and reduces its marginal production cost to c. A choice of R produces a marginal production cost of either 0 ("success") or c ("failure"), and it costs the acquirer I but the potential entrant $2 \cdot I$. The incumbents' stage-two strategy space in the G subgame is $\{1N, 1R, 2N, 2R\}$.[6] The first component of each pair indicates how many plants the incumbent will maintain (a choice of 2 costs G); the second component indicates whether (R) or not (N) the incumbent invests in process R&D at a sunk cost of I. Note that loss-making in equilibrium is ruled out by the inclusion of the $1N$ strategy, which incurs no sunk costs, and so an "exit" strategy may legitimately be ignored.

Lemma 1 allows us to drop the strategies of E and $2N$ from the strategy spaces.

Lemma 1. (i) In the A and G subgames the potential entrant will never optimally choose a corporate structure of E because it is strictly dominated by one of $\varnothing$. (ii) In the G subgame an incumbent will never optimally choose a corporate structure of $2N$ because it is strictly dominated by one of $1N$.
Proof. Both (i) and (ii) follow directly from the assumption of Bertrand competition.

[6] The G subgame is identical to the potential-entry game in Ferrett (2004), where the purpose was to examine the effects of an entry threat on equilibrium industrial structures.

Throughout our analysis we maintain the following assumption, which seems intuitively reasonable, on t and c:

(A) $$0 < t < c < 1$$

Equilibrium industrial structures are derived as follows. The A and G subgames are solved backwards to isolate subgame perfect Nash equilibria in pure strategies. In both subgames firms behave non-co-operatively. The stage-one choice of which subgame to play is determined by the co-operative greenfield/ acquisition decision rule (GADR): the A subgame is selected if and only if the integrated monopolist's profits are strictly greater than the combined profits of the incumbents in the G subgame. Therefore, the G-equilibrium represents a threat point if take-over negotiations break down.

2.2. Market Size and Net Revenue

There are two countries in the world. Demand conditions in both are identical, and the product is homogeneous. Market demand in either country is

$$Q_k = \mu \cdot (1 - x_k)$$

Q_k and x_k are demand and price in country k respectively, $k \in \{1, 2\}$. μ measures the "size" of either national product market, and it can be interpreted as an index of the number of homogeneous consumers in each country, all of whom have a reservation price of 1.

Net revenue equals revenue minus variable costs. If either national product market is monopolised by firm i with a constant marginal cost of c_i, the monopoly price will be

$$x^M(c_i) = \frac{1}{2} \cdot (1 + c_i)$$

The monopolist's net revenue per consumer is

$$R^M(c_i) = \frac{\mu}{4} \cdot (1 - c_i)^2$$

If a national product market is served by a duopoly, then firm i's net revenue per consumer is $R(c_i, c_j)$, where c_i is firm i's marginal cost and c_j is its rival's marginal cost. At Bertrand equilibrium:

$$R(c_i, c_j) = \begin{cases} 0 \ \text{ for } \ c_j \in [0, c_i] \\ \mu \cdot (1 - c_j) \cdot (c_j - c_i) \ \text{ for } \ c_j \in [c_i, x^M(c_i)] \\ R^M(c_i) \ \text{ for } \ c_j \in [x^M(c_i), 1] \end{cases}$$

These results are standard. Net revenues at a Bertrand equilibrium with more than two firms can be straightforwardly described using (2) if c_j is reinterpreted as the minimum of firm i's rivals' marginal costs (i.e. $c_j \equiv \min\{c_1, c_2, ..., c_{i-1}, c_{i+1}, ..., c_N\}$).

3. Positive Analysis

3.1. Equilibria in the A subgame

Table 1 gives the payoff matrix in the A subgame. Because both the acquirer and the potential entrant own 2 plants, the trade cost *t* is irrelevant in the A subgame: international trade flows never occur in equilibrium. If the potential entrant chooses $\varnothing$, then the acquirer monopolises both product markets. If the potential entrant chooses *R*, then either firm must possess a marginal production cost advantage over its rival to earn $R(0, c)$ in both countries, which occurs with probability $p(1-p)$ when both firms undertake R&D.

Acquirer → Potential entrant ↓	N	R
$\varnothing$	$E\pi_A = 2\mu R^M(c)$ $E\pi_3 = 0$	$E\pi_A = 2p\mu R^M(0) + 2(1-p)\mu R^M(c) - I$ $E\pi_3 = 0$
R	$E\pi_A = 0$ $E\pi_3 = 2p\mu R(0,c) - 2I$	$E\pi_A = 2p(1-p)\mu R(0,c) - I$ $E\pi_3 = 2p(1-p)\mu R(0,c) - 2I$

Table 1: Payoff Matrix in the A subgame

We consider the potential entrant's optimal decision first, which may be conditional on the acquirer's prior choice. If the acquirer chooses *N*, then the potential entrant has $R \succ \varnothing$ iff

$$\mu > \frac{I}{R(0,c)p} \tag{1}$$

If the acquirer chooses *R*, then the potential entrant has $R \succ \varnothing$ iff

$$\mu > \frac{I}{R(0,c)p(1-p)} \tag{2}$$

For $p \in (0, 1]$ RHS(2) > RHS (1), so there are three distinct situations to be faced by the acquirer when making her stage-two decision (see Figure 1). For $\mu <$ RHS(1) entry is *blockaded*: regardless of the acquirer's choice, the potential entrant chooses $\varnothing$. In this case the acquirer has $R \succ N$ iff

$$\mu > \frac{I}{2[R^M(0) - R^M(c)]p} \tag{3}$$

For $\mu \in$ (RHS(1), RHS(2)) the potential entrant's optimal decision is conditional on the acquirer's choice: by choosing *R*, the acquirer can *deter entry*; however, entry will occur if the acquirer chooses *N*. Therefore, the acquirer has $R \succ N$ iff

$$\mu > \frac{I}{2R^M(c) + 2[R^M(0) - R^M(c)]p} \tag{4}$$

Finally, for $\mu >$ RHS(2) the potential entrant chooses R regardless of the acquirer's prior choice, so the acquirer must *accommodate* entry. Therefore, the acquirer has $R \succ N$ iff

$$\mu > \frac{I}{2R(0,c)p(1-p)} \tag{5}$$

By comparing RHS(3), RHS(4) and RHS(5), we derive the following result.

Lemma 2. Relative to the benchmark of blockaded entry: (i) the acquirer is "more likely" to invest in R&D when entry can be deterred; and (ii) if entry must be accommodated, the acquirer is "less likely" to invest in R&D for large p, but "more likely" for small p.

The result in Lemma 2 allows us to characterise the acquirer's optimal behaviour in terms of Fudenberg and Tirole's (1984) taxonomy of an incumbent's investment strategies in anticipation of entry. When entry can be deterred, the acquirer behaves as a "top dog" (part (i)). However, when entry must be accommodated, the acquirer behaves as a "puppy dog" for large p but as a "top dog" for small p (part (ii)).[7] In part (ii) we compare the optimal R&D behaviour of a monopolist to that of a duopolist, and the result reflects variations in the strength of Arrow's "replacement effect": insofar as undertaking R&D gives the acquirer a chance to "escape competition" in the duopoly (i.e. when accommodating entry), the acquirer will have a stronger incentive to undertake R&D as a duopolist than as a monopolist. When p is small, so there is little chance that the potential entrant's R&D will succeed, the "replacement effect" in duopoly is strong, and thus the acquirer is "more likely" to undertake R&D when entry must be accommodated than under blockaded entry. However, when p is large, the "replacement effect" in duopoly is weak: the potential entrant's R&D is likely to succeed, so that R&D success will not allow the acquirer to "escape competition". Therefore, for large p the acquirer is "more likely" to undertake R&D under blockaded, rather than accommodated, entry.

The equilibria of the A subgame are plotted in (p,μ)-space in Figure 2.

[INSERT FIGURE 2 HERE]

Although the entry threat in the A subgame does alter the acquirer's "incentives" to invest in R&D (see Lemma 2), it does not alter the acquirer's equilibrium behaviour relative to the benchmark of blockaded entry. In the absence of a potential entrant, the acquirer would optimally choose R if and only if $\mu >$ RHS(3), and this also describes the acquirer's equilibrium behaviour in the presence of an entry threat.

3.2. Equilibria in the G subgame

The G subgame is solved and extensively discussed in Ferrett (2004); here, we present the solution and catalogue its properties that are relevant for our purpose. Rather than discussing the derivation of expected profits in each industrial structure, we highlight

[7] The "top dog" invests in "strength" (by undertaking extra sunk investments) to look tough and ward off rivals, whereas the "puppy dog" conspicuously avoids looking "strong" (by reducing spending on sunk investments) to appear inoffensive and avert aggressive reactions from rivals.

several general features and then present a specimen derivation. Expected profits can be viewed as a weighted average of realized profits across all possible "states of nature", where each state is associated with a distinct configuration of R&D outcomes across firms and the weight applied equals the probability of that state's occurrence.

For illustrative purposes, consider the firms' expected profits when firms 1 and 2 choose corporate structures of 1*R* and 2*R* respectively. If the potential entrant chooses ∅, then the incumbents' expected profits are[8]

$$E\pi_1 = p(1-p)\mu[R(0,c)+R(t,c)]-I$$
$$E\pi_2 = p(1-p)\mu[R(0,c+t)+R(0,c)]+p^2\mu R(0,t)+(1-p)^2\mu R(c,c+t)-G-I$$

Because firm 2 has a local plant in country 1, firm 1 must possess a marginal *production* cost advantage if it is to earn strictly positive net revenue. This occurs with probability $p(1-p)$ when 1's R&D investment succeeds but 2's fails. On the other hand, firm 2 can earn strictly positive net revenue *at home* when the firms' marginal production costs are the same because the trade cost insulates its domestic plant from foreign competition.

If the potential entrant chooses *R*, then the firms' expected profits are

$$E\pi_1 = p(1-p)^2\mu[R(0,c)+R(t,c)]-I$$
$$E\pi_2 = 2p(1-p)^2\mu R(0,c)+p^2(1-p)\mu R(0,t)-G-I$$
$$E\pi_3 = 2p(1-p)^2\mu R(0,c)+p^2(1-p)\mu R(0,t)-2I$$

Firm 1 faces two local rivals and must possess marginal production cost advantages over both with probability $p(1-p)^2$ to earn $R(0, c)$ at home and $R(t, c)$ abroad. If firm 2 alone innovates successfully, it earns $R(0, c)$ in both countries; additionally, because firm 2 faces only one local rival in its home country (the potential entrant, firm 3), if both incumbents' R&D investments succeed but the potential entrant's fails, then firm 2 earns $R(0, t)$ at home. The potential entrant is in the same position as incumbent 2. (Note that, when the potential entrant chooses *R*, the incumbents' expected net revenues have a factor of $p(1-p)$: because the potential entrant owns a plant in each country, a necessary condition for an incumbent to earn strictly positive net revenue is that its own R&D succeeds but the potential entrant's fails. Furthermore, entry reduces the incumbents' expected profits.)

Because of the complexity of the G subgame we place restrictions on the four cost parameters *t*, *c*, *G* and *I* when deriving its solution. Ferrett (2004) shows that the following two assumptions are sufficient to fix the form of a plot of G-equilibria in (p,μ)-space.

(B) $$R(0,c+t)-R(c,c+t)+R(t,c)-R(0,c)>0$$

(C) $$G \geq I > 0$$

[8] Note that we adopt the convention throughout, where a firm earns strictly positive net revenue in both countries in Bertrand equilibrium, of writing domestic net revenue as the first term in square brackets and foreign net revenue as the second.

Assumption (B) on t and c is only slightly more restrictive than our maintained assumption (A). (In general (B) holds if the gap $c - t$ is sufficiently large.) By invoking (B) and (C), both of which hold under wide ranges of variation in the cost parameters, we can draw general conclusions about equilibrium behaviour in the G subgame. Given assumptions (B) and (C), Figure 3 illustrates the equilibria of the G subgame in (p,μ)-space. The inter-regional boundaries in Figure 3 are defined in the Appendix.[9]

[INSERT FIGURE 3 HERE]

Key to Figure 3

Region	Equilibrium Industrial Structure
I	$\{1N, 1N; \varnothing\}$
II	$\{1N, 1R; \varnothing\}$
III	$\{1R, 1R; \varnothing\}$
IV	$\{1R, 1R; \varnothing\}$; $\{1N, 2R; \varnothing\}$
V	$\{1R, 1R; \varnothing\}$; $\{1N, 1N; R\}$ or $\{1N, 2R; \varnothing\}$
VI	$\{1R, 1R; R\}$* or $\{1R, 2R; \varnothing\}$
VII	$\{2R, 2R; \varnothing\}$*
VIII	$\{1R, 1R; R\}$; $\{1R, 1R; R\}$ or $\{2R, 2R; \varnothing\}$
IX	$\{1R, 1R; R\}$
X	$\{2R, 2R; R\}$*

(Note: * denotes a dominant strategy equilibrium.)

In the key to Figure 3 multiple equilibria within a region are separated by semicolons. Where G-equilibria are separated by "or", the relevant equilibrium depends on whether entry by firm 3 is accommodated (R) or strategically deterred ($\varnothing$) by the incumbents. In Ferrett (2004) we show that, where both entry-deterring and entry-accommodating equilibria potentially exist ("or"), the entry-deterring equilibrium arises for all μ in the relevant region if $G = I$. As G rises relative to I, the entry-accommodating equilibria become "more likely" to exist. Intuitively, these results follow because in entry-deterring equilibria at least one of the incumbents undertakes greenfield-FDI.

3.3. Equilibrium industrial structures: A-equilibrium vs. G-equilibrium.

In this section we compare the A- and G-equilibria for given parameter values to derive (overall) equilibrium industrial structures and the equilibrium mode of FDI. This task comprises two steps. (The mechanics are presented in the Appendix, which is available from the author on request.) First, we locate the inter-regional boundaries in the A subgame (Figure 2) relative to those in the G subgame (Figure 3), so that both the A- and G-equilibria are fixed for given parameter values. Second, we determine the equilibrium industrial structure by comparing the acquirer's profits at the A-equilibrium to the incumbents' at the G-equilibrium. A complication arises when there are multiple G-equilibria (A-equilibria are always unique: see Figure 2). In

[9] The appendix is available from the author on request.

this case the selected subgame may depend on which G-equilibrium is selected *within* the G subgame. Of course, if the A-equilibrium dominates all the G-equilibria, then we can unambiguously conclude that the A subgame will be played in equilibrium (and vice versa). Figure 4 illustrates the model's equilibrium industrial structures in (p, μ)-space.

[INSERT FIGURE 4 HERE]

Key to Figure 4

<table>
<tr><th rowspan="2">Region</th><th colspan="2">Small p</th><th colspan="2">Large p</th></tr>
<tr><th>Small t</th><th>Large t</th><th>Small t</th><th>Large t</th></tr>
<tr><td>I</td><td>$\{N; \varnothing\}$</td><td>$\{1N, 1N; \varnothing\}$</td><td>$\{N; \varnothing\}$</td><td>$\{1N, 1N; \varnothing\}$</td></tr>
<tr><td>II, III</td><td colspan="4">$\{R; \varnothing\}$</td></tr>
<tr><td>IV</td><td>$\{1R, 1R; \varnothing\}$</td><td>N/A</td><td>$\{1R, 1R;\varnothing\}$</td><td>N/A</td></tr>
<tr><td>V</td><td>Small G:
$\{1R, 2R; \varnothing\}$
Large G:
$\{1R, 1R; R\}$</td><td colspan="3">Small G: $\{1R, 2R; \varnothing\}$
Large G: $\{R, R\}$</td></tr>
<tr><td>VI</td><td>$\{1R, 1R; R\}$</td><td>Small I:
$\{1R, 1R; R\}$
Large I:
$\{R; R\}$</td><td>$\{R; R\}$</td><td>Small I:
$\{1R, 1R; R\}$
Large I:
$\{R; R\}$</td></tr>
<tr><td>VII</td><td colspan="2">N/A</td><td>$\{2R, 2R; \varnothing\}$</td><td>Small G, I:
$\{2R, 2R; \varnothing\}$
Large G, I:
$\{R; R\}$</td></tr>
<tr><td>VIII</td><td colspan="2">Small G, I: $\{2R, 2R; R\}$
Large G, I: $\{R; R\}$</td><td colspan="2">$\{R; R\}$</td></tr>
</table>

Figure 4 provides implications for the relationships between p, μ and equilibrium industrial structures; however, the derived relationships can be quite complex.

Consider first equilibria in "small" markets. The choice between $\{1N, 1N; \varnothing\}$ and $\{N; \varnothing\}$ in region I depends on t in an intuitively-appealing way: large t affords the incumbents in the G subgame sufficient protection to monopoly-price, implying no (strict) profitability gains from acquisition-FDI; but if t is small, acquisition-FDI increases aggregate profits by eliminating the "import competition" faced by each G-incumbent. In regions II and III the generation of acquisition-FDI in equilibrium is unsurprising because the acquirer is a global monopolist in A-equilibrium (no entry occurs).[10]

In intermediate-sized markets (region IV) the equilibrium industrial structure is the G-equilibrium of $\{1R, 1R; \varnothing\}$ because both the A- and G-equilibria are duopolistic. Entry is "more likely" to occur in the A subgame than in the G subgame, which makes

[10] The difference between regions II and III concerns the discarded G-equilibrium, which is $\{1N, 1N; \varnothing\}$ in II and $\{1N, 1R; \varnothing\}$, $\{1R, 1R; \varnothing\}$, $\{1N, 2R; \varnothing\}$ or $\{1N, 1N; R\}$ in III. Section 4 explores the significance of this difference in welfare terms.

intuitive sense because the entrant faces a monopoly in the A subgame but a duopoly in the G subgame.[11]

In "large" markets (regions V-VIII) there are two, opposing influences on equilibrium. As noted above, entry is made "more likely" by acquisition, which favours the G-equilibrium. However, acquisition also allows the incumbents to economise on sunk costs: large *G* causes acquisition-FDI to be substituted for costly greenfield-FDI, and large *I* favours the single research lab of the integrated firm in the A subgame over the incumbents' independent research labs in the G subgame.

Changes in *t* have distinct effects on the incentives for greenfield- and acquisition-FDI. In models of equilibrium greenfield-FDI with "national" product markets increasing *t* unambiguously increases a firm's "incentive" to undertake greenfield-FDI abroad (the "tariff-jumping" motive). In our modelling of acquisition-FDI the decision rule for acquisition-FDI compares the G-incumbents' combined profits to the acquirer's profits (which are independent of *t* because the potential entrant has two plants so international trade does not occur in the A subgame), which is a qualitatively different comparison to that for greenfield-FDI. Under $\{1R, 1R; R\}$ the derivative of the G-incumbents' expected profits with respect to *t* is $2p(1-p)\mu\left[p\frac{\mathrm{d}R(0,t)}{\mathrm{d}t}+(1-p)\frac{\mathrm{d}R(t,c)}{\mathrm{d}t}\right]$, where $[\cdot]$ is a convex combination of $\mathrm{d}R(0, t)/\mathrm{d}t$ and $\mathrm{d}R(t, c)/\mathrm{d}t$. For small *p* the derivative approximately equals $2p(1-p)^2\mu\frac{\mathrm{d}R(t,c)}{\mathrm{d}t}<0$, so increases in *t* reduce the G-incumbents' profits under $\{1R, 1R; R\}$ and strengthen the incentive to undertake (tariff-jumping) acquisition-FDI. This effect was observed for small *p* and large *G*, *I* in regions V and VI. However, for large *p* the derivative approximately equals $2p^2(1-p)\mu\frac{\mathrm{d}R(0,t)}{\mathrm{d}t}\geq 0$, so increases in *t* increase the G-incumbents' profits under $\{1R, 1R; R\}$ and weaken the incentive for acquisition-FDI. This latter effect occurs for large *p* and small *I* in region VI.[12]

Proposition 1 summarises some of the "positive" features of the equilibrium industrial structures in Figure 4.

Proposition 1:
1. Acquisition-FDI "often" (i.e. for "large" sets of parameter values) arises in equilibrium in small and medium-sized markets, where it does not encourage subsequent (rent-dissipating) entry.
2. For greenfield-FDI to arise in equilibrium, two conditions appear necessary: a "large" market size; and "small" sunk costs of greenfield-FDI and R&D. (In large markets the profitability of acquisition-FDI is likely to be reduced by

[11] Therefore, acquisition is a "soft" response to an entry threat. The relatively minor exception to this occurs in a small part of region III, where the A-equilibrium is $\{R; \varnothing\}$ but the G-equilibrium might be $\{1N, 1N; R\}$. However, the latter is Pareto dominated (for the incumbents) by $\{1R, 1R; \varnothing\}$ so is unlikely to arise.

[12] Aside from regions V and VI, changes in *t* also cause switches between acquisition-FDI and G-equilibria involving no greenfield-FDI in region I, where the relationship is again perverse: *decreases* in *t* generate acquisition-FDI (because $\mathrm{d}R(c, c+t)/\mathrm{d}t \geq 0$).

subsequent entry, which is "more likely" if the incumbents choose acquisition-FDI than if they choose exporting or greenfield-FDI.)

3. The strategic use of greenfield-FDI by the incumbents to deter entry by the "outside" firm may prevent acquisition-FDI from arising in equilibrium by bolstering the incumbents' "disagreement profits" and rendering an acquisition unprofitable.[13]
4. Increases in the sunk costs of greenfield-FDI and R&D can cause the substitution (in large markets) of acquisition-FDI for greenfield-FDI in equilibrium. (Because the integrated firm formed by acquisition-FDI runs only one research lab by assumption, undertaking acquisition-FDI allows the incumbent firms to economise on R&D investments.)
5. The association between trade costs and equilibrium acquisition-FDI is positive (as in the case of "tariff-jumping" greenfield-FDI) if the probability of R&D success is small but *negative* if it is large. For a large probability of R&D success, we show that increases in trade costs offer heightened protection to rival national firms in their home markets, thus (potentially) rendering integration via acquisition-FDI unprofitable.

4. Normative Analysis

In this section we perform some illustrative welfare comparisons between the A- and G-equilibria. Our welfare concept is *global social welfare*, which is composed of total expected consumer surplus across both countries and total expected profits across the three firms. To keep the analysis tractable and brief, we concentrate on four distinct pairings of A- and G-equilibria that arise in Figure 4 (each is coded with a "C" to represent "comparison"):

C1. In region I of Figure 4 we compare the welfare properties of the G-equilibrium of {1*N*, 1*N*; ∅} to those of the counterpart A-equilibrium of {*N*; ∅}.

C2. In region II of Figure 4 we compare the welfare properties of the G-equilibrium of {1*N*), 1*N*; ∅} to those of the counterpart (and selected) A-equilibrium of {*R*; ∅}.

C3. In region III of Figure 4 we compare the welfare properties of the G-equilibrium of {1*R*, 1*R*; ∅} to those of the counterpart (and selected) A-equilibrium of {*R*; ∅}.[14]

C4. In region VIII of Figure 4 we compare the welfare properties of the G-equilibrium of {2*R*, 2*R*; *R*} to those of the counterpart A-equilibrium of {*R*; *R*}.

The welfare comparisons set out in C1 – C4 concentrate on small and medium-sized markets and on very large markets. In each of C1 – C4 the A- and G-equilibria considered are symmetric (identical) across the two countries.

[13] This finding illustrates the importance of analysing both forms of FDI simultaneously: the option of undertaking greenfield-FDI makes acquisition-FDI unprofitable in equilibrium, a point that would be missed in models concentrating exclusively on one type of FDI. For example, note that in region V of Figure 4 acquisition-FDI occurs in equilibrium only if *G* is large, which means that {1*R*, 1*R*; *R*} would arise in the G subgame. If *G* is small, then the entry-deterring equilibrium of {1*R*, 2*R*; ∅} exists in the G subgame, and acquisition is unprofitable.

[14] Note that {1*R*, 1*R*; ∅} is *not* a G-equilibrium below the lowest dashed line in Figure 4.

First we consider consumer surplus in each pairing of A- and G-equilibria. Let

$$S[x_k] = \frac{\mu}{2} \cdot (1 - x_k)^2$$

denote aggregate consumer surplus in country k at a market price of x_k. We are implicitly assuming that the income effects of price changes are negligible, e.g. that the good in question represents a small share of the 'representative' consumer's spending.

The following results for expected consumer surplus, E$S[x_k]$, in the three possible A-equilibria are straightforwardly derivable:

In $\{N; \varnothing\}$, $ES[x_k] = S\left[x^M(c)\right]$.

In $\{R; \varnothing\}$, $ES[x_k] = pS[0.5] + (1-p)S\left[x^M(c)\right]$.

In $\{R; R\}$, $ES[x_k] = p^2 S[0] + 2p(1-p)S\left[\min\{c, 0.5\}\right] + (1-p)^2 S[c]$

Note that $x^M(0) = 0.5$, so $S[0.5]$ is the consumer surplus associated with monopoly-pricing on the basis of a marginal cost of 0. Note also that $S[0.5] > S[x^M(c)]$ for all $c > 0$ because the equilibrium monopoly price is increasing in marginal cost. Expected consumer surplus rises as we move (successively) through the A-equilibria from $\{N; \varnothing\}$, to $\{R; \varnothing\}$, to $\{R; R\}$. This result is intuitive: extra R&D investments and tougher "competition" (via entry) both benefit consumers.

Expected consumer surplus in the three G-equilibria in C1 – C4 is:

In $\{1N, 1N; \varnothing\}$, $ES[x_k] = S\left[\min\left\{c+t, x^M(c)\right\}\right]$.

In $\{1R, 1R; \varnothing\}$,

$$\begin{aligned} ES[x_k] &= p^2 S\left[\min\{t, 0.5\}\right] + p(1-p)S\left[\min\{c+t, 0.5\}\right] \\ &+ p(1-p)S\left[\min\left\{c, x^M(t)\right\}\right] + (1-p)^2 S\left[\min\left\{c+t, x^M(c)\right\}\right] \end{aligned}.$$

In $\{2R, 2R; R\}$,

$$ES[x_k] = p^3 S[0] + 3p(1-p)^2 S\left[\min\{c, 0.5\}\right] + 3p^2(1-p)S[0] + (1-p)^3 S[c].$$

As with the A-equilibria examined above, it is straightforward to show that expected consumer surplus rises as we move (successively) through the G-equilibria from $\{1N, 1N; \varnothing\}$, to $\{1R, 1R; \varnothing\}$, to $\{2R, 2R; R\}$. The intuition for these rises in consumer surplus is also the same as with the A-equilibria: extra R&D investments and tougher "competition" (both via inward greenfield-FDI and entry) both benefit consumers.

Before carrying out the welfare comparisons described in C1 – C4, the results of which are summarized below in Proposition 2, we consider total expected profits in each pairing of A- and G-equilibria. The useful feature for this purpose of the small and medium-sized markets considered in C1 – C3 is that entry occurs in neither the A- nor the G-equilibrium. Therefore, the comparison of total profits between the two equilibria has already been accomplished in our application of the GADR. A simple way of undertaking the profit comparison in C4 is to note that the entrant firm makes higher expected profits in $\{R; R\}$ than in $\{(2, R), (2, R); R\}$, so a *sufficient* (but unnecessary) condition for total expected profits to be higher in {R; R} is that the *incumbents* prefer {R; R}. This occurs for large (≥ 0.5) p (see the key to Figure 4).

We summarize the results of our welfare comparisons in C1 – C4 in Proposition 2.

Proposition 2:

1. Within both the A and G subgames, increases in industry spending on R&D and greenfield-FDI increase expected consumer surplus.
2. A sufficient condition for consumers to prefer the G- to the A-equilibrium is that industry spending on R&D is higher at the G-equilibrium.
3. The welfare comparison of A- and G-equilibria generally involves a Williamson (1968)-type trade-off between profits and consumer surplus.
4. The possibility of Pareto dominant acquisition-FDI exists in small markets when industry R&D spending is larger at the A- than the G-equilibrium (i.e. in C2).

Part 2 of Proposition 2 uses the fact that there is more "competition" in the G subgame. In part 3 the Williamson trade-off referred to means that total expected profits are higher, but consumer surplus lower, at the A-equilibrium than at the G-equilibrium. In all of C1 – C4 the occurrence of acquisition-FDI in equilibrium is sufficient for industry profits to be higher at the A-equilibrium than at the G-equilibrium.[15] Acquisition-FDI certainly (i.e. for all permissible parameter values) occurs in equilibrium in C2 and C3, and it occurs in equilibrium in C1 if and only if $x^M(c) > c + t$ and in C4 if and only if p is "large" (≥ 0.5).

On the other hand, consumer surplus is certainly lower under acquisition-FDI in C3 and C4. Consumer surplus is lower under acquisition-FDI in C1 if and only if $x^M(c) > c + t$ (i.e. whenever acquisition-FDI arises there in equilibrium); and in C2 consumer surplus is lower for all p under acquisition-FDI if and only if $c + t < 0.5$.[16] Therefore, the occurrence of acquisition-FDI in equilibrium in C1, C3 and C4 is accompanied by a loss of consumer welfare relative to the alternative G-equilibrium (the Williamson trade-off), and the occurrence of acquisition-FDI in equilibrium in C2 reduces consumer welfare for all p if and only if $c + t < 0.5$.[17]

However, there are circumstances in our model when the A-equilibrium Pareto dominates the G-equilibrium so no Williamson trade-off exists (part 4 of Proposition 2): both total profits and consumer surplus are higher at the A-equilibrium. In C2 (region II of Figure 4) acquisition-FDI clearly raises total profits (relative to the G-equilibrium "threat point"). Furthermore, for sufficiently large p expected consumer surplus is higher under {R; ∅} than {1N, 1N; ∅} if and only if $c + t > 0.5$, which ensures that the equilibrium monopoly price if R&D is successful in {R; ∅} is below

[15] In C1 – C3 it is necessary too.

[16] If $c + t < 0.5 = x^M(0) < x^M(c)$, then consumer surplus in {1N, 1N; ∅} is $S(c + t) > S(0.5)$, the maximum consumer surplus under acquisition (at $p = 1$). Note that consumer surplus at $p = 0$ is always higher in {1N, 1N; ∅} than {R; ∅}.

[17] These differential welfare properties (in terms of profits and consumer surplus) of the A- and G-equilibria could be used to justify a role for public policy in regulating acquisition-FDI flows if the weight placed on consumer surplus in the social welfare function is sufficiently large.

the equilibrium price in {1*N*, 1*N*; ∅}.[18] Therefore, the A-equilibrium *can* Pareto dominate the G-equilibrium if industry R&D spending is larger following acquisition-FDI than it would be otherwise. This gives some (limited) support to the argument that acquisition-FDI can foster "technological progress" (the benefits of which outweigh the costs of monopolization) and qualifies our result above (part 3) on the Williamson trade-off between the A- and G-equilibria (and its related policy implications).

The finding that for given parameter values R&D can occur in A- but not in G-equilibrium is perhaps counter-intuitive because the G subgame is "more competitive": for example, Aghion et al. (2001, p. 468) argue that "an increase in PMC [product market competition] can stimulate R&D by increasing the incremental profit from innovating, that is, by strengthening the motive to innovate in order to *escape* competition with 'neck-and-neck' rivals." The key to the puzzle lies in comparing firms' "incentives" to innovate (i.e. increases in net revenues) in the A and G subgames, where the equilibria are {*A*; ∅} and {1*N*, 1*N*; ∅} respectively.[19] If t is very large and no greenfield-FDI is undertaken, then for either R&D outcome a G-incumbent investing in R&D will be able to monopoly-price at home but will export nothing. Therefore, such a firm undertaking R&D would expect to earn exactly *half* the net revenues of the acquirer undertaking R&D in the A subgame. This limiting example highlights clearly the source of the acquirer's stronger "incentive" to innovate in region II of Figure 4: its larger output base, over which a process innovation can be spread, due to the elimination ("jumping") of trade costs following acquisition-FDI. The cause of Pareto dominant acquisition-FDI in our model (an "output base" effect) differs from that in Horn and Persson (2001b), where mergers are associated with savings in fixed and variable production costs ("synergies").

5. Concluding Comments

By building a model where the *form* of FDI (greenfield-FDI or acquisition-FDI) is endogenously selected, the key aim of this paper was to isolate the determinants of the equilibrium form of FDI. Furthermore, by allowing other aspects of industrial structure to be endogenously determined in equilibrium (i.e. firms' investment levels in R&D and the number of firms), our modelling structure can be used to investigate the differential relationships between the two forms of FDI and those wider industry characteristics.[20] In our illustrative welfare analyses (section 4), the inclusion of endogenous R&D decisions also allows us to examine whether acquisition-FDI can sometimes be justified (despite the welfare costs associated with possible monopolization) because it fosters "technological development" by increasing industry R&D spending.

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[18] Note that $x^{M}(c)$, which is the equilibrium price in {1*N*, 1*N*; ∅} if t is "very large", <u>must</u> be greater than 0.5.

[19] In region II of Figure 4 entry by firm 3 into the A subgame is blockaded, so the acquirer's "incentive" to innovate is $2p\mu[R^{M}(0) - R^{M}(c)]$; a G-incumbent's "incentive" to choose 1*R* over 1*N* in response to 1*N* (given that 3 will subsequently choose ∅) is $p\mu[R(0, c + t) - R(c, c + t) + R(t, c)]$. The "incentive" to innovate is stronger for the acquirer if and only if condition (A1) in the Appendix fails (this is also required for the *existence* of region II), which occurs for "sufficiently large" t.

[20] Of course, the inclusion of potential entry prevents the implementation of the GADR becoming a (trivial) comparison of monopoly and (total) duopoly profits.

Some of our key positive results are:

- Acquisition-FDI "often" (i.e. for "large" sets of parameter values) arises in equilibrium in small and medium-sized markets, where it does not encourage subsequent (rent-dissipating) entry.
- For greenfield-FDI to arise in equilibrium, two conditions appear necessary: a "large" market size; and "small" sunk costs of greenfield-FDI and R&D. (In large markets the profitability of acquisition-FDI is likely to be reduced by subsequent entry, which is "more likely" if the incumbents choose acquisition-FDI than if they choose exporting or greenfield-FDI.)
- The strategic use of greenfield-FDI by the incumbents to deter entry by the "outside" firm may prevent acquisition-FDI from arising in equilibrium by bolstering the incumbents' "disagreement profits" and rendering an acquisition unprofitable. This finding illustrates the importance of analysing both forms of FDI simultaneously: the option of undertaking greenfield-FDI makes acquisition-FDI unprofitable in equilibrium, a point that would be missed in models concentrating exclusively on one type of FDI.
- Increases in the sunk costs of greenfield-FDI and R&D can cause the substitution (in large markets) of acquisition-FDI for greenfield-FDI in equilibrium. (Because the integrated firm formed by acquisition-FDI runs only one research lab by assumption, undertaking acquisition-FDI allows the incumbent firms to economise on R&D investments.)
- The association between trade costs and equilibrium acquisition-FDI is positive (as in the case of "tariff-jumping" greenfield-FDI) if the probability of R&D success is small but *negative* if it is large. For a large probability of R&D success, we show that increases in trade costs offer heightened protection to rival national firms in their home markets, thus (potentially) rendering integration via acquisition-FDI unprofitable.

We compared (for a limited set of parameter values) the welfare properties of industrial structures associated with acquisition-FDI to those of the corresponding "threat point" equilibria (i.e. where the incumbents choose between exporting and greenfield-FDI as means of serving the foreign product market). We found some evidence that acquisition-FDI flows are associated with a Williamson (1968)-type welfare trade-off between industry profits and consumer surplus, which could suggest a role for public policy in protecting consumers' interests in the presence of acquisition-FDI flows. However, it is not true that acquisition-FDI *always* reduces consumer welfare (relative to the "threat point"): when acquisition-FDI raises industry R&D spending, it can also raise consumer surplus despite monopolization. (Nevertheless, such Pareto dominant acquisition-FDI, which could be viewed as verifying the "failing firm" defence of international takeovers, occurs in very special circumstances.)

A general conclusion of this paper is that greenfield- and acquisition-FDI are theoretically quite distinct (in terms of both the positive and the normative aspects of the industrial structures that they are associated with), which casts doubt on the legitimacy of many analyses that treat FDI as a homogeneous flow of funds. However, further work is needed to test the robustness both of this general conclusion and of our more specific results. Our modelling structure is relatively stylised, and future work will attempt to relax some of our assumptions.

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Figures

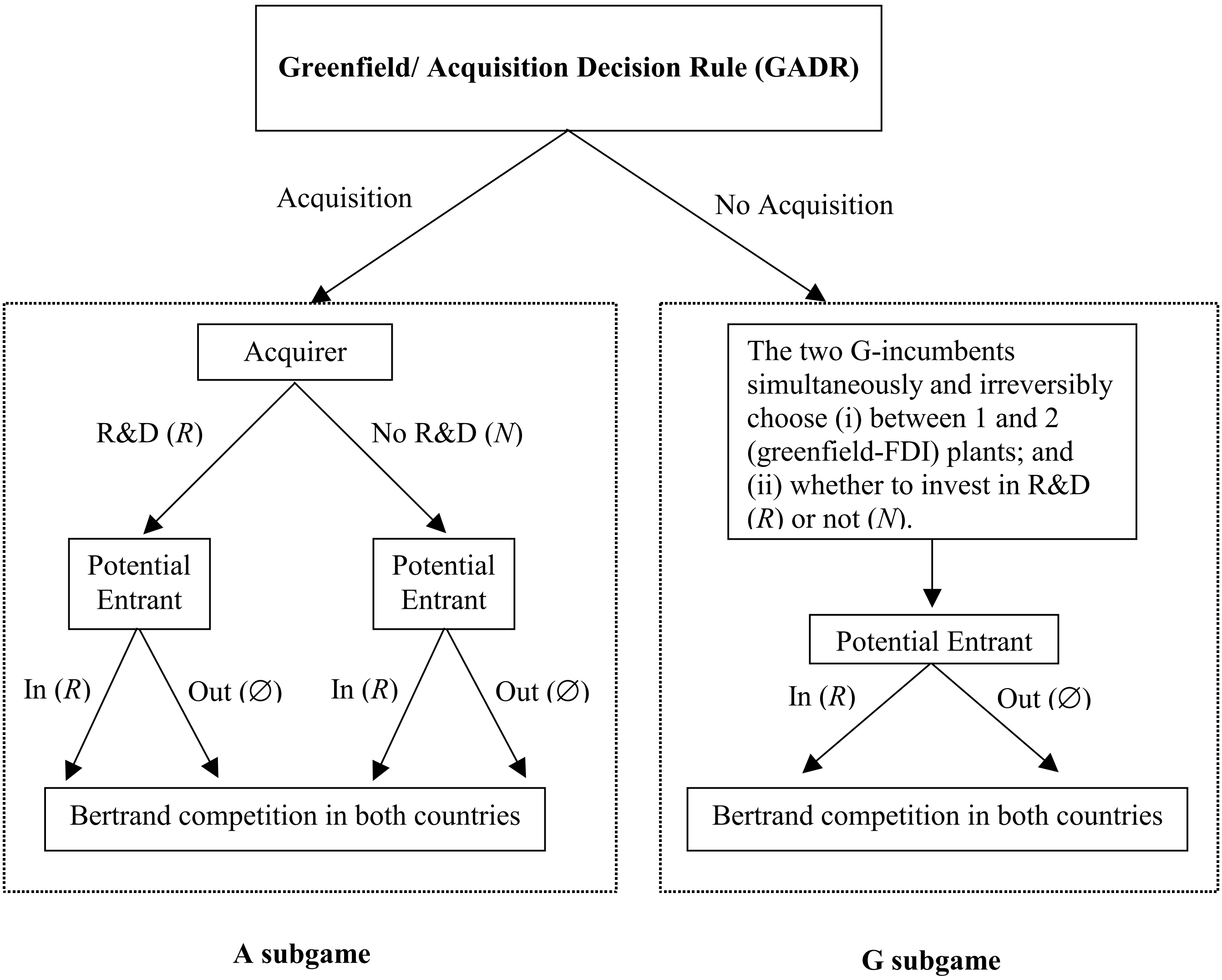

Figure 1: Game Tree

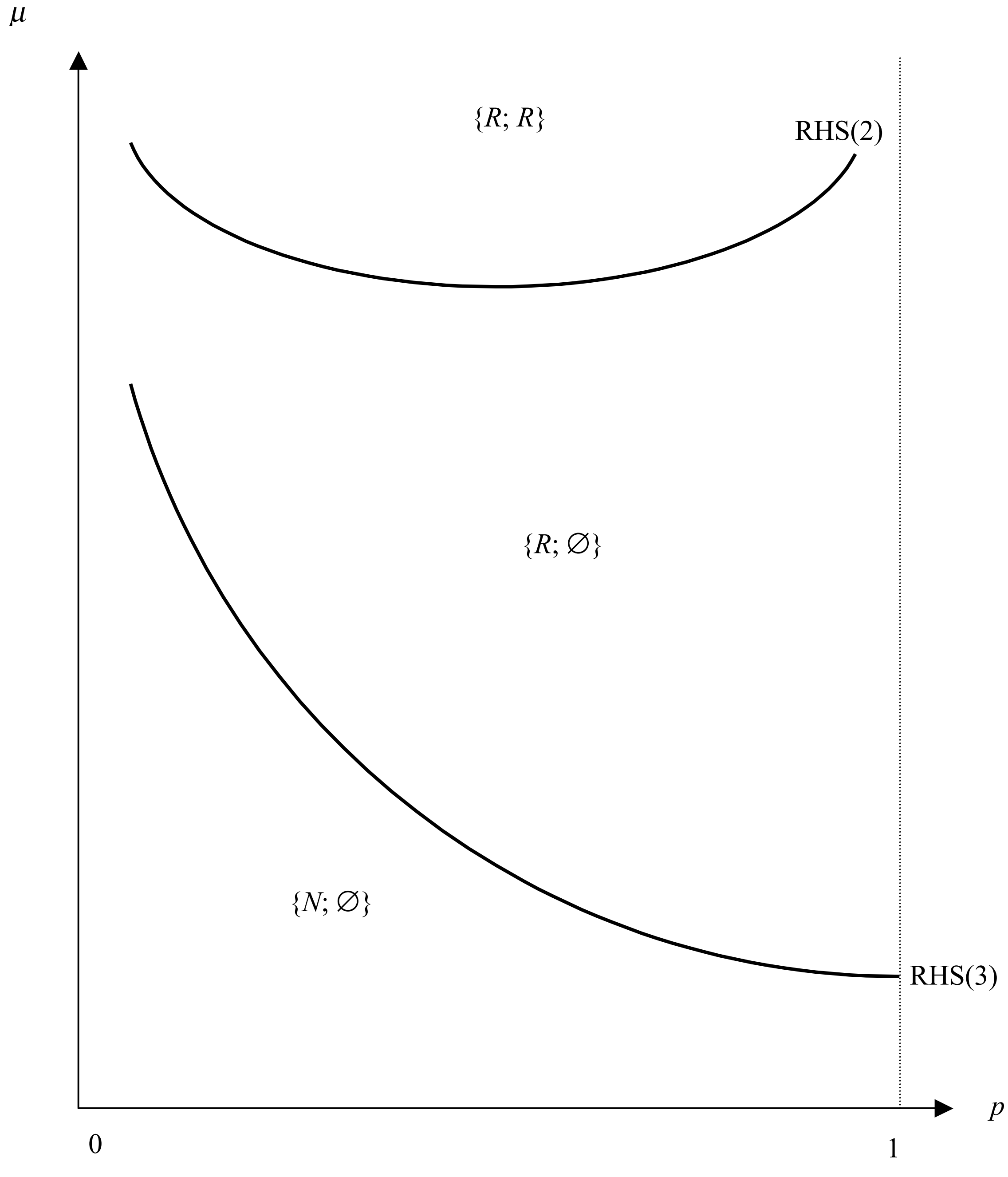

Figure 2: Equilibria in the A Subgame

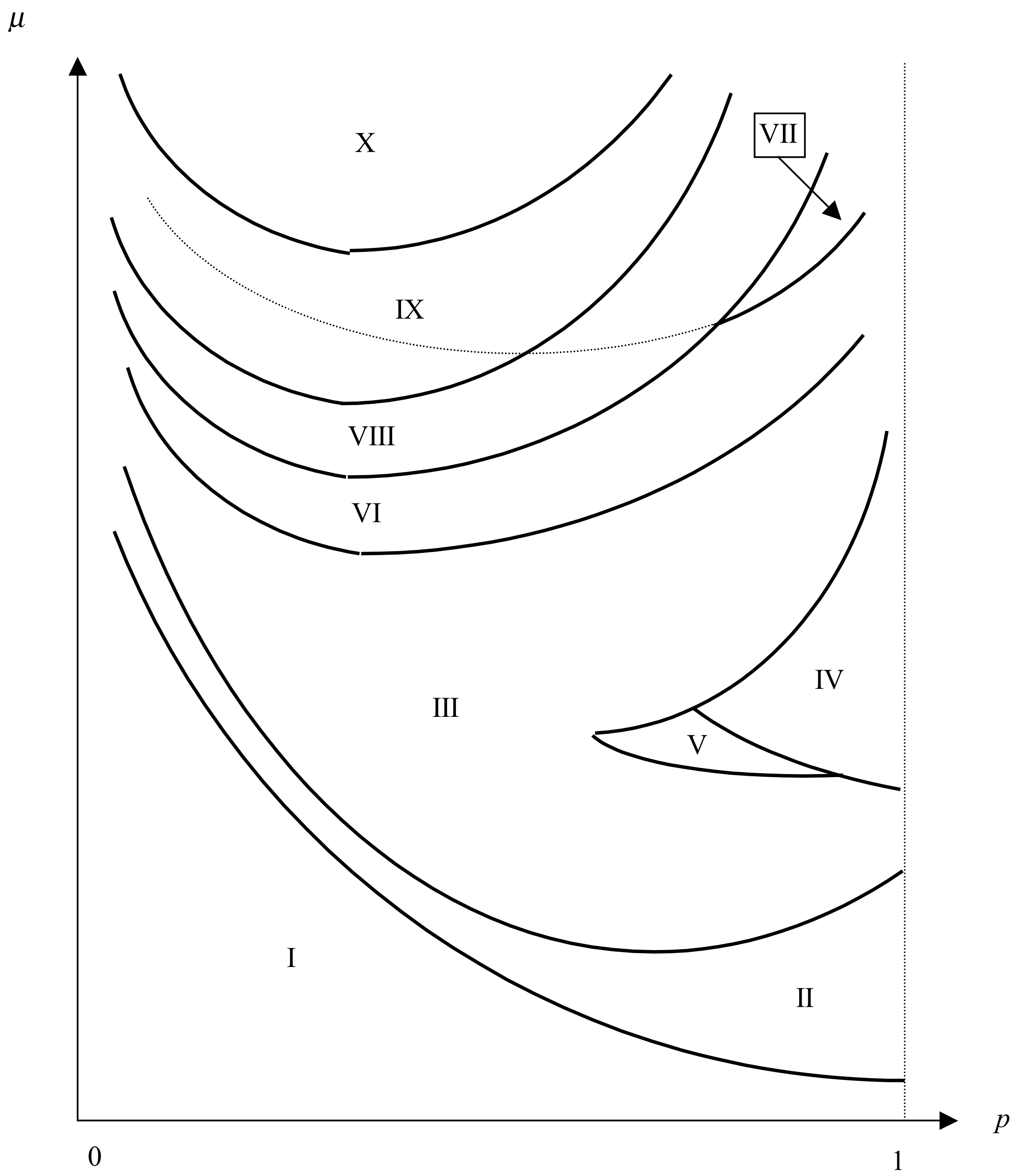

Figure 3: Equilibria in the G Subgame

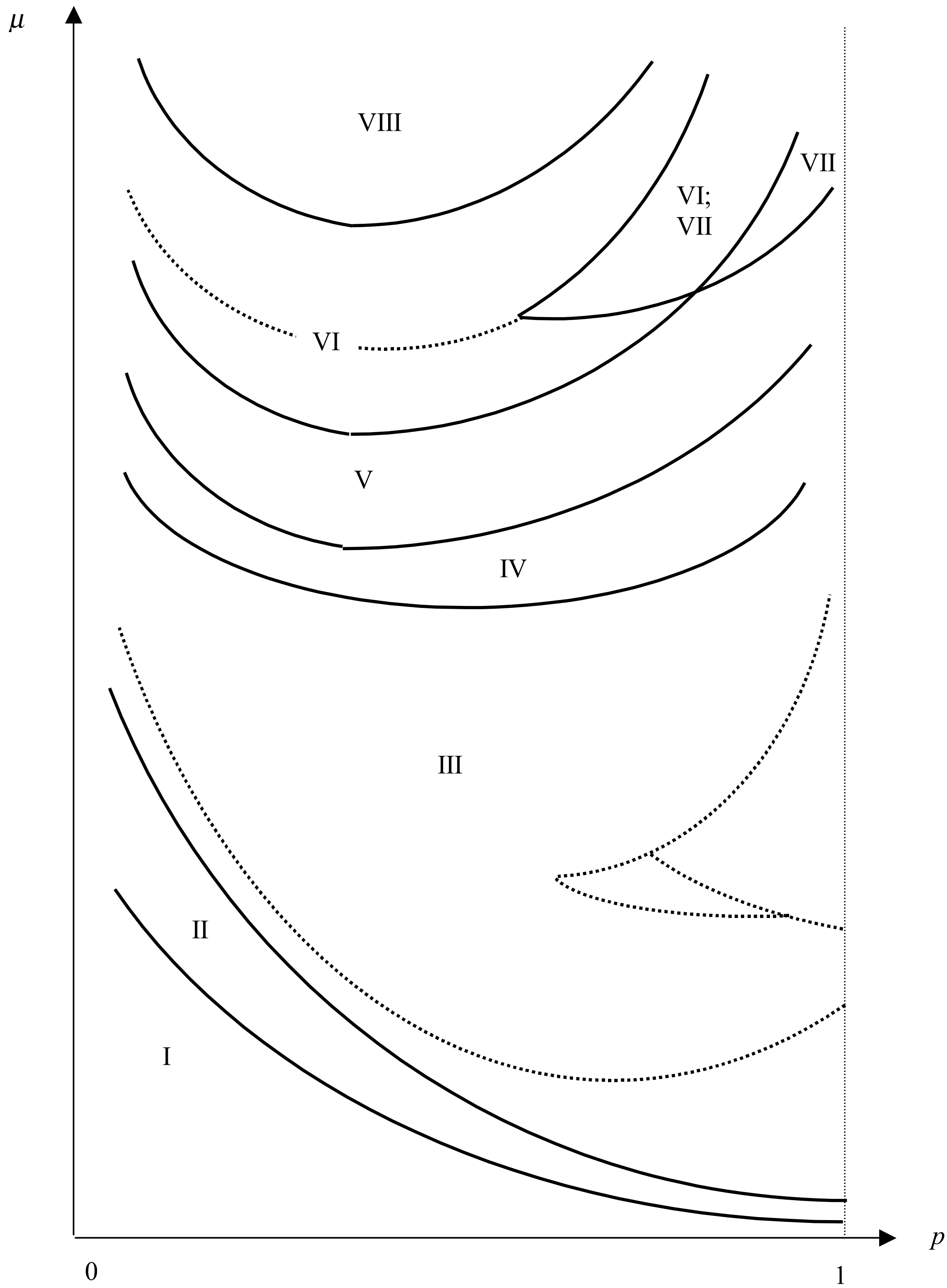

Figure 4: Equilibrium Industrial Structures (the Greenfield/ Acquisition Choice)

[Note that dashed lines are inter-regional boundaries from the G Subgame.]