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ABSTRACT

Foreign Production, Strategic Choice and the Domestic Market Effect*

This Paper presents a simple model of the interaction between two firms, based in different countries, each of which faces the export vs. multinational enterprise (MNE) choice concerning the serving of each other's home market. The basic game structure is similar to that elsewhere in the literature (Horstmann & Markusen (1992) and Rowthorn (1992)). To this, I add a further choice: investment in a new technology that allows a corporate-wide reduction in variable costs (i.e. cost reducing R&D). In the presence of such corporate-wide investment, the firms' decisions concerning each other's home markets are interdependent. Furthermore, strategic motives for foreign direct investment (FDI) relate not only to a firm's foreign market profits, but also to those from their domestic market. This is because one firm's export vs. MNE choice can influence both its rival's choice and investment behaviour. One possibility is that a firm sets up a plant overseas in order to influence the behaviour of its rival, even though its profits from serving the foreign market would be higher by exporting.

JEL Classification: F23, L13
Keywords: foreign direct investment, multinational enterprise, strategic choice

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NON-TECHNICAL SUMMARY

This Paper presents a simple model of the interaction between two firms, based in different countries, each of which faces the export vs. multinational enterprise (MNE) choice concerning the serving of each other's home market. The basic game structure is similar to that elsewhere in the literature (Horstmann & Markusen (1992) and Rowthorn (1992)). To this, I add a further choice: investment in a new technology that allows a corporate-wide reduction in variable costs (i.e. cost reducing R&D). In the presence of such corporate-wide investment, the firms' decisions concerning each other's home markets are interdependent. Furthermore, strategic motives for foreign direct investment (FDI) relate not only to a firm's foreign market profits, but also to those from their domestic market. This is because one firm's export vs. MNE choice can influence both its rival's choice and investment behaviour. One possibility is that a firm sets up a plant overseas in order to influence the behaviour of its rival, even though its profits from serving the foreign market would be higher by exporting.

Suppose there are two countries, A and B, and two firms, Firm 1 and Firm 2. Initially both Firm 1 and Firm 2 exist, with Firm 1 based in A and Firm 2 based in B. Each has a plant which is able to produce a homogeneous good. The game starts as the opportunity arises for each firm to serve the overseas market for this good. There is a three-stage game. In the first stage Firm 1 makes two decisions: (i) whether or not to serve the market in B and if so by which method: exporting or multinational production, and (ii) whether or not to invest (using, say, R&D) in a new technology that reduces its variable costs. In the second stage Firm 2 makes its choices concerning both the market in A and investment. In the third stage, firms set outputs simultaneously. Thus I choose to have firms make their choices of whether to be multinational and invest *sequentially*. This is to permit the two choices to be used together by a first-mover in order to influence the corresponding decisions of its rival.

I will first describe a base case where neither firm is permitted to invest in the new technology. In this case, there is no interdependence between firms' choices: (i) a firm's export vs. MNE choice cannot be used to bring about the exit of the rival from the latter's domestic market – as there are no fixed costs of *remaining* in the market and no possibility of a firm suffering a variable cost disadvantage in its home market; (ii) the firms' export vs. MNE choices are not interdependent because the firms' foreign markets are different markets and there is no mechanism by which they are related.

By introducing investment, one introduces interdependence between firms' export vs. MNE choices. This is because the corporate-wide nature of the investment provides a mechanism by which the firms' foreign markets are related. A firm's export vs. MNE choice influences its rival's incentives to invest. This is because: the rival's incentive to invest is increasing in its total

output (as investment is a fixed outlay in exchange for a per-unit saving); by being an MNE, a firm makes its rival's home-dedicated output, and so total output, relatively small (relative to if the firm was domestic or an exporter); so, by being multinational a firm may deter its rival from investing. This brings about interdependence between firms' export vs. MNE choices because the rival's output in all markets is smaller as a non-investor than as a investor, so, there is less incentive for a firm to incur the fixed cost of local production if it does not invest. Therefore, by being multinational, a firm may deter its rival from being an MNE as a result of deterring it from investing.

I present results for a case where the attractiveness of investment is such that: an MNE will invest, but investment behaviour by an exporter varies with the per-unit transport cost (*t*) and with the actions of its rival. I am especially interested in investigating the motives for FDI when a firm will not invest as an exporter if its rival is a multinational investor, but will invest otherwise. Among the results are instances where firms are interdependent with respect to their decisions between being domestic, exporting or being multinational. In each case, these instances occur for only a certain range of the plant-specific fixed cost (*G*). It is also the case that there is a negative and monotonic relationship between the number of multinationals and *G*. However, *t* is non-monotonically related to multinationality, i.e. increases in *t* can bring more or less multinational production. Also, a firm's decision about foreign production may influence, and so be influenced by, domestic market profits. The point is: in the case considered, a firm has a greater incentive to go multinational in a certain range of *t* because it can deter the other firm from investing. In this case, being an MNE brings higher profits in the domestic market than does exporting. So a firm may choose to go multinational even though it would export, if merely trying to maximize foreign market profits.

Foreign Production, Strategic Choice and the Domestic Market Effect

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This paper presents a simple model of the interaction between two firms, based in different countries, each of which faces the export v MNE choice concerning the serving of each other's home market. The basic game structure is similar to that elsewhere in the literature (Horstmann & Markusen (1992), and Rowthorn (1992)). To this, I add a further choice: investment in a new technology that allows a corporate-wide reduction in variable costs (i.e. cost reducing R&D). In the presence of such corporate-wide investment, the firms' decisions concerning each other's home markets are interdependent. Furthermore, strategic motives for foreign direct investment (FDI) relate not only to a firm's foreign market profits, but also to those from their domestic market. This is because one firm's export v MNE choice can influence both its rival's choice and investment behaviour. One possibility, is that a firm sets up a plant overseas in order to influence the behaviour of its rival, even though its profits from serving the foreign market would be higher by exporting.

1 Introduction

This paper presents a simple model of the interaction between two firms, based in different countries, each of which faces the export v MNE choice concerning the serving of each other's home market. Here then, I explore the possibility that a foreign firm, such as Saint Gobain, the French glass manufacturer, in some way interacts with a home country firm, say Pilkington Glass UK, when deciding whether to set up production in the UK. Furthermore, the interaction is to be such that Saint Gobain's decision to have UK production may influence Pilkington's decision of whether to set up in France. The former may, by being multinational, be able to deter the latter from also being an MNE[2].

The basic model structure is similar to that elsewhere in the literature (Horstmann & Markusen (1992), and Rowthorn (1992)). To this, I add a further choice: investment in a new technology that allows a corporate-wide reduction in variable costs (i.e. cost reducing R&D)[3]. In the presence of such corporate-wide investment, the firms' decisions concerning each other's home markets are interdependent. Furthermore, strategic motives for foreign direct investment (FDI) relate not only to a firm's foreign market profits, but also to those from their domestic market. This is because one firm's export v MNE

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[2] Indeed, the firm-level data used by Pavelin (1999) shows that Saint Gobain has a manufacturing presence in the UK, but Pilkington has no such presence in France.

[3] Petit & Sanna-Randaccio (1998) have shown the possible link between R&D expenditures and the manner of international expansion. They reveal a positive two-way link between R&D and FDI that is also present in the model presented here. In their model a monopolist is the decision-maker and so firm interdependence (the main focus here) is ruled out by assumption.

choice can influence both its rival's choice and investment behaviour. One possibility, is that a firm sets up a plant overseas in order to influence the behaviour of its rival, even though its profits from serving the foreign market would be higher by exporting.

The basic assumptions are outlined in section 2. To fix ideas, in section 3 I consider the case where neither firm is permitted to invest, then the full model, where investment is allowed, is presented in section 4, section 5 concludes.

2 Assumptions, notation & structure of the game

Suppose there are two countries, A and B, and two firms, Firm 1 and Firm 2. Initially both Firm 1 and Firm 2 exist, with Firm 1 based in A and Firm 2 based in B. Each has a plant which is able to produce a homogeneous good. The game starts as the opportunity arises for each firm to serve the overseas market for this good. There is a three stage game. In the first stage Firm 1 makes two decisions: (i) whether or not to serve the market in B, and if so by which method: exporting or multinational production, and (ii) whether or not to invest (using, say, R&D) in a new technology that reduces its variable costs. In the second stage Firm 2 makes its choices concerning both the market in A and investment. In the third stage, firms set outputs simultaneously.

Thus I choose to have firms make their choices of whether to be multinational and invest *sequentially*. This is to permit the two choices to be used together by a first-mover in order to influence the corresponding decisions of its rival. I want to focus upon this firm interdependence and show as clearly as possible the manner in which it can affect the motives of firms. If instead firms were to choose simultaneously, potential strategic motives of firms would either give rise to multiple equilibria or be lost altogether. So, sequential choice allows me to more straightforwardly isolate behaviour that seeks to manipulate any firm interdependence. The role played by sequential choice in a firm gaining a strategic advantage finds echoes in the real world. Firm and industry histories[4] often argue that some kind of first-mover advantage has been instrumental in a firm achieving a position of dominance. Here the first-mover is able to use its decision concerning the manner of its international expansion to alter the corresponding choice of its rival to its own advantage.

Firms produce at a constant marginal cost, c. On exports they must incur an extra variable unit cost, t (tariffs or transport costs), whilst a multinational must incur an extra fixed cost, G (the cost of setting up a plant abroad). Investment in the new technology reduces variable costs by Δ (where $\Delta<c$) and increases fixed costs by f. Therefore the cost functions for Firm 1 are:

non-investor exporter

$$TC = cq^A + (c+t)q^B \qquad (1)$$

[4] See for example the history of the soft drinks industry in Sutton (1991).

investor exporter

$$TC=(c-\Delta)q^{A}+(c-\Delta+t)q^{B}+f \tag{2}$$

non-investor multinational

$$TC=cq^{A}+cq^{B}+G \tag{3}$$

investor multinational

$$TC=(c-\Delta)q^{A}+(c-\Delta)q^{B}+f+G \tag{4}$$

The two countries have identical linear inverse demand functions:

$$A \quad : \quad P^{A}=1-q_1^{A}-q_2^{A} \tag{5}$$

$$B \quad : \quad P^{B}=1-q_1^{B}-q_2^{B} \tag{6}$$

It is assumed that the firms found it unprofitable to make the investment in cost reduction before the opportunity to serve a foreign market arose[5]. This implies a restriction on f and Δ according to the following inequality.

$$f>\frac{1}{2}\Delta(1-c+\frac{1}{2}\Delta) \tag{7}$$

Given this, firms do not find it optimal to invest if they are both domestic, i.e. when they are monopolists in their home country markets and do not serve the foreign market.

3 The non-investment case

I will first describe a base case where neither firm is permitted to invest in the new technology. In this case, there is no interdependence between firms' choices: (i) a firm's export v MNE choice cannot be used to bring about the exit of the rival from the latter's domestic market - as there are no fixed costs of *remaining* in the market, and no possibility of a firm suffering a variable cost disadvantage in its home market[6]; (ii) the firms' export v MNE choices are not interdependent because the firms' foreign markets are different markets and there is no mechanism by which they are related.

This base case is again useful for three pedagogical reasons: it familiarises the reader with (a) the graphical representation of results and; (b) the nature of the relationships between the key cost parameters and the degree of multinationality; (c) it highlights the value-added by introducing the investment choice.

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[5] This condition is a rearrangement of the investment rule : *0>O5* (see section 4.1 below, and Appendix B: equation (75)) and is referred to later in this paper as the condition *f>X3*.

[6] Strategic motives for FDI that are derived from deterring a foreign firm from entering its domestic market, are discussed by, for example, Smith (1987).

I illustrate the range of possible outcomes graphically using figure 1. The notation used is (Firm 1's choice concerning the foreign market, Firm 2's choice concerning the foreign market) - E=exporter, M=multinational, O=stays out of the market.

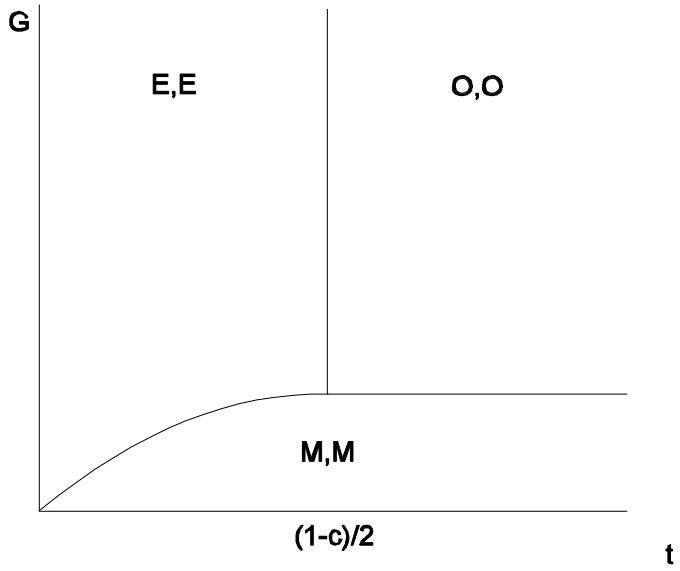

figure 1
The non-investment case

This shows that increases in *t* move equilibria away from exporting and towards more multinational outcomes (e.g. for low *G*, (E,E) to (M,M)). On the other hand, increases in *G* move equilibria away from multinational outcomes and towards greater exporting behaviour (e.g. for low *t*, (M,M) to (E,E)).[7]

These relationships are unsurprising, in that they would be predicted by cost minimisation considerations alone. This is because there is no significant strategic interaction concerning the export v MNE choice: how one firm chooses is not influenced by its rival's choice. For example, say Firm 1 goes multinational. As a result, Firm 2 faces a smaller residual demand in its domestic market, and conditions in its foreign market are left unaltered. As the export v MNE choice is determined solely by foreign market profits, Firm 1's choice has no impact upon Firm 2's export v MNE choice. Thus, I derive the following propositions:

Proposition 1

In the non-investment case, the firms' foreign production decisions are not interdependent

Proposition 2

In the non-investment case, there are monotonic relationships between the number of multinationals and both t and G: t is positively related to multinationality and G is negatively related to multinationality.

[7] The symmetry between firms' choices in figure 1 is dependent upon the assumption of identical markets. The relaxation of this (say, by markets differing in size) would bring the potential for firms to act differently from each other, but propositions 1 and 2 would still follow.

4 An investment case

I now turn to the case where firms choose both how best to serve the market overseas, and whether or not to invest in a variable cost reducing technology. Firm 1 remains the first-stage leader by assumption, before final stage simultaneous Cournot competition.

By introducing investment, one introduces interdependence between firms' export v MNE choices. This is because the corporate-wide nature of the investment provides a mechanism by which the firms' foreign markets are related.

A firm's export v MNE choice influences its rival's incentives to invest. This is because: the rival's incentive to invest is increasing in its total output (as investment is a fixed outlay in exchange for a per-unit saving); by being an MNE, a firm makes its rival's home-dedicated output, and so total output, relatively small (relative to if the firm was domestic[8] or an exporter); so, by being multinational a firm may deter its rival from investing. This brings about interdependence between firms' export v MNE choices because: the rival's output in all markets is smaller as a non-investor than as a investor; so, there is less incentive for a firm to incur the fixed cost of local production if it does not invest. Therefore, by being multinational, a firm may deter its rival from being an MNE as a result of deterring it from investing. The results in this section illustrate this interdependence between firms.

Also, the results show how FDI can be strategically motivated purely to influence the rival's investment behaviour, with no effect on that firm's export v MNE choice. This case illustrates how, in the presence of corporate-wide investment, strategic motives concerning the export v MNE choice partly relate to the firm's home market.

4.1 Investment rules

I first derive the conditions for the investment to be profitable. These will vary depending on:

(a) whether the firm is itself domestic, an exporter or an MNE;

(b) whether its rival is a domestic non-investor, domestic investor, exporter non-investor, exporter investor, multinational non-investor or multinational investor.

A Firm i, Firm j notation is used since the derivation of these investment rules does not depend upon the identity of the firm. The investment rules for Firm i are derived[9], having first calculated the profits for non-investing and investing for each combination of strategies[10]:

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[8] Domestic is used to refer to a firm which chooses to serve only the market in its home country.

[9] For a derivation of these investment rules, see Appendix B: equations (37) to (87).

[10] See Appendix B: equations (1) to (36) for a list of these profit expressions. These follow in a straightforward way from the more general analysis presented in Appendix A.

Given Firm j is an exporter non-investor, Firm i would find it profitable to invest when:

domestic, if	$t > -1 + c - \Delta + 9f/4\Delta$	=	O1
exporting, if	$t < 2 - 2c + 2\Delta - 9f/4\Delta$	=	E1
multinational, if	$t > -2 + 2c - 2\Delta + 9f/4\Delta$	=	M1

Given Firm j is an exporter investor, Firm i would find it profitable to invest when:

domestic, if	$t > -1 + c + 9f/4\Delta$	=	O2
exporting, if	$t < 2 - 2c - 9f/4\Delta$	=	E2
multinational, if	$t > -2 + 2c + 9f/4\Delta$	=	M2

Given Firm j is a multinational non-investor, Firm i would find it profitable to invest when

domestic, if	$0 > -1 + c - \Delta + 9f/4\Delta$	=	O3
exporting, if	$t < 1 - c + \Delta - 9f/8\Delta$	=	E3
multinational, if	$0 > -1 + c - \Delta + 9f/8\Delta$	=	M3

Given Firm j is a multinational investor, Firm i would find it profitable to invest when:

domestic, if	$0 > -1 + c + 9f/4\Delta$	=	O4
exporting, if	$t < 1 - c - 9f/8\Delta$	=	E4
multinational, if	$0 > -1 + c + 9f/8\Delta$	=	M4

Given Firm j is a domestic non-investor, Firm i would find it profitable to invest when:

domestic, if	$0 > -1 + c - \Delta/2 + 2f/\Delta$	=	O5
exporting, if	$t < 17/16 - 17/16c + 25\Delta/32 - 9f/8\Delta$	=	E5
multinational, if	$0 > -1 + c - 25\Delta/34 + 18f/17\Delta$	=	M5

Given Firm j is a domestic investor, Firm i would find it profitable to invest when:

domestic, if	$0 > -1 + c - \Delta/2 + 2f/\Delta$	=	O6
exporting, if	$t < 17/16 - 17/16c + 9\Delta/32 - 9f/8\Delta$	=	E6
multinational, if	$0 > -1 + c - 9\Delta/34 + 18f/17\Delta$	=	M6

For example, consider the condition $t<E2$. Here the firm faces a rival that is an exporter investor. If Firm i chooses to export, the investment would only be profitable if transport costs are 'low', i.e. if $t<E2$ where $E2=2-2c-9f/4\Delta$. This is because an exporter's output is decreasing in t; so at higher t, it will have less incentive to incur a fixed cost in exchange for a per unit saving. As can be seen from this condition, the smaller is f and the larger is Δ, the higher is the critical value of t, i.e. the more likely it is that the firm will find it profitable to invest.

Alternatively, the rule for a multinational or domestic firm, when faced with an exporter (e.g.

t>M1 or *t>O2*), shows that investment is only profitable if *t* is sufficiently *large*. The intuition here is that *t* drives up the costs of the exporter, and so advantages the multinational or domestic firm, thereby increasing their optimal output.

As would be expected, the condition can always be expressed as a critical value of *t*, except in those cases where two non-exporters interact, in which case *t* is irrelevant.

4.2 Narrowing down the range for the attractiveness of investment

In the next sub-section, I will use these conditions to establish the equilibrium outcomes in a game structured as described in section 2. But, it will clarify the exposition if I now focus more specifically on those cases which are most interesting for present purposes. This amounts to specifying a range of values for *f* and Δ: the investment outlay and the cost saving that it yields.

First, since the main focus of attention is on the interaction between the export v MNE and investment choices, there is no particular interest in cases where, for all values of *t* and *G*, either no firm invests or both firms invest.

I present results for a case where the attractiveness of investment is such that: an MNE will invest, but investment behaviour by an exporter varies with *t*, and with the actions of its rival. I am especially interested in investigating the motives for FDI when a firm will not invest as an exporter if its rival is a multinational investor, but will invest otherwise. This occurs where *t* lies between the critical values given by E4 and E2. Therefore the parameterisation chosen will ensure that both E4 and E2 represent positive values of *t* and, in order to avoid unnecessary confusion, that this region lies in a region of *t* where foreign entry deterrence is not possible. This parameterisation requires that:

$$E4 = 1 - c - 9f/8\Delta > 0 \quad \text{and} \quad E2 = 2 - 2c - 9f/4\Delta < (1-c-\Delta)/2$$

$$\therefore \; f < 8\Delta(1-c)/9 \quad =X1 \qquad \therefore \; f > 2\Delta(1-c+\Delta/3)/3 \quad =X2$$

Condition *f<X1* ensures that an exporter will, if *t* is sufficiently low, find it optimal to invest even if it is given they are to face a multinational investor.

Second, I assumed earlier that the firms do not find it optimal to invest before the opportunity arises to serve the foreign market. This implies:

$$f > \Delta(1-c+\Delta/2)/2 \quad =X3$$

To complete the characterisation I require a quasi-investment rule (*t<E7*). This describes a firm's choice between being an exporter *investor* and domestic *non-investor*, given its rival is a domestic non-investor.

A firm does not necessarily find it most profitable to export for all *t* that give a positive optimal exported output, i.e. for all $t<(1-c+2\Delta)/2$. This is because an extra fixed cost must be incurred when exporting in this case - the cost of investment, *f*. So the critical value of *t* that is derived concerning this choice facing a firm will be some $t<(1-c+2\Delta)/2$ and is as follows:

$$t < (1-c)/2 + \Delta - 3(4f-2\Delta(1-c+\Delta/2))^{1/2}/4 \qquad =E7$$

It turns out to be the case that it is only if $E7>(1-c-\Delta)/2$, that an exporter investor will face a domestic non-investor in an equilibrium outcome[11]. Therefore, in order to promote the diversity of outcomes obtained in the next sub-section, I assume E7 is greater than $(1-c-\Delta)/2$:

$$E7 = (1-c)/2 + \Delta - 3(4f-2\Delta(1-c+\Delta/2))^{1/2}/4 > (1-c-\Delta)/2$$
$$\therefore \quad f < \Delta(1-c+5\Delta/2)/2 \qquad =X4$$

The range of *f* which satisfy all five of these conditions is bounded from above by X4 for $6(1-c)/37<\Delta<14(1-c)/45$ and X1 for $14(1-c)/45<\Delta<1-c$ and from below by X2 i.e. condition $f>X3$ is not binding (for a graphical representation see figure 2).

To summarise, *suppose that the values of c, f and Δ are sufficiently favourable that a firm will always find it optimal to invest if it is a multinational. As an exporter, it will also find it profitable to invest if its rival does not invest. An exporter will find it optimal to invest even if its rival invests, but only so long as t is sufficiently small. A domestic firm will prefer not to invest.*

Figure 2 depicts the combinations of *f* and Δ required for the desired characterisation of investment. For example, if $\Delta=\Delta_1$ then *f* must lie between f_1 and f_2. As can be seen, this case is by no means exhaustive, but it does cover an interesting set of parameterisations, as it is possible that investment behaviour will change over the range of *t* considered. The aim is to reveal the interesting results and the mechanisms behind them, to in turn discover the potential for interdependencies between firms' decisions.

[11] If $t>(1-c-\Delta)/2$, it is not profitable to export as a non-investor if the rival is an investor. [See Appendix B: equation (113).]

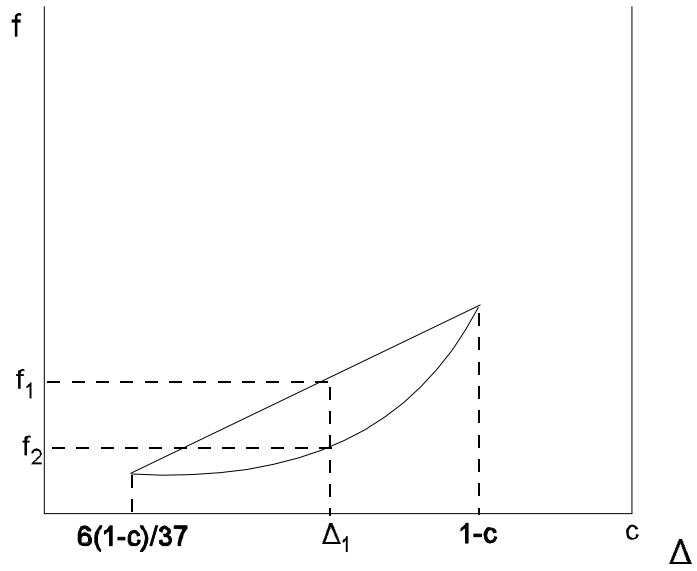

figure 2
The attractiveness of investment

Given this characterisation of the attractiveness of investment, some key investment rules appear in *t,G* space as shown in figure 3 below.

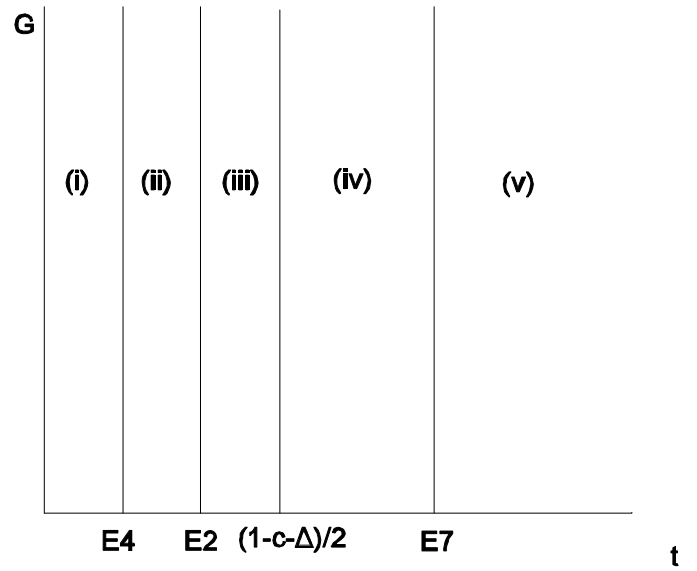

figure 3
An investment case: the key regions in *t,G* space

The significance of the regions shown in figure 3 can be summarised in the following table.

(i)	Exporting is profitable	An exporter will invest
(ii)	Exporting is profitable	An exporter will invest unless it is given it will compete against a *multinational investor*

(iii)	Exporting is profitable	An exporter will invest unless it is given it will compete against an *investor*
(iv)	Exporting is not profitable if competing against an *investor*	An exporter will invest unless it is given it will compete against an *investor*
(v)	Exporting is not profitable	

4.3 Equilibria

It is worth re-stating here that the game structure is as follows:

First stage : Firm 1 chooses whether or not to enter the market in B and if so by which method (exporting or multinational production).
Firm 1 decides whether to invest in variable cost reduction.

Second stage : Firm 2 chooses whether or not to enter the market in A and if so by which method (exporting or multinational production).
Firm 2 decides whether to invest in variable cost reduction.

Third stage : Firms set outputs simultaneously.

Thus, Firm 2 chooses its strategy (in stage 2) given what Firm 1 has already chosen (in stage 1). Firm 1 therefore makes its choice in the knowledge that its decision may affect the actions of its rival. The equilibrium concept employed is subgame perfection. Essentially the game is solved by first obtaining optimal outputs, and so prices and profits, for each firm given each possible combination of the firms' first stage choices. Then for any parameterisation, one finds the optimal first stage choice for each firm, given each of the possible first stage choices of its rival. Thus we can know how Firm 2 will choose given each of Firm 1's possible choices - this gives a list of outcomes from which Firm 1 must choose. The equilibrium outcome is that member of this list that is most advantageous for Firm 1. Notationally, outcomes are expressed as follows: ({Firm 1's strategy in serving their foreign market}{Firm 1's investment strategy},{Firm 2's strategy in serving their foreign market}{Firm 2's investment strategy}) - O=domestic, E=exporter, M=multinational; I=investor, N=non-investor.

region (i)

In this range of t both firms will always invest, and a sufficiently low G[12] will cause both firms to be multinational (MI,MI). For higher G[13] Firm 2 will export if Firm 1 goes multinational (MI,EI) and would also export were Firm 1 to export (EI,EI). Given this Firm 1 prefers (EI,EI) and so chooses to be an exporter investor.

[12] This is $G < 4t(1-c+\Delta-t)/9$. [See Appendix B: equations (96) and (102).]

[13] This is $4t(1-c+\Delta-t)/9 < G$.

region (ii)

A firm will invest unless it is domestic or an exporter and it is given it is to face a multinational investor. For this range of t a sufficiently small G[14] will again cause both firms to be multinational (MI,MI). *At higher G[15], Firm 2 would export and not invest if Firm 1 was a multinational (MI,EN), but would be an MNE itself were Firm 1 to export (EI,MI)*. Given this Firm 1 prefers to go multinational (MI,EN). At still higher G[16], Firm 2 would export and not invest if Firm 1 chose to be an MNE (MI,EN), but would follow suit were Firm 1 to be an exporter (EI,EI). Given this Firm 1 prefers to be a multinational (MI,EN). At highest levels of G[17], Firm 1 prefers (EI,EI) to (MI,EN) and so exports.

region (iii)

A firm will not invest if it is an exporter and it is given it is to face an investor. Both firms prefer to be multinational at sufficiently low G[18], (MI,MI). At higher G[19], Firm 2 will be an exporter non-investor. Given this Firm 1 must choose between (MI,EN) and (EI,EN). For intermediate G[20], Firm 1 will prefer to be multinational (MI,EN) and for highest levels of G[21] Firm 1 will prefer to export (EI,EN).

region (iv)

An exporter will set foreign dedicated output at zero if facing an investor. Again, both firms will be multinational if G[22] is sufficiently low (MI,MI). *At higher G[23], Firm 2 will be domestic if Firm 1 is multinational (MI,ON) and will be an MNE if Firm 1 exports (EI,MI)* - Firm 1 prefers to be multinational (MI,ON). At still higher G[24], Firm 2 will respond to an exporter investor Firm 1 by being a domestic non-

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[14] This is $G < 8\Delta(1-c)/9 + 4t(1-c-t-\Delta)/9 - f$. [See Appendix B: equation (101).]

[15] This is $8\Delta(1-c)/9 + 4t(1-c-t-\Delta)/9 - f < G < 4t(1-c+\Delta-t)/9$. [See Appendix B: equation (96).]

[16] This is $4t(1-c+\Delta-t)/9 < G < 4\Delta(1-c+3\Delta/2)/9 + 4t(1-c-t+3\Delta/2)/9$. [See Appendix B: equation (103).]

[17] This is $G > 4\Delta(1-c+3\Delta/2)/9 + 4t(1-c-t+3\Delta/2)/9$.

[18] This is $G < 8\Delta(1-c)/9 + 4t(1-c-t-\Delta)/9 - f$. [See Appendix B: equation (101).]

[19] This is $G > 8\Delta(1-c)/9 + 4t(1-c-t-\Delta)/9 - f$.

[20] This is $8\Delta(1-c)/9 + 4t(1-c-t-\Delta)/9 - f < G < 4t(1-c+2\Delta-t)/9$. [See Appendix B: equation (93).]

[21] This is $G > 4t(1-c+2\Delta-t)/9$.

[22] This is $G < (1-c+\Delta)^2/9 + 4\Delta(1-c)/9 - f$. [See Appendix B: equation (105).] It is interesting to note that foreign profits in (MI,MI) are positive for higher G than given here but Firm 2 prefers to remain domestic. This is because as a domestic firm it would not invest and in (MI,MI) the positive foreign market profits and higher Home market profits in (MI,MI) do not cover the fixed cost of investment, f.

[23] This is $(1-c+\Delta)^2/9 + 4\Delta(1-c)/9 - f < G < 8\Delta(1-c)/9 + 4t(1-c-t)/9 - f$ for $(1-c-\Delta)/2<t<(1-c+\Delta)/2$, [see Appendix B: equation (95)] and is $(1-c+\Delta)^2/9 + 4\Delta(1-c)/9 - f < G < (1-c+\Delta)^2/4+(4\Delta/9+2t/9)(1-c+t/2)$ for $(1-c+\Delta)/2<t<E7$ [see Appendix B: equation (108)]. The critical value of $t=(1-c+\Delta)/2$ is important because at t greater than this value, an investor finds it unprofitable to export to the foreign market in order to compete in duopoly with a foreign investor.

[24] This is $8\Delta(1-c)/9 + 4t(1-c-t)/9 - f < G < 4t(1-c+2\Delta-t)/9$ for $(1-c-\Delta)/2<t<(1-c+\Delta)/2$, and is $(1-c+\Delta)^2/4+(4\Delta/9+2t/9)(1-c+t/2) < G < 4t(1-c+2\Delta-t)/9$ for $(1-c+\Delta)/2<t<E7$. [See Appendix B: equation (90).]

investor - Firm 1 prefers (MI,ON) to (EI,ON) and so goes multinational. At highest levels of G[25] Firm 1 prefers (EI,ON) to (MI,ON) and so exports.

region (v)

An exporter will set foreign dedicated output at zero. Again, both firms will be multinational if G[26] is sufficiently low (MI,MI). *At higher G[27], Firm 2 will be domestic if Firm 1 is multinational (MI,ON) and will be an MNE if Firm 1 is domestic (ON,MI)* - Firm 1 prefers to be multinational (MI,ON). At highest levels of G[28] Firm 2 will be domestic; Firm 1 prefers (ON,ON) to (MI,ON) and so remains domestic.

This set of equilibria are summarised graphically in figure 4 below.

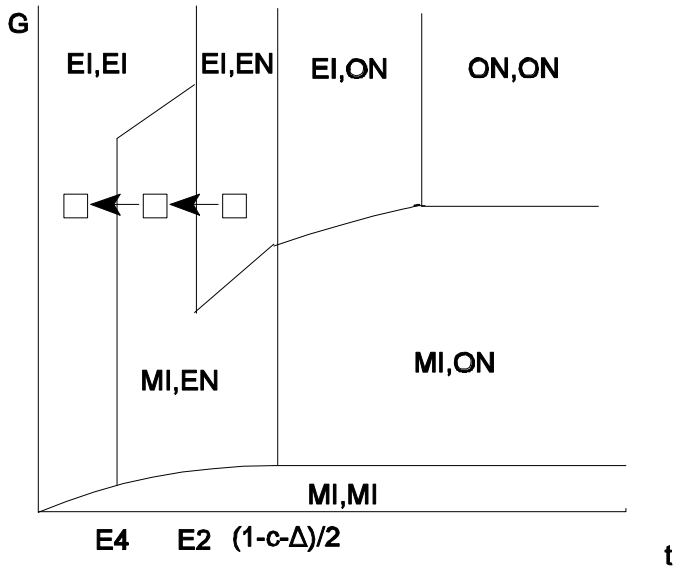

figure 4
An investment case

I will now discuss two features of these results. Firstly, the interdependence between the firms' export v MNE choices, and secondly, the presence of strategic motives that bring a non-monotonic relationship between *t* and FDI.

4.4 Interdependence between firms' export v MNE choices

Proposition 3

In the investment case considered, the firms' foreign production decisions are interdependent

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[25] This is $G > 4t(1-c+2\Delta-t)/9$.

[26] This is $G < (1-c+\Delta)^2/9 + 4\Delta(1-c)/9 - f$. [See Appendix B: equation (105).]

[27] This is $(1-c+\Delta)^2/9 + 4\Delta(1-c)/9 - f < G < \Delta(1-c+\Delta/2)/2 + (1-c+2\Delta)^2/9 - f$. [See Appendix B: equation (109).]

[28] This is $G > \Delta(1-c+\Delta/2)/2 + (1-c+2\Delta)^2/9 - f$.

Among the results (described in section 4.3) are instances where firms are interdependent with respect to their decisions between being domestic, exporting or being multinational. In each case, these instances occur for only a certain range of *G* and are marked out by being described in italicised text.

In region (ii), Firm 2 will export if Firm 1 is an MNE (MI,EN), but will be an MNE if Firm 1 exports (EI,MI). In region (iv), Firm 2 will be domestic if Firm 1 is an MNE (MI,ON), but will be an MNE if Firm 1 exports (EI,MI). In region (v), Firm 2 will again be domestic if Firm 1 is an MNE (MI,ON), but will be an MNE if Firm 1 is domestic (ON,MI).

The common thread throughout is that Firm 1's choice between O, E and M influences Firm 2's investment behaviour. In all cases, by being multinational, Firm 1 deters Firm 2 from investing, and as a non-investor, Firm 2's foreign-dedicated output is not sufficiently large to recoup the fixed cost of local production. Therefore, Firm 1 deters Firm 2 from being an MNE by being an MNE itself[29].

Here I have presented results given a particular attractiveness of investment. This begs the question: Does this interdependence reside only in the case discussed? The answer is no. This interdependence is found for any parameterisation of *f* and Δ that permits one firm's investment behaviour to be sensitive to a rival's export v MNE choice[30]. So, the restrictions necessary to eliminate this interdependence would ensure for all *t*, that each firm's investment behaviour is the same irrespective of whether its rival is domestic, an exporter or an MNE. The restrictions on *f* and Δ imposed in section 4.2 are mainly designed to isolate the strategic motives discussed next.

4.5 Increased incidence of multinationals from tariff reductions and the domestic market effect

Proposition 4

In the investment case considered, there is a negative and monotonic relationship between the number of multinationals and G. However, ***t is non-monotonically related to multinationality****.*

Proposition 5

In the investment case considered, a firm's decision about foreign production may influence, and so be influenced by, domestic market profits.

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[29] This underlying mechanism has some echo in the strategic trade literature. There, the strategic actors are Governments in their setting of tariffs and/or export subsidies for oligopolistic industries. In certain circumstances a Government will find it optimal to impose a tariff or subsidy that advantages the firm(s) based in its country - driving up repatriated profits. By advantaging its firm(s), a Government places them in the position of strategic leader in the output game - in a similar way as R&D investment does in this model.

Therefore, one difference between the strategic trade literature and the model presented here is that here firms, rather than Governments, are the strategic decision-makers. Another is that here the strategic tools are the investment and export v MNE decisions, rather than tariffs or subsidies. The most important divergence however, comes from firms in the strategic trade literature not being permitting to be multinational - they may serve a foreign market only by exporting.

[30] Given this, the rival's O, E, M choice will indirectly influence the firm's O, E, M choice because, for some range of *G,* the firm's export v MNE choice will depend upon its own investment behaviour.

Figure 4 shows that increases in *t* can move equilibria away from exporting and towards more multinational outcomes (e.g. (EI,EI) to (MI,EN) to (MI,ON)). Increases in *G* move equilibria away from multinational outcomes and towards greater exporting behaviour (e.g. (MI,MI) to (MI,EN) to (EI,EN)) - there is a negative and monotonic relationship between multinationality and *G*. However, we do not have a monotonic relationship between multinationality and *t*. From figure 4 we obtain proposition 4.

To illustrate this point, initially consider a combination of *t* and *G* which places us in region (iii) with an equilibrium outcome of (EI,EN). If *t* is instead smaller then, for sufficiently small *G,* we instead find (MI,EN) - increased multinationality. If *t* were lower still, then we find (EI,EI) - decreased multinationality[31]. The reason is that the incentive to be multinational is greater in region (ii) than in other regions, as Firm 1 can, by being multinational, deter Firm 2 from investing. So, the added incentive to be an MNE comes from ensuring that your rival is at a cost disadvantage. In region (ii), a sufficiently high *G* combined with Firm 1 being multinational, causes Firm 2 to choose to export and not invest (MI,EN). If on the other hand Firm 1 exports, Firm 2 exports and invests (EI,EI). Therefore in this range of *t,* Firm 2's investing behaviour is dependent on Firm 1's export v MNE choice. Firm 1 can ensure that it faces competition from a non-investor by being multinational.

It follows that in region (ii) at sufficiently high *G*, Firm 1 has an incentive to be multinational that derives partially from its home market in A (proposition 5). If it goes multinational, it will face a non-investor not only in B, but also in A. It is for this reason that, in region (ii), Firm 1 may choose to become a multinational (MI,EN) when profits derived from the market in B would be higher were it to be an exporter (EI,EI). Firm 1 prefers (MI,EN) because of the higher profits earned in A. This is true in the shaded region[32] shown in figure 5. It is important to note that the non-monotonic relationship between *t* and multinationality does not rely upon Firm 1 choosing contrary to the maximisation of foreign market profits, i.e. the shaded region represents only a subset of the combinations of *t* and *G* which exhibit this non-monotonicity.

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[31] Follow the path of boxes and arrows in figure 4 from right to left. The path shown and described in the text is not to be interpreted as a fall in *t* through time. A move from MI to EI would involve a disinvestment of *G*. However *G* is a non-recoverable sunk cost. Therefore if *t* is falling, switching from multinational production to exporting would require the firm to abandon the foreign plant without recouping any part of *G*. However, the switch referred to here is that Firm 1 would instead choose to export rather than be multinational if *t* were lower, i.e. to not build the foreign plant in the first place.

[32] This region is bounded from above by $4\Delta(1-c+3\Delta/2)/9 + 4t(1-c-t+3\Delta/2)/9$ and from below by $2\Delta(1-c+3\Delta/2)/9 + 4t(1-c-t+\Delta)/9$. [See Appendix B: equations (110) and (111).]

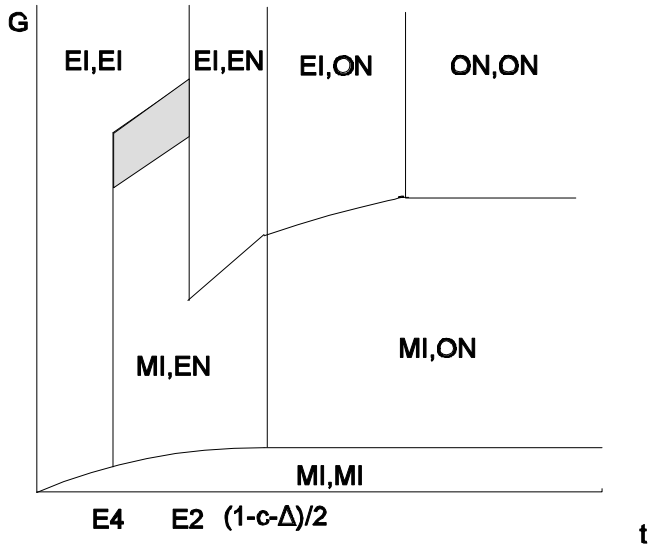

figure 5
An investment case: the domestic market effect

This feature of the results is clearly less generally found than the firm interdependence discussed in the previous sub-section. While its existence is not wholly restricted to the particular parameterisation of *f* and Δ imposed in section 4.2[33], the attractiveness of investment must be in some narrow range (relative to the set of all feasible parameterisations). I focus on this example of strategically motivated FDI in order to illustrate how corporate-wide investment introduces the potential for such motives to arise.

5 Conclusion

The model presented places the export v MNE choice within the context of strategic interaction between firms based in different countries. In a basic model, absent the investment decision, there is shown to be no interdependence between firms' foreign production. However, once corporate-wide investment in variable cost reduction is permitted, there is an interdependence between the firms in both the investment and export v MNE decision. By being multinational, a firm can not only influence the investment behaviour of its rival, but also its export v MNE choice. When facing a multinational, as opposed to an exporter or domestic firm, the rival has less incentive to either invest or be multinational. Thus there is a negative interdependence between the foreign production of these firms based in different countries.

Such interdependence brings a potential for strategically motivated FDI. In the case considered, a firm has a greater incentive to go multinational in a certain range of *t* because it can deter the other firm from investing, i.e. (MI,EN) versus (EI,EI). In this case, being an MNE brings higher profits in the

[33] All that is actually required is $E4<(1-c-\Delta)/2$ and $E2>0$ which give $f>4\Delta(1-c+\Delta)/9$ and $f<8\Delta(1-c)/9$ respectively. The restrictions on *f* and Δ imposed in section 4.4.2 isolate a subset of the parameter values isolated here.

domestic market than does exporting. So a firm may choose to go multinational even though it would export, if merely trying to maximise foreign market profits.

This simple model is illustrative of a potential for interdependencies and strategic motives. Its applicability to the real world is, I think, best judged in two ways. Firstly, by the intuitive appeal of the mechanisms that bring these interdependencies about: crucially, does one believe that, by being multinational (rather than domestic or an exporter), a firm may reduce a foreign rival's incentives to invest in some firm-specific asset? Secondly, by an empirical assessment of whether such interdependencies actually exist. Regarding the latter of these, one can turn to evidence presented by Pavelin (1999). He presents a firm-level econometric study of UK firms. It is only an exploratory first step in assessing the real world role played by interdependence of the type outlined here. However, in that study, significant negative interdependence between foreign operations is a seemingly robust finding through time and across geographical region.

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Appendix A

1 Monopoly

A firm serves the market at variable cost c. The fixed cost incurred in serving the market is G. Market demand can be expressed by the following linear inverse demand curve: $p=a-q$; where p=price; q=output dedicated to the market.

Derivation of Equilibrium Profits

$$\pi=(p-c)q-G \tag{1}$$

substituting for p

$$\pi=(a-q-c)q-G \tag{2}$$

first order condition

$$\frac{\delta\pi}{\delta q}=a-2q-c=0 \tag{3}$$

solving for q

$$q=\frac{(a-c)}{2} \tag{4}$$

substituting q into inverse demand

$$p=\frac{(a+c)}{2} \tag{5}$$

substituting p, q into (1)

$$\pi=\frac{(a-c)^2}{4}-G \tag{6}$$

2 Cournot Duopoly

Firm 1 and Firm 2 compete in Cournot duopoly. Firm 1 (Firm 2) serves the market at variable cost c_1 (c_2). The fixed cost incurred by Firm 1 (Firm 2) in serving the market is G_1 (G_2). Market demand can be expressed by the following linear inverse demand curve: $p=a-q_1-q_2$; where p=price; q_i=Firm i's output dedicated to the market.

Derivation of Equilibrium Profits

$$\begin{aligned}\pi_1&=(p-c_1)q_1-G_1\\ \pi_2&=(p-c_2)q_2-G_2\end{aligned} \tag{1}$$

substituting for p

$$\begin{aligned}\pi_1&=(a-q_1-q_2-c_1)q_1-G_1\\ \pi_2&=(a-q_2-q_1-c_2)q_2-G_2\end{aligned} \tag{2}$$

first order condition

$$\begin{aligned}\frac{\delta\pi_1}{\delta q_1}&=a-2q_1-q_2-c_1=0\\ \frac{\delta\pi_2}{\delta q_2}&=a-2q_2-q_1-c_2=0\end{aligned} \tag{3}$$

solving for q_1 and q_2

$$\begin{aligned}q_1&=\frac{(a-q_2-c_1)}{2}\\ q_2&=\frac{(a-q_1-c_2)}{2}\end{aligned} \tag{4}$$

substituting q_2 (q_1) into q_1 (q_2)

$$\begin{aligned}q_1&=\frac{(a-2c_1+c_2)}{3}\\ q_2&=\frac{(a-2c_2+c_1)}{3}\end{aligned} \tag{5}$$

substituting q_1 and q_2 into inverse demand

$$p=\frac{(a+c_1+c_2)}{3} \tag{6}$$

substituting p, q_1 and q_2 into (1)

$$\pi_1 = \frac{(a - 2c_1 + c_2)^2}{9} - G_1$$
$$\pi_2 = \frac{(a - 2c_2 + c_1)^2}{9} - G_2 \quad (7)$$

Appendix B

1 Profits

(EN,EN)

$$\pi_1 = \frac{(1 - c + t)^2}{9} + \frac{(1 - c - 2t)^2}{9} \quad (1)$$

$$\pi_2 = \frac{(1 - c + t)^2}{9} + \frac{(1 - c - 2t)^2}{9} \quad (2)$$

(EI,EI)

$$\pi_1 = \frac{(1 - c + \Delta + t)^2}{9} + \frac{(1 - c + \Delta - 2t)^2}{9} - f \quad (3)$$

$$\pi_2 = \frac{(1 - c + \Delta + t)^2}{9} + \frac{(1 - c + \Delta - 2t)^2}{9} - f \quad (4)$$

(EI,EN)

$$\pi_1 = \frac{(1 - c + 2\Delta + t)^2}{9} + \frac{(1 - c + 2\Delta - 2t)^2}{9} - f \quad (5)$$

$$\pi_2 = \frac{(1 - c - \Delta + t)^2}{9} + \frac{(1 - c - \Delta - 2t)^2}{9} \quad (6)$$

(MN,MN)

$$\pi_1 = \frac{(1 - c)^2}{9} + \frac{(1 - c)^2}{9} - G \quad (7)$$

$$\pi_2 = \frac{(1 - c)^2}{9} + \frac{(1 - c)^2}{9} - G \quad (8)$$

(MI,MI)

$$\pi_1 = \frac{(1 - c + \Delta)^2}{9} + \frac{(1 - c + \Delta)^2}{9} - G - f \quad (9)$$

$$\pi_2 = \frac{(1 - c + \Delta)^2}{9} + \frac{(1 - c + \Delta)^2}{9} - G - f \quad (10)$$

(MI,MN)

$$\pi_1 = \frac{(1 - c + 2\Delta)^2}{9} + \frac{(1 - c + 2\Delta)^2}{9} - G - f \quad (11)$$

$$\pi_2 = \frac{(1-c-\Delta)^2}{9} + \frac{(1-c-\Delta)^2}{9} - G \quad (12)$$

(MN,EN)

$$\pi_1 = \frac{(1-c+t)^2}{9} + \frac{(1-c)^2}{9} - G \quad (13)$$

$$\pi_2 = \frac{(1-c)^2}{9} + \frac{(1-c-2t)^2}{9} \quad (14)$$

(MI,EI)

$$\pi_1 = \frac{(1-c+\Delta+t)^2}{9} + \frac{(1-c+\Delta)^2}{9} - G - f \quad (15)$$

$$\pi_2 = \frac{(1-c+\Delta)^2}{9} + \frac{(1-c+\Delta-2t)^2}{9} - f \quad (16)$$

(MI,EN)

$$\pi_1 = \frac{(1-c+2\Delta+t)^2}{9} + \frac{(1-c+2\Delta)^2}{9} - G - f \quad (17)$$

$$\pi_2 = \frac{(1-c-\Delta)^2}{9} + \frac{(1-c-\Delta-2t)^2}{9} \quad (18)$$

(MN,EI)

$$\pi_1 = \frac{(1-c-\Delta+t)^2}{9} + \frac{(1-c-\Delta)^2}{9} - G \quad (19)$$

$$\pi_2 = \frac{(1-c+2\Delta)^2}{9} \frac{(1-c+2\Delta-2t)^2}{9} - f \quad (20)$$

(EN,ON)

$$\pi_1 = \frac{(1-c)^2}{4} + \frac{(1-c-2t)^2}{9} \quad (21)$$

$$\pi_2 = \frac{(1-c+t)^2}{9} \quad (22)$$

(EI,ON)

$$\pi_1 = \frac{(1-c+\Delta)^2}{4} + \frac{(1-c+2\Delta-2t)^2}{9} - f \quad (23)$$

$$\pi_2 = \frac{(1-c-\Delta+t)^2}{9} \quad (24)$$

(MN,ON)

$$\pi_1 = \frac{(1-c)^2}{4} + \frac{(1-c)^2}{9} - G \quad (25)$$

$$\pi_2 = \frac{(1-c)^2}{9} \tag{26}$$

(MI,ON)

$$\pi_1 = \frac{(1-c+\Delta)^2}{4} + \frac{(1-c+2\Delta)^2}{9} - G - f \tag{27}$$

$$\pi_2 = \frac{(1-c-\Delta)^2}{9} \tag{28}$$

(EN,OI)

$$\pi_1 = \frac{(1-c)^2}{4} + \frac{(1-c-\Delta-2t)^2}{9} \tag{29}$$

$$\pi_2 = \frac{(1-c+2\Delta+t)^2}{9} - f \tag{30}$$

(EI,OI)

$$\pi_1 = \frac{(1-c+\Delta)^2}{4} + \frac{(1-c+\Delta-2t)^2}{9} - f \tag{31}$$

$$\pi_2 = \frac{(1-c+\Delta+t)^2}{9} - f \tag{32}$$

(MN,OI)

$$\pi_1 = \frac{(1-c)^2}{4} + \frac{(1-c-\Delta)^2}{9} - G \tag{33}$$

$$\pi_2 = \frac{(1-c+2\Delta)^2}{9} - f \tag{34}$$

(MI,OI)

$$\pi_1 = \frac{(1-c+\Delta)^2}{4} + \frac{(1-c+\Delta)^2}{9} - G - f \tag{35}$$

$$\pi_2 = \frac{(1-c+\Delta)^2}{9} - f \tag{36}$$

2 Derivation of the Investment Rules

The derivation of the equalities are presented here. In the main text the investment rules are given as inequalities in order to show how the decisions of firms are influenced by the critical value given here. For reasons of notational clarity, the investment rules are presented for Firm 1 only. The analysis corresponds exactly to that for Firm 2 - in the main text the investment rules are presented in Firm i, Firm j notation.

Firm 1: (ON,EN) v (OI,EN)

$$non-investor \qquad \pi_1 = \frac{(1-c+t)^2}{9} \tag{37}$$

$$investor \qquad \pi_1 = \frac{(1-c+2\Delta+t)^2}{9} - f \tag{38}$$

equating (37) and (38), we get

$$t = -1+c-\Delta+\frac{9f}{4\Delta} \qquad = O1 \tag{39}$$

Firm 1: (EN,EN) v (EI,EN)

$$non-investor \qquad \pi_1 = \frac{(1-c+t)^2}{9} + \frac{(1-c-2t)^2}{9} \tag{40}$$

$$investor \qquad \pi_1 = \frac{(1-c+2\Delta+t)^2}{9} + \frac{(1-c+2\Delta-2t)^2}{9} - f \tag{41}$$

equating (40) and (41), we get

$$t = 2-2c+2\Delta-\frac{9f}{4\Delta} \qquad = E1 \tag{42}$$

Firm 1: (MN,EN) v (MI,EN)

$$non-investor \qquad \pi_1 = \frac{(1-c+t)^2}{9} + \frac{(1-c)^2}{9} - G \tag{43}$$

$$investor \qquad \pi_1 = \frac{(1-c+2\Delta+t)^2}{9} + \frac{(1-c+2\Delta)^2}{9} - G - f \tag{44}$$

equating (43) and (44), we get

$$t = -2+2c-2\Delta+\frac{9f}{4\Delta} \qquad = M1 \tag{45}$$

Firm 1: (ON,EI) v (OI,EI)

$$non-investor \qquad \pi_1 = \frac{(1-c-\Delta+t)^2}{9} \tag{46}$$

$$investor \qquad \pi_1 = \frac{(1-c+\Delta+t)^2}{9} - f \tag{47}$$

equating (46) and (47), we get

$$t = -1+c+\frac{9f}{4\Delta} \qquad = O2 \tag{48}$$

Firm 1: (EN,EI) v (EI,EI)

$$non-investor \qquad \pi_1 = \frac{(1-c-\Delta+t)^2}{9} + \frac{(1-c-\Delta-2t)^2}{9} \tag{49}$$

$$investor \qquad \pi_1 = \frac{(1-c+\Delta+t)^2}{9} + \frac{(1-c+\Delta-2t)^2}{9} - f \tag{50}$$

equating (49) and (50), we get

$$t = 2 - 2c - \frac{9f}{4\Delta} \qquad = E2 \tag{51}$$

Firm 1: (MN,EI) v (MI,EI)

$$non\text{-}investor \qquad \pi_1 = \frac{(1-c-\Delta+t)^2}{9} + \frac{(1-c-\Delta)^2}{9} - G \tag{52}$$

$$investor \qquad \pi_1 = \frac{(1-c+\Delta+t)^2}{9} + \frac{(1-c+\Delta)^2}{9} - G - f \tag{53}$$

equating (52) and (53), we get

$$t = -2 + 2c + \frac{9f}{4\Delta} \qquad = M2 \tag{54}$$

Firm 1: (ON,MN) v (OI,MN)

$$non\text{-}investor \qquad \pi_1 = \frac{(1-c)^2}{9} \tag{55}$$

$$investor \qquad \pi_1 = \frac{(1-c+2\Delta)^2}{9} - f \tag{56}$$

equating (55) and (56), we get

$$0 = -1 + c - \Delta + \frac{9f}{4\Delta} \qquad = O3 \tag{57}$$

Firm 1: (EN,MN) v (EI,MN)

$$non\text{-}investor \qquad \pi_1 = \frac{(1-c)^2}{9} + \frac{(1-c-2t)^2}{9} \tag{58}$$

$$investor \qquad \pi_1 = \frac{(1-c+2\Delta)^2}{9} + \frac{(1-c+2\Delta-2t)^2}{9} - f \tag{59}$$

equating (58) and (59), we get

$$t = 1 - c + \Delta - \frac{9f}{8\Delta} \qquad = E3 \tag{60}$$

Firm 1: (MN,MN) v (MI,MN)

$$non\text{-}investor \qquad \pi_1 = \frac{(1-c)^2}{9} + \frac{(1-c)^2}{9} - G \tag{61}$$

$$investor \qquad \pi_1 = \frac{(1-c+2\Delta)^2}{9} + \frac{(1-c+2\Delta)^2}{9} - G - f \tag{62}$$

equating (61) and (62), we get

$$0 = -1 + c - \Delta + \frac{9f}{8\Delta} \qquad = M3 \tag{63}$$

Firm 1: (ON,MI) v (OI,MI)

$$non\text{-}investor \qquad \pi_1 = \frac{(1-c-\Delta)^2}{9} \tag{64}$$

$$investor \qquad \pi_1 = \frac{(1-c+\Delta)^2}{9} - f \tag{65}$$

equating (64) and (65), we get

$$0 = -1 + c + \frac{9f}{4\Delta} \qquad = O4 \tag{66}$$

Firm 1: (EN,MI) v (EI,MI)

$$non-investor \qquad \pi_1 = \frac{(1-c-\Delta)^2}{9} + \frac{(1-c-\Delta-2t)^2}{9} \tag{67}$$

$$investor \qquad \pi_1 = \frac{(1-c+\Delta)^2}{9} + \frac{(1-c+\Delta-2t)^2}{9} - f \tag{68}$$

equating (67) and (68), we get

$$t = 1 - c - \frac{9f}{8\Delta} \qquad = E4 \tag{69}$$

Firm 1: (MN,MI) v (MI,MI)

$$non-investor \qquad \pi_1 = \frac{(1-c-\Delta)^2}{9} + \frac{(1-c-\Delta)^2}{9} - G \tag{70}$$

$$investor \qquad \pi_1 = \frac{(1-c+\Delta)^2}{9} + \frac{(1-c+\Delta)^2}{9} - G - f \tag{71}$$

equating (70) and (71), we get

$$0 = -1 + c + \frac{9f}{8\Delta} \qquad = M4 \tag{72}$$

Firm 1: (ON,ON) v (OI,O#)

$$non-investor \qquad \pi_1 = \frac{(1-c)^2}{4} \tag{73}$$

$$investor \qquad \pi_1 = \frac{(1-c+\Delta)^2}{4} - f \tag{74}$$

equating (73) and (74), we get

$$0 = -1 + c - \frac{1}{2}\Delta + \frac{2f}{\Delta} \qquad = O5 = O6 \tag{75}$$

Firm 1: (EN,ON) v (EI,ON)

$$non-investor \qquad \pi_1 = \frac{(1-c)^2}{4} + \frac{(1-c-2t)^2}{9} \tag{76}$$

$$investor \qquad \pi_1 = \frac{(1-c+\Delta)^2}{4} + \frac{(1-c+2\Delta-2t)^2}{9} - f \tag{77}$$

equating (76) and (77), we get

$$t=\frac{17}{16}-\frac{17}{16}c+\frac{9}{32}\Delta-\frac{9f}{8\Delta} \qquad =E5 \tag{78}$$

Firm 1: (MN,ON) v (MI,ON)

$$non-investor \qquad \pi_1=\frac{(1-c)^2}{4}+\frac{(1-c)^2}{9}-G \tag{79}$$

$$investor \qquad \pi_1=\frac{(1-c+\Delta)^2}{4}+\frac{(1-c+2\Delta)^2}{9}-G-f \tag{80}$$

equating (79) and (80), we get

$$0=-1+c-\frac{25}{34}\Delta+\frac{18f}{17\Delta} \qquad =M5 \tag{81}$$

Firm 1: (EN,OI) v (EI,OI)

$$non-investor \qquad \pi_1=\frac{(1-c)^2}{4}+\frac{(1-c-\Delta-2t)^2}{9} \tag{82}$$

$$investor \qquad \pi_1=\frac{(1-c+\Delta)^2}{4}+\frac{(1-c+\Delta-2t)^2}{9}-f \tag{83}$$

equating (82) and (83), we get

$$t=\frac{17}{16}-\frac{17}{16}c+\frac{9}{32}\Delta-\frac{9f}{8\Delta} \qquad =E6 \tag{84}$$

Firm 1: (MN,OI) v (MI,OI)

$$non-investor \qquad \pi_1=\frac{(1-c)^2}{4}+\frac{(1-c-\Delta)^2}{9}-G \tag{85}$$

$$investor \qquad \pi_1=\frac{(1-c+\Delta)^2}{4}+\frac{(1-c+\Delta)^2}{9}-G-f \tag{86}$$

equating (85) and (86), we get

$$0=-1+c-\frac{9}{34}\Delta+\frac{18f}{17\Delta} \qquad =M6 \tag{87}$$

3 Derivation of the Decision Rules

In each case the firm will choose the first option listed if the inequality is satisfied. Only the decision rules for Firm 1 are given. By symmetry the corresponding rules for Firm 2 are identical.

Firm1: (EN,ON) v (MN,ON) - equating (21) and (25)

$$G=\frac{4}{9}t(1-c-t) \tag{88}$$

Firm1: (EN,ON) v (MI,ON) - equating (21) and (27)

$$G=\frac{17}{18}\Delta(1-c+\frac{25}{34}\Delta)+\frac{4}{9}t(1-c-t)-f \tag{89}$$

Firm1: (EI,ON) v (MI,ON) - equating (23) and (27)

$$G=\frac{4}{9}t(1-c+2\Delta-t) \tag{90}$$

Firm1: (EN,EN) v (MN,EN) - equating (1) and (13)

$$G=\frac{4}{9}t(1-c-t) \tag{91}$$

Firm1: (EN,EN) v (MI,EN) - equating (1) and (17)

$$G=\frac{8}{9}\Delta(1-c+\Delta)+\frac{4}{9}t(1-c+\Delta-t)-f \tag{92}$$

Firm1: (EI,EN) v (MI,EN) - equating (5) and (17)

$$G=\frac{4}{9}t(1-c+2\Delta-t) \tag{93}$$

Firm1: (EN,EI) v (MN,EI) - equating (6) and (19)

$$G=\frac{4}{9}t(1-c-\Delta-t) \tag{94}$$

Firm1: (EN,EI) v (MI,EI) - equating (6) and (15)

$$G=\frac{8}{9}\Delta(1-c)+\frac{4}{9}t(1-c-t)-f \tag{95}$$

Firm1: (EI,EI) v (MI,EI) - equating (3) and (15)

$$G=\frac{4}{9}t(1-c+\Delta-t) \tag{96}$$

Firm1: (EN,MN) v (MN,MN) - equating (14) and (7)

$$G=\frac{4}{9}t(1-c-t) \tag{97}$$

Firm1: (EN,MN) v (MI,MN) - equating (14) and (11)

$$G=\frac{8}{9}\Delta(1-c+\Delta)+\frac{4}{9}t(1-c-t)-f \tag{98}$$

Firm1: (EI,MN) v (MI,MN) - equating (20) and (11)

$$G=\frac{4}{9}t(1-c+2\Delta-t) \tag{99}$$

Firm1: (EN,MI) v (MN,MI) - equating (18) and (12)

$$G=\frac{4}{9}t(1-c-\Delta-t) \tag{100}$$

Firm1: (EN,MI) v (MI,MI) - equating (18) and (9)

$$G=\frac{8}{9}\Delta(1-c)+\frac{4}{9}t(1-c-\Delta-t)-f \tag{101}$$

Firm1: (EI,MI) v (MI,MI) - equating (16) and (9)

$$G=\frac{4}{9}t(1-c+\Delta-t) \tag{102}$$

Firm1: (EI,EI) v (MI,EN) - equating (3) and (17)

$$G=\frac{4}{9}\Delta(1-c+\frac{3}{2}\Delta)+\frac{4}{9}t(1-c+\frac{3}{2}\Delta-t) \quad (103)$$

Firm1: (EI,EN) v (MI,ON) - equating (5) and (27)

$$G=\frac{5}{36}(1-c)^2+\frac{1}{18}\Delta(1-c-\frac{7}{2}\Delta)+\frac{2}{9}t(1-c+2\Delta-\frac{5}{2}t)-f \quad (104)$$

Firm1: (MI,MI) v (ON,MI) - equating (9) and (28)

$$G=\frac{(1-c+\Delta)^2}{9}+\frac{4}{9}\Delta(1-c)-f \quad (105)$$

Firm1: (MI,ON) v (EN,EN) - equating (27) and (1)

$$G=\frac{5}{36}(1-c)^2+\frac{17}{18}\Delta(1-c+\frac{25}{34}\Delta)+\frac{2}{9}t(1-c-\frac{5}{2}t)-f \quad (106)$$

Firm1: (MN,EN) v (MI,ON) - equating (13) and (27)

$$G=\frac{5}{36}(1-c)^2+\frac{17}{18}\Delta(1-c+\frac{25}{34}\Delta)-\frac{2}{9}t(1-c+\frac{1}{2}t)-f \quad (107)$$

Firm1: (MI,OI) v (ON,EI) - equating (35) and (24)

$$G=\frac{(1-c+\Delta)^2}{4}+(\frac{4}{9}\Delta-\frac{2}{9}t)(1-c+\frac{1}{2}t)-f \quad (108)$$

Firm1: (MI,ON) v (ON,ON) - equating (27) and (73)

$$G=\frac{(1-c+2\Delta)^2}{9}+\frac{1}{2}\Delta(1-c+\frac{1}{2}\Delta)-f \quad (109)$$

Foreign Market Profits for Firm 1 in (MI,EN) and (EI,EI)

$$\frac{(1-c+2\Delta)^2}{9}-G=\frac{(1-c+\Delta-2t)^2}{9} \quad (110)$$

rearranging (108)

$$G=\frac{2}{9}\Delta(1-c+\frac{3}{2}\Delta)+\frac{4}{9}t(1-c+\Delta-t) \quad (111)$$

4 Zero Profitability Constraints

Profits are non-negative at positive output for both firms if the inequality is satisfied. It is assumed that $0<c<1$ and $0<\Delta<c$.

Profits in A

(#N,EN)

$$t<1-c \quad (112)$$

(#I,EN)

$$t<\frac{1-c-\Delta}{2} \quad (113)$$

(#N,EI)

$$\Delta<1-c+t \quad ; \quad t<\frac{(1-c+2\Delta)}{2} \tag{114}$$

(#I,EI)

$$t<\frac{(1-c+\Delta)}{2} \tag{115}$$

(#N,MN)

$$G<\frac{(1-c)^2}{9} \tag{116}$$

(#I,MN)

$$G<\frac{(1-c-\Delta)^2}{9} \tag{117}$$

(#N,MI)

$$\Delta<1-c \quad ; \quad G<\frac{(1-c+2\Delta)^2}{9} \tag{118}$$

(#I,MI)

$$G<\frac{(1-c+\Delta)^2}{9} \tag{119}$$