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Abstract

We argue that different industrial ownership structures generate different incentives for firms to engage in FDI. We compare (partially) cooperative structures such as the Japanese *kieretsu* and Korean *chaebol* systems, with competitive structures such as US firms. We find significant differences in the probability of initial FDI and the lag between initial entry and subsequent investments. This has further implications for the optimal FDI incentives of potential host countries.

Keywords: FDI; Networks; Keiretsu.

JEL classification: F10, F21, F23.

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1 Introduction.

Over the past 20 years there has been a significant increase worldwide in the levels of foreign direct investment.[1] There are several diverse motivations for this trend.[2] However, whatever the initial motivation, a firm locating production facilities outside of its home country faces a host of potential problems. For example it takes time to learn how to operate efficiently in a foreign labor market and under a foreign legal system. In deciding if and when to engage in FDI a firm will exploit any information that helps it deal with these problems. It seems probable then that firms learn from the experiences of those that have preceded them. There will be positive information externalities generated by early entrants for the later ones.[3] As Lin and Saggi [15] have pointed out this leads to strategic incentives to carry out FDI. A firm that carries out early FDI reduces its own costs, but also bestows positive informational externalities upon later entrants. To date this literature has focused on the FDI decisions of independent corporations. However, some of the biggest corporate players in this game originate from Japan and Korea, where there exist large semi-cooperative industrial networks bound together by significant levels of overlapping share holdings.[4] We argue that

[1] The OECD[18] reports that by the end of 1990 OECD countries had accumulated an investment position of $1,720 billion for outward stocks and $1,270 for inward stocks. From 1995 to 1997 the total outflows of FDI from the OECD countries rose from $300,215 million to $354,909 million per annum (???)[22].

[2] These include a rational response to trade barriers (see Blonigen and Feenstra [4]), and attractive new opportunities for low cost production for firms from the industrial countries arising as a consequence of political changes in the former Soviet Block countries, a shift towards a market economy in China, and increased openness in many S.E. Asian economies.

[3] This accords well with the evidence on within firm learning or "experience effects" as investigated by Kogut and Chang [13][14], Yu [24], Hennart and Park [9], and Belderbos [2].

[4] For example in the Mitsubishi *keiretsu* the 28 core companies hold an average (with only a small variance) of 28% of each others shares.

these different industrial ownership structures provide different incentives to internalize the externalities inherent in FDI. It follows, therefore, that industrial ownership structure will have significant implications for the timing and frequency of FDI and the incentives that a potential host country might offer potential corporate investors.

In our analysis we follow the lead of Lin and Saggi (op cit) and adopt a model similar to that proposed by Fudenberg and Tirole [7] in the IO literature on technology adoption. We assume that there are two identical firms that must simultaneously choose their probabilities of FDI in a foreign market. Each chooses their probability as a Nash best reply to the other's.

If the two firms are independently owned, the incentive to enter by the first (leader) firm arises from the cost advantages typically associated with lower production costs. The incentives to enter for the second (follower) firm are more complex, as with the leader there is an incentive to follow immediately so as to exploit reductions in production costs. However, the follower also has an incentive to delay, because by doing so they may observe the experiences of the leader, and exploit the information obtained to lower their own entry costs. The optimal delay by the follower involves equating these two effects at the margin.

If, however, the firms are both members of a (partially) cooperative industrial grouping, such as a Japanese *keiretsu* or Korean *chaebol*, their incentives are more complex.[5] For the leader, as before, lower production costs provide an incentive for entry. However, there are other incentives. Since the firms are semi-cooperative the leader partially internalizes the effects it has on the follower. This involves taking into consideration both the effect

[5] For an explanation of the origins of *keiretsu* see [11] and [20].

entry has on the followers current profits and the entry cost reduction that the follower will subsequently enjoy. The followers optimal delay decision is also more complex. In addition to the incentives faced by an independent follower the semi-cooperative follower also partially internalizes the effects its entry has on the leaders profits.[6]

We are able to explain as a symmetric stationary mixed strategy equilibrium how the probability of FDI (and thus it's frequency in repeated trials) and the delay between the first and second entrant depends on the basic parameters of the economy. Most particularly we discover the industrial ownership structure is important for the probability of initial FDI, and the delay between the initial and subsequent investments. It is shown that the relationship between industrial ownership structure and the probability of FDI may be broken down into two effects; (i) A direct effect that works through the incentives provided by sharing of the payoffs due to entry, and, (ii) an indirect effets that feeds back onto initial entry decisions via changes in delay between initial and subsequent entry. For an increase in cooperation the direct effect causes the probability of FDI to fall while the indirect effects causes it to rise. For both fully cooperative and fully competitive industrial ownership structures the direct effect dominates the indirect effect and the relationship between cooperation and the probability of initial FDI is negative. For partially cooperative cases the conclusions are less clear cut. However, for all levels of cooperation, as cooperation increases the delay between initial and subsequent entry increases. Furthermore, there is a "dampening effect": The

[6] Our analysis is related to the burgeoning literature on the role of networks in international trade. See Rauch and Feenstra [21] and the JIE 1999 symposium on Business and Social Networks in International Trade.

greater is the degree of overlapping share ownership the less sensitive will be the probability of entry by the first firm to any changes in the models underlying parameters.

Earlier attempts to explain the effects of *keiretsu* membership on FDI ([6], [16]) have focused on the role of cheap finance supplied by group member banks. These explanations predict that *keiretsu* membership should facilitate FDI, yet the empirical evidence fails to support this story (see [3], [12], [8], and [17]) . Our work suggests why this might be true. The cheap finance story may be correct, but is only part of the picture. The strategic incentives we highlight follow naturally from the actual institutional structure of industrial ownership, explain the ambiguities found in the empirical literature, and point to what may be needed to sort out these conflicting effects.

2 The Model.

2.1 Basic Structure.

We assume that there are two identical firms that may produce output either in their domestic economies or abroad, via FDI. The two firms may be either fully independent, as in the case of most US firms, or, alternatively, they may be partially linked via overlapping shareholdings such as in the case of Japanese *keiretsu* and Korean *chaebol* members.

Let $\Pi_{i,j}$ be the flow of (own) profits enjoyed by firm i, given the response of firm j. If one firm engages in domestic production, D, and the other produces via FDI, F,then its flow profits are denoted Π_{DF}, similarly Π_{DD} indicates that both firms engage in domestic production, and so on. To capture the different potential forms of industrial ownership structure we introduce the parameter $\alpha \in [0, \frac{1}{2}]$ which represents the claims of each firm on the others profits.[7] If we denote the total profits of firm i as P_i we may write the possibilities as

$$P_i = (1-\alpha)\Pi_{m,k} + \alpha\Pi_{k,m} \;\; m = D, F \; k = D, F.$$

Given that FDI lowers marginal costs, it follows that profits will vary across the different combinations of domestic production and FDI. We assume that

$$\Pi_{FD} > \Pi_{FF} > \Pi_{DD} \quad \text{and} \quad \Pi_{DF} \leq \Pi_{DD} < \Pi_{FF} \tag{1}$$

These inequalities may be generated in one of (at least) two ways. Our preferred interpretation is that they reflect labor costs. We argue that FDI allows the firms to exploit cheap labor in the host country, but their entry pushes up wages in the appropriate labor pool.[8] [9] This allows us to interpret our conclusions as widely as possible; the firms engaged in FDI

[7] In the Japanese *keiretsu* system there are other mechanisms by which cooperation may be induced between members. The role of associated commercial banks in providing repeated funding to members, and the placement of bank officials in senior positions in the members hierarchies seem particulaly important. α may therefore be interpreted more widely as a measure of cooperation rather than simply cross shareholdings. Orru, Hamilton and Suzuki[19] suggest "power and influence are exercised reciprocally among firms through shareholding, interlock ties, trade links, bank loans and business assiciations". Similar observations are made by Aoki [1].

[8] For example Feenstra and Hanson [5] find that for regions of Mexico in which FDI is concnertrated more than 50% of the increase in the total wages of skilled workers can be attributed to the effects of foreign capital inflows.

[9] From 1991-95 the following non OECD countries with low labour costs (or more generally production costs) recieved the following inflows of FDI in millions of US dollars
China $112,673
Malaysia $24,335
Singapore $24,161
Argentina $16,286
Brazil $12,387
Indonesia $11,720
Thailand $9,368.
Source OECD Financial Market Trends, No 67, June 1997.[23]

do not necessarily produce similar outputs, or sell their outputs in the same geographical markets.[10] We may now utilize this structure to examine the firms' FDI decisions.

2.2 The Firms' Problem.

Suppose that at some date $t = 0$ each firm is engaged exclusively in domestic production.[11] The problem each must solve is if and when to switch to FDI. In the absence of switching costs the inequalities (1) jointly imply that each firm would choose FDI at $t = 0$. However, switching production from one country to another is clearly costly. To model these costs we assume that the first firm to switch incurs a time invariant fixed cost C. The second however may observe the experience of the first and learn in a way that reduces its switching cost. We assume that the longer the second waits the more it learns and the lower its cost. If the first firm enters at $t = t^*$, and the second follows at $t = t^{**}$ then we express the entry cost of the second firm as $Ce^{-\gamma(t^{**}-t^*)}$ where $e^{-\gamma(t^{**}-t^*)}$ captures the cost reducing value of information and is parameterized by $\gamma > 0$.[12] The degree to which the first entrant internalizes the effect it has on the second's costs depends on α, where $\alpha = 0$ represents zero internalization and $\alpha = \frac{1}{2}$ full internalization.

The solutions to the firms' decision problems involve choosing strategies that specify a

[10] Linn and Saggi (op cit.) assume the firms to be duopolists operating in the same output market, and show that these profit rankings may arise from either Cournot of Bertrand competition.

[11] We might think of this as the time at which FDI became a potentially lower cost mode of production. Either because of the relaxation of legal restriction by the host country, an improvement in the host country's labour force, or an increase (real or threatened) in tariffs for that country's home market etc.

[12] Clearly similar firms may learn more from each other than dissimilar firms will. However, the firms also face common problems such as learning to deal with a foreign legal system and foreign labour markets and practices. We thus abstract from differential learning in this paper.

probability of FDI at each point in time given the strategy of the other. Let the probability of firm i switching to FDI at time t be $\rho_i(t)$. At any time t three possible outcomes may arise .

1. One firm switches to FDI and enjoys lower production costs but incurs the switching cost C. The other firm continues to produce domestically and waits to undertake FDI until the marginal gain to patience associated with the cost reducing information externality $e^{-\gamma(t^{**}-t^{*})}$ just equals the gain in profit attributable to the production cost reduction from producing in the potential host country.

2. Both firms switch to FDI. Each enjoys the same reduction in production costs while incurring identical switching costs.

3. Neither firm switches to FDI, they both continue with domestic production and play an identical game in the next instant $t + dt$.

The solution to the firm's problem, and the equilibrium for the game, must be obtained by solving the model recursively to obtain the subgame perfect equilibrium. We thus look at the second entrant's decision first.{We thus begin by examining the decision of the second entrant.}

2.2.1 When the Follower Switches to FDI.

Suppose that the first entrant has already undertaken FDI at time $t = t^*$. The second firm's value function at any time $\widehat{t} \geq t^*$ may be written (see appendix 1)

$$V(\widehat{t}, t^{**}) = (1-\alpha)\left(1 - e^{-r(t^{**}-\widehat{t})}\right)\frac{\Pi_{DF}}{r} + e^{-r(t^{**}-\widehat{t})}\frac{\Pi_{FF}}{r}$$
$$+\alpha\left(1 - e^{-r(t^{**}-\widehat{t})}\right)\frac{\Pi_{FD}}{r} - (1-\alpha)\,Ce^{-\gamma(t^{**}-t^*)}e^{-r(t^{**}-\widehat{t})}$$

where r is the interest rate. Now differentiating with respect to t^{**} taking the limit as $\widehat{t} \to t^{**}$ and rearranging the resultant expression yields[13]

$$t^{**} = t^* + \left(\frac{1}{\gamma}\right)\ln\left[\frac{(\gamma + r)(1-\alpha)\,C}{\Pi_{FF} - (1-\alpha)\,\Pi_{DF} - \alpha\Pi_{FD}}\right] \tag{2}$$

where $t^{**} - t^* \equiv \bar{t}$ represents the optimal delay by the follower.

2.3 The Symmetric Mixed Strategy Equilibrium.

Given that the follower optimally delays entry for the interval $\left(\frac{1}{\gamma}\right)\ln\left[\frac{(\gamma+r)(1-\alpha)C}{\Pi_{FF}-(1-\alpha)\Pi_{DF}-\alpha\Pi_{FD}}\right]$, we may now examine the probability of entry by the first entrant at any time t. As discussed above there are three possible outcomes at each $t \leq t^*$, either one, both, or neither of the firms will switch to FDI. Define $\rho_\alpha(t)$ as the probability of either firm switching to FDI at t.[14] We may now define their value functions for each of the possible outcomes (see appendix 2)

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[13] Notice that if $\alpha = 0$ we get the Lin and Saggi (op. cit.) solution.

[14] Since we are examining symmetric equilibria.

1. Both firms switch to FDI at time t

$$V(t^*, t^*) = \frac{\Pi_{FF}}{r} - C$$

this occurs with probability $\rho_\alpha(t)^2$.

2. One firm switches at $t = t^*$ the other continues domestic production until $t = t^{**}$

$$V(t^*, t^{**}) = (1-\alpha)\left[\left(1 - e^{-r(t^{**}-t^*)}\right)\frac{\Pi_{FD}}{r} + e^{-r(t^{**}-t^*)}\frac{\Pi_{FF}}{r} - C\right]$$
$$+\alpha\left[\left(1 - e^{-r(t^{**}-t^*)}\right)\frac{\Pi_{DF}}{r} + e^{-r(t^{**}-t^*)}\frac{\Pi_{FF}}{r} - Ce^{-(\gamma+r)(t^{**}-t^*)}\right]$$

for the leader

$$V(t^{**}, t^*) = (1-\alpha)\left[\left(1 - e^{-r(t^{**}-t^*)}\right)\frac{\Pi_{DF}}{r} + e^{-r(t^{**}-t^*)}\frac{\Pi_{FF}}{r} - Ce^{-(\gamma+r)(t^{**}-t^*)}\right]$$
$$+\alpha\left[\left(1 - e^{-r(t^{**}-t^*)}\right)\frac{\Pi_{FD}}{r} + e^{-r(t^{**}-t^*)}\frac{\Pi_{FF}}{r} - C\right]$$

for the follower. This occurs with probability $\rho_\alpha(t)(1-\rho_\alpha(t))$.

3. When neither switches at $t = t*$ then the same game is played in the next instance, denote as $V_0(t) = V_0(t+\delta)\forall t$ the value of playing the game. This occurs with probability $(1-\rho_\alpha(t))^2$.

For there to be a mixed strategy equilibrium each firm must be indifferent at every t between continuing domestic production and FDI. So $\rho_\alpha(t)$ must satisfy

$$\rho_\alpha(t)V(t^*, t^*) + (1-\rho_\alpha(t))V(t^*, t^{**}) = \rho_\alpha(t)V(t^{**}, t^*) + (1-\rho_\alpha(t))V_0(t) \qquad (3)$$

hence the probability of FDI becomes

$$\rho_\alpha(t) = \frac{V(t^*, t^{**}) - V_0(t)}{V(t^*, t^{**}) - V_0(t) + V(t^{**}, t^*) - V(t^*, t^*)}. \qquad (4)$$

By definition the value of playing the game is

$$V_0(t) = \rho_\alpha(t)^2 V(t^*,t^*) + \rho_\alpha(t)(1-\rho_\alpha(t))\left[V(t^*,t^{**}) + V(t^{**},t^*)\right] + (1-\rho_\alpha(t))^2 V_0(t) \tag{5}$$

Using (3) and (5) gives

$$V_0(t) = V(t^{**},t^*)$$

so (4) immediately reduces to

$$\rho_\alpha(t) = \frac{V(t^*,t^{**}) - V(t^{**},t^*)}{V(t^*,t^{**}) - V(t^*,t^*)}$$
$$= \frac{(1-2\alpha)\left[(1-e^{-r(t^{**}-t^*)})\left(\Pi_{FD} - \Pi_{DF}\right) - r(1-e^{-(\gamma+r)(t^{**}-t^*)})C\right]}{(1-e^{-r(t^{**}-t^*)})\left[(1-\alpha)\,\Pi_{FD} + \alpha\Pi_{DF} - \Pi_{FF}\right] + \alpha(1-e^{-(\gamma+r)(t^{**}-t^*)})rC} \tag{6}$$

This is the stationary equilibrium solution for $\rho_\alpha(t)$[15]. {It provides a clear illustration of the nature of first-mover advantage. That benefit varies directly with the value differential that accrues to the leader, and it varies inversely with the value of the information externalities thyat are captured by the follower through the delay of FDI.} Using this structure we are now able to investigate the implications of differing industrial ownership networks for FDI.

[15] There may also be asymmetric pure strategy equilibria. We analyse the mixed strategy equilibrium because it allows an explanation of the initial entry decision. In the pure strategy equilibria initial entry occurs at the first possible instant. The analysis of subsequent entry is the same in each case.

3 The Effects of Industrial Ownership Structure on the Timing of FDI.

3.1 Initial Entry.

How does industrial structure affect the timing of FDI? The probability of initial entry may be written

$$\rho_\alpha(t) = \frac{(1-2\alpha)\,\rho_0(t)}{1-\alpha\rho_0(t)} = \rho(\alpha, \bar{t}(\alpha)) \tag{7}$$

where $\bar{t} \equiv t^{**} - t^{*}$ and $\rho_0(t) = \frac{\Pi_{FD}-\Pi_{DF}-zrC}{\Pi_{FD}-\Pi_{FF}}$ is the probability of initial entry by fully independent firms, i.e. $\alpha = 0$, and $z \equiv \frac{\left(1-e^{-(\gamma+r)\bar{t}}\right)}{\left(1-e^{-r\bar{t}}\right)}$.

Differentiating (7) with respect to α using (6) and simplifying a little we get

$$\frac{d\rho_\alpha(t)}{d\alpha} = \frac{\partial\rho}{\partial\alpha} + \frac{\partial\rho}{\partial\rho_0}\frac{\partial\rho_0}{\partial\bar{t}}\frac{\partial\bar{t}}{\partial\alpha} = \frac{\rho_0(t)\,(\rho_0(t)-2)}{(1-\alpha\rho_0(t))^2}$$
$$+\left[\frac{(1-2\alpha)}{(1-\alpha\rho_0(t))^2}\right]\left[\frac{r^2e^{-r\bar{t}}(1-e^{-(\gamma+r)\bar{t}})C - r(\gamma+r)e^{-(\gamma+r)\bar{t}}(1-e^{-r\bar{t}})C}{(1-e^{-r\bar{t}})^2(\Pi_{FD}-\Pi_{FF})}\right]\frac{\partial\bar{t}}{\partial\alpha} \tag{8}$$

differntiating (2) wrt α and substituting into the resulting expression gives

$$\frac{d\rho_\alpha(t)}{d\alpha} = \frac{\rho_0(t)\,(\rho_0(t)-2)}{(1-\alpha\rho_0(t))^2}$$
$$-\left[\frac{(1-2\alpha)}{(1-\alpha\rho_0(t))^2}\right]\left[\frac{r^2e^{-r\bar{t}}(1-e^{-(\gamma+r)\bar{t}})C - r(\gamma+r)e^{-(\gamma+r)\bar{t}}(1-e^{-r\bar{t}})C}{(1-e^{-r\bar{t}})^2(\Pi_{FD}-\Pi_{FF})}\right]$$
$$\times\left(\frac{1}{\gamma}\right)\left[\frac{\Pi_{DF}-\Pi_{FD}}{\Pi_{FF}-(1-\alpha)\,\Pi_{DF}-\alpha\Pi_{FD}} + \frac{1}{1-\alpha}\right] \tag{9}$$

Inspection of (9) reveals that the effect of a change in ownership structure α has two effects on initial FDI entry probabilities, a direct effect $\frac{\partial\rho}{\partial\alpha}$ and an indirect effect $\frac{\partial\rho}{\partial\rho_0}\frac{\partial\rho_0}{\partial\bar{t}}\frac{\partial\bar{t}}{\partial\alpha}$. We analyse and explain these two effects in turn.

3.1.1 The Direct Effect.

For a given period of delay between initial and subsequent entry, $\bar{t}$, the probability of initial FDI at any time t is a decreasing function of the level of cooperation (i.e. cross-ownership shares) in the industrial structure.[16] This follows immediately from considering the mixed strategy equilibrium condition which says that each firm must be indifferent between FDI and domestic production. The equilibrium condition (3) may be rewritten as

$$\rho_\alpha(t)V(t^*,t^*) + (1-\rho_\alpha(t))V(t^*,t^{**}) = V(t^{**},t^*).$$

Hence for any given $\bar{t}$, as α increases the value of $V(t^{**},t^*)$ declines, because the leader shares with the follower a greater proportion of the profit increase, and also shares in a greater proportion of the profit decrease the follower experiences. $\rho_\alpha(t)$ must therefore fall to maintain the equilibrium. In incentive terms the leader has less incentive to undertake FDI as it enjoys both a smaller fraction of the gains and a greater fraction of the losses its action induces.

3.1.2 The Indirect Effect.

A change in α also has an indirect effect on the probability of initial FDI working through the optimal delay between initial and subsequent entry. This effect is represented by the second term in (9). We see immediately that since $\alpha \leq \frac{1}{2}$ it follows that $\frac{(1-2\alpha)}{(1-\alpha\rho_0(t))^2} \geq 0$, while in the next section we show that $\frac{d\bar{t}}{d\alpha} > 0$. Furthermore it is established in the appendix that $\frac{r^2e^{-r\bar{t}}(1-e^{-(\gamma+r)\bar{t}})C - r(\gamma+r)e^{-(\gamma+r)\bar{t}}(1-e^{-r\bar{t}})C}{(1-e^{-r\bar{t}})^2(\Pi_{FD}-\Pi_{FF})} > 0$. Thus this effect is positive and tends to offset the

[16] And concave since $\frac{d^2\rho_\alpha(t)}{d\alpha^2} = \frac{2\rho(t)^2(\rho(t)-2)}{(1-\alpha\rho(t))^3} < 0$.

direct effect. The longer is the optimal delay, the further in the future and hence lower are the discounted costs of entry that the second entrant imposes on the first. Thus the greater is α the greater is the incentive for each firm to initially enter. Furthermore, the indifference condition of the mixed strategy equilibrium requires that, given a longer optimal delays makes initial entry more attracive, then each firm must enter with a higher probability to make the *other* firm indifferent.

Clearly an important question is whether the influence of the direct or of the indirect effect of industrial ownership structure determines inital FDI entry probabilities. Without further assumptions we cannot generally say which effect will dominate. However, using (2) and (9) we can establish the following limiting properties (see also appendix 3).

3.1.3 Limit Properties.

Considering the limit properties of the model as the cooperation parameter α approaches the limits of 0, no cooperation, and $\frac{1}{2}$, full cooperation, we obtain the following

$\alpha \rightarrow 0$	$\alpha \rightarrow \frac{1}{2}$
$\rho_\alpha(t) \rightarrow \dfrac{\Pi_{FD} - \Pi_{DF} - \left[\frac{\left(1-e^{-(\gamma+r)\bar{t}}\right)}{\left(1-e^{-r\bar{t}}\right)}\right] rC}{\Pi_{FD} - \Pi_{FF}} > 0$	$\rho_\alpha(t) \rightarrow 0$
$\frac{\partial \rho_\alpha(t)}{\partial \alpha} \rightarrow \rho_0(t)\left(\rho_0(t) - 2\right)$ $+ \left[\frac{r^2 e^{-r\bar{t}}(1-e^{-(\gamma+r)\bar{t}})C - r(\gamma+r)e^{-(\gamma+r)\bar{t}}(1-e^{-r\bar{t}})C}{(1-e^{-r\bar{t}})^2(\Pi_{FD}-\Pi_{FF})^2}\right]$ $\times \left[\frac{\Pi_{FF}-\Pi_{FD}}{\gamma}\right] < 0$	$\frac{\partial \rho_\alpha(t)}{\partial \alpha} \longrightarrow \frac{\rho_0(t)(\rho_0(t)-2)}{(1-\alpha\rho_0(t))^2} < 0$

Hence for both the cases of full cooperation and full competition a negative relationship exists between the degree of occooperation and the equilibrium initial entry probabilities.[17]

[17] Unfortunately we have been unable to establish the monotonicity property necessary to prove that this result holds over the entire range $\alpha \in [0, \frac{1}{2}]$. However, numerical simulations (unreported) have failed to

3.2 Comparative Statics and the "Dampening Effect".

As expression (9) indicates, changes in the underlying parameters of the model can affect the probability of initial FDI. Most interestingly the impact of changes in the underlying parameters have systematically smaller effects the greater is the degree of cooperation α. This may be seen by differentiating (7) with respect to $\rho_0(t)$ giving

$$\frac{d\rho_\alpha(t)}{d\rho_0(t)} = \frac{(1-2\alpha)}{(1-\alpha\rho_0(t))^2} \in [0,1]$$

further differentiation of the expression wrt α gives

$$\frac{d\left(\frac{d\rho_\alpha(t)}{d\rho_0(t)}\right)}{d\alpha} = \frac{2\left[\alpha\frac{\partial\rho_0}{\partial\alpha} + \rho_0\right](1-2\alpha) - 2\left(1-\alpha\rho_0(t)\right)}{(1-\alpha\rho_0(t))^3} < 0$$

it now follows that for any change in any underlying parameter, x, we have

$$\left|\frac{d\rho_\alpha(t)}{dx}\right| = \left|\frac{d\rho_\alpha(t)}{d\rho_0(t)}\frac{d\rho_0(t)}{dx}\right| < \left|\frac{d\rho_0(t)}{dx}\right|.$$

This is the dampening effect, and tells us that for a given change in any underlying parameter

- The effect on the probability of FDI will be smaller the more cooperative is the underlying industrial structure.

disprove our suspicion that the direct effect dominates the indirect effect over the whole range of α.

The actual comparative statics effects are summarized in the following table (details may be found in appendix 4)

Variable.	*Comparative Statics.*	*Sign for all* $\alpha \in [0, 1/2]$
Interest Rate.	$\frac{d\rho_\alpha(t)}{dr}$	+/-
Rate of Information Flow.	$\frac{d\rho_\alpha(t)}{d\gamma}$	+/-
Entry Cost.	$\frac{d\rho_\alpha(t)}{dC}$	+/-
Profit Differential $\Pi_{FD} - \Pi_{DF}$	$\frac{d\rho_\alpha(t)}{d(\Pi_{FD}-\Pi_{DF})}$	+
Profit Differential $\Pi_{FD} - \Pi_{FF}$	$\frac{d\rho_\alpha(t)}{d(\Pi_{FD}-\Pi_{FF})}$	-

That the signs of the first three comparative statics effects are ambiguous is not surprising. An increase in the interest rate lowers the present discounted value of all revenues. The fact that the gains from FDI accrue in the initial $t^{**} - t^{*}$ period tends to encourage FDI. However, since the cost of FDI for the leader is primarily an up-front cost C then this tends to discourage FDI.[18] An increase in γ, the rate at which information reduces the cost of entry for the follower, has the direct effect of reducing the advantage to being the leader as opposed to the follower, but it also raises the marginal value of patience to the follower and thus tends to cause the follower to delay entry. This gives the leader a greater incentive to enter. Similar arguments hold for C: the direct effect of an increase in C makes entry less attractive to the leader. However, to the extent that the follower tends to delay entry as C increases, entry becomes more attractive for the leader.

[18] As we shall see shortly the interval $t^{**} - t^{*}$ also increases with r this pushes the costs for the follower further into the future and also raises the relative cost of being the leader further reducing the incentive to enter.

3.3 Subsequent Entry.

Consider next the effect of the industrial ownership structure on the optimal delay between the entry of the leader and follower. Using $t^{**} - t^{*} = \left(\frac{1}{\gamma}\right) \ln \left[\frac{(\gamma+r)(1-\alpha)C}{\Pi_{FF}-(1-\alpha)\Pi_{DF}-\alpha\Pi_{FD}}\right]$ we may immediately obtain

$$\frac{d\left(t^{**}-t^{*}\right)}{d\alpha} = -\left(\frac{1}{\gamma}\right)\left[\frac{\Pi_{DF}-\Pi_{FD}}{\Pi_{FF}-(1-\alpha)\,\Pi_{DF}-\alpha\Pi_{FD}} + \frac{1}{1-\alpha}\right] > 0$$

the more cooperative is the industrial ownership structure the longer is the delay between the entry of the first and second firms. This is intuitive. A larger α reduces the incentive for the second firm to enter for two reasons. First, the second firm shares in the profit advantage, Π_{FD}, enjoyed by the first. By its own entry the second firm reduces this advantage (by $\Pi_{FD} - \Pi_{FF}$) and, thus, indirectly penalizes itself. Second, the second firm shares its gains from entry ($\Pi_{FF} - \Pi_{DF}$) with its rival. Both considerations reduce the incentive to enter. It follows that the second firm waits longer to enter (delays entry for longer) the more cooperative is the industrial structure.

The further comparative static properties of subsequent entry are (see appendix 4)

Variable.	*Comparative Statics.*	*Sign for all* $\alpha \in (0, 1/2]$
Interest Rate.	$\frac{d(t^{**}-t^{*})}{dr}$	+
Rate of Information Flow.	$\frac{d(t^{**}-t^{*})}{d\gamma}$	+
Entry Cost.	$\frac{d(t^{**}-t^{*})}{dC}$	+
Profit Differential $\Pi_{FF} - \Pi_{DF}$	$\frac{d(t^{**}-t^{*})}{d(\Pi_{FF}-\Pi_{DF})}$	-
Profit Differential $\Pi_{DF} - \Pi_{FD}$	$\frac{d(t^{**}-t^{*})}{d(\Pi_{DF}-\Pi_{FD})}$	-/0

We see that the follower delays entry longer the greater are r, γ, and C. A rise in the interest rate causes a delay in entry by the follower because the present discounted value of the profit gain from entry declines while at any time t the up front entry cost is unaffected. Thus the firm waits longer for the information externality to reduce the entry cost before entering. A higher γ means that the rate at which information reduces the entry cost is greater and thus raises the marginal value of delay. An increase in C means that entry is more costly, so that for any interest rate and rate of flow of information the marginal value of patience rises. $\Pi_{FF} - \Pi_{DF}$ represents the gross profit gain to the follower due to entry. As this increases the optimal period of delay falls. The explanation of the influence of $\Pi_{DF} - \Pi_{FD}$ on optimal delay involves two effects: a rise in Π_{DF} lowers the value of the stream of profits the follower foregoes by delaying entry, while a fall in Π_{FD} reduces the value to the leader of being first and hence the damage the follower imposes on the leader by removing this advantage through entry. Notice that this latter effect vanishes if $\alpha = 0$.

3.4 Discussion.

3.4.1 Relationship to the Empirical Literature.

The previous literature on the effects of *keiretsu* membership on FDI focuses on the possibility that membership provides access to preferential or cheap finance. Flah [6] suggests that *keiretsu* are less prone to agency problems because the concentration of shareholding in the associated bank facilitates the monitoring of creditworthiness and firm performance. The cost of financial intermediation is thus reduced.[19] McCormack [16] argues that the

[19] Notice that in our model a rise in the interest rate unambiguously increases the delay between intial and subsequent entry (see the comparative statics results). Furthermore, if $t^{**} - t^{*}$, is not "too large" our

integration of *keiretsu* firms and their banks releases managers from the need to signal the profitability of their firms by distributing dividends, thus allowing internal funds to be used for investment purposes. Each of these arguments suggests that *keiretsu* membership should promote FDI. Our analysis tends to suggest the opposite.

Empirical tests of the explanatory power of *keiretsu* membership for Japan's FDI performance have had rather mixed results. There appears to be no robust empirical support for the general proposition that *keiretsu* membership exerts a significant influence on the FDI decisions. Belderbos and Sleuwaegen [3] state "The variables related to horizontal business groups do not contribute to the explanation of investment decisions in western industrialized countries". The more specific focus on close banking ties as a defining characteristic of *keiretsu* has been corroborated by Hoshi et al [12]. Yet, the influence of horizontal *keiretsu* on FDI remains elusive. Fukao et al. [8] conclude that "no empirical support is evident to support the hypothesis that the proportion of overseas production is greater for companies belonging to a [horizontal] *keiretsu* or a corporate group." McKenzie [17] states that the "decision [to manufacture abroad] does not appear to be strongly influenced by whether or not the company is a member of either a vertical *keiretsu* or a horizontal *keiretsu*". Interestingly, from our perspective, McKenzie did detect some influence of *keiretsu* membership on the "size" of overseas production of Japanese firms. However, the influence detected is weak, is only apparent if overseas production is located in developing countries, and operates to

model also predicts that an increase in the interest rate will lower the probability of initial entry. While we, obviously, do not provide an explicit model of the cheap finance argument, it is interesting to note that lowering r while simultaneousy raising α, which would represent a move from a *non-keiretsu* to *keiretsu* environment, yields ambigious effects on FDI. This is not inconsistent with the evidence.

constrain the scale of operations. These findings run counter to McKenzie's priors and to those of the preceding literature, but they are precisely in line with the predictions of our model.

We believe that the failure to detect in the data a significant relationship between FDI activity and *keiretsu* membership is precisely because there are countervailing effects. The effects of cheap finance are offset by the strategic incentives developed in this paper. Incentives that follow naturally from the institutional structure of *keiretsu.* It remains for future empirical work to untangle these two stories.

3.4.2 Potential Policy Implications of the Analysis

Clearly the analysis provided in our theoretical model is too stylized and short on detail to provide an adequate guide to policy. However, equally clearly the effects that we uncover have some policy relevance. We have shown that there are incentives for *keiretsu* and *chaebol* members to be quite conservative in their FDI behavior. For any given set of model parameters firms from partially cooperative industrial groupings may be less inclined to undertake initial FDI and will certainly delay longer in undertaking subsequent investments. Furthermore, the Dampening Effect suggests that these firms are also likely to be less responsive at the margin to any incentives for FDI that a potential host country might offer. The underlying intuition seems quite powerful: in this context overlapping ownership networks seem to dilute incentives. However, we are cautious in suggesting that potential host countries should target policies to attract FDI from less cooperative firms. Our model does not tell us anything about incentives in situations where both *keiretsu* and *non-keiretsu* firms are potential entrants. Furthermore, while firms from industrial structures with overlapping ownership networks might be less responsive to incentives to undertake FDI, they are by the same logic less likely to exit once they have entered.

Appendix 1: Derivation of $V(\hat{t}, t^{**})$, the value to the follower at $\hat{t}$ of switching to FDI at t^{**}.

The value of the firm is the sum of own profits plus the share in the rival which may be written

$$\begin{aligned} V(\hat{t}, t^{**}) &= (1-\alpha)\left[\int_{t=\hat{t}}^{t^{**}} (\Pi_{DF})\, e^{-r(t-\hat{t})}dt + \int_{t=t^{**}}^{\infty} (\Pi_{FF})\, e^{-r(t-\hat{t})}dt - Ce^{-\gamma(t^{**}-t^{*})}e^{-r(t^{**}-\hat{t})}\right] \\ &\quad +\alpha\left[\int_{t=\hat{t}}^{t^{**}} (\Pi_{FD})\, e^{-r(t-\hat{t})}dt + \int_{t=t^{**}}^{\infty} (\Pi_{FF})\, e^{-r(t-\hat{t})}dt\right] \\ &= (1-\alpha)\left[\int_{t=\hat{t}}^{t^{**}} (\Pi_{DF})\, e^{-r(t-\hat{t})}dt - Ce^{-\gamma(t^{**}-t^{*})}e^{-r(t^{**}-\hat{t})}\right] + \int_{t=t^{**}}^{\infty} (\Pi_{FF})\, e^{-r(t-\hat{t})}dt \\ &\quad +\alpha\left[\int_{t=\hat{t}}^{t^{**}} (\Pi_{FD})\, e^{-r(t-\hat{t})}dt\right] \end{aligned}$$

solving the integrals provides the expression in the text.

Appendix 2: Value functions in the mixed strategy equilibrium.

When both firms chooses to engage in FDI at t^* we get

$$V(t^*, t^*) = (1-\alpha)\left[\int_{t=t^*}^{\infty} (\Pi_{FF})\, e^{-r(t-t^*)}dt - C\right] + \alpha\left[\int_{t=t^*}^{\infty} (\Pi_{FF})\, e^{-r(t-t^*)}dt - C\right]$$

solving the integrals gives

$$V(t^*, t^*) = \frac{\Pi_{FF}}{r} - C$$

When one firm switches at $t = t^*$ and the other continues domestic production until t^{**}, for the first entrant we have

$$V(t^*,t^{**}) = (1-\alpha)\left[\int_{t=t^*}^{t^{**}} (\Pi_{FD})\, e^{-r(t-t^*)}dt + \int_{t=t^{**}}^{\infty} (\Pi_{FF})\, e^{-r(t-t^*)}dt - C\right]$$
$$+\alpha\left[\int_{t=t^*}^{t^{**}} (\Pi_{DF})\, e^{-r(t-t^*)}dt + \int_{t=t^{**}}^{\infty} (\Pi_{FF})\, e^{-r(t-t^*)}dt - Ce^{-(\gamma+r)(t^{**}-t^*)}\right]$$

solving the integrals gives

$$V(t^*,t^{**}) = (1-\alpha)\left[\left(1-e^{-r(t^{**}-t^*)}\right)\frac{\Pi_{FD}}{r} + e^{-r(t^{**}-t^*)}\frac{\Pi_{FF}}{r} - C\right]$$
$$+\alpha\left[\left(1-e^{-r(t^{**}-t^*)}\right)\frac{\Pi_{DF}}{r} + e^{-r(t^{**}-t^*)}\frac{\Pi_{FF}}{r} - Ce^{-(\gamma+r)(t^{**}-t^*)}\right].$$

For the second

$$V(t^{**},t^*) = (1-\alpha)\left[\int_{t=t^*}^{t^{**}} (\Pi_{DF})\, e^{-r(t-t^*)}dt + \int_{t=t^{**}}^{\infty} (\Pi_{FF})\, e^{-r(t-t^*)}dt - Ce^{-(\gamma+r)(t^{**}-t^*)}\right]$$
$$+\alpha\left[\int_{t=t^*}^{t^{**}} (\Pi_{FD})\, e^{-r(t-t^*)}dt + \int_{t=t^{**}}^{\infty} (\Pi_{FF})\, e^{-r(t-t^*)}dt - C\right]$$

again solving the integrals provides

$$V(t^{**},t^*) = (1-\alpha)\left[\left(1-e^{-r(t^{**}-t^*)}\right)\frac{\Pi_{DF}}{r} + e^{-r(t^{**}-t^*)}\frac{\Pi_{FF}}{r} - Ce^{-(\gamma+r)(t^{**}-t^*)}\right]$$
$$+\alpha\left[\left(1-e^{-r(t^{**}-t^*)}\right)\frac{\Pi_{FD}}{r} + e^{-r(t^{**}-t^*)}\frac{\Pi_{FF}}{r} - C\right]$$

Appendix 3: Derivation of the sign of the indirect effect of the cooperation parameter on the probabilities of initial entry.

We have

$$\frac{\partial\rho}{\partial\rho_0}\frac{\partial\rho_0}{\partial\bar{t}}\frac{\partial\bar{t}}{\partial\alpha} = \left[\frac{(1-2\alpha)}{(1-\alpha\rho_0(t))^2}\right]\left[\frac{r^2e^{-r\bar{t}}(1-e^{-(\gamma+r)\bar{t}})C - r(\gamma+r)e^{-(\gamma+r)\bar{t}}(1-e^{-r\bar{t}})C}{(1-e^{-r\bar{t}})^2(\Pi_{FD}-\Pi_{FF})}\right]\frac{\partial\bar{t}}{\partial\alpha}$$

elsewhere we show $\frac{\partial \bar{t}}{\partial \alpha} > 0$, and it is easily seen that for $\alpha \leq \frac{1}{2}$ that $\frac{(1-2\alpha)}{(1-\alpha\rho_0(t))^2} > 0$, so the sign of the effect depends on the sign of $\frac{r^2 e^{-r\bar{t}}(1-e^{-(\gamma+r)\bar{t}})C - r(\gamma+r)e^{-(\gamma+r)\bar{t}}(1-e^{-r\bar{t}})C}{(1-e^{-r\bar{t}})^2(\Pi_{FD}-\Pi_{FF})}$, noting that the denominator is positive we thus need to sign $r^2 e^{-r\bar{t}}(1-e^{-(\gamma+r)\bar{t}})C - r(\gamma+r)e^{-(\gamma+r)\bar{t}}(1-e^{-r\bar{t}})C$, which immediately simplifies to the requirement that we sign $re^{-r\bar{t}}(1-e^{-(\gamma+r)\bar{t}}) - (\gamma+r)e^{-(\gamma+r)\bar{t}}(1-e^{-r\bar{t}})$ dividing by $e^{-r\bar{t}}e^{-\gamma\bar{t}}$ this reduces to $re^{(\gamma+r)\bar{t}} - (\gamma+r)e^{r\bar{t}} + \gamma$. Since e^xmay be expressed as the infinite Maclaurin series $e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + ...$ we have

$$re^{(\gamma+r)\bar{t}} - (\gamma+r)e^{r\bar{t}} + \gamma = r\left\{1 + (\gamma+r)\bar{t} + \frac{[(\gamma+r)\bar{t}]^2}{2!} + \frac{[(\gamma+r)\bar{t}]^3}{3!} + \dots\right\}$$
$$-(\gamma+r)\left\{1 + r\bar{t} + \frac{[r\bar{t}]^2}{2!} + \frac{[r\bar{t}]^3}{3!} + \dots\right\} + \gamma$$
$$= r\left\{\frac{[(\gamma+r)\bar{t}]^2}{2!} + \frac{[(\gamma+r)\bar{t}]^3}{3!} + \dots\right\} - (\gamma+r)\left\{\frac{[r\bar{t}]^2}{2!} + \frac{[r\bar{t}]^3}{3!} + \dots\right\} > 0$$

Appendix 4: Comparative statics for the probability of initial entry $\rho_\alpha(t)$.

Exploiting the relationship $\frac{d\rho_\alpha(t)}{d\rho_0(t)} = \frac{(1-2\alpha)}{(1-\alpha\rho_0(t))^2} > 0$ and

$$\rho_0(t) = \frac{\left(1-e^{-r(t^{**}-t^*)}\right)(\Pi_{FD} - \Pi_{DF}) - r(1-e^{-(\gamma+r)(t^{**}-t^*)})C}{\left(1-e^{-r(t^{**}-t^*)}\right)(\Pi_{FD} - \Pi_{FF})}$$

we may write the actual comparative statics effects as follows

$$\frac{d\rho_0(t)}{dr} = \frac{C\left[(t^{**}-t^*)\, re^{-r(t^{**}-t^*)}\left(1-e^{-\gamma(t^{**}-t^*)}\right) - \left(1-e^{-r(t^{**}-t^*)}\right)\left(1-e^{-(r+\gamma)(t^{**}-t^*)}\right)\right]}{\left(1-e^{-r(t^{**}-t^*)}\right)^2(\Pi_{FD}-\Pi_{FF})}$$
$$-\left(\frac{rC}{\Pi_{FD}-\Pi_{FF}}\right)\left(\frac{\partial z}{\partial(t^{**}-t^*)}\right)\frac{1}{\gamma}\left(\frac{1}{\gamma+r}\right) \gtreqless 0$$

where $z \equiv \frac{\left(1-e^{-(\gamma+r)(t^{**}-t^*)}\right)}{\left(1-e^{-r(t^{**}-t^*)}\right)}$ as in the text, and where we are also exploiting the derivations given in appendix 5.

$$\frac{d\rho_0(t)}{d\gamma} = -\frac{(t^{**}-t^{*})\,e^{-(\gamma+r)(t^{**}-t^{*})}rC}{\left(1-e^{-r(t^{**}-t^{*})}\right)(\Pi_{FD}-\Pi_{FF})}$$

$$-\left(\frac{rC}{\Pi_{FD}-\Pi_{FF}}\right)\left(\frac{\partial z}{\partial\,(t^{**}-t^{*})}\right)\left(\frac{1}{\gamma}\left(\frac{1}{\gamma+r}\right)-\frac{\ln\left[\frac{(r+\gamma)C}{\Pi_{FF}-\Pi_{DF}}\right]}{\gamma^2}\right)\gtreqless 0$$

$$\frac{d\rho_0(t)}{dC} = -\frac{\left(1-e^{-(\gamma+r)(t^{**}-t^{*})}\right)r}{\left(1-e^{-r(t^{**}-t^{*})}\right)(\Pi_{FD}-\Pi_{FF})} - \left(\frac{rC}{\Pi_{FD}-\Pi_{FF}}\right)\frac{\partial z}{\partial\,(t^{**}-t^{*})}\frac{1}{\gamma C}\gtreqless 0$$

$$\frac{d\rho_0(t)}{d\,(\Pi_{FD}-\Pi_{DF})} = \frac{1}{\Pi_{FD}-\Pi_{FF}} > 0$$

$$\frac{d\rho_0(t)}{d\,(\Pi_{FD}-\Pi_{FF})} = -\frac{\Pi_{FD}-\Pi_{DF}-zrC}{(\Pi_{FD}-\Pi_{FF})^2} < 0$$

where $\frac{\partial z}{\partial(t^{**}-t^{*})} = \frac{\gamma e^{-(\gamma+r)(t^{**}-t^{*})}\left(1-e^{-r(t^{**}-t^{*})}\right)-r\left(1-e^{-\gamma(t^{**}-t^{*})}\right)e^{-r(t^{**}-t^{*})}}{\left(1-e^{-r(t^{**}-t^{*})}\right)^2} < 0$

if $\frac{\gamma}{r} < \frac{e^{r(t^{**}-t^{*})}\left(e^{\gamma(t^{**}-t^{*})}-1\right)}{\left(e^{r(t^{**}-t^{*})}-1\right)}$

Appendix 5: Comparative statics for the delay in subsequent entry $t^{**}-t^{*}$.

Differentiating $t^{**} = t^{*} + \left(\frac{1}{\gamma}\right)\ln\left[\frac{(\gamma+r)(1-\alpha)C}{\Pi_{FF}-(1-\alpha)\Pi_{DF}-\alpha\Pi_{FD}}\right]$ appropriately yields

$$\frac{d\,(t^{**}-t^{*})}{dr} = \frac{1}{\gamma}\frac{1}{(\gamma+r)} > 0$$

$$\frac{d\,(t^{**}-t^{*})}{d\,(\Pi_{FD}-\Pi_{FF})} = \left(\frac{\alpha}{\gamma}\right)\left[\frac{1}{\Pi_{FF}-(1-\alpha)\,\Pi_{DF}-\alpha\Pi_{FD}}\right] > 0$$

$$\frac{d\,(t^{**}-t^{*})}{d\,(\Pi_{FF}-\Pi_{DF})} = -\left(\frac{1-\alpha}{\gamma}\right)\left[\frac{1}{\Pi_{FF}-(1-\alpha)\,\Pi_{DF}-\alpha\Pi_{FD}}\right] < 0$$

$$\frac{d\left(t^{**}-t^{*}\right)}{dC}=\frac{1}{\gamma C}>0.$$

$$\frac{d\left(t^{**}-t^{*}\right)}{d\gamma}=\frac{1}{\gamma}\left[\frac{1}{(\gamma+r)}-\left(\frac{1}{\gamma}\right)\ln\left(\frac{(\gamma+r)\left(1-\alpha\right)C}{\Pi_{FF}-\left(1-\alpha\right)\Pi_{DF}-\alpha\Pi_{FD}}\right)\right]=\frac{1}{\gamma}\left[\frac{1}{(\gamma+r)}-\left(t^{**}-t^{*}\right)\right].$$

the necessary condition for $\frac{d(t^{**}-t^{*})}{d\gamma}>0$ is thus $\frac{\gamma}{(\gamma+r)}-\ln\left(\gamma+r\right)>\ln\left(\frac{(1-\alpha)C}{\Pi_{FF}-(1-\alpha)\Pi_{DF}-\alpha\Pi_{FD}}\right)$ which tends to hold for large C.

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