Physical Capital, Knowledge Capital and the Choice Between FDI and Outsourcing

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Abstract

A somewhat older literature, supported by considerable empirical evidence, considered the multinational firm's mode choice for foreign production between an owned subsidiary and a licensing contract in an environment where the firm is transferring primarily knowledge-based assets. An important assumption in this literature is that the relevant knowledge is absorbed by the local manager or licensee over the course of time: knowledge is non-excludable; More recently, a number of papers have adopted a property-right view of the firm, and assume the application abroad of physical capital and assume that ownership rights guarantee that the owner retains full and exclusive rights to the capital should a relationship break down. In this paper we combine both forms of capital assets in a single model. The model predicts that foreign direct investment (owned subsidiaries) is more likely than licensing when the ratio of knowledge capital to physical capital is high, or when market value is high relative to the book value of capital (high Tobin's-Q). We believe that this prediction is consistent with existing empirical evidence.

1 1. Introduction

Foreign direct investment (FDI) has grown at rates greatly outpacing the growth in world trade over the last several decades. This has naturally led to increased interest in FDI by academic researchers and policy makers. Part of that interest has been directed to the determinants of the choice of mode by which firms service foreign markets, including options such as exporting, owned foreign affiliates (FDI), licensing and subcontracting, and joint ventures. This in turn relates to more general discussion in microeconomics about the "boundaries of the firm": decisions as to which activities should be undertaken within the ownership structure of the firm, and which activities should be contracted or outsourced to arm's-length firms.

There is a rich and extensive literature on the boundaries of the firm, and we can make no attempt to survey it here. Instead, we will direct our efforts along lines which have been productive in the field of international trade, where researchers have attempted to model a multinational's decision as to whether to establish a foreign subsidiary or contract with a foreign supplier to produce a good for local sales or for export back to the parent firm. These questions use to be referred to as the "internalization" problem, but more recently are being referred to by the converse label, "outsourcing". But they are really the same thing: whether or not to internalize an activity inside the firm, or to outsource it to an arm's-length firm.

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Much of the more recent literature under the name outsourcing has drawn from an approach which, we assert, focuses on properties of physical capital such as plant and equipment. On the other hand, the empirical literature and recent theoretical literature has emphasized the importance of knowledge-based assets in explaining the decision to become a multinational firm. An earlier theoretical literature under the internalization label also took the latter approach.

The purpose of this paper is to inquire whether or not the nature of the capital required by a subsidiary makes an important difference to the choice of mode, either subsidiary or licensee. Specifically, we wish to differentiate between physical capital and knowledge-based capital assets, and ask whether a more physical capital-intensive firm will be more or less likely to chose internalization via a subsidiary rather than outsource compared to a knowledge-capital-intensive firm.

As just alluded to, the somewhat older literature assumed knowledge-based assets and in particular assumed that the multinational firm (the principal) cannot prevent a licensee (the agent) from absorbing or learning the relevant knowledge over time. Even though the multinational "owns" the knowledge-based asset, it gets transferred to a licensee. This literature emphasizes the jointness property of knowledge capital, the ability to use it fully in multiple locations at the same time (Markusen's (2002) knowledge-capital model), which leads to multi-plant production in the first place. It suggests that the jointness properly also leads to the problem of asset dissipation: knowledge-assets are easily transferred but also easily absorbed by the licensee. Formal models include Horstmann and Markusen (1987),

Ethier and Markusen (1996), Markusen (2001), Fosfuri, Motta and Rønde (2001) and Glass and Saggi (2002).

By contrast, more recent literature is focused around the Grossman-Hart-Moore property-right approach (Grossman and Hart (1986) and Hart and Moore (1990)), which seems (implicitly) more appropriate for physical capital in that the relevant asset has no jointness property and that the owner of the residual rights has full control of the asset if a relationship or negotiation breaks down. Important papers include Grossman and Helpman (2002, 2004), Antrás (2003, 2005), and Feenstra and Hanson (2005).

Our model combines the two approaches in a simple two-period incomplete-contracting model. A firm requires both physical and knowledge capital for a foreign subsidiary, along with non-contractible effort by a foreign licensee or manager. Effort is relatively more important as a complement to physical capital than knowledge capital, creating the well-understood advantage for using a licensee who owns the physical capital and thus captures the full benefit of his or her effort. However, knowledge capital transferred by the multinational is absorbed by the licensee during the first period regardless of who "owns" it. We assume that the value of this knowledge to a manager or licensee outside the relationship depends on working with the physical capital, the two assets being complements. Thus the advantage to the multinational in owning the physical capital is that it reduces the incentives or ability of the licensee to use the knowledge for private or outside uses in period 2.

This tension, ownership by the multinational reduces agent's effort while preserving the value of the knowledge capital, is the fundamental difference between the present paper

and previous ones. Our result is that firms that are more physical-capital intensive will tend to license (outsource), while firms that are more knowledge-capital intensive with tend to establish subsidiaries (internalize). We believe that this is consistent with all available empirical evidence.

We are of course aware that some existing literature emphasizes that capital-intensive firms are more like to establish subsidiaries (Antrás 2005), but this refers to capital use relative to labor and materials, not to physical versus knowledge-capital intensity. Our model does not offer cross-section predictions about mode choice as a function of industry or firm capital-labor ratios. Rather, our predictions would more appropriately be examined by using a type of Tobin's q; specifically, the ratio of a firm's market value (reflecting knowledge-based assets as well as physical capital) to its book value of capital (largely reflecting physical capital only). Our prediction would be that firms/industries with higher q's would be more likely to establish foreign subsidiaries. Existing evidence, reviewed in Markusen (1995, 2002) does indeed suggest that this is the case.[1]

[1] See Morck and Yeung (1991, 1992) for evidence on the importance of information-related intangible assets in the FDI decision. For events in which firms do transfer technology abroad, articles by Davidson and McFetridge (1984), Mansfield and Romeo (1980), Teece (1986), and Wilson (1977) show technology is more likely to be transferred internally within the firm by R&D intensive firms producing new and technically complex products. Licenses are used to transfer older technologies. Blomstrom and Zejan (1991) get similar results with respect to joint ventures: firms are less likely to seek a foreign partner when intangible assets are important.

Ferrantino (1993), Lee and Mansfield (1996), and Mansfield (1984) include findings that weak protection of intellectual property lead to exports rather than either licensing of FDI and/or promote FDI over licensing and the choice between wholly and partly owned subsidiaries.

Smith (2001) finds that stronger foreign patent rights increase US firms transfers of knowledge more by licensing than by affiliate sales. Yang and Maskus (2001) find that countries with stronger patent rights attract larger arm's-length volumes of licensed technology, although licensing is not compared to FDI. Maskus, Saggi and Puttitanum (2005) find that stronger patent protection increases the probability of inward FDI and has very little effect on licensing; but they note that this overall finding is driven by high technology sectors, and that lower technology sectors have the opposite result (stronger protection increases licensing more than FDI).

2 The Model

A multinational firm (MNE) in the North, denoted as M, plans to produce a product (either intermediate or final) in the South due to cost advantages of manufacturing there. Production in the South requires in each period the services of a local agent/manager, denoted as A, and two types of asset services: physical capital, K and knowledge capital or intellectual property, S. Physical capital can be owned either by the MNE or by the local agent; intellectual capital is initially owned by the MNE.

There are two periods of production, $t = 1, 2$, and there is no discounting. At the beginning of $t = 1$, M makes a once-for-all choice between two possible organizational forms: foreign direct investment (FDI) or outsourcing. With FDI, M acquires (and owns) the physical capital used for production in the South and employs A under a one-period employment contract to manage a production process utilizing M's capital. Both capital acquisition and A's hiring occur at the beginning of $t = 1$. A's employment contract is re-negotiated at the beginning of $t = 2$. M also decides each period how much intellectual capital to transfer to A to be utilized in production. With outsourcing, A acquires (and owns) the physical capital, with capital acquisition again occurring at the beginning of $t = 1$. M signs a one-period licensing contract with A that licenses an amount s_1 of M's intellectual capital to A for use in production at $t = 1$. This licensing agreement is re-negotiated at the beginning of $t = 2$, with an amount s_2 transferred at $t = 2$.

In our model to come, stronger foreign patent rights and intellectual property protection can be thought of as increasing x, thus making outsourcing more attractive, a result consistent with these empirical findings.

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As in Grossman and Hart (1989), ownership of physical capital bestows control rights on the owner. Specifically, the owner can decide the uses to which the capital can be put and can exclude access to the capital for any other uses at any time. That having been said, the owner cannot typically control how intensively the capital is used in a given activity. We capture these features of physical capital by assuming that there is an exogenous and fixed amount, $K = \overline{K}$, that is required to produce in any period. We think of this assumption on capital as simple means of capturing some characteristic of the production technology used in the industry in which M operates. The cost of K is r per unit and the owner of K decides in what production activities K is used. Production at $t = 1$ results in depreciation of the physical capital asset. The extent of depreciation depends on effort, e, exerted by A in using the asset "properly". The amount of capital passing into period 2 is given by $K_2 = \overline{K} - \delta\overline{K}(1 - e)$. Since an amount $\overline{K}$ is required for production in each period, the less effort exerted by A, the higher are the capital costs for the owner of capital at $t = 2$. Effort is unobservable by M and so uncontractible for M; effort is costly for A, with effort cost given by the increasing, convex function $C = c(e) > 0$.

Intellectual capital, by contrast, does not have the same excludability properties. The owner of intellectual capital may not be able to control to the same extent the uses to which the capital is put and to capture the returns that the intellectual capital generates. In essence, property rights to intellectual capital are harder to define and protect than is the case for physical capital. We capture these features of intellectual capital in the following way. We assume that, at $t = 1$, there exists a fraction $x < 1$ of S that is "explicit knowledge"

in the sense that the uses of this part of M's intellectual capital can be defined in a $t = 1$ licensing agreement, they can be measured and the returns appropriated by M. In this sense, the fraction x of M's intellectual capital can be "owned" in the same way as physical capital is owned. A fraction $1 - x$ of S is "tacit knowledge" and is not contractible at $t = 1$ in the sense that its current and future uses cannot be controlled by M in a $t = 1$ licensing agreement and any returns that it generates cannot be specifically appropriated by M in the agreement. The value of x is assumed to be exogenous to the firm and can be thought of as capturing either characteristics of the intellectual capital utilized by M or a characteristic of the legal regime of the country in which M is contracting. For simplicity, we assume that all intellectual capital is contractible at $t = 2$. We assume further that M is endowed with 1 unit of intellectual capital: $S = 1$.

The fact that M cannot fully control A's use of intellectual capital at $t = 1$ becomes relevant if there is some use to which A can ultimately put the intellectual capital for which the benefits to A are not fully appropriable by M. To capture this possibility, we assume that, through the process of producing at $t = 1$, A generates new intellectual capital at $t = 2$. This new capital generates potential private, in the sense of not capturable by M in the licensing agreement, benefits to A given by $B(K_B, s_1) \geq 0$. Given the features of intellectual capital, we assume that $B(K_B, s_1) = 0$ for $s_1 \leq x$ while $B(K_B, s_1) > 0$ for $s_1 > x$. We also assume that $B(K_B, s_1) = 0$ for $K \leq \overline{K}$ (the capital requirement) and that, if permitted by the contract, A can use the same capital for both this private project as well as for M's activity.

Note that this set of assumptions allows a simple characterization of the environment in which M and A operate. Specifically, the values of $\overline{K}$ and x completely define the environment – characteristics of the relevant industry – under consideration. The value of $\overline{K}$ gives the physical relative to intellectual capital intensity of the industry and x features of the appropriabilty of M's intellectual asset. Subsequent analysis will consider how variation in the economic environment – variation in $(\overline{K}, x)$ pairs – affects the observed pattern of outsourcing and FDI.

The gross surplus that accrues to M and A from production at $t = 1$ is given by $U(\overline{K}, s_1) \geq 0$, with $U(K, s_1) = 0$ for all $K < \overline{K}$, $U(\overline{K}, 0) = 0$ and $U_2 > 0$. The gross common (i.e., excluding any private benefits that may accrue to A) surplus accruing to M and A should they contract at $t = 2$ is given by $V(\overline{K}, s_2) - \alpha B(K_B, s_1) > 0$, with $\alpha \geq 1$, $V_2 > 0$ and $V(K, s_1) = 0$ for all $K < \overline{K}$, $V(\overline{K}, 0) = 0$. The assumptions that surplus cannot be generated by intellectual capital alone and that surplus is increasing in s captures the idea that physical and intellectual capital are complements in our setting.

If M chooses FDI at $t = 1$, then we assume that there is a perfectly elastic supply of agents with opportunity cost $W \geq 0$ available to M in each period to utilize as employees. Should M choose outsourcing at $t = 1$, then, again, we assume that A has an opportunity cost of W at $t = 1$ (and of at least W at $t = 2$). In both the case of FDI and outsourcing, we assume that the agent not owning capital at $t = 1$ (M in the case of outsourcing and A in the case of FDI) is not able to raise the amount $\overline{K}$ sufficiently quickly to be able to produce alone at $t = 2$. This fact produces a (potential) specific relationship between M and A at

$t = 2$. In this case, the $t = 2$ surplus is allocated based on the Nash bargaining solution. Both A and M are risk neutral and make choices to maximize expected income.

The timing of decisions in the game is as follows: At the beginning of $t = 1$, M chooses between FDI and outsourcing. If M chooses FDI, then M offers A an employment contract involving payment to A at the end of the period of w_1; if M chooses outsourcing, M and A negotiate a contract involving a transfer to A of intellectual capital, s_1, and a licensing payment from A to M of ℓ_1. In either case, should A accept the contract, A chooses an effort level e, M chooses the level of intellectual capital to use (this level is determined by the licensing contract under outsourcing) and the surplus $U(\overline{K}, s_1)$ is realized. At the beginning of $t = 2$, the capital stock outcome $K_2 = \overline{K} - \delta\overline{K}(1 - e)$ is realized. Under FDI, M offers A a second employment contract involving a payment w_2, whose value can be conditioned on the realization K_2, and a specification of the uses to which A can put M's physical capital. If A accepts, M again chooses a level of intellectual capital utilization for A and M's joint activity and invests in new capital $\delta\overline{K}(1-e)$ while A engages in any private activities permitted by the contract. Surpluses $V(\overline{K}, s_2) - \alpha B(K_B, s_1) - r\delta\overline{K}(1 - e)$ and $B(K_B, s_1)$ are realized. Under outsourcing, M and A negotiate a second contract involving a transfer to A of intellectual capital, s_2, and a licensing payment from A to M of ℓ_2. If the contract is agreed to, A invests in new capital $\delta\overline{K}(1 - e)$ while M transfers intellectual capital s_2. A also undertakes any feasible private activities. Finally, payoffs are realized as above. Transfers at $t = 2$ are determined via the Nash bargaining solution. In all cases, the equilibrium levels of e, s_1, s_2 are the result of Subgame Perfect Nash equilibrium strategy

choices by A and M.

3 Analysis

We begin by analyzing the complete contracting case so as to provide a benchmark for the subsequent analysis of the incomplete contracting situation. For the incomplete contracting case, we analyze first the FDI contract equilibrium and then the outsourcing equilibrium. Finally, we compare equilibrium payoffs for M and determine the situations in which M prefers FDI to outsourcing.

3.1 The complete contracting case

The complete contracting solution is given as the solution to the problem

$$\max_{e,s_1,s_2} U(\overline{K}, s_1) + V(\overline{K}, s_2) + (1-\alpha)B(K_B, s_1) - c(e) - r\delta\overline{K}(1-e)$$

Since both $U(\overline{K}, s_1)$ and $V(\overline{K}, s_2)$ are increasing in s and M can control whether or not A uses S for private purposes with complete contracting, M chooses $s_1 = s_2 = 1$. Further, since $\alpha \geq 1$, the contract prohibits A from undertaking the private project as doing so decreases total surplus. The level of effort for A is is given by e^*, defined by the condition

$$r\delta\overline{K} = c'(e^*). \tag{1}$$

3.2 Equilibrium under FDI

We begin by analyzing the equilibrium contract at $t = 2$. Since M owns the physical asset under FDI, M can control the use of K at $t = 2$. Given $\alpha > 1$, even were M able to capture all of A's benefit, $B(\cdot)$, M would be worse off allowing A to utilize M's capital than not. As a result, the contract that M offers A restricts A to using K only for M's project (i.e., the contract prohibits a from using K in A's private project). Formally, the contract sets $K_B^F = 0$, implying that $B\left(K_B, s_1\right) = B\left(0, s_1\right) = 0$ for all s_1. Further, since $V_2(\overline{K}, s_2) > 0$, M chooses intellectual capital transfer of $s_2^F = 1$. Finally, since the contract prohibits A from pursuing any private activity, A's outside option is simply W. As a result, the contract that M offers A involves a payment $w_2^F = W$. M's payoff at $t = 2$ is, therefore, $V\left(\overline{K}, 1\right) - r\delta\overline{K}(1 - e) - W$.

At $t = 1$, M will optimally choose $s_1^F = 1$, since $U(\overline{K}, s_1)$ is increasing in s_1 and the payoff at $t = 2$ is independent of the value of s_1. Further, since effort is costly for A and A's compensation at $t = 2$ is independent of e, A will choose $e^F = 0$. M, recognizing this fact, offers a payment of $w_1^F = W$. M's two period payoff from choosing FDI is $\Pi_M^F = U\left(\overline{K}, 1\right) + V\left(\overline{K}, 1\right) - r(\overline{K} + \delta\overline{K}) - 2W$. We summarize these results below

Proposition 1 *Under the FDI option, the unique equilibrium contract pair is* $s_1^F = s_2^F = 1$, $w_1^F = w_2^F = W$ *and* $K_B^F = 0$. *Under this contract, A chooses effort level* $e^F = 0$ *and M's equilibrium payoff is* $\Pi_M^F = U\left(\overline{K}, 1\right) + V\left(\overline{K}, 1\right) - r(\overline{K} + \delta\overline{K}) - 2W$.

Note that, under FDI, the equilibrium contract is a standard wage-employment contract. The agent employee exerts no effort in maintaining physical capital and undertakes no tasks other than those involved in working directly for M. The contract allows M, via control of

physical capital, to control the use of M's intellectual capital. As such, the contract exhibits the oft discussed features of an insourced activity (see Williamson (198): low-powered incentives (and so problems of moral hazard) but control over asset use.

3.3 Equilibrium under outsourcing

Unlike the case of FDI, under outsourcing, A now owns the physical capital while M still owns the intellectual capital. This ownership difference impacts both the ability of M to control the use of intellectual capital and the incentives that A has to invest in maintaining physical capital. To see the overall effect of this ownership difference, consider the equilibrium contract at $t = 2$. Since A owns the physical capital, A can control the use of K and so can credibly threaten to use K for own purposes if $s_1 > x$ (recall that M maintains control of all intellectual capital if $s_1 \leq x$). Indeed, A will choose this option unless the contract at $t = 2$ provides A with sufficient inducement not to do so. Specifically, if M and A fail to reach an agreement at $t = 2$ and $s_1 > x$, then A can use the intellectual capital not controlled by M under the initial licensing agreement either to produce an imitation of M's product, yielding return to A of $V\left(\overline{K}, s_1 - x\right)$, or for the private purpose, yielding return $B\left(K_B, s_1\right)$, or for both. Since $\alpha > 1$, the best choice for A if there is no agreement with M at $t = 2$ is to produce the imitation only and obtain gross payoff $V\left(\overline{K}, s_1 - x\right)$. This payoff forms A's threat point in the bargaining with M.

Should A receive at least $V\left(\overline{K}, s_1 - x\right)$ in the licensing agreement, M and A will contract at $t = 2$. Since $\alpha \geq 1$ and $V(\cdot)$ is increasing in s, it will be in both M's and A's interest whenever $s_1 > x$ to have a contract that stipulates that $K_B^O = 0$ and $s_2 = 1$. Again,

however, A must receive sufficient return in the contract to choose $K_B^O = 0$. By choosing $K_B^O = \overline{K}$, A can guarantee a payoff of $B\left(\overline{K}, s_1\right) + V\left(\overline{K}, s_1 - x\right) + [V\left(\overline{K}, 1\right) - \alpha B\left(\overline{K}, s_1\right) - V\left(\overline{K}, s_1 - x\right)]/2$ in the Nash bargaining. Therefore, A must receive at least this amount to be induced to agree to a contract having $K_B^O = 0$. Together, these results yield an equilibrium contract at $t = 2$ given as follows:

Proposition 2 *Under outsourcing and with $s_1 > x$, the unique equilibrium contract at $t = 2$ yields $s_2 = 1$, $K_B^O = 0$ and licensing payment ℓ_2 such that M's payoff is $[V\left(\overline{K}, 1\right) - V\left(\overline{K}, s_1 - x\right) - B\left(\overline{K}, s_1\right)/2$ and A's (gross) payoff is $[V\left(\overline{K}, 1\right) + V\left(\overline{K}, s_1 - x\right) + B\left(\overline{K}, s_1\right)/2$*

In order to undertake production at $t = 2$, A must invest in replacement capital and so incurs capital cost, under any scenario, of $r\delta\overline{K}(1 - e)$. As a result, A's net payoff under the equilibrium contract at $t = 2$ is $[V\left(\overline{K}, 1\right) + V\left(\overline{K}, s_1 - x\right) + B\left(\overline{K}, s_1\right)/2 - r\delta\overline{K}(1 - e)$.

Two features of the equilibrium contract at $t = 2$ are worth noting. First, if $s_1 > x$, then a higher s_1 reduces $M's$ equilibrium payoff at $t = 2$. This occurs through two channels. First, since A already possesses $s_1 - x$ knowledge capital that cannot be taken back by M, it makes A less dependent on M's knowledge capital in production. This means A will pay a lower license fee to M for the (main) production. Second, s_1 enables A to have an outside project that reduces M's value and so again lowers the license fee. The other feature worth noting is that A is the residual claimant on the returns to effort. Since A also bears the full cost of effort, A will have incentives to exert the first-best effort level. This is shown below.

Turning to the $t = 1$ contract, since there is a perfectly elastic supply of agents at $t = 1$ and intellectual capital is fully contractible for $s_1 \leq x$, M captures all incremental returns to the use of intellectual capital for $s_1 \leq x$: for $s_1 \leq x$, M's licensing revenues at

$t = 1$ are $U\left(\overline{K}, s_1\right) - r\overline{K} - W$. Since $U(\cdot)$ is increasing in s_1, M will choose to license at least x units of intellectual capital. Since M cannot commit to transferring any $s_1 > x$ ($s_1 > x$ is not contractible) nor capture returns at $t = 1$ from doing so and since M's returns at $t = 2$ are decreasing for $s_1 > x$, the equilibrium licensing contract at $t = 1$ is $(l_1^*, s_1^*) = \left(U\left(\overline{K}, x\right) - r\overline{K} - W, x\right)$.

Under the equilibrium pair of outsourcing contracts, A's payoff is $\Pi_A^O = V\left(\overline{K}, 1\right)/2 - r\delta\overline{K}(1-e) - c(e) - W$. A's effort choice, therefore, is given by the condition $c'(e^*) = r\delta\overline{K}$, resulting in the the first-best level of effort. $M's$ payoff from outsourcing is then $\Pi_M^O = U\left(\overline{K}, x\right) - r\overline{K} - W + V(\overline{K}, 1)/2$. The results for the outsourcing contract are summarized below.

Proposition 3 *Under the outsourcing option, the unique equilibrium contract pair is* $(l_1^* = U\left(\overline{K}, x\right) - r\overline{K} - W,\ s_1^* = x)$, $(\ell_2^* = V\left(\overline{K}, 1\right)/2,\ s_2 = 1)$. *The equilibrium effort choice by* A *is* e^* *and equilibrium payoffs are* $\Pi_A^O = V\left(\overline{K}, 1\right)/2 - r\delta\overline{K}(1-e^*) - c(e^*) - W$ *and* $\Pi_M^O = U\left(\overline{K}, x\right) - r\overline{K} - W + V(\overline{K}, 1)/2$.

Note that outsourcing generates efficient effort by the agent but leads to inefficient transfer of intellectual capital. FDI, by contrast, leads to efficient transfer of intellectual; capital but shirking by the agent. Below we investigate the circumstances under which one option is preferred to the other.

3.4 Equilibrium Choice of Organization Form

To determine M's choice between FDI and outsourcing, consider the payoff difference under the two options. This difference is given by

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$$\begin{aligned}\Pi_M^F - \Pi_M^O &= [U\left(\overline{K},1\right) + V\left(\overline{K},1\right) - r\overline{K}(1+\delta) - 2W] - [U\left(\overline{K},x\right) - r\overline{K} - W + .5V(\overline{K},1)] \\ &= .5V\left(\overline{K},1\right) - r\delta\overline{K} + [U\left(\overline{K},1\right) - U\left(\overline{K},x\right)] - W\end{aligned}$$

In the above expression, the term $U\left(\overline{K},1\right) - U\left(\overline{K},x\right) > 0$ represents the gain from FDI due to better intellectual capital transfer. The term $.5V\left(\overline{K},1\right) - W > 0$ represents the increased surplus accruing to M due to avoidance of hold-up under FDI created by the fact that M owns the complementary capital. the term $r\delta\overline{K}$ represents the cost of FDI due to agent shirking under FDI. When $U\left(\overline{K},1\right) - U\left(\overline{K},x\right) + .5V\left(\overline{K},1\right) - W > r\delta\overline{K}$, then M chooses FDI; when $U\left(\overline{K},1\right) - U\left(\overline{K},x\right) + .5V\left(\overline{K},1\right) - W < r\delta\overline{K}$, M chooses outsourcing.

To proceed further with an analysis of the environments – $\overline{K}, x$ pairs – in which M chooses FDI or outsourcing, we need to make some assumptions about the ways that gross surplus varies over this space. Specifically, we need to make assumptions on the behavior of $U\left(\overline{K},1\right) - U\left(\overline{K},x\right)$ and $V\left(\overline{K},1\right) - r\delta\overline{K}$. Recall that environments with larger values of $\overline{K}$ represents ones in which the production technology is more physical capital, relative to intellectual capital, intensive. Based on this notion, we assume in what follows that i) for any value of x and for all $\overline{K}$, $U\left(\overline{K},1\right) - U\left(\overline{K},x\right)$ is non-increasing in $\overline{K}$ and ii) $V\left(\overline{K},1\right) - r\delta\overline{K}$ is decreasing in $\overline{K}$. The first condition states that, the more physical capital intensive is the industry, the less impact reductions in intellectual capital have on gross surplus in the first period. In essence, this condition represents our definition of physical capital intensive industries. The second condition implies that the moral hazard problem is more severe for industries that are more physical capital intensive.

Given these conditions, we have the following result:

Result 1 *The incentive for M to choose FDI relative to outsourcing is greater when (i) $\overline{K}$ is lower and/or (ii) when x is lower.*

Put simply, FDI becomes more attractive to M as M's product is intensive in intellectual capital and/or intellectual capital is difficult for M to control under a licensing agreement. When M's activity is either extremely intensive in physical capital or intellectual capital is easy to protect under a licensing agreement, outsourcing becomes more attractive to M. Indeed, given our conditions on $U(\cdot)$, we can show the following:

Proposition 4 *For all $x \in [0,1)$, there exist values $K_1(x), K_2(x)$ with $0 < K_1(x) < K_2(x) < \infty$ such that FDI is chosen for any $\overline{K} \leq K_1(x)$ and outsourcing is chosen for any $\overline{K} \geq K_2(x)$. For all $\overline{K} > 0$, there exists a value $x(\overline{K}) < 1$ such that outsourcing is chosen for any $x \geq x(\overline{K})$ and FDI is chosen for any $x < x(\overline{K})$.*

Together, the above proposition implies that FDI is the preferred choice for M when M's product is intensive in intellectual capital and intellectual capital is difficult for M to control under a licensing agreement. When M's activity is either extremely intensive in physical capital or intellectual capital is easy to protect under a licensing agreement, outsourcing is M's preferred choice. Thus, for instance, we see the manufacturing of standard electronics equipment such as DVD players, CD players and regular TV's outsourced as are items like Nike or Adidas athletic shoes. In all of these cases, production is physical capital intensive and, what intellectual capital there is, is easily controlled under a licensing agreement. We do not see Microsoft outsourcing the writing of its operating systems.

An implication of this result is the following. Imagine two firms in different industries that are equally intensive in physical capital – have the same values of $\overline{K}$ – but have different

value of x. Firm 1 is in an industry in which $x < x(\overline{K})$ while Firm 2 is in an industry for which $x > x(\overline{K})$. In this case, Firm 1 chooses FDI while Firm 2 chooses outsourcing. This makes Firm 1 look different from Firm 2 in several ways at $t = 1$. First, Firm 1 will have higher returns at $t = 1$ than Firm 2 ($U\left(\overline{K}, 1\right) > U\left(\overline{K}, x\right)$). Second, since intellectual capital greater than x is tacit, Firm 1's book value (physical capital value plus the value of explicit intellectual capital) at $t = 1$ will be lower than Firm 2's. These two facts combined suggest a relationship between Tobin's q and outsourcing – firm's with high Tobin's q are more likely to be using FDI while firm's with low Tobin's q are more likely to be outsourcing.

4 Conclusion

In this paper we have examined how the non-excludability of intellectual property leads to the ownership of a complementary asset, in our case capital, as a means of protecting intellectual property. The result we find is that firms that are largely dependent on intellectual property for their returns will protect these returns by engaging in FDI rather than outsourcing. The ownership of capital protects the returns of the complementary asset, intellectual property. The cost of this ownership is weak incentives for firm management. Firms whose returns rely little on intellectual property and mainly on physical capital outsource to provide stronger management incentives. An implication of these facts is that firms that choose FDI will have larger values of Tobin's q, all else equal, than will firms that outsource.

References

[1] Antrás, Pol (2003), "Firms, Contracts, and Trade Structure", Quarterly Journal of Economics 118, 1375-1418.

[2] Antrás, Pol (2005), "Incomplete Contracts and the Product Cycle", American Economic Review 95, 1054-1071.

[3] Caves, Richard E.(2007), Multinational Enterprise and Economic Analysis. Cambridge: Cambridge University Press, third edition.

[4] Davidson William H. and Donald G. McFetridge (1984), "International Technology Transactions and the Theory of the Firm", Journal of Industrial Economics 32, 253-264.

[5] Ethier, Wilfred J. and James R. Markusen (1996), "Multinational Firms, Technology Diffusion and Trade," Journal of International Economics 41, 1-28.

[6] Feenstra, Robert C. and Gordon H. Hanson (2005), "Ownership and Control in Outsourcing to China: Estimating the Property-Rights Theory of the Firm", Quarterly Journal of Economics 120, 729-761.

[7] Ferrantino, Michael J., (1993), "The Effect of Intellectual Property Rights on International Trade and Investment", Weltwirtschaftliches Archiv 129, 300-331.

[8] Lee, J.-Y. and Edwin Mansfield (1996), "Intellectual Property Protection and U.S. Foreign Direct Investment", Review of Economics and Statistics 78, 181-186.

[9] Fosfuri, Andrea, Massimo Motta and Thomas Rønde (2001), Foreign direct investments and spillovers through workers' mobility, Journal of International Economics 53, 205-222.

[10] Glass, Amy J. And Kamal Saggi (2002), "Multinational firms and technology transfer", Scandinavian Journal of Economics 104, 495-513.

[11] Grossman, Sanford J. and Oliver D. Hart (1986), "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration, Journal of Political Economy 94,: 691-719.

[12] Grossman, Gene and Elhanan Helpman (2002), "Integration versus Outsourcing in Industry Equilibrium", Quarterly Journal of Economics 117, 85-120.

[13] Grossman Gene M. And Elhanan Helpman (2004), "Managerial incentives and the international organization of production", Journal of International Economics 63, 237-262.

[14] Hart, Oliver D. and John Moore (1990), "Property Rights and the Nature of the Firm", Journal of Political Economy 98, 1119-1158.

[15] Horstmann, Ignatius J. and James R. Markusen (1987), "Licensing Versus Direct Investment: A Model of Internalization by the Multinational Enterprise," Canadian Journal of Economics 20, 464 481.

[16] Mansfield, Edwin and Anthony Romeo (1980), "Technology Transfer to Overseas Subsidiaries by U.S. Firms", Quarterly Journal of Economics 94, 737-750.

[17] Mansfield, Edwin (1984), "R&D and Innovation: Some Empirical Finding", in Zvi Grilliches (editor), R&D, Patents and Productivity, Chicago: University of Chicago Press, 127-148.

[18] Markusen, James R. (1995), "The Boundaries of Multinational Enterprises and the Theory of International Trade", Journal of Economic Perspectives 9, 169-189.

[19] Markusen, James R. (2001), "Contracts, Intellectual Property Rights, and Multinational Investment in Developing Countries", Journal of International Economics 53, 189-204.

[20] Markusen, James R. (2002), Multinational Firms and the Theory of International Trade, Cambridge: MIT Press.

[21] Maskus, Keith E, Kamal Saggi and Thitima Puttitanun (2005), "Patent Rights and International Technology Transfer through Direct Investment and Licensing", in Keith E. Maskus and Jerome H. Reichman (editors), International Public Goods and Transfer of Technology under a Globalized Intellectual Property Regime, Cambridge: Cambridge University Press, 265-281.

[22] Morck, Randall and Bernard Yeung (1991), "Why Investors Value Multinationality", Journal of Business 64, 165-187.

[23] Morck, Randall and Bernard Yeung (1992), "Internalization: An Event Study", Journal of International Economics 33, 41-56.

[24] Smith, Pamela (2001), Patent rights and bilateral exchange: a cross-country analysis of U.S. exports, FDI, and licensing, Journal of International Economics, forthcoming.

[25] Teece, David (1986), The Multinational Corporation and the Resource Cost of International Technology Transfer, Cambridge: Ballinger.

[26] Wilson, Robert W. (1977), "The Effect of Technological Environment and Product Rivalry on R&D Effort and Licensing of Inventions", Review of Economics and Statistics 59, 171-78.

[27] Yang, G. F. And Keith E. Maskus (2001), "Intellectual property rights and licensing: An econometric investigation", Weltwirtschaftsliches Archiv 137, 58-79.