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# Knowledge Spillovers and FDI Ownership

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# Knowledge Spillovers and FDI Ownership

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**Abstract**

Responding to a rapidly increasing empirical literature, this paper is one of the first studies to formally model the relationship between knowledge spillovers and Foreign Direct Investment (FDI) ownership. In contrast to existing studies, we assume a concave relationship between ownership and knowledge spillovers, which we use to derive the levels of ownership at which Multinational Entreprises (MNEs) are willing to participate in FDI ventures. We also take explicit account of absorptive capacity considerations. Our findings indicate that MNEs typically choose for either high or low degrees of ownership (integration) when knowledge spillovers matter. Only when their activities are sufficiently subsidized, or when the absorptive ability of local firms is very low, will MNEs opt for more equally owned foreign ventures. Utilizing a dataset of firms in 22 transition countries, we then test these propositions. The empirical evidence indeed largely supports our theoretical results. One of the policy implications of our model is that ownership requirements imposed by governments in transition countries may have adverse effects on inward FDI.

**Key-Words:** Knowledge spillovers, multinationals, ownership, transition countries

**JEL-Codes:** F23, L23, O33

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# 1 Introduction

Recent surveys of the literature regarding knowledge spillovers from FDI have concluded that there exists little consensus about the magnitude, direction or even the existence of knowledge spillovers (Barba Navaretti and Venables, 2004; Görg and Greenaway, 2004). This may in part be caused by econometric problems. Specifically, it has been argued that results depend crucially on the use of cross-section versus time-series data, or on the way in which multinational presence is measured (Görg and Strobl, 2001). Additionally, the intangible nature of knowledge spillovers impedes proper measurement and accordingly, precise empirical estimation.

Although measurement and methodological problems are potentially valid reasons for the lack of consistency in empirical results, in this paper we put forward a theoretical explanation, that deals with the relationship between knowledge spillovers on the one hand, and different types of FDI on the other. Specifically, we argue that differing degrees of FDI ownership give rise to different amounts of knowledge spillovers. This observation is based on two grounds: First, some knowledge spillover channels are relevant for some types of FDI, whereas they are irrelevant for others. Second, the large tacit component in knowledge spillovers will cause differences in spillovers between various types of FDI.

More recently, some studies have taken acknowledged the relationship between knowledge spillovers and FDI ownership. Müller and Schnitzer (2006) develop a theoretical model in which they consider a Joint Venture (JV) between a MNE and a Host Country (HC). They study the effects of spillovers and ownership on the amount of technology transfer (by MNE) and on the profits for both MNE and HC. They show, inter alia, that MNE's profits strictly increase in ownership and strictly decrease in spillovers but that HC, by engaging in active tax or investment policy, can change MNE's incentives to the advantage of HC. Specifically, although spillovers increase when the MNE decreases its share of ownership, it may become optimal for MNE to share ownership with HC, thus providing a rationale for a joint venture. Accordingly, HC can benefit from increased spillovers through active policy.

Empirically, the relationship between knowledge spillovers and ownership has been studied as well, but the results vary. Blomström and Sjöholm (1999) do not find any evidence of a relationship, whereas Dimelis and Louri (2002) find evidence of minority ownership inducing intra-industry spillovers, in contrast to majority foreign-owned firms. At the other end of the spectrum, Javorcik and Spatareanu (2003) and Javorcik (2004*a*) find evidence of fully foreign-owned firms inducing intra-industry spillovers, whereas partial ownership induces inter-industry spillovers.

A common element in all these studies is that initially a linear relationship between foreign ownership and (intra industry) knowledge spillovers is assumed, i.e. either increased ownership increases spillovers due to an increase in technology transfer by the MNE, or it decreases spillovers due to an increase in MNE control (cf. Javorcik, 2006).[1] Our analysis deviates from these studies in that we argue that the relationship between ownership and spillovers is not linear, but curvilinear (concave). Moreover, we also incorporate absorptive ability as a factor influencing knowledge spillovers in our model, which has been shown to be relevant (Cohen and Levinthal, 1989; Grünfeld, 2003; Keller, 2004). Additionally, the number of host country firms will be of some importance, as this influences MNE profits.

Our theoretical model shows that MNEs will typically choose rather extreme degrees of integration when engaging in a foreign venture. That is, they will usually require fairly high or fairly low degrees of ownership. Only when sunk costs or absorptive ability are sufficiently low will the MNE be willing to invest at more equal degrees of ownership. All this is due to the perceived spillover threat of engaging in equally owned joint ventures.

Since many transition countries have functioned as important hosts of FDI in recent years, as well as the fact that governments of some of these countries have been known to impose ownership requirements on foreign investors, they provide an interesting setting to empirically test our model. Employing a dataset of approximately 400 firms in 22 transition countries, the empirical results point

[1] In fact, this dichotomy in the relationship is the reason for Blomström and Sjöholm (1999) to have no *ex ante* expectation regarding the sign of the relationship.

out that the relationship between FDI ownership and knowledge spillovers may be concave, implying that more equally owned types of FDI potentially create the largest spillover gains for the local partner.

From a policy perspective, we find - in accordance with Müller and Schnitzer (2006) - that FDI policy in the host country can (partly) align the interests of the MNE and its foreign partner, but that there exists a trade-off between such FDI policy and host country policy aimed at increasing the absorptive ability of local firms. Moreover, requiring shared ownership may have adverse effects, leading the MNE to invest in another country since the original investment may no longer be profitable. Instead, subsidizing the FDI project, investing in local absorptive ability or improving the quality of local institutions may sort larger gains for the transition country.

The remainder of this paper is structured as follows. In Section 2 we introduce the theoretical model. Section 3 discusses the model implications and derives three testable propositions. Section 4 presents the empirical analysis and a discussion of the results. Section 5 addresses some policy implications that follow from our model. Finally, Section 6 concludes.

# 2 The model

This section describes the model that derives the relationship between knowledge spillovers and FDI ownership. Unlike earlier models in this vein (cf. Blomström and Sjöholm, 1999; Dimelis and Louri, 2002; Javorcik, 2004*a*; Javorcik and Spatareanu, 2003; Müller and Schnitzer, 2006) we deviate from the assertion that this relationship is linear and instead propose a curvilinear, concave relationship. Before explaining the rationale for this approach, we first discuss the model setup.

When faced with the choice of investing abroad, the MNE essentially makes two decisions: It decides whether or not to engage in FDI and (provided that it decides to invest) at what degree of integration (i.e. ownership) to do so. In our model, the integration decision is only determined by knowledge spillover considerations and, as we will discuss below, follows directly from the investment decision. As a starting point, we consider technological space in the host country in which the MNE is considering to invest. The location of both the MNE and its potential partner firm in technological space is modeled in a Hotelling-like fashion (Hotelling, 1929). Specifically, we assume that the $n$ host country firms are located at equal distances from each other and that their location is fixed along a line. Without loss of generality we normalize the length of this line to 1 so that the distance between two local firms becomes $1/n$.[2] Accordingly, for $n \geq 2$ (an assumption that we will make throughout the paper), the MNE will always locate in between two local firms. Technological distance $x$ is then defined as the distance between the MNE and the local firm that it is closest to, i.e. $0 \leq x \leq 1/2n$. Given that the MNE decides to invest (which it will only if net profits are nonnegative, an issue that we will return to later) the problem it faces is to choose the degree of integration that maximizes profits net of knowledge spillovers. This calls for a relationship between knowledge spillovers and the degree of integration.

The linear relationship that is hypothesized in much of the earlier literature is based on the view that either higher integration gives the MNE more control over the transferred knowledge and consequently leads to less knowledge spillovers, or that higher integration will induce the MNE to transfer more of its own technology to the foreign JV and hence lead to higher spillovers.[3] Accordingly, the sign of the relationship has been left as an empirical matter, but the evidence - as was mentioned before - is ambiguous.

In this paper we argue that the linearity assumption (either positive or negative) may be wrong for two reasons. The first reason hinges on the fact that the linearity assumption fully disregards the different channels through which knowledge spillovers from FDI occur. The tree main channels that have been distinguished in previous literature are labor turnover, vertical linkages and demonstration effects (Djankov and Hoekman, 2000; Saggi, 2002). Taking these into account, it can be argued that

[2] We ignore endpoint problems because our focus is on the MNE's location decision between two host firms, and not on modeling competition between host firms.

[3] Note that there is an explicit distinction between a knowledge *transfer* and a knowledge *spillover*. The former is a purposeful transmission of knowledge, either from the parent to the JV or between the JV partners. The latter is an externality, i.e. an unconscious diffusion of knowledge from one JV partner to the other. Accordingly, a knowledge spillover may be the result of a knowledge transfer.

different types of FDI (in terms of integration) lead to the (unintended) employment of different combinations of spillover channels. In fact, under the plausible assumption that, ceteris paribus, the degree of effective knowledge spillovers is positively related to the number of relevant knowledge spillover channels, we argue that intermediately integrated types of FDI potentially lead to the highest spillovers. The reason is that such types of FDI possibly employ all three distinguished knowledge spillover channels. Minority types of FDI on the other hand only lead to demonstration effects and vertical linkages, whereas majority types of FDI only trigger labor turnover as a spillover channel. Accordingly, we expect a curvilinear, concave relationship to appear between integration and knowledge spillovers due to the related number of spillover channels.

The second reason for such a relationship relies on the *tacit* component of knowledge, as opposed to its *codified* component. The tacit component of knowledge is embodied in people, routines and practices and requires informal and flexible mechanisms to spill over, such as personal interaction or communication. The codified component on the other hand is embodied in tangibles, such as blueprints and products, and more easily allows for spillovers through for instance reverse engineering or imitation (Makhija and Ganesh,1997). Given that codified knowledge spillovers can largely be prevented by means of patenting, this implies that a large part of spillovers are bound to be tacit. Hence those types of FDI that require intensive (and informal) communication and cooperation between all parties involved will potentially create the largest spillovers.[4] Such a situation will arise when the venture is more or less equally shared, giving another reason to expect a concave relationship between the degree of integration and knowledge spillovers.[5] Moreover, since such alliances are often aimed at creating synergies through learning (Makhija and Ganesh, 1997) they require some minimum amount of knowledge transfer (that is, *purposeful* knowledge

[4] Indeed, in a study of Danish telecommunication firms, Dahl and Pedersen (2004) find informal contacts between employees to be an important channel of knowledge difussion.

[5] A related argument put forward by, *inter alia*, Beamish and Banks (1987) and Blodgett (1992) is that International Joint Ventures (IJVs) with more equal ownership structures promote higher levels of trust between partners and hence lead to increased knowledge exchange.

transmission between the parties involved - see footnote 3). This knowledge transfer allows both parties to integrate the other's knowledge base and thereby further strengthens spillover potential, for instance by adding to the absorptive capacity of the local partner (Lane et al., 2001).[6]

Denoting the MNE's degree of integration by $I$ we can denote the concavity in $I$ by the following relationship:

$$g(I) = -I^2 + I \tag{1}$$

In our model, the degree of integration $I$ in turn is determined by the technological distance $x$ between the MNE and its local partner. We can model this relationship in two distinct ways. On the one hand, we could model a positive relationship between $I$ and $x$. The view that underlies such a relationship perceives technological proximity as an opportunity. This implies that the MNE values a partnership more when the partner is technologically more similar to the MNE. Accordingly, it will lower its degree of integration. Alternatively, one could argue that the MNE will consider technological proximity as a threat and thus increases its degree of integration when its partner is technologically more similar. This view is in line with more established theories of the MNE such as the OLI-paradigm (Dunning, 1977) and the knowledge-capital model of FDI (Markusen, 2001). Moreover, it also accords with arguments put forward by Makhija and Ganesh (1997) and Multinelli and Piscitello (1998) that asymmetry in capabilities between JV partners is one of the key motivations to form a JV in the first place. Therefore we specify a negative relationship between integration and technological distance: The larger the technological similarity between the partners, the higher the MNE´'s degree of integration, hence:

$$I = 1 - 2xn \text{ s.t. } 0 \leq x \leq 1/2n \tag{2}$$

Note that this formulation ensures that $I$ is bounded on the domain $[0, 1]$.

So far we have only considered the MNE´'s integration decision and its consequences for the

[6] Indeed, Lyles and Salk (1996) found evidence that IJVs with 50/50 ownership control had significantly higher levels of knowledge acquisition than majority controlled IJVs.

extent of spillovers. However, the local partner's ability to absorb external knowledge may be another factor influencing the degree of knowledge spillovers through partly-owned FDI (Cohen and Levinthal, 1989; Keller, 2004; Lane et al., 2001). Although this factor has not yet been explicitly taken into account in studies modeling the relationship between spillovers and FDI ownership, Dimelis and Louri (2002, p.466) hint at its importance: "Differences in responses [to differing degrees of foreign presence] between high and low productivity domestic firms should also be taken into account in the design of the appropriate [FDI] policy."

We split absorptive capacity into two components: absorptive ability and absorption potential. Both these components are related to the degree of technological similarity between the MNE and its partner: If both firms are technologically very similar absorptive ability is high because the partner firm is technologically able enough to absorb the MNE's knowledge. However, absorption potential is low in this case, due to the absence of a large technological gap (and thus learning potential) between the MNE and its partner. Conversely, if both firms are technologically very dissimilar, absorptive ability is low because the partner firm does not have the technological requirements to absorb the MNE's knowledge. But now, because of the presence of a large technological gap, absorption potential is high. Both effects combined therefore imply a curvilinear, concave relationship between technological distance and the amount of knowledge spillovers through absorptive capacity $h(x)$:

$$h(x) = x(\frac{1}{n} - ax) \text{ s.t. } a \geq 2 \tag{3}$$

where $a$ is the inverse of absorptive ability and the $x$ in front of the parentheses represents absorption potential. The inclusion of the term $1/n$ guarantees that $h(x)$ reaches its optimum within the domain of the model.[7] To see this, recall that technological distance $x$ is defined with respect to the local firm that is closest to the MNE, so that $0 \leq x \leq 1/2n$. Given our discussion of the curvilinearity

[7] This formulation also implies that absorptive capacity $h(x)$ decreases as the number of local firms $n$ increase. An intuition for this is that for a given amount of absorptive capacity, for instance in terms of skilled labor present in the host economy, an increase in $n$ will lead to a decrease in absorptive capacity per firm, due to a reallocation of skilled labor over the extended set of local firms.

between $S$ and $x$, this implies that $h(x)$ should reach its optimum within this interval: This is indeed guaranteed by the inclusion of the term $1/n$, given the restriction $a \geq 2$.

We are now able to construct a spillover function that depends both on the MNE's degree of integration $g(I)$ and the local partner firms' absorptive capacity $h(x)$:

$$S = F\left[g(I), h(x)\right] \tag{4}$$

For simplicity, we assume that $F(.)$ is a positive additive function of its arguments. Accordingly, using the formulations in (1), (2) and (3) we arrive at the following explicit formulation of the spillover function:[8]

$$S = -x^2(a+1) + \frac{3x}{2n} \tag{5}$$

Of course, the MNE's integration decision is not solely dependent on the amount of spillovers it faces. Therefore, we also introduce a simple profit function. We assume that JV profits (i.e. the profits of both the MNE and its partner firm) are positively related to technological distance $x$ (again in line with the need for asymmetry assumption) and negatively related to the total number of local firms (which represents a market stealing effect):

$$\pi_{JV} = \frac{x}{n} \tag{6}$$

The MNE's share of these profits is then proportional to its degree of ownership $I$, minus some amount of sunk costs $c$ that it has to incur when investing in the host country:

$$\pi_{MNE} = I\left(\frac{x}{n}\right) - c = -2x^2 + \frac{x}{n} - c \tag{7}$$

Note that the MNE profit function thus becomes a concave function of technological distance and also of the degree of integration (by virtue of (2)). This implies that increased technological

[8] While adding $g(I)$ and $h(x)$ we scale down the former by $4n^2$. The reason for doing so is that we have no *ex ante* motivation to expect a relationship between $S$ and $n$ through $I$. Indeed, the only reason for $2n$ to appear in (2) is to assure that $I$ is bounded on [0,1]. Hence by dividing $g(x)$ by $4n^2$ we get rid of the unwanted concave transformation on $2n$ in (2).

distance first leads to increased MNE profits (at a decreasing rate), then reaches a maximum and thereafter lowers MNE profits (at an increasing rate). This relationship is caused by two opposing effects following from an increase in $x$: On the one hand, an increase in $x$ induces an increase in $\pi_{JV}$ (and thus an increase in $\pi_{MNE}$) due to an increase in asymmetry between the MNE and its partner. On the other hand, an increase in $x$ also induces a decrease in $I$ and thus lowers MNE's share of $\pi_{JV}$. As long as the former effect outweighs the latter, MNE profits will increase.

An important implication from the concavity of MNE profits *and* knowledge spillovers with respect to $I$ is that we obtain potentially *two* MNE participation constraints. Without the presence of knowledge spillovers, the participation constraints could simply be derived from the condition that $\pi_{MNE} \geq 0$. However, since we explicitly allow for knowledge spillovers, this condition becomes $\pi_{MNE} - S \geq 0$. Note that when this condition is satisfied, not only do we know that the MNE will engage in FDI, but we can also immediately derive the degree(s) of integration at which it will do so. We illustrate this graphically by means of Figure 1 below.

**<< INSERT FIGURE 1 ABOUT HERE >>**

The solid curve in the figure denotes spillovers $S$ and the dashed curve denotes MNE profits $\pi_{MNE}$, both as a function of the degree of integration. The participation constraint is determined at the point where knowledge spillovers are equal to profits. From the figure it follows that there are potentially two participation constraints: One lower constraint $\hat{I}_L$ and one upper constraint $\hat{I}_U$. In between these two constraints, knowledge spillovers are larger than MNE profits and the MNE will not invest in the host country. Consequently, only for degrees of integration lower than $\hat{I}_L$ or above $\hat{I}_U$ will the MNE invest in the host country.

More formally, we can derive the participation constraints by letting $S$ in (5) equal $\pi_{MNE}$ in (7) and then using (2) to express the found $x$ values in terms of $I$. This yields:

$$\hat{I}_L = 1 - \frac{\Lambda^+}{(a-1)} \; ; \; \hat{I}_U = 1 - \frac{\Lambda^-}{(a-1)} \tag{8}$$

where

$$\Lambda = \frac{1}{2n} \pm \sqrt{\frac{1}{4n^2} + 4c(a-1)} \tag{9}$$

Note that the existence of either participation constraint is not guaranteed. In the Appendix we derive specific cost conditions to assure the existence of one or both of the participation constraints. Furthermore, we would like to note that the condition $\pi_{MNE} - S \geq 0$ is more restrictive than $\pi_{MNE} \geq 0$ iff $S \geq 0$. Indeed, in our model we only allow for positive knowledge spillovers. Negative spillovers would effectively imply knowledge spilling over from the partner firm to the MNE; although earlier literature has identified conditions under which this may happen (Driffield and Love, 2003; Fosfuri and Motta, 1999) it is not our present focus, since we assume that the MNE is technologically more advanced than its local partner.[9] Or, in the words of Kuemmerle (1999), in this paper we only consider *home-base-exploiting* FDI and not *home-base-augmenting* FDI.

# 3 Model implications

The model developed in the previous section yields some interesting implications, both from a policy perspective as well as from an empirical point of view. In this section we will discuss the comparative static properties of the model and derive some testable propositions. A discussion of the policy implications is postponed until Section 5.

In our model, three parameters determine the decision of MNEs to engage in FDI and their choice of ownership ($n$, $a$ and $c$). Since we have potentially two participation constraints, we also have to check the comparative statics for both. Table 1 below summarizes all the comparative static effects in our model, evaluated at the two participation constraints. What follows is a largely intuitive discussion of these effects. A more formal derivation of the comparative statics is relegated to the Appendix.

**<< INSERT TABLE 1 ABOUT HERE >>**

[9] This also seems an acceptable assumption in the case of most IJVs in transition countries, to which we will turn in Section 4.

First consider the influence of a change in the number of local firms $n$ on the two participation constraints. From the table it follows that the direction of change in the lower participation constraint, induced by an increase in $n$, depends on the level of sunk costs $c$. Specifically, as long as $c \leq 0$ this derivative is positive, implying that the lower participation constraint will increase following an increase in $n$.[10] Moreover, in the Appendix we show that $\hat{I}_U$ only exists for $c \leq 0$. Hence it follows that as long as both participation constraints exist (i.e. as long as $c \leq 0$), an increase in the number of local (competitor) firms will induce the MNE to invest at more equal degrees of integration. The reason for this is that an increase in $n$ will lead both JV profits and spillovers to decrease, but the latter decreases faster than the former.[11] Accordingly, given that *net* profits are thus increasing over the entire range of ownership structures, the MNE will be able to opt for more equal degrees of ownership while still obtaining nonnegative net profits. However, as soon as $\hat{I}_U$ disappears (i.e. as soon as $c > 0$), an increase in $n$ will cause the MNE to lower its degree of integration unambiguously, i.e. the sign of $\partial \hat{I}_L / \partial n$ becomes negative. Since $\hat{I}_L$ is located at relatively low degrees of integration, the MNE will opt for increasingly lower degrees of integration after an increase in $n$ to compensate the profit loss by a decrease in spillover costs.[12] Hence we arrive at the first testable proposition:

**Proposition 1** *An increase in the number of local (competitor) firms will have an ambiguous effect on the observed degree of MNE ownership in a JV between a MNE and a local firm.*

Second, consider the influence of a change in absorptive ability $1/a$ on the participation constraints. From the table it follows that a decrease in absorptive ability (i.e. an increase in $a$) will cause the MNE to invest at more equal degrees of ownership (i.e. $\hat{I}_L$ will shift up and $\hat{I}_U$ will shift

[10] It may appear nonsensical to allow for negative sunk costs. However, we explicitly consider these as they may be the result of government policies aimed at attracting FDI. Surely, such policies are readily observed in practice (Blomström and Kokko, 2003; Davies, 2005).

[11] From (7) and (5) it can be derived that, ceteris paribus, spillovers decrease by a fraction of 3/2 of JV profits.

[12] Recall from Figure 1 that $\hat{I}_L$ is located to the left of the spillover maximum. Accordingly, increasing integration would serve to increase spillover costs.

down). More equal ownership structures become more attractive, since now there is less potential of knowledge spilling over to the partner. Consequently, the cooperative gains motivation in favor of cooperation tends to dominate the spillover-hazard argument against cooperation as absorptive ability weakens. This yields the second proposition:

**Proposition 2** *An increase in the absorptive ability of the local partner firm will cause the MNE to choose more extreme (i.e. less equal) degrees of ownership in a JV with a local firm.*

Finally, consider the effect of a change in sunk costs. The table indicates that an increase in sunk costs will lead the MNE to invest at more extreme degrees of ownership (i.e. $\hat{I}_L$ will shift down and $\hat{I}_U$ will shift up). If the MNE is already highly integrated, increasing sunk costs will lead it to further increase its degree of ownership in order to recoup the increased sunk costs by capturing a larger part of JV profits. On the other hand, if the MNE has only a small degree of ownership to begin with, it will not choose to increase its degree of integration because in that case, knowledge spillovers will increase as well. Therefore it will further decrease ownership, thereby decreasing its spillover costs and thus compensating for the increased sunk costs. This leads to our third and final proposition:

**Proposition 3** *An increase in the sunk costs incurred by the MNE will cause the MNE to choose more extreme (i.e. less equal) degrees of ownership in a JV between a MNE and a local firm.*

If our assumptions regarding the concavity of the relationship between ownership and spillovers on the one hand, and profits and ownership on the other hand are correct, and consequently that our model implications hold as well, we should be able to corroborate the above propositions empirically. We turn to such an investigation in the next section.

# 4 Empirical evidence

In this section we will empirically test our theoretical model by investigating whether the propositions derived in Section 3 can be confirmed. As we already noted before, earlier papers have modeled or assumed a linear relationship between knowledge spillovers and ownership (Blomström and Sjöholm, 1999; Dimelis and Louri, 2001; Javorcik, 2004*a*; Javorcik and Spatareanu, 2003), but the evidence in favor of this linear relationship has been rather mixed. Therefore, our empirical investigation should be viewed primarily as a test regarding the validity of our hypothesized curvilinear relationship between ownership and knowledge spillovers.

## 4.1 Data and method

From an empirical point of view, the countries in Central and Eastern Europe make an interesting set of test cases for our present purposes. First of all, the flow of FDI into many of these countries has increased substantially during the past years due to their transition from centrally planned to market economies. Second, the governments in these countries have been known to restrict foreign ownership in particular cases, thus conveying their suspicion regarding the relationship between ownership structure and the extent to which this may benefit the local economy (Hoekman and Javorcik, 2006; Lyles and Salk, 1996).

Because we have no command over any firm-level dataset pertaining to transition countries which allows us to simultaneously calculate productivity measures as well as degrees of MNE ownership, we will investigate the propositions of Section 3. The data for our empirical analysis are derived from the World Bank's Business Environment and Enterprise Performance Survey (BEEPS). This survey contains data on 4104 firms in 22 transition countries over the period 1999-2000. The questions in the survey mainly address issues regarding the (institutional) business environment and its influence on the firm's functioning and performance. Yet some of these variables may be interpreted as proxies for sunk investment costs, number of competitor firms and absorptive ability.

In the original database, only 500 firms are (partly) foreign owned. Since our model does not concern purely domestically owned firms, we limit our sample to these 500 firms. However, in matching the observations of the different variables included in the regressions we lose another 110 observations, so that 390 firms remain.

As our dependent variable we compute a dummy, taking the value of 1 for equally owned subsidiaries, and 0 for minority, majority of fully owned firms. Determining the boundaries in degree of ownership for which a firm is marked as "equally owned" is of course somewhat arbitrary. Therefore, we experiment with different intervals ranging from 33%-66% to 45%-55% as the ranges for which we interpret ownership as equally shared. Accordingly, our dependent variable measures the probability of observing an equally owned JV.

The first explanatory variable, *competitors*, measures the perceived number of competitors in the domestic market and is thus a measure for $n$. Since Proposition 1 in Section 3 predicts an ambiguous effect of $n$ on $I$, we do not have any *ex ante* expectations regarding this variable. *Skilled workers* measures the actual level of skilled workers in the firm relative to the desired level on a scale from 1 to 6. A score of 1 denotes a relatively high degree of absorptive ability whereas a score of 6 denotes relatively low absorptive ability. According to Proposition 2, an increase in absorptive ability will lead to less equal degrees of integration. Hence we expect the sign of this variable to be positive. We also interact this variable with a dummy, *Skilled workers X EU Dum* that takes the value 1 for those transition countries that have recently become a member of the European Union.[13] The reason for doing this is that we expect differing effects between EU accession and non-accession countries. Specifically, since institutions governing the protection of (intellectual) property rights are generally better developed in the EU accession countries, it can be expected that the cooperative gains of absorptive ability may be larger relative to the spillover losses.[14] Hence, we expect the magnitudes of their coefficients to differ. Finally, the variables *state investment*, *credit obstacles* and *state employment intervention* measure the amount of fixed investment that is financed through the state government (as a % of total fixed investment), the firm's perceived obstruction of receiving (information on) credit (on a 1-4 scale) and the regularity with which the government intervenes in

[13] In our sample these are the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia and Slovakia. Cyprus and Malta (the remaining two recent EU accession countries) are not included in the sample.

[14] From Table 1 (p.47) in Javorcik (2004*b*) it indeed follows that 5 of the 8 EU-10 accession countries that are included in her sample score above average on the Ginarte and Park index of intellectual property rights.

the firm's employment decisions (on a 1-6 scale) respectively. These three variables may thus be regarded as being related to sunk/fixed costs $c$ of investment. From Proposition 3 we know that increased sunk costs lead to more extreme degrees of integration in our model. Accordingly we expect negative coefficient signs for both *credit obstacles* and *state employment intervention* and a positive coefficient for *state investment*. Table 2 below provides some summary statistics and correlation coefficients.

<< **INSERT TABLE 2 ABOUT HERE** >>

Given that our dependent variable is a binary variable that takes the value of 1 when the firm JV is equally owned and 0 otherwise (i.e. minority, majority or fully foreign owned), the appropriate econometric method is probit analysis. Accordingly, the following model will be tested empirically:

$$I_{equal} = \Phi(x_i'\beta) + \varepsilon_i \ \text{ s.t. } \varepsilon_i \overset{N}{\sim} (\mu, \sigma_\varepsilon^2) \tag{10}$$

where $\Phi(.)$ denotes the standard normal distribution function and $x_i'$ is a vector containing the explanatory variables that were discussed above. As an additional remark, we would like to note that the specification of this model is in fact conditional on an earlier decision by the MNE, i.e. the decision to engage in FDI in the first place. It thus would be more appropriate to estimate a two-stage probit, in which the first equation describes the probability that a firm engages in FDI and the second then estimates the ownership decision. However, in the database we have no information regarding the factors that have been shown to influence the FDI decision (Markusen, 2001) so that this two-step procedure is not feasible. However, Javorcik (2006) shows that estimating such a two-step procedure leads to very similar results as those obtained in the one-step probit. Moreover, in our theoretical model, the ownership decision directly follows from the investment decision, so that also from a theoretical point of view, the one-step approach is somewhat warranted.

## 4.2 Results and discussion

Table 3 below presents the estimation results from the model in (10). For three out of four regressions, the coefficient on *number of competitors* is positive, which is (partly) in accordance with our expectations. However, it is never significant. It should be noted however, that this variable takes on only three values: 1 if there are no competitors, 2 if there are 1-3 competitors and 3 if there are more than 3 competitors. Hence, this variable does not allow for a great deal of variety and this may explain its insignificance in Table 3.

**<< INSERT TABLE 3 ABOUT HERE >>**

The coefficient on *skilled workers* is negative, and (marginally) significant when interacted with the EU-dummy. First of all, the fact that the coefficient on *skilled workers* alone is insignificant but becomes significant when interacted with the *EU dummy* indicates that there are indeed differing effects of absorptive ability on the degree of integration between the EU accession countries *vis-a-vis* the non-accession countries. Second, the negative coefficient of the interaction variable is not in accordance with Proposition 2, since it implies that a decrease in absorptive ability will actually lower MNE's incentives to engage in equally owned types of FDI. However, as mentioned in the previous subsection, this result could be driven by the fact institutions governing property rights are relatively better developed in the accession countries, implying that the cooperative gains from increased absorptive ability might outweigh the spillover hazard. Nonetheless, we would then still expect to see a positive and significant coefficient for *skilled workers.* Accordingly, Proposition 2 cannot be corroborated by these results.

The coefficient on *state investment* is positive and significant in three out of four regressions. This variable may be interpreted as a form of government subsidy to attract new business by providing easy capital for financing sunk investment. Accordingly, more state investment implies lower relative sunk costs. In our model, this in turn implies more equally shared FDI types, which is in accordance with these empirical results. The coefficient on *credit obstacles* is negative, as we expected given that higher credit obstacles potentially increase sunk investment costs. However, it is insignificant in all regressions. The coefficient on *state employment intervention* is negative and significant in three out of four regressions. Given that state employment intervention such as dismissal-protection increases operating costs, again this result is in line with our expectations.

Another fact that stands out from Table 3 is that whereas the first three regressions perform reasonably well in terms of the significance of the explanatory variables, the fourth clearly underperforms. An obvious reason for this is that the interval in which firms are considered as "equally shared " in the final model is relatively small compared to the intervals of the other models. In fact, for $33\% \leq I \leq 66\%$ there are 125 equally shared firms, for $40\% \leq I \leq 60\%$ this number is 106 and for $45\% \leq I \leq 55\%$ there are 64. Thus this number decreases relatively strongly in the final model, indicating that this interval could very well be too small.

As we already discussed before, some transition countries impose(d) legal requirements regarding the extent of ownership that a foreign firm is allowed to control in domestic firms (cf. Golub, 2003; Javorcik, 2006). Rationales for such requirements are often along the lines of the desire to maintain the sovereignty of specific industries (such as defense) or the belief that restricting foreign ownership allows more easy access to foreign technology. Whichever the reason, such restrictions effectively imply that FDI is less than fully owned simply because this is imposed by law. Accordingly, observing equally owned types of FDI and relating this to spillover considerations in such countries would be false. In order to correct for this, we re-estimate the model in (10) now including country-dummies to correct for inter alia legal ownership restrictions. Table 4 below presents the results.

**<< INSERT TABLE 4 ABOUT HERE >>**

The results in the table indicate that the estimates are quite robust to the inclusion of country dummies. A notable change is the (total) effect of absorptive ability on the probability of observing equally owned types of FDI. In this case we observe a positive and significant effect of *skilled workers* individually, and a notably stronger negative effect of this variable interacted with the EU dummy.

Indeed, the observed positive effect is in accordance with Proposition 2 and indicates that in the non-accession countries, increased absorptive capacity decreases the MNE's incentives to equally share the JV project. As explained above, relatively weak property rights protection could be at the heart of this effect, implying that the spillover hazard of increased absorptive ability dominates the potential gains through cooperation. In line with this argument, we again observe that the opposite holds in the EU accession countries.

Summarizing these results in terms of our three propositions in Section 3, we find that proposition one has neither been confirmed nor rejected, whereas proposition three has largely been confirmed by the empirical results. Proposition 2 is confirmed for non accession countries and rejected for EU accession countries. It appears that the cooperative gains from the presence of skilled workers outweighs the spillover costs for the latter group, while the opposite holds in the former group. Accordingly, the evidence for transition countries seems to be quite supportive of our theoretical model, hypothesizing a curvilinear relationship between knowledge spillovers and ownership. However, it is noted that they should be interpreted with caution, since they do not test the direct relationship between knowledge spillovers and FDI ownership.

# 5 Policy implications

In this section we will briefly consider some of our model's policy implications. Many of these already follow form the derived propositions in Section 3. Again consider the effect of varying sunk costs in our model. Obviously, sunk costs affect the participation constraints only through MNE profits in (7). Suppose that sunk costs decrease: In terms of Figure 1 this implies that, ceteris paribus, the MNE profit curve will shift upward, shifting the two participation constraints inward and consequently inducing the MNE to consider investing at more equal degrees of integration. For the local partner firm, this is a favorable development since knowledge spillovers increase as well. Consequently, according to our model, host country policies subsidizing inward FDI (or more accurately: inward JV activity) can align the incentives of both the MNE and its local partner, leading to more equally owned JVs in which spillovers are higher.[15]

Second, absorptive ability affects the participation constraints through the absorptive capacity function in (3). A decrease in absorptive ability (i.e. and increase in $a$) decreases effective spillovers $S$ in two ways: It makes spillovers commence only at higher degrees of MNE integration (in terms of Figure 1, the lower participation constraint shifts outward, away from the origin of the figure) and it causes the maximum amount of effective spillovers to decrease (in terms of Figure 1, the optimum of $S$ shifts down). These two effects combined can cause the lower participation constraint to vanish altogether, implying that the MNE will find it profitable to invest for the entire range of $I$ below $\hat{I}_U$. However, although this will thus again lead the MNE to consider more equally owned types of FDI, this is no longer in the best interest of the local partner, since the spillover optimum has shifted as a result of decreased absorptive capacity as well. Accordingly, from the local partner's point of view, a favorable policy strategy of the host country government is to stimulate the creation of sufficient absorptive capacity, causing both the extent of spillovers as well as the maximum amount of effective spillovers to increase.

Given that the government is budget constrained, there thus arises a policy trade-off in this model: The government budget can be directed either toward subsidizing inward FDI and thus lowering sunk costs for the investing MNE, or it can be used in order to provide e.g. high quality education and training to the economy's labor force or to stimulate corporate and public R&D programs, so that absorptive capacity is increased (cf. Wang and Blomström, 1992: pp. 151-152). Although from a normative point of view it may be tempting to conclude that investing in absorptive capacity would be first-best, it has to be noted that the benefits of such a policy strategy may take several years to take effect. Indeed, a one-shot subsidy granted to a potential foreign investor will yield gains that are almost instantaneous. Accordingly, the optimal policy strategy will depend on the context in the host economy and be influenced by issues such as rates of time preference, the extent

[15] As mentioned, such FDI subsidizing policies are often observed empirically (*cf.* Blomström and Kokko, 2003; Davies, 2005).

to which the local government is budget constrained and the composition of the local labor force.

Moreover, an additional implication from the model in Section 2 is that imposing ownership requirements on foreign investors may have adverse effects on inward FDI. From Figure 1 it is clear immediately that requiring JV ownership to be shared relatively equally with local firms may lead to negative net profits for the MNE and hence deter the FDI project altogether. On the other hand, in view of the discussion above, combining such requirements with additional FDI subsidizing policies could have the intended effect if the combination of ownership requirements and granted subsidies is properly balanced.

Nonetheless, from the empirical investigation in Section 4 yet another issue arises: Instead of focusing too much on FDI subsidizing policies or imposing ownership requirements, governments of transition countries may better invest resources in improving institutions governing the protection of (intellectual) property rights. For the empirical results hint at the fact that MNEs are actually more willing to engage in equally owned types of FDI if such institutions are better developed *despite the fact that absorptive capacity of the local partner is high.* Hence improving local institutions may not only serve to increase (high-tech) inward FDI (cf. Javorcik, 2004*b)* but also promote shared ownership of such IJVs.

## 6 Conclusion

In this paper, we have proposed an alternative explanation for the diverse findings in the FDI-spillover literature that is based on the FDI ownership structures. Specifically, we have deviated from earlier literature by positing a concave relationship between FDI ownership and knowledge spillovers instead of a linear one. We also include absorptive capacity and the number of local (competitor firms) in our model in order to derive participation constraints that determine the range of ownership degrees at which the MNE will be willing to invest abroad, despite the fact that spillovers exist.

The results of our theoretical model show that the MNE will typically choose rather extreme degrees of integration when investing abroad. However, the range of ownership degrees over which the MNE is willing to setup a foreign production facility will increase due to either a decrease in absorptive ability of the local firm and a decrease in sunk costs. As a result, the MNE will then be more willing to engage in equally shared ventures with foreign partners, which benefits the partner firm (and therefore also the host country) in terms of higher knowledge spillovers. The effect of an increase in the number of local (competitor) firms is ambiguous. Employing a dataset of approximately 400 firms in 22 transition countries we indeed find that these theoretical results are largely supported. Additionally, we find that the quality of local institutions may influence the effect of absorptive ability on MNE's incentives to share its FDI project.

From a policy perspective, we argue that in assessing the amount of money spent on subsidizing foreign activities, policy makers should also recognize the positive effect of increasing absorptive ability, for instance by improving the provision of education or investing in R&D. Specifically, spending more money on FDI policy through subsidies may lead to less investment in absorptive ability, implying a trade-off between these two policy strategies. Context specific factors such as the extent to which the government is budget constrained and the general rate of time preference in the economy will eventually determine the optimal policy. Additionally, from our model it also follows that imposing ownership requirements without any additional policy measures may serve to deter inward FDI.

All in all, we believe to have shown that FDI ownership may indeed affect knowledge spillovers in a non-trivial manner. In empirical economic modeling this relationship has been largely absent. Those studies that do take account of the relationship have assumed it to be linear instead of concave. Indeed, the literature's broad neglect of the relationship between FDI ownership structures and knowledge spillovers could provide a possible explanation for the apparent lack of consensus in empirical results. Accordingly, more empirical research, specifically investigating a potential concave relationship between knowledge spillovers and ownership, is warranted

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## Appendix

### Participation Constraint Existence

For analytical convenience, we express all the participation constraints in terms of technological distance $x$. Note that, by virtue of (2), $\hat{I}_L$ corresponds to $\hat{x}_U$ and $\hat{I}_U$ corresponds to $\hat{x}_L$.

In order to see why the existence of either one of the participation constraints in (8) is not guaranteed, if suffices to recall that $x$ is bounded between 0 and $1/2n$. Accordingly, the participation constraint $\widehat{x}$ should also be located somewhere in between these two values in order to be defined. Since we know the exact domain on which $x$ is defined, it is fairly straightforward to derive some conditions that guarantee their existence.

In order for the lower constraint to exist, it has to be located at or above the lower bound of the domain of our model, i.e. it has to be larger than or equal to 0. From this it follows that:

$$\begin{aligned} \frac{1}{2n} &\geq \sqrt{\frac{1}{4n^2} + 4c(a-1)} \qquad \text{c[1]} \\ &\Rightarrow c \leq 0 \end{aligned}$$

We can derive the cost condition that guarantees the existence of the upper participation constraint in a similar way:

$$\begin{gathered} \sqrt{\frac{1}{4n^2} + 4c(a-1)} \leq \frac{2a-3}{2n} \qquad \text{c[2]} \\ \Rightarrow c \leq \frac{4a-8}{16n^2} \end{gathered}$$

From Figure 1 and our formulation of knowledge spillovers in (5) and profits in (7), it follows that a situation may arise at which MNE profits are larger than knowledge spillovers over the entire domain of $I$.[16] In this situation, both participation constraints obviously do not exist. In order to determine under what condition this situation will arise, we note that in the limit (i.e. in the situation just before profits become strictly larger than knowledge spillovers over the entire domain) the upper and lower participation constraint will coincide ($\hat{x}_L = \hat{x}_U$). From this we can derive a "lower bound" cost condition that guarantees the existence of the participation constraint(s):

$$c \geq -\frac{1}{16n^2(a-1)} \qquad \text{c[3]}$$

If c[3] is not satisfied, MNE profits will thus be strictly higher than knowledge spillovers over the entire domain and no participation constraint will exist. This can also be seen by noting that allowing $c \leq 0$ introduces the possibility of a negative square root in (8). As it turns out, the condition that ensures this square root to be nonnegative is the same as c[3] which indeed implies that if c[3] is not satisfied, the participation constraints are not defined.

As mentioned in Section 2 we already established that since we only allow for nonnegative knowledge spillovers, $\pi_{MNE} - S \geq 0$ directly implies $\pi_{MNE} \geq S$. Accordingly, if we establish a condition under which spillovers are positive and relate this to the participation constraints, we can establish a condition under which *net* profits will be nonnegative. From (5) it is easily derived that $S \geq 0$ requires $x \leq 3/\left[2n(a+1)\right]$.[17] Accordingly, we also require our participation constraint to be less than or equal to this value. Rewriting this requirement of nonnegative *net* profits in terms of sunk costs $c$ yields:

$$c \leq \frac{3}{2}\frac{a-2}{n^2\,(a+1)^2} \qquad \text{c[4]}$$

We have now established four cost conditions. The question arises how they compare to each other. To this end, consider Figure 2 below. The figure plots the four different cost conditions against different values of $a$ on the horizontal axis (the origin thus takes a value of $a = 2$). While interpreting the figure, note that conditions c[1], c[2] and c[4] are of the $\leq$ kind, while c[3] is of the $\geq$ kind.

[16] In fact, given that the curvature of the spillover function is tighter than that of the MNE profit function (i.e. $|\partial^2\pi/\partial x^2| < |\partial^2 S/\partial x^2|$), profits can be strictly larger than knowledge spillovers even beyond the domain of the model.

[17] Obviously, the other value is $x \geq \mathbf{0}$ but since our model is bounded by 0 from below, this condition is automatically satisfied in our model.

**<< INSERT FIGURE 2 ABOUT HERE >>**

The area in between c[3] and c[1] (i.e. the a-axis) is the area in which both participation constraints exist. Note that this area lies entirely below c[4], so that we can conclude that MNE net profits are indeed nonnegative in this area. In the area between the a-axis and c[4] only the upper participation constraint exists while MNE net profits are still nonnegative. In the area above c[4] but below c[2], the upper participation constraint exists as well, but here MNE net profits are negative, so that the MNE will not invest in this area. For the area below c[3], MNE profits are strictly larger than knowledge spillovers over the entire domain of the model, so that there are no participation constraints. Note that as $a \to \infty$ (i.e. absorptive ability goes to zero) the limit of c[3] is 0 whereas the limit of c[4] is 0 as well (by l'Hôpital's rule). This implies that the region in which the participation constraints exist for positive MNE profits gradually disappears. Instead, the region in which MNE profits that are strictly larger than knowledge spillovers increases gradually. This is of course due to the steady decrease in absorptive ability: In terms of Figure 1, this implies that the spillover function will reach its optimum for lower values of $x$. At the same time, the value of knowledge spillovers at this optimum will decrease as well. These two effects combined make knowledge spillovers peter out rather quickly. Another interpretation of this result is that as $a$ increases, the relevance of absorptive ability for the MNE's integration decision decreases. In the limit, all that matters to the MNE in making its investment and integration decision is the amount of sunk costs $c$.

## Comparative Statics

For analytical clarity, all derivatives are first computed in terms of $x$ and then in $I$. The formulation of the participation constraints from (8) can be expressed in terms of $x$ as:

$$\widehat{x}_L = \frac{\Lambda^-}{2(a-1)} \; ; \; \widehat{x}_U = \frac{\Lambda^+}{2(a-1)}$$

For all derivatives we will need the partial derivatives of $\Lambda$ with respect to the different parameters as well:

$$\begin{aligned}
\frac{\partial \Lambda}{\partial n} &= -\frac{1}{2n^2} \pm \left(-\frac{1}{4n^3}\right)\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}} \\
\frac{\partial \Lambda}{\partial a} &= \pm \frac{2c}{\sqrt{\frac{1}{4n^2}+4c(a-1)}} \\
\frac{\partial \Lambda}{\partial c} &= \pm \frac{2(a-1)}{\sqrt{\frac{1}{4n^2}+4c(a-1)}}
\end{aligned}$$

Using this in the derivatives of (8) we get the results as displayed in Table 5:

<< **INSERT TABLE 5 ABOUT HERE** >>

In order to determine the sign of the derivatives, we check under which conditions (if any) they are larger than zero.

$$\begin{aligned}
\frac{\partial \hat{x}_U}{\partial n} &= \frac{\left[-\frac{1}{2n^2} - \frac{1}{4n^3}\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}}\right]}{2(a-1)} \geq 0 \\
-2n &\geq \left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}} \\
4n^2 &\leq \frac{1}{\frac{1}{4n^2}+4c(a-1)} \\
16n^2c(a-1) &\leq 0 \Rightarrow c \leq 0
\end{aligned}$$

Where the last inequality follows from our assumptions that $n, a \geq 2$. Hence $\partial \hat{x}_U/\partial n \geq 0$ iff $c \leq 0$.

$$\begin{aligned}
\frac{\partial \hat{x}_L}{\partial n} &= \frac{\left[-\frac{1}{2n^2} + \frac{1}{4n^3}\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}}\right]}{2(a-1)} \geq 0 \\
2n &\geq \left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}} \\
4n^2 &\geq \frac{1}{\frac{1}{4n^2}+4c(a-1)} \\
16n^2c(a-1) &\geq 0 \Rightarrow c \geq 0
\end{aligned}$$

Where the last inequality again follows from $n, a \geq 2$. Hence $\partial \hat{x}_L/\partial n \geq 0$ iff $c \geq 0$. However, since according to c[1] $\hat{x}_L$ does not exist for $c \geq 0$ it follows that in our model setup it always holds that $\partial \hat{x}_L/\partial n \leq 0$

$$\frac{\partial \hat{x}_U}{\partial a} = \frac{4c(a-1)\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}} - 2\left(\frac{1}{2n}+\sqrt{\frac{1}{4n^2}+4c(a-1)}\right)}{4(a-1)^2} \geq 0$$

$$2c(a-1)\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}} \geq \frac{1}{2n}+\sqrt{\frac{1}{4n^2}+4c(a-1)}$$

$$\frac{-2c(a-1)-\frac{1}{4n^2}}{\sqrt{\frac{1}{4n^2}+4c(a-1)}} \geq \frac{1}{2n}$$

$$-4nc(a-1)-\frac{1}{2n} \geq \sqrt{\frac{1}{4n^2}+4c(a-1)}$$

$$16n^2c^2(a-1)+4c(a-1)+\frac{1}{4n^2} \leq \frac{1}{4n^2}+4c(a-1)$$

$$16n^2c^2(a-1) \leq 0$$

Given that $a, n \geq 2$ it follows that the last inequality can never hold, which implies that $\partial \hat{x}_U/\partial a < 0$.

$$\frac{\partial \hat{x}_L}{\partial a} = \frac{-4c(a-1)\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}} - 2\left(\frac{1}{2n}-\sqrt{\frac{1}{4n^2}+4c(a-1)}\right)}{4(a-1)^2} \geq 0$$

$$-2c(a-1)\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}} \geq \frac{1}{2n}-\sqrt{\frac{1}{4n^2}+4c(a-1)}$$

$$\frac{2c(a-1)+\frac{1}{4n^2}}{\sqrt{\frac{1}{4n^2}+4c(a-1)}} \geq \frac{1}{2n}$$

$$4nc(a-1)+\frac{1}{2n} \geq \sqrt{\frac{1}{4n^2}+4c(a-1)}$$

$$16n^2c^2(a-1)+4c(a-1)+\frac{1}{4n^2} \geq \frac{1}{4n^2}+4c(a-1)$$

$$16n^2c^2(a-1) \geq 0$$

Again, given that $a, n \geq 2$ the last inequality will always hold, which implies that $\partial \hat{x}_L/\partial a > 0$.

$$\frac{\partial \hat{x}_U}{\partial c} = \frac{2(a-1)\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}}}{2(a-1)} \geq 0$$

$$\frac{1}{\frac{1}{4n^2}+4c(a-1)} \geq 0$$

Given our discussion regarding cost condition c[3] in the previous part of the Appendix, this inequality most always hold. Accordingly, in our model setup it will always hold that $\partial \hat{x}_U/\partial c \geq 0$.

$$\frac{\partial \hat{x}_L}{\partial c} = \frac{-2(a-1)\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}}}{2(a-1)} \geq 0$$

$$-\frac{1}{\frac{1}{4n^2}+4c(a-1)} \geq 0$$

For the same reason as before, this inequality will never hold. Thus in our model setup it will always hold that $\partial \hat{x}_L / \partial c \leq 0$.

From (2) we can derive that $\hat{I} = 1 - 2\hat{x}n$ and accordingly that $\hat{I}(\hat{x}_U) = 1 - 2\hat{x}_U n$ and $\hat{I}(\hat{x}_L) = 1 - 2\hat{x}_L n$. Consequently, we obtain the following:

$$\frac{\partial \hat{I}(\hat{x}_U)}{\partial n} = \frac{-\left[\Lambda^+ + n(\partial \Lambda^+ / \partial n)\right]}{(a-1)}$$

$$= \frac{-\left[\sqrt{\frac{1}{4n^2}+4c(a-1)} - \frac{1}{4n^2}\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}}\right]}{(a-1)} \geq 0$$

$$\frac{1}{4n^2} \geq \frac{1}{4n^2} + 4c(a-1)$$

$$0 \geq 4c(a-1) \Rightarrow c \leq 0$$

Where the last inequality follows from the fact that $a \geq 2$. Hence $\partial \hat{I}(\hat{x}_U)/\partial n \geq 0$ iff $c \leq 0$.

$$\frac{\partial \hat{I}(\hat{x}_L)}{\partial n} = \frac{-\left[\Lambda^- + n(\partial \Lambda^- / \partial n)\right]}{(a-1)}$$

$$= \frac{-\left[-\sqrt{\frac{1}{4n^2}+4c(a-1)} + \frac{1}{4n^2}\left(\frac{1}{4n^2}+4c(a-1)\right)^{-\frac{1}{2}}\right]}{(a-1)} \geq 0$$

$$\frac{1}{4n^2} + 4c(a-1) \geq \frac{1}{4n^2}$$

$$4c(a-1) \geq 0 \Rightarrow c \geq 0$$

Where the last inequality follows from the fact that $a \geq 2$. Hence $\partial \hat{I}(\hat{x}_L)/\partial n \geq 0$ iff $c \geq 0$. However, since according to c[1] $\hat{x}_L$ does not exist for $c \geq 0$ it follows that in our model setup it always holds that $\partial \hat{I}(\hat{x}_L)/\partial n \leq 0$

$$\frac{\partial \hat{I}(\hat{x}_U)}{\partial a} = -2\frac{\partial \hat{x}_U}{\partial a} > 0$$

$$\frac{\partial \hat{I}(\hat{x}_L)}{\partial a} = -2\frac{\partial \hat{x}_L}{\partial a} < 0$$

This follows directly from our discussion of $\partial \hat{x}_U/\partial a$ and $\partial \hat{x}_L/\partial a$ above.

$$\frac{\partial \hat{I}(\hat{x}_U)}{\partial c} = -2\frac{\partial \hat{x}_U}{\partial c} \leq 0$$

$$\frac{\partial \hat{I}(\hat{x}_L)}{\partial c} = -2\frac{\partial \hat{x}_L}{\partial c} \geq 0$$

Again this follows immediately from our discussion of $\partial \hat{x}_U/\partial c$ and $\partial \hat{x}_L/\partial c$ above.

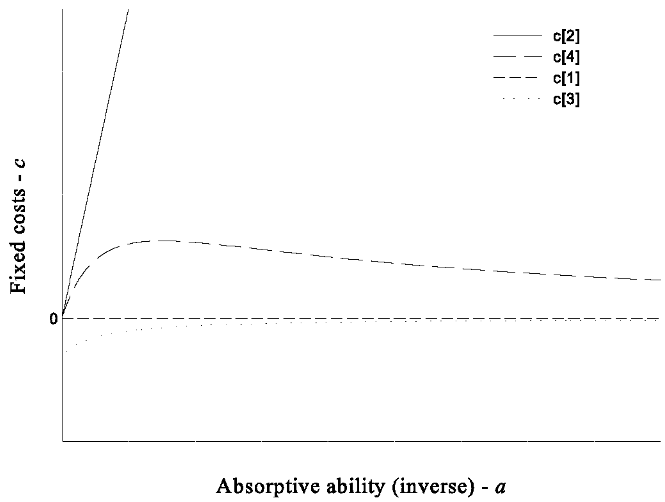


Figure 1: Cost conditions

Table 1: Comparative Static Results

| **Parameter** | $\partial \hat{I}_L/\partial(.)$ | $\partial \hat{I}_U/\partial(.)$ |
|---|---|---|
| $n$ | +/- [a] | - |
| $a$ | + | - |
| $c$ | - | + |

Notes: (a) Negative if c>0, positive otherwise

Table 2: Summary Statistics and Correlation Coefficients

| | Mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.Integr:33-66 | 0.32 | 0.47 | 1.00 | | | | | | | | |
| 2.Integr:40-60 | 0.27 | 0.45 | 0.89 | 1.00 | | | | | | | |
| 3.Integr:45-55 | 0.16 | 0.37 | 0.64 | 0.73 | 1.00 | | | | | | |
| 4.Compet. | 2.63 | 0.66 | 0.05 | 0.06 | -0.01 | 1.00 | | | | | |
| 5.State Inv. | 1.02 | 7.15 | 0.14 | 0.11 | 0.08 | -0.01 | 1.00 | | | | |
| 6.Credit Ob. | 2.29 | 1.17 | -0.07 | -0.05 | -0.02 | 0.03 | -0.09 | 1.00 | | | |
| 7.State Emp. | 5.47 | 1.05 | -0.11 | -0.10 | -0.04 | -0.08 | 0.09 | 0.10 | 1.00 | | |
| 8. Skilled | 3.81 | 1.02 | 0.00 | -0.03 | -0.09 | 0.10 | 0.01 | -0.01 | -0.07 | 1.00 | |
| 9. EU x Skilled | 1.57 | 2.03 | -0.10 | -0.12 | -0.02 | 0.01 | -0.11 | -0.09 | 0.03 | 0.29 | 1.00 |

Notes: Number of Observations = 390

Table 3: Probit analysis of equal ownership

| | $33\% \leq I \leq 66\%$ | $33\% \leq I \leq 66\%$ | $40\% \leq I \leq 60\%$ | $45\% \leq I \leq 55\%$ |
|---|---|---|---|---|
| Constant | -1.47 | -1.42 | -1.51 | -0.99 |
| | (0.56) | (0.55) | (0.57) | (0.57) |
| Competitors | 0.08 | 0.08 | (0.14) | -0.01 |
| | (0.10) | (0.10) | (0.10) | (0.11) |
| Skilled Workers | -0.02 | 0.02 | -0.02 | -0.13* |
| | (0.07) | (0.07) | (0.07) | (0.07) |
| Skilled Workers x EU-dum | | -0.06* | -0.07** | 0.01 |
| | | (0.03) | (0.04) | (0.04) |
| State Investment | 0.03*** | 0.03** | 0.02** | 0.01 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| Credit Obstacles | -0.05 | -0.06 | -0.05 | -0.01 |
| | (0.06) | (0.06) | (0.06) | (0.07) |
| State Employment Interv. | -0.17** | -0.16** | -0.15** | -0.08 |
| | (0.07) | (0.07) | (0.07) | (0.07) |
| McFadden $R^2$ | 0.032 | 0.038 | 0.035 | 0.017 |
| Log-Likelihood | -236.8 | -235.3 | -220.2 | -171.2 |
| $N$ | 390 | 390 | 390 | 390 |

Notes: Huber/White-robust standard errors within parentheses. *=0.1sig. **=0.05 sig. ***=0.01 sig.

Table 4: Analysis of equal ownership including fixed country effects

| | $33\% \leq I \leq 66\%$ | $33\% \leq I \leq 66\%$ | $40\% \leq I \leq 60\%$ | $45\% \leq I \leq 55\%$ |
|---|---|---|---|---|
| Constant | -1.98 | -0.98 | -1.00 | -0.36 |
| | (0.63) | (0.69) | (0.70) | (0.71) |
| Competitors | 0.12 | 0.12 | (0.21)* | 0.04 |
| | (0.12) | (0.12) | (0.12) | (0.13) |
| Skilled Workers | 0.06 | 0.24** | 0.23** | 0.14 |
| | (0.08) | (0.11) | (0.11) | (0.12) |
| Skilled Workers x EU-dum | | -0.44*** | -0.49*** | -0.43** |
| | | (0.17) | (0.17) | (0.17) |
| State Investment | 0.03** | 0.03** | 0.02** | 0.02* |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| Credit Obstacles | -0.04 | -0.03 | -0.03 | 0.00 |
| | (0.07) | (0.07) | (0.07) | (0.07) |
| State Employment Interv. | -0.17** | -0.18** | -0.14* | -0.11 |
| | (0.08) | (0.08) | (0.08) | (0.08) |
| Country Dummies | Yes | Yes | Yes | Yes |
| McFadden $R^2$ | 0.134 | 0.145 | 0.035 | 0.017 |
| Log-Likelihood | -211.0 | -209.0 | -220.2 | -171.2 |
| $N$ | **390** | **390** | **390** | **390** |

Notes: Huber/White-robust standard errors within parentheses. *=0.1sig. **=0.05 sig. ***=0.01 sig.

Table 5: Comparative Static Derivatives

| **Parameter** | $\partial \hat{x}_U / \partial(.)$ | $\partial \hat{x}_L / \partial(.)$ |
|---|---|---|
| $n$ | $\frac{1}{2(a-1)} \cdot \frac{\partial \Lambda^+}{\partial n}$ | $\frac{1}{2(a-1)} \cdot \frac{\partial \Lambda^-}{\partial n}$ |
| $a$ | $\frac{\partial \Lambda^+ / \partial a[2(a-1)] - 2\Lambda^+}{4(a-1)^2}$ | $\frac{\partial \Lambda^- / \partial a[2(a-1)] - 2\Lambda^-}{4(a-1)^2}$ |
| $c$ | $\frac{1}{2(a-1)} \cdot \frac{\partial \Lambda^+}{\partial c}$ | $\frac{1}{2(a-1)} \cdot \frac{\partial \Lambda^-}{\partial c}$ |