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A note on asset specificity

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Abstract

In this note, we discuss the theoretical formulation of the concept of specificity and expose preliminary results showing that different types of asset specificity call for the use of different control rights. Contrary to transaction cost and property right theories, but in line with increasing empirical evidence, high levels of specificity do not necessarily lead to unified ownership.

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1. Introduction

That specific assets should be owned by a common agent is one of the most prominent results of the incomplete contracts and property rights theory (Grossman and Hart 1986, Hart and Moore 1990, HM), as well as transaction cost economics (Williamson 1985). Specificity generates "lock-in" effects and creates a risk of hold-up, which can be overcome by unified ownership.

However, specificity involves complementarity and specialization, and ownership alone may not be sufficient to cope with these two aspects. Recent developments have shown that ownership can be un-bundled into the right to use (access) an asset and the right to exclude (veto) others from using it (Bel 2013) [1], thus providing more flexibility. Moreover, the type and degree of specificity are especially important (Williamson 1985) and have various effects on contracting and governance features (Williamson 1983).

This note builds on Bel (2013) but goes further by examining the notion of specificity more deeply, highlighting multiple forms, and evaluating their consequences. In particular, the note discusses the theoretical formulation of the concept of specificity and exposes preliminary results showing that different types of asset specificity call for the use of different control rights. Contrary to transaction cost and property right theories, but in line with increasing empirical evidence (see e.g., David and Han 2004, Carter and Hodgson 2006), high levels of specificity do not necessarily lead to unified ownership.

2. The Model

We build on HM and consider a seller S, a buyer B, and an external agent E (e.g., another seller or another buyer) who respectively hold assets a_S, a_B, a_E ($\underline{A} = \{a_S, a_B, a_E\}$). A coalition of agents G can access or veto a set of assets. $\beta(G)$ is the set of assets that G can securely access, that is, that G can access and that no one else outside of G can veto.

The agents invest some effort $e_i (i \in N = \{S, B, E\})$ on the assets, where e_i represents the level and the cost of effort, and in a coalition G produce a value $v_G(A, e) \equiv v_G(A)$ where A is the set of assets that the coalition securely accesses, e is the vector of investment, and v is concave in e_i ($V_N(\underline{A}) \equiv V$). At date 0, the agents agree on an allocation of rights over their respective assets. At date 1, they make unobservable investment on the assets that they securely access. Then they produce and share the surplus at date 2. Except the allocation of rights, which is enforceable at date 2, no variable is contractible, and the agents share the surplus through bargaining, using the Shapley value as the solution concept. The allocation of rights at date 0 determines the threat points of the agents in the bargaining game at date 2. We assume that side payments between agents are allowed, so that efficient trading at date 0 leads to an allocation of rights that maximizes the overall surplus at date 2.

[1] Access provides power (Rajan and Zingales 1998) and exclusivity (veto) fosters investment (Segal and Whinston 2000). See also Segal (2003) for an analysis of inclusive and exclusive contracts.

In a coalition G, an agent i's marginal return on investment is given by $\partial v_G(A)/\partial e_i \equiv v_G^i(A)$. There is superadditivity in agents and assets ($v_G(A) \geq v_{G'}(A') + v_{G\setminus G'}(A \setminus A')$), so that there are gains from trade and it is always desirable for the agents to reach an agreement. We keep HM's assumptions of human capital investment ($v_G^i(A) = 0$, if $i \notin G$), complementarity of investments at the margin ($(\partial/\partial e_j)v_i^i(A) \geq 0, \forall i \neq j$), and highest marginal return for the grand coalition controlling all assets ($v_G^i(A) \leq V^i, \forall i \in G, \forall A$), but relax the assumptions of positive marginal return ($v_G^i(A) \geq 0$) and complementarity at the margin ($v_G^i(A) \geq v_G^i(A'), \forall A \supseteq A'$)[2].

- Optimal Allocation of Rights

Given an allocation of rights, each agent chooses its level of investment at date 1 in order to maximize its ex-ante net benefit, anticipating that the ex-post value will be shared through bargaining. Computing the Shapley value, the agents' ex-ante net benefit ($\forall i \neq j \neq k \in N$) is:

$$\frac{1}{3}v_i(\beta(i)) + \frac{1}{6}\left[v_{ij}(\beta(i,j)) - v_j(\beta(j))\right] + \frac{1}{6}\left[v_{ik}(\beta(i,k)) - v_k(\beta(k))\right] + \frac{1}{3}\left[V - v_{jk}(\beta(j,k))\right] - e_i$$

The Nash equilibrium (NE) level of investment is characterized by the first order conditions:

$$\frac{1}{3}v_i^i(\beta(i)) + \frac{1}{6}v_{ij}^i(\beta(i,j)) + \frac{1}{6}v_{ik}^i(\beta(i,k)) + \frac{1}{3}V^i = 1$$

In a first-best world, the three agents would cooperate and the first-best level of investment $\hat{e}$ would be determined by $V^i = 1, \forall i \in N$. But with incomplete contracts, given the concavity of the value function, there is underinvestment because $v_G^i(A) \leq V^i, \forall i \in G, \forall A, G$. The most efficient – second-best – allocation of rights β^* maximizes the agents' marginal returns of investments and thus their equilibrium level of investment and welfare (see HM for the proof). Henceforth, an agent 'should' grant some rights when it is efficient from a welfare standpoint.

Complementarity leads to increased marginal return[3], but exploiting complementarity often requires specialization. Specializing, though, reduces the marginal return in alternative uses. A specific asset is generally defined as a special purpose asset that loses value when redeployed in alternative uses, should the original transaction be terminated (Williamson 1985) but also as a complementary asset that increases marginal return (Hart 1995). We adopt these definitions.

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[2] Those assumptions have been relaxed respectively by Rajan and Zingales (1998) (specializing may reduce an asset owner's outside option) and by Bel (2013) (the presence of a second asset may reduce marginal return when the costs of coordination are too high or investment is crowded out).

[3] This definition corresponds to a broad concept of complementarity [or substitution] in which increasing the use of one factor (here assets) increases [reduces] the marginal product of the other (here human capital investment) (Milgrom and Roberts 1990).

Definition. An asset a_j [j] is *complementary* to another asset $a_i \in A$ or $i \in G$ if its presence raises the marginal return with the other asset; that is, $\forall l \in G$, $v_G^l(A \cup \{a_j\}) = (1+\gamma)v_G^l(A)$, $\forall A \not\ni a_j$ [resp. $v_{G \cup j}^l(A) = (1+\gamma)v_G^l(A)$, $\forall G \not\ni j$], where $\gamma > 0$ represents the degree of complementarity.

Definition. An asset a_j [j] is *specialized* to another asset $a_i \in A$ or $i \in G$ if its marginal return is reduced in the absence of the other asset; that is $\forall l \in G$, $v_G^l(A \setminus \{a_i\}) = (1-\sigma)v_G^l(A)$, $\forall A \ni a_j$ [resp. $v_{G \setminus i}^l(A) = (1-\sigma)v_G^l(A)$, $\forall G \ni j$], where $\sigma > 0$ represents the degree of specialization[4].

Definition. An asset is *specific* to another asset if it is complementary and specialized to it.

Ownership is composed of two rights (Bel, 2013): the right to use an asset (access) and the right to prevent its use by other agents (veto). Ownership can be un-bundled and those two rights can be granted separately. When ownership is transferred to another agent, only the beneficiary agent can use the asset. However, when an agent grants access to another agent (e.g., through a licensing contract), both agents can use the asset independently; and when an agent grants veto (e.g. through an exclusive contract) to another agent, no agent can independently use the asset. The characteristics of assets impact the ability to use access and veto rights. In the absence of slavery, a human asset cannot be used independently (accessed) nor owned by a different agent, and a rivalrous[5] physical asset should not be accessed by different agents (Table 1).

Table 1. Asset Type and Control Rights

Asset Type	Access	Veto	Ownership
Human Asset		X	
Rivalrous (R) Physical Asset		X	X
Nonrivalrous (NR) Physical Asset	X	X	X

This leads to our first result.

[4] For simplicity, we assume that γ and σ stay constant in presence of other agents and assets. Moreover, $\sigma \geq 1$ when the returns to specialization are negative (Rajan and Zingales 1998).

[5] An asset is rivalrous if one agent's use limits another agent's use. Accessing the asset simultaneously would reduce its value.

Proposition 1. *(i) (Complementarity) If a_B is NR and complementary to a_S or S, B should grant access on a_B to S ; (ii) (Specialization) If a_B or B is specialized to a_S or S, there exists a minimum degree of specialization $\hat{\sigma}$ above which B should grant veto on a_B or B to S.*

Proof. *(i)* To be efficient, granting access must (weakly) increase all agents' marginal returns of investment. If a_B is complementary to a_S or S, the impact for S of getting access to a_B is:

$$I_C = \frac{1}{3}[v_S^S(a_S a_B) - v_S^S(a_S)] + \frac{1}{6}[v_{SE}^S(a_S a_B a_E) - v_{SE}^S(a_S a_E)] \quad \text{(there is no change when } S \text{ is with } B\text{)}$$

$$= \frac{1}{3}[(1+\gamma)v_S^S(a_S) - v_S^S(a_S)] + \frac{1}{6}[(1+\gamma)v_{SE}^S(a_S a_E) - v_{SE}^S(a_S a_E)]$$

$$= \gamma([\frac{1}{3}v_S^S(a_S)] + \frac{1}{6}[v_{SE}^S(a_S a_E)]) \geq 0$$

Moreover, the impact for B is equal to zero (B still has access to a_B), and the impact for E ($\frac{1}{6}[v_{SE}^E(a_S a_B a_E) - v_{SE}^E(a_S a_E)] = \frac{1}{6}\gamma v_{SE}^E(a_S a_E)$) is nonnegative. (If B is complementary to a_S or S, access on B cannot be granted since B is a human asset).

(ii) If a_B is specialized to a_S [or S], the impact for B of granting veto on a_B to S is:

$$I_V = \frac{1}{3}[v_B^B(\varnothing) - v_B^B(a_B)] + \frac{1}{6}[v_{BE}^B(a_E) - v_{BE}^B(a_B a_E)]$$

$$= \frac{1}{6}v_{BE}^B(a_E) - \frac{(1-\sigma)}{6}[2v_B^B(a_B a_S) + v_{BE}^B(a_B a_S a_E)] \left[\text{resp.} = \frac{1}{6}v_{BE}^B(a_E) - \frac{(1-\sigma)}{6}[2v_{BS}^B(a_B) + v_{BSE}^B(a_B a_E)]\right]$$

I_V increases with σ, and is nonnegative for $\sigma \geq \hat{\sigma}$ (where $\hat{\sigma} = 1 - \frac{v_{BE}^B(a_E)}{2v_B^B(a_B a_S) + v_{BE}^B(a_B a_S a_E)}$ [resp. $\hat{\sigma} = 1 - \frac{v_{BE}^B(a_E)}{2v_{BS}^B(a_B) + v_{BSE}^B(a_B a_E)}$]). The impact is equal to zero for S and for E is $\frac{1}{6}[v_{BE}^E(a_E) - v_{BE}^E(a_B a_E)] = \frac{1}{6}[v_{BE}^E(a_E) - (1-\sigma)v_{BE}^E(a_B a_S a_E)]$ [resp. $= \frac{1}{6}[v_{BE}^E(a_E) - (1-\sigma)v_{BSE}^E(a_B a_E)]$], which is nonnegative when $\sigma \geq \hat{\sigma}$ (where $\hat{\sigma} = 1 - \frac{v_{BE}^B(a_E)}{v_{BE}^B(a_B a_S a_E)}$ [resp. $\hat{\sigma} = 1 - \frac{v_{BE}^B(a_E)}{v_{BSE}^B(a_B a_E)}$]).

If B (instead of a_B) is specialized to a_S [or S], it is straightforward to show that the impact of B giving veto on her human asset to S (B cannot produce without S) is equal to zero for S and is nonnegative for B and E when $\sigma \geq \hat{\sigma}$ (where $\hat{\sigma} = 1$).

With complementarity, granting access increases the outside option of the beneficiary agent, which now has access to both assets, while leaving the outside option of the grantor unaffected, and this is efficient.

On the other hand, granting veto affects the value in the absence of the beneficiary agent, which becomes $V_V = \frac{1}{3} v_B^B(\varnothing) + \frac{1}{6} v_{BE}^B(a_E)$. Specializing reduces the value with the asset in alternative uses $\bar{V}(\sigma) = \frac{1}{3} v_B^B(a_B) + \frac{1}{6} v_{BE}^B(a_B a_E) \equiv (1-\sigma)[\frac{1}{3} v_B^B(a_B a_S) + \frac{1}{6} v_{BE}^B(a_B a_S a_E)]$. If the degree of specialization σ is high enough, it may be that $\bar{V}(\sigma) \leq V_V$ so that granting veto becomes optimal. In particular, if B is so specialized to a_S or S that her marginal return in alternative relationships is negative, B is better off giving veto on her human asset to S, to prevent her from seeking relationships with external agents (veto 'ties her hands').

Complementarity and specialization may occur among physical or human assets, leading to four types of asset specificity[6] (Table 2).

Table 2. Complementarity, Specialization, and Specificity

Types of Asset Specificity ($\forall l \in G$)	**Complementarity**	**Specialization**
Relationship Specificity (RS) (j *specific to* $i \in G$)	$v^l_{G\cup j}(A) = (1+\gamma) v^l_G(A)$ $\forall G \not\ni j$	$v^l_{G\setminus i}(A) = (1-\sigma) v^l_G(A)$ $\forall G \ni j$
Human Asset Specificity (HAS) (j *specific to* $a_i \in A$)	$v^l_{G\cup j}(A) = (1+\gamma) v^l_G(A)$ $\forall G \not\ni j$	$v^l_G(A \setminus a_i) = (1-\sigma) v^l_G(A)$ $\forall G \ni j$
Dedicated Asset (DA) (a_j *specific to* $i \in G$)	$v^l_G(A \cup a_j) = (1+\gamma) v^l_G(A)$ $\forall A \not\ni a_j$	$v^l_{G\setminus i}(A) = (1-\sigma) v^l_G(A)$ $\forall A \ni a_j$
Physical Asset Specificity (PAS) (a_j *specific to* $a_i \in A$)	$v^l_G(A \cup a_j) = (1+\gamma) v^l_G(A)$ $\forall A \not\ni a_j$	$v^l_G(A \setminus a_i) = (1-\sigma) v^l_G(A)$ $\forall A \ni a_j$

[6] Williamson (1983) highlights human, dedicated asset, site, and physical asset specificity (here, we regroup site and physical asset specificity), and later adds brand name capital (specificity of a NR asset) and temporal specificity (a type of site specificity) (Williamson 1991), whereas HM analyze relationship specificity in general, which for them encompasses all types of specificity between human and physical assets.

Complementarity calls for access, whereas specialization calls for veto, thus specificity – generally speaking – should call for ownership. However, the characteristics of the assets involved lead to different contractual outcomes depending on the type of asset specificity. This is summarized in the following Proposition, where we use the definitions above and assume bilateral complementarity (if one asset is complementary to a second asset, the later is likely to be complementary to the former).

Proposition 2. *When a_B or B is specific to a_S or S, the agents should grant the following control rights on their assets:*

- *RS: veto on B to S if $\sigma \geq 1$*
- *HAS: access on a_S to B if a_S is NR; veto on B to S if $\sigma \geq 1$*
- *DA: ownership on a_B to S if $\sigma \geq \hat{\sigma}$; access on a_B to S if $\sigma < \hat{\sigma}$ and a_B NR*
- *PAS: access on a_S to B if a_S is NR; bilateral access on a_S and a_B if they are both NR; ownership on a_B to S if a_S is R and $\sigma \geq \hat{\sigma}$; access on a_B to S if a_S is R and $\sigma < \hat{\sigma}$*

The proof is straightforward, decomposing specificity into complementarity and specialization, and applying Proposition 1, with two caveats. First, with specialization, veto should be given if $\sigma \geq \hat{\sigma}$ by Proposition 1, where $\hat{\sigma} = 1$ when the agent – not the asset – is specialized (see the proof of Proposition 1). Second, when B is specialized to a_S but gets access to a_S because a_S is complementary, it maximizes the marginal return of B and it is then not efficient to grant veto or ownership on its own asset to S.

Proposition 2 shows that granting ownership is not always the proper answer to asset specificity. Different types of asset specificity require different control rights.

3. Conclusion

Extant literature argues that asset specificity calls for integration. But specificity involves two aspects: complementarity and specialization. Depending on the type of assets involved and the degrees of complementarity and specialization, granting ownership may not always be the best way to foster incentives. These are only preliminary results. Adopting a more fine-grained notion of the concept of asset specificity and extending the bundle of rights that compose ownership (see e.g., Ostrom 2000) may lead to a better understanding of empirical incentive responses, justifying the existence of alternative forms of organizations such as employment contracts (granting of veto rights on human asset in case of HAS or RS), licensing (granting of access rights in case of PAS between a R and a NR asset), strategic alliances (bilateral granting of access rights in case of PAS between NR assets), or joint ventures (bilateral granting of veto rights in case of bilateral RS).

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