



Spoiling synergy



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HIGHLIGHTS

- Assets (or agents, activities) may be complementary but substitutes at the margin.
- Substitution at the margin may lead agents to underinvest in effort.
- When the effort effect dominates the synergy effect, a merger may be inefficient.

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ABSTRACT

Assets may be complementary – producing more return together – but substitute at the margin – generating lower marginal return when assets are together, leading agents to underinvest. When the effort effect dominates the synergy effect, merging complementary assets may not be efficient.

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1. Introduction

Complements go together, and this intuition has been applied to the allocation of tasks within an organization and to the choice of team members (see [Brickley et al., 2009](#) for example). This reasoning also underlies the prediction in the property-rights model that complementary assets should be owned together ([Hart and Moore, 1990](#)). In contrast, this paper presents a model in which complementary assets should not always be used together.

Complementary assets (or agents, activities) generate a higher level of surplus together than when they are separate, for a given level of effort. However, complementary assets can be substitutes at the margin—merging them decreases the marginal return of effort. Consequently, as their marginal return from effort is lower, agents have a decreased incentive to put in effort when assets are merged: With substitution at the margin, the presence of complementary assets crowds out incentives to invest ([Bel, 2013](#)). In fact marginal substitution involves substitution between investment and assets. When the complementarity of assets

‘automatically’ brings additional return, why make extra effort? This spoiling effect of synergy may have crucial consequences if the loss in surplus from lower levels of effort when assets are merged outweigh the surplus coming from complementarity.

Our study is closely related to the literature on the paradoxes of synergy. Synergies, for example in the form of economies of scope ([Panzar and Willig, 1981](#)) are a key motivation for mergers and acquisitions. But most mergers destroy value and synergies fail to materialize or are offset by post-merger transaction costs ([Jones and Hill, 1988](#)), agency costs ([Jensen, 1986](#)), contagion or capacity effect ([Shaver, 2006](#)), or influence costs ([Rajan et al., 2000](#)), leading to ‘dissynergy’ ([Jones and Hill, 1988](#)). The present study investigates the consequences of a different phenomenon: synergy may endogenously crowd out effort through a substitution effect. In a way, there is a parallel with the literature on incentives in teams, in which the work environment, being the flow of information ([Winter, 2010](#)) or the composition of the team ([Bel et al., 2015](#)), may affect investment incentives. We show here that asset complementarity may have a similar effect.¹

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¹ However, the mechanism underlying reduced investment is different here. It is a substitution effect, not the relative difference in marginal returns between

Two assets (or resources or activities) are complementary when the marginal return with one asset increases in the presence of the other, i.e. if the production function is supermodular in assets (Milgrom and Roberts, 1990). However, complementarity between assets – when the cross-partial derivative between assets is positive – does not preclude substitution between assets and investment—when the cross-partial derivative with respect to investment and assets is negative.² This is precisely this substitution effect that may overcome the advantage of synergy. Our purpose here is to make this mechanism explicit and study its consequences for mergers.

2. The model and results

Consider a model with a principal and two agents.³ A principal P owns two physical assets A_1 and A_2 that are necessary for ‘production’. The agents M_1 and M_2 can independently make some human capital investment⁴ e_i , $i = 1, 2$ on their respective asset, at a cost $C_i(e_i)$ to produce an output $r_i(e_i) = r(a_i | e_i)$, $\forall i = 1, 2$. The principal is considering merging the two assets to benefit from some complementarities. With the merged assets, the agents would produce $R(e_1, e_2) = r(\{a_1, a_2\} | (e_1, e_2))$. R , r_1 , r_2 are standard concave twice differentiable production functions. The assets are said to be complementary if the marginal benefit of an asset increases with the presence of the second asset (Milgrom and Roberts, 1990), i.e. if $r(\{a_1, a_2\} | (e_1, e_2)) - r(a_2 | e_2) \geq r(a_1 | e_1) - r(\emptyset)$. Or, assuming $r(\emptyset) = 0$:

$$R(e_1, e_2) \geq r_1(e_1) + r_2(e_2).$$

In other words, the assets are complementary if the combined output is greater than the sum of the individual outputs, *keeping investment levels constant*. The value $S(e_1, e_2) = R(e_1, e_2) - r_1(e_1) - r_2(e_2)$ represents the *synergy* between the two assets, which are complementary if $S > 0$.

Assets can be complementary but this is not necessarily the case *at the margin* and it is possible that $\frac{\partial R(e_1, e_2)}{\partial e_i} \leq \frac{\partial r_1(e_1)}{\partial e_i} + \frac{\partial r_2(e_2)}{\partial e_i}$, $\forall i = 1, 2$, i.e.:

$$\frac{\partial R(e_1, e_2)}{\partial e_i} \leq \frac{\partial r_i(e_i)}{\partial e_i}, \quad \forall i = 1, 2. \quad (1)$$

With substitution at the margin, when investment increases, the return increases less when the second asset is present. Hence, with higher investment the advantage of the complementary asset decreases and the benefit of synergy decreases with investment. Inequation (1) above is equivalent to:

$$\frac{\partial S(e_1, e_2)}{\partial e_i} \leq 0, \quad \forall i = 1, 2.$$

Result 1. When assets are complementary but substitutes at the margin, the benefit of synergy is decreasing in effort.

When assets are substitutes at the margin, the presence of an additional asset interacts with the level of investment. Assets are

not directly substitutes among themselves (in fact they are complementary), but they are substitutes to investment.⁵ The benefit of an additional asset is lower when investment is higher and, as we will see below, the presence of the additional asset decreases the incentive to invest of the agent. For example, the owner of a repair shop who increases his own marketing (or quality) efforts sees the benefit of complementarity with a car dealer reduced as a large part of the potential ‘synergetic’ customers are already brought in by the extra efforts. The marketing efforts are substitute to the synergy, and increased marketing efforts crowd out the benefits of synergy.

At date 0, the principal chooses to merge or not to merge the two assets to maximize ex ante surplus. At date 1, the agents choose their level of relationship-specific non-contractible effort. Finally, and at date 2, the agents bargain over the share of surplus with the principal. Following the literature, we assume that ex post surplus is distributed according to a linear bargaining solution (for example the Shapley value). Furthermore, no date 1 variable is contractible at date 0.

2.1. Equilibrium investments

The principal (and her assets) and the agents are indispensable. The bargaining power of the principal is such that her share of ex-post surplus is⁶:

$$\alpha r_1(e_1) + \alpha r_2(e_2) + \beta S(e_1, e_2), \quad \alpha, \beta \in [0, 1].$$

The ex ante payoff for each agent is then:

$$(1 - \alpha)r_i(e_i) + \frac{(1 - \beta)}{2}S(e_1, e_2) - C_i(e_i), \quad \forall i = 1, 2.$$

In the merger, anticipating bargaining, the agents set their effort to maximize their ex ante payoff, and the equilibrium level of effort (e_i^M, e_2^M) is given by:

$$(1 - \alpha)r'_i(e_i^M) + \frac{(1 - \beta)}{2} \frac{\partial S(e_1^M, e_2^M)}{\partial e_i} = C'_i(e_i^M), \quad \forall i = 1, 2.$$

On the other hand, when the assets are independent, the equilibrium level of investment (e_i^I, e_2^I) by the agents is given by:

$$(1 - \alpha)r'_i(e_i^I) = C'_i(e_i^I), \quad \forall i = 1, 2.$$

Given the concavity of the production functions:

$$e_i^M < e_i^I \quad \text{if} \quad \frac{\partial S(e_1, e_2)}{\partial e_i} < 0, \quad \forall i = 1, 2.$$

Proposition 1. When the assets are complementary but substitutes at the margin, agents invest a lower level of effort after merger.

In the example above, the merger between the car dealer and the repair shop brings additional ‘synergetic’ customers that reduce the repair shop owner’s incentives to invest in marketing (or in quality).

2.2. Social welfare

Welfare will be higher with [without] a merger if and only if:

$$\begin{aligned} r_1^I + r_2^I - C_1(e_1^I) - C_2(e_2^I) \\ \leq [\geq] r_1^M + r_2^M + S^M - C_1(e_1^M) - C_2(e_2^M). \end{aligned} \quad (2)$$

complementary and independent agents (Bel et al., 2015) or the systematic investment of another agent (Winter, 2009, 2010), that drives the results.

² Using the theory of supermodularity, several authors (e.g. Siggelkow, 2002) have studied the effect of asset complementarity or substitution in different contexts.

³ This model can be extended both in terms of the number of agents and the exact nature of the synergies between them.

⁴ Throughout the paper, we will use the terms investment or effort indifferently.

⁵ The cross-partial derivative between assets and investments is negative (see Milgrom and Roberts, 1990).

⁶ The bargaining power on r_i (assumed to be identical across agents) and S may be different, since the principal has to bargain independently with each agent i on r_i , but with the two agents on S .

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