Institut für Volkswirtschaftslehre

Volkswirtschaftliche Diskussionsreihe

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Beitrag Nr. 307, Dezember 2009

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Abstract

Gaining access to technologies, competencies, and knowledge is observed as one of the major motives for corporate mergers and acquisitions. In this paper we show that a knowledge-based firm's probability of being a takeover target is influenced by whether relevant specific human capital aimed for in acquisitions is directly accumulated within a specific firm or is bound to its founder or manager owner.

We analyze the incentive effects of different arrangements of ownership in a firm's assets in the spirit of the Grossman-Hart-Moore incomplete contracts theory of the firm. This approach highlights the organizational significance of ownership of complementary assets. In a small theoretical model we assume that the entrepreneur's specific human capital, as measured by the patents they own, and the physical assets of their firm are productive only when used together. Our results show that it is not worthwhile for an acquirer to purchase the alienable assets of this firm due to weakened incentives for the initial owner. Regression analysis using a hand collected dataset of all German IPOs in the period from 1997 to 2006 subsequently provides empirical support for this prediction.

This paper adds to previous research in that it puts empirical evidence to the Grossman-Hart-Moore framework of incomplete contracts or property rights respectively. Secondly, we show that relevant specific human capital that is accumulated by a firm's founder or manager owner significantly decreases that firm's probability of being a takeover target.

JEL classification: G32, D23, G34

Keywords: ownership structure, property rights, mergers & acquisitions

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Acknowledgements: We would like to thank participants of the EARIE Annual Conference 2009 in Ljubljana/Slovenia, participants of the X. Symposium of the GEABA in Vallendar/Germany, and especially Ulrich Lichtenthaler, Joel Stiebale, Stefano Trento, and Peter Welzel for valuable comments and feedback on this research.

I. Introduction

For the last couple of years many of the world's economies have been facing radical changes in their market places. On the one hand, there has been an explosion of entrepreneurial activities in technology and knowledge intensive sectors all over the world, driven by technological but also by political and cultural changes (Audretsch and Thurik 2001). On the other hand, mainly the same forces have led to an increase in international activities of firms, creating global players, which gives pressure to firms even if they act on national markets only. In this context, a particular firm's success increasingly depends on its capability of innovating faster than its best competitors (Teng 2007). One crucial facet of this capability is the development of novel technologies, products, and services. Industries with short innovation cycles and technologically complex products could make it infeasible for firms to internally develop all new technologies they need for innovation at sufficient pace (Ranft and Lord 2002). Mergers and acquisitions can be a viable vehicle in pursuing a resource-based strategy as they allow for access to strategic resources that enable acquirers to create a sustainable competitive advantage (Wernerfelt 1984; Barney 1991). As a consequence, the acquisition of technologies, competencies, and knowledge from external sources has become one of the major motives for corporate mergers and acquisitions in recent years.

However, acquiring strategic resources seems increasingly difficult if tacit knowledge is required for optimal resource exploitation. A firm's competitive advantage is determined by the specific assets at its disposal which include limitedly marketable knowledge assets as well as assets complementary to these. Even within firms it is oftentimes impossible to successfully replicate or imitate certain assets due to the tacit characteristics of some of their complementary resources without transferring key individuals that have accumulated the respective knowledge and know-how (Teece, Pisano, and Shuen 1997). Obviously, these issues will be of even higher importance if specific knowledge-intense assets as well as the complementary tacit knowledge and specific human capital are to be acquired from sources external to a respective firm as is the case in mergers and acquisitions.

This paper aims at adding to our understanding of corporate M&As by analyzing influences on a knowledge-based firm's probability of being a takeover target for acquirers seeking access to novel technologies and similar widely knowledge-based inputs they can exploit in their innovation endeavors. Many high-tech start-ups for example are taken over by larger firms early in their firm life cycles (Dai 2005). These larger firms on the one hand own the necessary resources to bring the entrepreneurial firms' innovations to the market. On the other hand, they largely depend on novel technologies possessed by high-tech start-ups, given the

increasing pressure of timing innovations in many industries. This paper, however, significantly differs from most previous research. Work on resource access by means of takeovers up to now has only considered total patents that were at a potential target's disposal as a measure for its intangible assets such as technologies and innovative capacity. This paper explicitly differentiates among such knowledge assets that are directly owned by a respective firm and those that belong to a firm's founder or manager owner and are being employed in the potential target's value creation process.

In particular, we show that firms that do not directly own essential and indispensable intangible assets have a significantly lower probability of being takeover targets. Although this might be puzzling and on first sight not in line with predictions of the resource-based view of the firm, this paper shows that its empirical findings directly correspond to predictions from the Grossman-Hart-Moore framework of incomplete contracts. A key tenet of this framework is that real world contracts, unlike contracts typically analyzed by agency theory, are mostly incomplete. Real world arrangements almost always involve contingencies that cannot be specified upfront because of their unforeseeable nature or simply as an exhaustive specification is too expensive (Brynjolfsson 1994). The allocation of residual rights of control, derived from ownership of alienable assets of a firm, will therefore have an important effect on the bargaining power positions of the parties to the contract after their relationship specific investments have been made. We directly link predictions from this framework with M&A transactions in that we assume that the entrepreneur as a holder of patents owns at least some of the knowledge and human capital critical to a firm's value creation process. After a takeover of their firm, the entrepreneur can be held-up by the firm's new owner in any circumstances that are not explicitly specified in their contract, especially if the initial owner is locked-in. This may be the case in negotiating the division of upfront unknown residual income resulting from the entrepreneur's continued investment into their specific human capital. As the initial owner can extract only little or even no value from their specific human capital investment without access to the firm's assets that the investment has been specified to, the acquirer will be in a position to reap at least some of the residual returns from their relationship by threatening to withhold the firm's assets. Grossman and Hart (1986) and Hart and Moore (1990) developed a theory of vertical integration of tangible assets to solve such potential hold-up situations. Brynjolfsson (1994) extends this theory by considering intangible assets such as information or specific human capital as key assets. We follow this line of literature by assuming that the entrepreneur's specific human capital, measured by the number of directly owned patents, is strongly complementary to the physical

assets of the firm. The value extractable from a takeover target's resources then depends on the specific investments made by individuals whose human capital is directly linked to these assets. However, these individuals, if not equipped with sufficiently complete contracts or protected by bargaining power from ownership of tangible assets, could anticipate the potential hold-up situation they might face due to the quasi sunk-cost character of their specific human capital investment. They might then invest less than optimal in their human capital and by doing so might lower residual gains resulting from this specific investment. As a consequence of this underinvestment the value extractable from the target decreases as initial owner's human capital is complementary to the target's assets and indispensable for proper exploitation. Since this likely underinvestment in turn will be anticipated by a potential acquirer it consequently will lower the respective firm's probability of being a takeover target.

The next section of this paper provides a short review of previous research on both mergers and acquisitions and young and innovative firms. Section III then argues from a theoretical model based on the Grossman-Hart-Moore incomplete contracts theory of the firm that the allocation of relevant human capital among a firm and its founder or manager owner has impacts on a potential acquirer's decision to take over the respective firm in order to gain access to its specific resources. Section IV describes the dataset which then is employed in section V for testing the corresponding hypothesis derived from the model. The final section summarizes.

II. Takeover Targets, Young and Innovative Firms, and Access to Technologies

The majority of research on corporate mergers and acquisitions investigates publicly traded companies, while privately held targets have remained largely unexplored (Ang and Kohers 2001). A large body of this literature has applied itself to predicting takeover targets with models based on publicly available information. Results reported by earlier studies such as Belkaoui (1978) or Dietrich and Sorensen (1984) suggest that these statistical models considerably surpass the stock market in predicting acquisition targets. While the stock market does not seem to predict takeover candidates even shortly before an acquisition announcement, most of these earlier studies report prediction accuracies ranging from 70% to 90% and target identifications up to twelve months prior to their takeover announcements (Palepu 1986). If these claims are valid these models could serve as the basis for investment decisions as it should be possible to earn abnormal rents by investing in likely takeover candidates (Powell 1997). Palepu (1986), however, argues that these models' prediction

accuracies are unreliable due to several methodology flaws. Using different estimation and sampling techniques he obtains a (statistically significant) model whose predictive ability does not allow for earning abnormal rents on the stock market. Investing in identified potential targets thus does not yield significant excess returns, i.e. its predictive abilities are not superior to the stock market.

Despite these drawbacks concerning the models' predictive abilities, research using acquisition likelihood models advances our understanding of the characteristics of acquisition candidates. These models can clarify motives underlying takeover activity (Powell 1997) and allow for the identification of firm characteristics that potentially influence the probability of being subject to a takeover attempt. Corresponding hypotheses state for example that an inefficiency of a firm's management, an imbalance between its growth and resource base, relatively small firm size, low price-earnings ratios, and takeover waves in a firm's industry positively influence its probability of being a takeover target. Empirical research suggests that predominantly firm size, an imbalance of growth and resource base, management inefficiency, and industry effects influence a firm's takeover probability. Palepu (1986) for example finds that smaller firms are more likely to be taken over than larger ones, and that an imbalance between firm growth and resource base or inefficient management make a takeover more likely. Contradicting general assumptions, a firm's likelihood of being a takeover target is reduced in his sample when there had already been takeovers in the respective industry. Similar results can be found by Powell (1997; 2004) who further differentiates between friendly and unfriendly takeovers. In this context, Powell (2004) finds that friendly takeovers tend to be directed towards smaller firms as compared to targets of unfriendly takeovers, while both groups exhibit growth-resource imbalances. However, there is also research that does not support the influence of any of the above mentioned firm characteristics. Dai (2005) for example, though primarily investigating venture capitalists' influence on post-IPO takeovers, does not find firm characteristics to significantly and robustly influence the likelihood of being acquired. Only firm age seems to reduce the likelihood of being acquired, meaning that elder firms are less likely acquisition targets than younger firms.

Another strand of research investigates differences in acquisitions of publicly traded versus privately held companies as well as the role and benefits of an initial public offering (IPO) - this is, a firm's transition from being privately held to being publicly traded - in a firm's development. M&A transactions generally involve information asymmetries between targets and acquirers which are associated with adverse selection costs. Literature suggests several ways of coping with asymmetric information involved in corporate acquisitions, such as stock

payments as opposed to cash (Eckbo, Giammarino, and Heinkel 1990) or an extended negotiation period allowing for a closer evaluation of the target (Coff 1999). However, especially in cases involving young firms with significant holdings of intangible assets whose value has not yet been signaled these information asymmetries often seem to be prohibitively high (Shen and Reuer 2005). Taking the firm public prior to its eventual sale therefore can significantly increase returns to its initial owners by reducing information asymmetries and with that reducing corresponding bid price discounts. Stock markets demand for standardized information disclosure, and stock prices as the aggregated information of several investors (Ellingsen and Rydqvist 1997) reflect the market's evaluation of a firm's performance. Additionally, as Shen and Reuer (2005) argue, the presence of a resale market for a firm's shares reduces a potential investor's downside risk. Most important, however, is the signaling mechanism that an IPO can be viewed as, as it discriminates firms of high quality from lower quality firms. This argument is in line with the reasoning by Zingales (1995). In a small theoretical model he can prove that it is advantageous for the initial owner to first take their firm public before they sell the majority of votes to a single acquirer, if (and only then) the initial owner beliefs they can further increase the firm's value in the time period between its IPO and the takeover, i.e., if they believe their firm is of high value. Zingales (1995) justifies this finding by explaining that a firm's value stems from two separate sources: the value of rights to its cash flows and the value of rights to its control. By selling both rights separately as proposed by his model the initial owner can maximize the proceeds from both of these sources of value. Neus and Walz (2005) finally show that even firms with considerable experience in selling off their ventures, namely venture capitalists, inevitably face the trade-off of either directly selling their not publicly traded venture capital investment at a discount or of conducting an IPO and subsequently waiting until the capital market is able to perceive an investment's realistic value and prospects.

Empirical research widely seems to support this important role the IPO plays in reducing information asymmetries connected with corporate mergers and acquisitions. Lian and Wang (2007) for example examine why dual tracking firms (this is, private firms entertaining acquisition offers at the same time as preparing for initial public offerings) withdraw from their IPO registrations after spending considerable money and effort preparing for IPOs only to be purchased by public acquirers. In addition to the above mentioned signaling mechanism of discriminating high from low quality firms an IPO can also be a focal point for potential acquirers since small business firms are often difficult to locate as potential targets. Lian and Wang (2007) argue that filing for IPO registrations in pursuing a dual tracking strategy

reduces the valuation uncertainty among withdrawn IPO private targets and their bidders. They show that withdrawn-IPO private targets sell at a 47 percent acquisition premium relative to comparable pure private targets that never had filed for IPO registrations. Brau, Francis, and Kohers (2003) analyze firm owner's choice between an IPO and a takeover by a public acquirer. Using a sample of over 9.500 U.S. privately held firms, they address the IPO versus takeover issue by examining market-timing, industry, deal-specificity, and funding demand factors. Their results show that the high-tech status of the private firm and the percentage of insider ownership, among others, positively influence the probability of a firm conducting an IPO. These findings are in line with the general assumption that young firms with large holdings of intangible assets such as technologies or patents need to signal their values as especially their acquisitions involve serious adverse selection risks. Accounting data provides little information regarding intangibles' values, and the ex post transferability of these resources can hardly be accessed during target valuation (Shen and Reuer 2005). A firm's willingness to comply with higher disclosure requirements as well as public valuation that both are connected with public trading in a firm's stock can lower adverse selection risks (Brau, Francis, and Kohers 2003).

Following Audretsch and Thurik (2001), the transition to an entrepreneurial economy that many industrialized western economies have been undergoing for years leads to competitive advantages that do not derive primarily from economic activities based on the traditional inputs, but increasingly from knowledge-based economic activities. This entrepreneurial economy, however, is characterized by high degrees of uncertainty, turbulence, and heterogeneity, so that innovations are radical and unforeseeable and competitive advantages based on successful innovations often only last for short time. These changed environmental conditions oftentimes seem to favor young and small entrepreneurial firms that are founded based on the belief in a new and widely untested invention or technology. Specific human capital and technological know-how play key roles in these "New Enterprises" as they can allow for competitive advantages, if successfully employed. As a consequence, knowledge-intense firms significantly depend on the continued availability of their knowledge-workers, this is, individuals who possess relevant specific human capital. Furthermore, many New Enterprises are founded for exploitation of ideas that involve a tedious period of further research and product development. In this course, many knowledge-based firms face severe financing constraints or simply lack basic business skills, so that from their point of view a takeover by a larger incumbent can be vital as well. Following Wernerfelt (1984), an acquisition can be viewed as the purchase of a resource bundle. For established firms in

dynamic and technology intense industries such an acquisition can be a viable (if not a necessary) way of accessing and incorporating intangible resources necessary for innovation. However, as argued by Barney (1995), strategic resources do not only have to be valuable and rare, inimitable and non-substitutable, but also exploitable in order to allow for creating a sustainable competitive advantage. Successful exploitation of entrepreneurial firms' intangible resources seems to pose exceptional difficulties to both their initial owners and to potential acquirers. As entrepreneurial firms existentially depend on their knowledge-workers' specific human-capital, but unlike other resources cannot own them (Mahnke 1997), knowledge-intense firms' success hinges on efficient incentives. Given incomplete contracting and the quasi sunk-cost character of their investments, knowledge-workers face a potential hold-up problem after specifying their human capital to a firm's value creation process (Mahnke 1997; Rajan and Zingales 2000). In order to mitigate the risk of individuals' underinvestment into their specific human capital literature suggests their participation in a firm's residual income. Equity ownership equips key individuals with the power to contradict unfavorable distributions of residual income and thus can provide essential incentives for optimal specific investment. Empirical research seems to support this reasoning. Lehmann (2006) for example finds that a CEO's equity ownership in German high-technology firms increases with the CEO's holdings in relevant intangible assets as measured by patent counts, while the likelihood of performance-related compensation components decreases. Consistent with the preceding reasoning, he concludes that equity ownership increases the CEO's incentives for relationship-specific investments as it increases their ex post bargaining position by allocating residual rights of control.

III. Model and Hypothesis

In this section we show why firms, in which the entrepreneur has essential knowledge for the production process, may show a lower probability of being targeted by takeover attempts than firms that do not have such characteristics. We base our reasoning on the Grossman-Hart-Moore framework (1986; 1990) and an extension by Brynjolfsson (1994). The former ones analyzed the effects of property rights in tangible assets on the incentives of the participants in a relationship. Especially the residual rights of control, which are equated with ownership, give their proprietors the power to decide on assets and their usage. Most important, owners can exclude others from working with their assets and therefore have a stronger bargaining power if an asset they own is essential to others. This leads to a well known hold-up problem for the other party if they need access to this specific asset in order to generate value.

Brynjolfsson (1994) extended this framework by relaxing the assumption that all assets under consideration have to be tradable and introduced information as an intangible asset into the model. Information can easily be interpreted as the essential knowledge of an entrepreneur so that we henceforth refer to this knowledge as the entrepreneurial asset a_e. All the alienable assets of the firm, this is, the "resource bundle target firm" (Wernerfelt 1984), are combined in the marketable asset a_t. In New Enterprises or knowledge-intense firms these two inputs are strictly complementary, and therefore no value can be realized without access to both the marketable asset as well as to the entrepreneurial knowledge and human capital (Brynjolfsson 1994; Audretsch and Thurik 2001; Rajan and Zingales 2000).

The model considers two periods. In $t = 0$, ex-ante, all participating agents can invest in their productivities for the production process. We adopt the definition of Hart and Moore (1990) for this investment x_i which is a "*pure investment in human capital*" (p. 1125). Furthermore, agents can only decide on the level and not on the type of investment. In the second period, $t = 1$, the production takes place and the resulting product is sold. We stay with the assumption of incomplete contracting in the ex-ante period. Both, the investment decision and the production, are too complex for proper definition in a contract in $t = 0$. Ex-post, however, all agents are supposed to be feasible of writing a complete contract, since the uncertainty of the production is gone and the specific investments as well as the resulting surplus are observable. These gains from production in $t = 1$ are then distributed among the agents through a multiperson bargaining process. Whereas Grossman and Hart (1986) imply a Nash bargaining, Hart and Moore (1990) as well as Brynjolfsson (1994) suggest a distribution according to the Shapley Value. The latter one adds that the *"exact rule for the division of the surplus will generally have no qualitative effect on the results as long as each agent's share of output is positively correlated with his access to essential assets"* (Brynjolfsson 1994, p. 1648)

In the modeling of Hart and Moore (1990) the value a specific coalition can create, $v(S, A(S)|X)$, is depending on the number of agents in the coalition S, the assets controlled by the coalition, $A(S)$, and the specific ex-ante investments and increases in all these variables. In consequence, the maximal value for a group of agents in $t = 1$ occurs in a coalition of all agents $\underline{S}$ who are in control of all necessary assets $\underline{A}$, this is, $v(\underline{S}, \underline{A}(\underline{S})|X)$. The marginal return on investment an agent gets in a specific coalition S amounts to

$$\frac{\partial}{\partial x_i} v(S, A(S)|X) \equiv v'(S, A(S)|X) \qquad (1)$$

and equals zero if agent i is not part of this specific coalition S.

Given these assumptions, the agent's maximization problem can be written as follows (Hart and Moore 1990, p. 1129):

$$\max_{x_i} \sum_{S|i\in S} \frac{(|S|-1)!*(n-|S|)!}{n!} * [v(S, A(S)|X) - v(S\backslash\{i\}, A(S\backslash\{i\})|X)] - c(x_i). \quad (2)$$

Agent $i's$ revenue is the difference between the coalition's revenue with and without them – therefore, with or without the assets they control – multiplied by the probability that they are in a given coalition. The cost function $c(x_i)$, this is, the costs associated with an agent's specific human capital investment, increases in x_i.

According to Brynjolfsson (1994) we restrain all synergies to occur only through the assets at a coalition's disposal and not through the coalition members. This and suppressing the reference to the vector of ex-ante investments simplify the further notation of the marginal return on investment to

$$v'\big(A(S)\big) = v'(S, A(S)|X). \quad (3)$$

In the following, we analyze agents' incentives for investments in their specific human capital in a simple setup with two agents and two assets.

In a first step we analyze agents' incentive schemes in the non-takeover situation, this is, a situation where the entrepreneur not only possesses their entrepreneurial knowledge and human capital but also owns the alienable assets of their firm. Our modeling considers an entrepreneur (Agent E) who has ownership and with that residual rights of control over both assets, the entrepreneurial asset a_e and the alienable asset a_t. This situation refers to the allocation of ownership when the firm has not been taken over by a potential acquirer (Agent A). Since both assets are necessary for the production process, no value can be created with only one of these (perfect complementarities). This will, as we show beneath, give the entrepreneur maximum incentives to invest in the production process by further specifying their human capital to the production process. Agent $E's$, the entrepreneur's, maximization problem, according to the Shapley Value, then is

$$\max_{x_E} [\tfrac{1}{2}\big(v(a_e, a_t) - v(\emptyset)\big) + \tfrac{1}{2}(v(a_e, a_t) - v(\emptyset)) - c(x_E)]. \quad (4)$$

Agent A, the potential acquirer, who in this non-takeover situation does not own any assets can only gain a profit if they are in a coalition together with the entrepreneur owning all the assets necessary for production. So Agent A faces a different maximization problem:

$$\max_{x_A}\left[\frac{1}{2}\big(v(a_e,a_t)-v(a_e,a_t)\big)+\frac{1}{2}(v(\emptyset)-v(\emptyset))-c(x_A)\right]. \qquad (5)$$

In both these equations the first terms account for the coalition of both agents ($S = \{Agent\ i, Agent\ j\}$), while the second terms represent the coalition with one agent being the only participant ($S = \{Agent\ i\}$. As stated earlier in this paper, simultaneous access to both assets is required for value creation. As a consequence of these perfect complementarities the values generated by all coalitions in control of less than both assets equal zero.

Translating these maximization problems into first order necessary conditions reveals different incentive schemes for the two agents under consideration. The first order necessary condition for Agent E, from maximization problem (4), leads to

$$\frac{1}{2}v'(a_e,a_t)+\frac{1}{2}v'(a_e,a_t)=c'(x_E)$$

$$v'(a_e,a_t)=c'(x_E) \qquad (6a)$$

which can be interpreted as their value-maximizing incremental investment in their human capital. Employing maximization problem (5), the first order necessary condition of Agent A, on the other hand, is given by

$$0=c'(x_A). \qquad (6b)$$

Obviously, the entrepreneur can claim all the value created in the production process in both possible coalitions. Since the entrepreneur has control of both assets that are simultaneously required for production, they do not face any hold-up problem as no other party can threaten to deny access to one of the two complementary assets. The potential acquirer, on the other hand, can only benefit if they are in a coalition with the entrepreneur. But even in this situation they do not have any incentive to make a specific investment since they do not control any assets and therefore lack any bargaining power in the division of surplus.

In a second step we now investigate agents' incentive schemes in the post-takeover situation, this is, a situation where the entrepreneur only controls their entrepreneurial knowledge because of its inalienable nature. The alienable assets that in the non-takeover setup were owned by the entrepreneur are now owned by the firm's acquirer. Our modeling thus considers Agent E only retaining their entrepreneurial asset a_e, and Agent A having purchased the alienable asset a_t and refers to the allocation of ownership when the firm has been taken over by an acquirer. Again, given the assets' perfect complementarities no coalition can create value in the production process without simultaneous access to both assets. This will, as we subsequently show, lower the entrepreneur's incentives to further

specify their human capital to the production process. Agent $E's$ and Agent $A's$ maximization problems, according to the Shapley Value from equation (3), are identical in the post-takeover situation and can be written in their general form as

$$\max_{x_i}[\tfrac{1}{2}\big(v(a_i, a_j) - v(a_j)\big) + \tfrac{1}{2}(v(a_i) - v(\emptyset)) - c(x_i)]. \qquad (7a)$$

From the assets' perfect complementarities follows again that the values generated by all coalitions controlling less than both assets amount to zero (i.e., $v(a_j) = v(a_i) = v(\emptyset) = 0$). This simplifies the above stated maximization problem to

$$\max_{x_i}[\tfrac{1}{2}v(a_i, a_j) - c(x_i)]. \qquad (7b)$$

This new allocation resulting from an acquisition of the entrepreneur's firm leads to different incentive schemes for the two agents as compared to the non-takeover situation. While Agent $E's$ incentives, as compared to equation (6a), are lowered to

$$\tfrac{1}{2}v'(a_t, a_e) = c'(x_E). \qquad (8a)$$

Relative to the non-takeover situation (equation 6b) Agent $A's$ incentives are increased to

$$\tfrac{1}{2}v'(a_t, a_e) = c'(x_A). \qquad (8b)$$

Comparing the entrepreneur's incentive scheme in the non-takeover situation (equation 6a) with their incentive scheme after a takeover of their firm (equation 8a) reveals that a takeover of the entrepreneur's firm decreases their incentives to specifically invest in the production process, this is, to further specify their knowledge and human capital. In the case of both assets being solely owned by the entrepreneur they are willing to make higher a specific investment (corresponding to a higher marginal revenue, the left-hand side of equation 6a) than they are in the case of separation of ownership in a firm's assets (left-hand side of equation 8a). As the entrepreneur has access to both the necessary assets in all possible coalitions in the non-takeover situation, they do not face a problem of potentially being held-up by another party. Following from this relatively higher marginal revenue in the non-takeover situation and from the shape of the cost function, we can conclude that the entrepreneur's specific human capital investment x_E will decrease if ownership in the alienable assets is transferred to another party. For the (potential) acquirer, on the other hand, incentives for specific investments increase by acquiring ownership in the alienable assets of the firm. In the non-takeover situation (equation 6b) they cannot bargain for any fraction of the resulting residual income (the left-hand side of equation 6b equals zero) and therefore

have no incentive for any specific investment. By purchasing the alienable assets of the firm (equation 8b), any value creation still is dependent on a coalition's access to the entrepreneur's knowledge so that only a coalition of both the acquirer and the entrepreneur can create any value. As an owner of complementary assets the acquirer now can threaten to withdraw these assets and with that has bargaining power to secure part of the resulting residual income which increases their incentives for investment. However, since any outside party could contribute the acquirer's share to the production process but the entrepreneur's share is unique, the both parties' contributions' relative relevance is likely to be extremely disproportionate. In consequence, any increase in an acquirer's incentives can be neglected relative to the considerable decrease in those of the entrepreneur. Given the entrepreneur's specific investment being indispensable for the value creation process their decreased investment will be inefficient in maximizing total production value, since the joint value of the production relationship is positively related to the specific ex-ante investments of the agents. In conclusion, the reallocation of ownership in a firm's assets in the course of a takeover inevitably lowers the value that can be extracted from the target's assets. This general result also holds for more than one entrepreneur (see Brynjolfsson 1994).

The model analyzed above shows clearly, that an outside agent only controlling the alienable assets of a firm can never be the best allocation of ownership if there is an entrepreneur whose knowledge is inalienable but essential for production. As Brynjolfsson (1994, p. 1651) argues, the "*ownership of the physical assets of the firm […] may be of little value when complementary information assets […] are not also controlled*". By acquiring a firm, the acquirer only gets control of the firm's alienable assets but is dependent on the initial owner's human capital investments. Thus, for knowledge-intense firms in the sense of Rajan and Zingales (2000) these findings consequently lead to the following hypothesis:

Hypothesis: *A firm's probability of being a takeover target significantly decreases with the extent to which relevant specific human capital and knowledge are inalienably bound to its founder or initial owner.*

IV. Dataset and Descriptive Statistics

Section two of this paper discussed findings on the role of IPOs in alleviating valuation issues arising from asymmetric information between potential acquirers and initial owners of privately held and especially knowledge-intense firms. Accordingly, our empirical analysis investigates newly publicly traded firms, this is, firms that had recently conducted their IPOs.

Our initial dataset compiled all IPOs of German issuers, as identified by their ISINs, in segments of *Deutsche Boerse AG* (German Stock Exchange) in the ten-year period from 1997 to 2006. Containing 433 IPOs in segments of *Deutsche Boerse AG's* regulated market our initial sample covered about 90 percent of total regulated market IPOs in Germany in the respective time period. Additionally, we included all 42 firms listed in *Deutsche Boerse AG's* primary statistics for this time period that had their IPOs in the open market segment. From these 475 observations 89 firms had to be excluded from further investigation, mostly since they declared insolvency until the end of the investigation period in December 2007 without having received any takeover bid. Our final dataset contained 345 IPOs in the regulated market and 41 IPOs in the open market, resulting in a total of 386 observations.

The dependent binary variable was assigned a one if the respective firm received a takeover bid during the investigation period and a zero otherwise, indicating a potential acquirer's intention to achieve control over that firm, this is, the bidder trying to acquire the respective firm. Information concerning takeover attempts was taken from listings of takeovers announcements compiled by Blättchen and Götz (2002; 2003a; 2003b; 2004a; 2004b; 2005a; 2005b; 2006a; 2006b) and Blättchen and Nespethal (2007a; 2007b; 2008), and from ad hoc announcements published through *Deutsche Gesellschaft fuer Ad-hoc Publizitaet (www.dgap.de)*, an institution assisting firms with complying with disclosure requirements. During our observation period 91 firms in our dataset received takeover bids.

As independent variables measures for knowledge-based resources and specific human capital accumulated by each firm as well as by its initial owners, and measures for a firm's age, size, and performance were collected. Furthermore, dummy variables for the firms' industries were assigned to avoid problems of unobserved heterogeneity by controlling for industry-specific differences. Accounting data and information regarding the firms' industries, foundation and IPO dates was taken from on-line data sources such as *Deutsche Boerse AG* and *OnVista AG*.

As a firm's age we considered the length of the period from its foundation until the receipt of a takeover bid or until the end of the investigation period, whichever occurred earlier. As a performance measure and proxy for management efficiency we computed the EBIT-to-Equity ratio. This performance measure is similar to those employed for example by Palepu (1986), who used the return on equity averaged over a period of four years, and Barnes (1999), who considered the ratio of profits before tax and shareholders' equity, among others. The obvious advantage of our performance measure is that it abstracts from firm specific cost of debt and its individual rate of taxes, both of which can directly be influenced by a potential acquirer

and are likely to be altered subsequent to the firm being acquired. Balance sheet totals were used as measures for firm size, which is also similar to for example Palepu (1986) and Powell (2004) and consistent with the notion that a corporate takeover can be viewed as the purchase of a resource bundle (Wernerfelt 1984). The size of this resource bundle then amounts to its total value as quantified by a firm's balance sheet total. Note, however, that instead of using balance sheet totals including a firm's revenues or the number of its employees in our analysis did not yield differing results. As with firm age, firm size, and firm performance were either collected to the end of the investigation period, if the respective firm had not received any takeover bid until then, or to the time a takeover bid was announced.

As measures for knowledge-based resources and specific human capital accumulated within each firm as well as by its initial owners we included counts of patents directly registered by the firm as a legal entity (*FIRM PATENTS*) and patents registered by a firm's human shareholders (*SHAREHOLDER PATENTS*). Similar to Audretsch and Lehmann (2004), information regarding both these measures was extracted from the German Patent Information System, the patent database of the *Deutsches Patent- und Markenamt* (German Patent and Trademark Office, *www.depatisnet.de*), searching for firm names and shareholder names as applicants of all the patents issued either until the respective firm received a takeover bid or until the end of the investigation period. Information regarding shareholdings of individuals at the time of IPO was taken from IPO prospectuses and on-line data sources such as *Deutsche Boerse AG* and *OnVista AG*. Patents registered by these initial owners are used to operationalize tacit knowledge and specific human capital bound to a firm's entrepreneur. While patents draft the basic contents and concept underlying a specific idea, technology, or the like, it may well be argued that there is always a significant amount of specific human capital that is necessary for exploitation of a patents' value. This human capital is bound to the person most familiar with a patent's use (this is, its owner) so that this person is indispensible for efficient use of a patented idea or technology. As shareholder patents and especially the underlying human capital and knowledge are specified to the use of the firm's physical assets, however, the patents' owner cannot further commercialize on these without simultaneous access to the physical assets. Anticipating ex post bargaining induced by a potential acquirer's bargaining power from asset ownership, the entrepreneur will consequently tend to underinvest in their human capital, this is, tend to decrease their sunk cost or lock-in, respectively. These effects are further intensified by considering that patents oftentimes do not provide perfect protection against theft and misuse as it is extremely difficult to prove infringements. The costs for hindering the potential acquirer from

unauthorized use, especially after the entrepreneur eventually left the firm, and the so-called "costs of the third party" are high. This aspect of incomplete protection of the entrepreneur's human capital investment additionally lowers their incentives. We refer to Lehmann (2006) for a more detailed discussion and further references. On the opposite, patents registered by the firm as the legal entity can directly be purchased by the firm's acquirer as part of the resource bundle, including the complementary knowledge and human capital. This is because these complementary resources are bound in a firm's employees whose incentives will not directly be affected by a change in firm ownership. The firm's acquirer simply replaces the initial owner as the counterparty to the employees' contracts. In consequence, as employees do neither face a change in their contracts' details nor in their ownership position in the firm, there does not result any change in incentives and with that no change in employees investment in human capital and use of assets and resources.

Table 1 below summarizes descriptive statistics of the independent variables for the two subsamples of firms, this is, firms that received takeover bids during our investigation period and firms that did not. The column on the right of the table reports the results from a two-tailed test of mean comparisons.

--- Please insert Table 1 about here ---

Consistent with the basic assumptions of our paper, mean patent counts for both firm patents as well as shareholder patents of the firms that received takeover bids are smaller than those of the firms that did not. However, this difference in means is only significant for the patents of the firms' shareholders, not for firm patents. In the latter case, the hypothesis that both means are equal cannot be rejected. Means of firm age, firm size, and firm performance are not significantly different between the two groups, so that our data does not seem to support corresponding hypotheses and results found in literature. Palepu (1986) and Powell (2004), for example, expect negative influences of firm size on the probability of being a takeover target. Dai (2005) finds that older firms are less likely to be takeover targets than younger ones. Palepu (1986), Barnes (1999), and Powell (2004) for example expect a negative influence of management efficiency, as measured by higher a firm performance, on a firm's probability of being a takeover target.

--- Please insert Table 2 about here ---

Table 2 above finally depicts the correlation coefficients of the exogenous variables.

V. Empirical Results

We use logistic regressions to examine if the likelihood of receiving a takeover bid during our investigation period is influenced by firm characteristics, estimating the following equation:

Prob (takeover bid = 1) = f (patents, firm age, firm size, performance, industry-dummies) + u.

Table 3 below presents the regression results for three different estimations. The first model only contains patents that are directly owned by the firm, measuring knowledge-based assets directly controlled by a firm and alienable in the course of an acquisition, while the second model only contains patents directly owned by the firm's initial owners as a proxy for knowledge and specific human capital bound to those individuals. The third model finally considers both firm and shareholder patents as independent variables. In addition to these variables, all three models include firm size, firm age, performance, and industry dummies.

--- Please insert Table 3 about here ---

The results of all three models do not exhibit any significant influences of the selected independent variables on acquisition likelihood, except for the patents directly owned by firms' initial owners. These shareholder patents were employed as a measure for the extent to which relevant specific human capital and knowledge are bound to a firm's entrepreneur or initial owner. Shareholder patents' coefficient is highly significant in both models that included directly owned shareholders' patents as an explanatory variable, supporting the postulated negative impact on firms' probability of receiving takeover bids. Based on our results, however, we cannot support previous research concerning an influence of one of the other explanatory variables on takeover probabilities. Even patents directly owned by the firms in our sample do not significantly influence takeover probability, this is, a firm's probability of being targeted by a takeover attempt does not seem to be impacted by its assemblage of knowledge-based assets.

The significantly negative impact of initial owner's patents on takeover probability, however, seems to strongly support the predictions that we derived from our model based on the Grossman-Hart-Moore framework. Our regression results provide support for the hypothesis that potential acquirers do anticipate potential underinvestment by initial owners arising from them being exposed to a potential hold-up by their firm's acquirer after their specific human capital investments being quasi sunk. As these individuals sell all their stakes in the firm or at least their controlling blocks in the course of a takeover, their bargaining power in the division of ex ante not fully specifiable residual income is drastically reduced which lowers their incentives for optimal human capital investment. Consequently, firms with entrepreneurs having holdings in essential specific human capital exhibit lower a likelihood of receiving takeover bids than firms that have all relevant intangible assets directly accumulated.

VI. Summary and Conclusion

In this paper we followed the suggestions made by Brynjolfsson (1994) that econometric work should be conducted in order to put empirical evidence to the Grossman-Hart-Moore framework of incomplete contracts and to the property rights approach. In addition to that, he also noticed that both researchers and practitioners still suffer from a lack of robust theoretical models that allow for testable predictions.

We applied the Grossman-Hart-Moore framework to the question of influences on the probability of corporate mergers and acquisitions. After a short review of relevant literature on takeover determinants and target characteristics we summarized the basic difficulties concerning entrepreneurial firms' dependency on specific human capital of key individuals and a potential acquirer's adverse selection risks. The underlying information asymmetries concerning the value of a target's intangible assets can at least partly be mitigated by public trading in its stock. With respect to the former problem, literature suggests participation of key individuals in a firm's equity to equip them with bargaining power in the distribution of residual income and thus provide them with incentives for optimal specific investment. Subsequently, we developed a theoretical model based on Grossman and Hart (1986), Hart and Moore (1990), and Brynjolfsson (1994) and formally derived the conclusion that incentives for relationship-specific investments in an individual's specific human capital indeed are weakened, if they do not own complementary physical assets of their firm as well. From these results we derived the hypothesis that a firm's probability of receiving a takeover bid will decrease with the extent to which relevant specific human capital is bound to its

initial owner, this is, the entrepreneur. Without simultaneous ownership of physical assets they are likely to be held-up by the firm's acquirer which will induce them to invest in their human capital only less than optimal. This underinvestment in turn can easily be anticipated by a potential acquirer and thus will lower the firm's takeover probability. Our final empirical investigation of this hypothesis based on a ten-year sample of German IPOs then provided highly significant support for the postulated negative impact of an entrepreneur's specific human capital on their firm's probability of being targeted by a potential acquirer.

With this paper we could provide further theoretic support and empirical evidence for the broadly supported assumption that equity ownership is an essential mechanism for providing incentives to key individuals in knowledge-based firms. Furthermore, it is one of the first papers that accomplishes both an application of the Grossman-Hart-Moore framework of incomplete contracts to mergers and acquisitions and the deduction of a testable prediction as well as its subsequent empirical analysis. However, there are some potential drawbacks which deserve attention in future research. In this context, special attention should be paid to the relative importance of an initial owner's human capital as measured by the patents they own, and to which extent this human capital is linked to the technologies and physical assets of the respective firm (see for example Harhoff, Scherer, and Vopel (2003)).

Table 1: Descriptive Statistics of the exogenous Variables

	Takeover (N=91)			Non-Takeover (N=295)			Ha: diff><0
Variables	Mean (Std. Dev.)	Min	Max	Mean (Std. Dev.)	Min	Max	t-value
Firm Patents	17.01 (44.57)	0	249	26.86 (70.12)	0	475	1.5880
Shareholder Patents	0.45 (1.49)	0	11	2.84 (9.3)	0	79	4.2423***
Firm Age	28.6 (28.49)	2.91	133.06	29.51 (31.89)	1.99	189	0.2431
Firm Size	869.8 (4433.54)	2.44	40726	1882.2 (17006.21)	0.74	217698	0.9256
Performance	-0.814 (5.7285)	-51.99	1.7	-0.118 (1.69)	-19.79	4.11	1.1439

The column on the right contains the results from two-tailed tests of mean comparisons. While the underlying Null hypothesis is that there are no significant differences between the group means, the alternative hypothesis tests whether these differences are significantly different from zero.

****, **, *: Significant at the 1%, 5%, and 10% levels, respectively.*

Table 2: Correlation Coefficients of the exogenous Variables

	Firm Patents	Shareholder Patents	Firm Age	Firm Size	Performance
Firm Patents	1				
Shareholder Patents	0.2574	1			
Firm Age	0.3958	-0.1000	1		
Firm Size	0.0842	-0.0286	0.0491	1	
Performance	0.0402	-0.0025	0.0094	0.0180	1

Table 3: Regression Results

Variables	Model I	Model II	Model III
Firm Patents	-0.0003927 (-0.17)		0.0009104 (0.37)
Shareholder Patents		-0.1126702*** (-2.74)	-0.1147597 *** (-2.72)
Firm Age	0.0023701 (0.46)	0.0005945 (0.12)	0.0000379 (0.01)
Firm Size	-4.31e-06 (-0.47)	-4.71e-06 (-0.81)	-5.10e-06 (-0.84)
Performance	-0.0645765 (-1.53)	-0.0635718 (-1.45)	-0.0642552 (-1.46)
Industry-Dummies	Yes	Yes	Yes
Intercept	-0.715574 *** (-2.94)	-0.6385177 *** (-2.63)	-0.6287127 ** (-2.54)
Pseudo R2	0.0439	0.0601	0.0604
Log pseudo LL	-201.56338	-198.14239	-198.08209

****, **, *: Significant at the 1%, 5%, and 10% levels, respectively. Z-Values in parentheses.*

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