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Entrepreneurial human capital, complementary assets, and takeover probability

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Thorsten V. Braun, Sebastian Krispin, and Erik E. Lehmann
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JEL: G32, D23, G34

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Entrepreneurial Human Capital, Complementary Assets, and Takeover Probability

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Abstract

Although acquisitions of high tech entrepreneurial firms are of great popularity, the limited empirical evidence shows that these acquisitions often lead to dismal results in that a large number of acquired inventors leave the company after the acquisition and those that remain exhibit poor performance. This study tries to explain this phenomenon and adds additional empirical results and explanations which are based on the seminal work of Grossman, Hart, and Moore. Using a hand collected dataset of all German IPOs from 1997 until 2006 we show that the takeover probability of young and high tech firms significantly decreases with the amount of patents as a measure of intangible and complementary assets owned by the owner-manager.

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I. Introduction

In their paper, titled “And the winner is – Acquired” Henkel et al. (2010) show that entrepreneurial firms enter into a contest with the winner being taken over by an incumbent firm. By choosing high risk levels of their R&D approach they provide a signal to an incumbent firm – and thus are the winner of the beauty contest. Their paper adds to an emerging literature both theoretical and empirically, pointing out that the market for corporate control serves as a matching mechanism between large and established firms on the one and small and entrepreneurial firms on the other hand (Hall, 1990; Blonigen/Taylor, 2000; Jones et al., 2001; Grimpe/Hussinger, 2008a,b; Bonardo et al., 2010). Entrepreneurial firms are assumed to be more likely to create breakthroughs but are not always able to bring the innovations to the market (Wright et al., 2004). In contrast, established and large firms have the financial resources but often provide only incremental innovations. Thus, taking over the entrepreneurial firm may lead to a win-win situation for both parties (Gans/Stern, 2000). Our study aims at adding to our understanding of this process 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. Our results provide empirical evidence that “The Winner is – not always acquired”.

Since start up and entrepreneurial innovation is more radical than that of incumbents, Granstrand and Sjolander (1990) suggest a division of scientific labor between entrepreneurial firms and established firms that implicitly defines their roles as targets and acquirers. Recent academic research focuses on this division of scientific labor and its impact on firm acquisitions (Colombo et al., 2010; Bonardo et al., 2010). Most of this literature points out that entrepreneurial firms are a preferred acquisition target because of their internally available technological capabilities, often measured by the number of patents as a predictor for takeover probability. Although the acquisition of innovative and entrepreneurial firms is of great popularity in academic literature, there is only limited evidence available on the acquisition of high-tech startups and entrepreneurial firms by larger incumbents. This literature shows dismal results in that a large number of acquired inventors leave the company after the acquisition and those that remain exhibit poor innovation outcome (see e.g. Ernst/Vitt, 2000; Paruchuri et al., 2006; Kapoor/Lim, 2007). Some studies tried to explain why these acquisitions often fail and have placed attention on whether the acquired firm is kept as a separate entity or integrated into the acquirer’s organization (Purunam/Srikanth,

2007; Kapoor/Lim, 2007), or how post-deal decision autonomy is granted to the individual acquired key inventor. Colombo et al. (2010) conclude that, while structural aspects of the post merger deal reorganization are still important, one needs to go a step further in order to understand the dismissal empirical findings.

We will go this step forward and contribute to this literature analyzing how the likelihood of entrepreneurial firms of being a takeover target is shaped by the specific role of the owner-manager of an entrepreneurial firm as the key inventor. This study differs insofar from earlier work in that it explicitly distinguishes between the manager-owner as the owner of the intangible assets and the entrepreneurial firm as the legal entity. Like Grimpe/Hussinger (2008a,b) or Bonardo et al. (2010) we include the number of patents as a proxy for firm specific knowledge and capabilities to create innovations and thus give incentives to an incumbent firm to select an entrepreneurial firm as a takeover target. In contrast to this work, we distinguish whether the patents are owned by the owner-manager of the entrepreneurial firm or by the entrepreneurial firm as a legal entity. We find compelling evidence that the likelihood of being a takeover target significantly decreases with the patents owned by the owner-manager. This result seems to be puzzling at a first glance or might seem to demand for treatment as an artificial fact.

Our paper is motivated by the double-sided moral-hazard problem observed and described in the venture capital literature (Gompers/Lerner, 2001) and the underlying theoretical framework on incomplete contracts by Grossman, Hart, and Moore (Grossman/Hart, 1986; Hart/Moore, 1990). The relationship between venture capitalists and entrepreneurial firms is characterized by double-sided moral hazard where the effort levels of both parties – the venture capitalist and the entrepreneurial firm - are either unobservable or nonverifiable and, thus, noncontractible. Thus, both parties tend to underinvest in partner specific relationships. The double-sided moral-hazard problem among an entrepreneurial firm and the venture capitalists could be transferred to the relationship between the acquirer and the entrepreneurial firm as the target. Entrepreneurial firms may have an incentive to be taken over – to win the contest – to attract resources necessary to market their inventions. And the acquirer is faced with the same problem as the venture capitalist with respect to how they can assure that the key inventors which are crucial for success remain in the firm after the acquisition and exhibit the expected performance. In the absence of perfect contracts, Grossman, Hart, and Moore argue that such problems of underinvestment in partner specific relationships could best be solved by vertical integration. Brynjolfson (1994) extended the Grossman-Hart-Moore framework by introducing knowledge as an intangible asset. His results point out that vertical

integration solves the problem of inefficient underinvestment in partner specific relationships. However, his results contradict real live experience: the entrepreneur who owns the intangible asset should own the physical assets of the incumbent firm. Thus, the acquisition process runs the opposite way and the entrepreneurial firm with the owner-manager owning the crucial intangible assets is the acquirer – and the incumbent firm with the physical assets is the target. Our study confirms this kind of mismatch in the acquisition process. Our results are thus not necessarily puzzling or artificial findings but may help to explain the dismal results often found in acquisitions of entrepreneurial firms.

The remainder of this paper is structured as follows. In the next section we provide a review of the three streams of literature mentioned above. In section 3 we formulate our hypotheses. Section 4 describes the dataset which then is employed in section 5 for testing the hypotheses. In the final section we summarize and discuss our findings and conclude.

II. Review of the Literature

Recent academic research on the acquisition of entrepreneurial firms by larger incumbents has focused on three important streams of literature. Entrepreneurial firms as takeover targets, the incentive of entrepreneurial firms to be taken over, and the factors shaping the likelihood of observing takeovers.

2.1 The demand for entrepreneurial firms as acquisition targets

The first stream of the literature analyzes the demand side – the need from established firms to takeover start ups and entrepreneurial firms. 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/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/Lord, 2002). Thus, they largely depend on novel

technologies possessed by high-tech start-ups, given the increasing pressure of timing innovations in many industries (Desyllas/Hughes, 2008). 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 (Dushnitzky/Lenox, 2005; Desyllas/Hughes, 2009).

2.2 The incentive for entrepreneurial firms to be an acquisition target

A second strand of the literature focuses on the supply side of this market – the supply of takeover targets.

Many high-tech start-ups for example are taken over by larger firms early in their firm life cycles because these larger firms own the necessary resources to bring the entrepreneurial firms' innovations to the market (Dai, 2005). Start ups and entrepreneurial firms often lack the resource base of established firm to commercialize their ideas and innovations. Then, it may be favorable for the entrepreneurial firm to be taken over by an established firm (Gans/Stern, 2000). If the number of entrepreneurial firms largely exceeds the number of established firms, the entrepreneurial firms may compete for being acquired (Henkel et al., 2010), otherwise the established firm may compete to acquire successful entrepreneurial firms (Norbäck et al., 2009). In Henkel et al. (2010) the entrepreneurial firm invests in R&D to signal the quality to a potential acquirer.

Another signaling mechanism is described by Zinagles (1995). He treats the IPO as a signaling mechanism discriminating firms of high quality from lower quality firms. There exists an emerging literature focusing on the interdependence between the IPO Market and the market for corporate control (Bonardo et al., 2010). IPOs can be part of a larger process of transferring control rights from the owner-manager of a privately held firm to another firm (Audretsch/Lehmann, 2007). IPOs may mitigate inefficiencies in the M&A markets for privately held targets (Ang/Kohers, 2001). 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/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/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. 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 et al., 1990) or an extended negotiation period allowing for a closer evaluation of the target (Coff, 1999).

Empirical research widely seems to support this important role the IPO plays in reducing information asymmetries connected with corporate mergers and acquisitions (Lian/Wang, 2007). 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/Wang, 2007). Brau, Francis, and Kohers (2003) analyze firm owner's choice between an IPO and a takeover by a public acquirer. 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.

2.3 Predicting takeover probability

A large body of 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) 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. 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. 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). 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. Desyllas and Hughes (2009) find substantial evidence that takeovers are more likely if both the acquirer and the target firm overlap in firm characteristics like R&D intensity. Takeover probability seems to be higher if the target is small and technology driven (Lehto/Lehtoranta, 2006; Grimpe/Hussinger, 2008b) and the targets technology portfolio is complementary to that of the acquirer (Grimpe/Hussinger, 2008a; Desyllas/Hughes, 2009). A recent paper close related to our study is Bonardo et al. (2010). They also analyze the effect of intellectual capital proxied by the number of patents on the likelihood of being a takeover target for IPO firms and find evidence that the number of patents significantly shape the likelihood of being a takeover target.

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.

III. Theoretical Framework and Hypothesis

3.1 Firm specific intangible assets and takeover probability

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. The M&A market might thus be a useful mechanism in establishing new ownership and management structures in entrepreneurial firms that can improve their productivity and maximize the financial return of the embodied human and technological capital. This leads us to formulate our first hypothesis:

H1: A firm's probability of being a takeover target increases with their internally available intellectual and technological capabilities.

3.2 Manager-owner specific intangible assets and takeover probability

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 (Colombo et al., 2010), knowledge-intensive 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 (Lehmann, 2006). 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 manager-owner 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 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.

As an owner of complementary assets the acquirer 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. Given the manager-owner's specific investment being

indispensable for the value creation process after the merger, 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 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. Or, 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:

H2: 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.

3.3 Firm specific variables and takeover probability

However, the probability of being taken over is not only shaped by complementary assets. One of the most popular hypotheses is derived from the corporate governance literature and is called the inefficient management hypothesis (Manne, 1965). Managers that cannot extract a firm's full value are replaced by means of mergers and acquisitions. The acquirer can raise the target's value by replacing its existing management with a more efficient one. Barnes (1999) and Powell (2004) among others similarly formulate this hypothesis:

H3: Firms with an inefficient management show a higher probability of being a takeover target.

Next, we test the growth-resource mismatch hypothesis (Palepu, 1986; Barnes, 1999; Powell, 2000). Firms with low growth but broad resource bases at their disposal are likely acquisition targets. Similarly, firms' higher acquisition likelihood in case of high growth but narrow resource bases could result from asymmetric information in takeover markets. Barnes (1999) adds the point that a mismatch in a firm's growth-resource characteristics might be interpreted as another aspect of management inefficiency as current managers for example could not fully exploit a firm's resource base.

H4: Firms with a mismatch among their growth and the financial resources at their disposal show a higher probability of being taken over.

Palepu (1986, p. 17) among others points out that firms that are in an industry subjected to ‘economic disturbances’ are likely acquisition targets. He thus accounts for variations in mergers and acquisitions across time and industries that can arise from economic shocks. A higher probability of takeovers should be expected in industries that recently experienced takeover activity.

H5: The number of acquisitions within the corresponding industry increases the likelihood of being a takeover target in this industry.

Furthermore, we use firm size and the time period since the IPO as predictors for being a takeover target. As Palepu (1986), Barnes (1999), or Powell (2004) state, certain costs of taking over a firm (e.g. those of integrating the target into the acquiring firm) might increase with the respective firm’s size so that there might simply be less potential acquirers that could afford an acquisition of the respective firm.

H6: The likelihood of being a takeover target decreases with the size of the firm.

Finally, we control for the time period since IPO. As proposed in literature, the IPO of a firm might be a mechanism to signal their superior quality and available technological capabilities (Bonardo et al., 2010). We expect the likelihood of being a takeover target to increase over time. However, we also assume that takeovers of IPO firms are associated with adverse selection effects in that the most valuable firms are being taken over in a short period after their IPO. This leads us to formulate the hypothesis:

H7: A firm’s probability of being a takeover target increases with the time after the IPO but with a decreasing rate.

IV. Research Design

4.1 Sample selection

In this study we focus on the impact of patents owned by the owner-manager on the likelihood of being a takeover target for entrepreneurial firms that went public in Germany from 1997 until 2006. 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 this total of 475 observations 89 firms had to be excluded from further investigation. We excluded banks and insurance companies, holdings and firms who 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. However, dropping those firms may lead to a selection bias in favor of more successful firms.

4.2 Variables and measurement

Our dependent variable is the observation whether a firm is taken over in this period or not. This 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.

Following other studies (see e.g. Grimpe/Hussinger, 2008; Bonardo et al., 2010) we take the number of patents as a measure for knowledge-based resources and specific human capital accumulated within each firm as well as by its initial owners. However, patent count measures are very questionable and heavily discussed in the literature. After all, as Griliches (1990, p. 1669) concludes, a patent represents a minimal quantum of invention that has passed both the scrutiny of the patent office as to its novelty and the test of the investment of effort and resources by the inventor and/or his organization into the development of this product or idea. As ideas and products differ in their market value, so do the underlying patents (we will refer to this point in section 5.3). 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*). Information regarding shareholdings of the owner-manager at the time of IPO was taken from IPO prospectuses and on-line data sources such as *Deutsche Boerse AG* and *OnVista AG*. 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.depatistnet.de), searching for firm names and shareholder names as applicants for all the patents issued either until the respective firm received a takeover bid or until the end of the investigation period.

We included the variable *STOCKMARKET TIME* that measures in weeks the duration from a firm's IPO until it either received a takeover bid or until the end of the observation period, respectively. As a *PERFORMANCE* measure and proxy for management efficiency we computed the EBIT-to-Equity ratio (Palepu, 1986; Barnes, 1999). The advantage of this performance measure is that it abstracts from firm specific cost of debt and its individual rate of taxes, which can 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). Palepu (1986), Barnes (1999), and Powell (2004) include a dummy variable that accounts for takeover activities in firms' industries (*INDUSTRY DISTURBANCE*) and a dummy variable indicating whether a respective firm is characterized by an imbalance between growth and resource base (*GROWTH-RESOURCE IMBALANCE*). In line with Palepu (1986) the industry disturbance variable was assigned a one if there had been a takeover bid in a firm's industry prior to the relevant point in time (this is, the firm itself receiving a takeover bid or the end of the observation period) and a zero otherwise. The growth-resource imbalance variable was assigned a one if the respective firm exhibited either a "high growth, low liquidity, high leverage" or a "low growth, high liquidity, low leverage" combination and a zero otherwise (see e.g. Palepu, 1986; Barnes, 1999; Powell, 2004). In line with these authors we judged these three criteria to be either high or low based on a comparison of a respective firm's *LIQUIDITY*, *LEVERAGE*, and *GROWTH* relative to its industry's average. We used a firm's compound annual growth rate of the number of its employees between IPO and the relevant point in time as growth measure, a firm's debt-to-equity ratio as a measure of leverage, and the ratio of current assets and balance sheet totals as a measure of liquidity. As with firm age, all these variables 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. Accounting data and information regarding the firms' industries, foundation, and IPO dates were taken from on-line data sources such as *Deutsche Boerse AG* and *OnVista AG*.

4.3 Sample description

Table 1 below summarizes descriptive statistics of the independent variables for the two subsamples of firms. Column 1 (2) contains the descriptive statistics for the subsample of firms which are (not) taken over after IPO. From the total of 386 included IPOs, 91 firms or 23,5% are being taken over. The last column contains the results from two-tailed tests of mean comparison.

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

Consistent with the basic assumptions of our paper, the mean value of the number of patents for both firms as well as owner-managers are smaller in the subsample of firms which are not taken over. However, this difference in means is only statistically significant for the patents of the firms' shareholders, not for firm patents. The number of firm patents is similar to the mean values shown by Bonardo et al. (2010). On average, the time from IPO to takeover is about 236 weeks or 60 months, with a minimum value of 15 weeks and a maximum value of 459 weeks or nearly 9 years. Firms in the subsample which are taken over are on average younger, smaller, show higher growth rates, lower performance, and a higher level of leverage. However, none of these variables differ significantly from the control group.

As table 2 shows, the correlations among the included variables are rather low. Interestingly, the number of patents and firm age show a rather small correlation coefficient (0.395), although one might assume that the number of patents increases over time. We find only high a correlation between PERFORMANCE and a firm's LEVERAGE. The negative sign shows that a firm's dept-to-equity ratio is negatively correlated with its performance.

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

4.4 Methodology

We apply logistic regressions to examine if the likelihood of receiving a takeover bid during our investigation period is influenced by firm characteristics. In particular, we estimate the following basic equation:

$$\begin{aligned}
\text{Prob}(\text{takeover bid} = 1): &= f(\text{patents, firm age, stock market time, stock market time} \\
&\text{squared, firm size, performance, industry-dummies, industry} \\
&\text{disturbance, growth-resource-imbalance, leverage, liquidity,} \\
&\text{growth}) + u.
\end{aligned}$$

To examine the effects of differences in patent ownership on takeover probability, we estimate three models. The first model only contains patents owned by the firm, measuring knowledge-based assets directly controlled by a firm and alienable in the course of an acquisition. The second model only includes the number of patents directly owned by the owner-manager as a proxy for knowledge and specific human capital bound to those individuals. The third model considers both firm and shareholder patents as independent variables.

V. Results and Discussion

5.1 Empirical results

The results of the empirical analysis are illustrated in table 3. Let us in brief consider the hypotheses developed in section 3. Hypothesis 1 (H1) is not supported by our results. Thus, we cannot confirm the results of previous studies that internally available technological capabilities as expressed by the number of patents significantly increase the likelihood of being a takeover target. Neither in model I where only the number of firm patents is included, nor in the joint model (model III) these coefficients significantly enter the regression in the expected way.

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

Our results corroborate our second and main hypothesis (H2). The number of patents owned by the owner-manager significantly decreases the likelihood of being a takeover target in both regressions. Thus, firms with owner-managers having holdings in essential specific human capital exhibit a lower likelihood of receiving takeover bids than firms that have directly accumulated all relevant intangible assets.

According to the broad literature in corporate governance about the disciplining mechanism of takeovers, hypothesis 3 (H3) states that firms with an inefficient management are more

likely of being taken over. However, the variable PERFORMANCE does not significantly enter the regressions and thus we reject the hypothesis. Also hypothesis 4 (H4), suggesting that firms with a mismatch among their growth and the financial resources at their disposal should show a higher probability of being taken over could not be confirmed by our results. Hypothesis 5 (H5) states that takeovers in the same industry should positively shape the likelihood of being a takeover target. Contrary to the expected positive influence of prior takeover activity in an industry on the takeover likelihood of other firms in that respective industry, we find a significantly negative impact of prior takeover bids. However, this result is in line with the evidence reported in Palepu (1986). Furthermore, we could not find statistically significant evidence for Hypothesis 6 (H6) that the likelihood of being a takeover target increases with firm size.

The variable *Stock Market Time* enters the regression in the suggested positive and significant way, and the square term also shows the predicted significantly negative sign. This confirms hypothesis 7 (H7) that the likelihood of being taken over increases with the duration of being listed at the stock market, but with a decreasing rate. All the other variables such as firm age, growth, liquidity or leverage are far away from showing any significant values.

5.2 Discussion of the results

Our results add to the emerging literature on entrepreneurial firms as takeover targets showing that patents are of particular interest for the acquisitions of entrepreneurial firms. However, our results go in the opposite way: while the number of patents owned by a firm has no statistically significant impact on the probability of being taken over, the opposite holds if the patents are owned by the owner-manager. Then, the probability of being taken over significantly decreases with the number of patents. While, at a first glance, this result might be puzzling, it fits into another type of literature which tries to explain why acquisitions of entrepreneurial firms by large incumbents often fail (see e.g. Ernst/Vitt, 2000; Kapoor/Lim, 2007). While some studies find evidence that structural aspects of the post-deal reorganization are important (see e.g. Puranam/Srikanth, 2007), our results are more in line with suggestions made by Colombo et al. (2010). The latter argue that the degree of post-deal decision autonomy granted to the individual acquired key inventor affects the outcome of their innovation activity.

Our analysis is based on the owner-manager as the individual key inventor of an entrepreneurial takeover target. Patents registered by these initial owners are used to measure tacit knowledge and specific human capital bound to a firm's key inventor. 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 indispensable 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 (Lehmann, 2006).

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. Thus, our results could help to explain the dismal findings that takeovers of entrepreneurial firms by incumbent firms often fail.

5.3 Drawbacks and robustness check

As for most papers, some limitations of our analysis need to be noted. The main limitations of the study come from the characteristics of the dataset. The most serious problem of this work is the use of patent counts as a proxy for intellectual capital and technological capabilities. Although other studies also rely on patent counts, this is by far not satisfying. In a famous survey, Zvi Griliches (1990) criticizes the use and abuse of patent counts as indicators for innovation behavior or technological indicators: Not all inventions are patentable, not all

inventions are patented, and finally, the inventions that are patented differ greatly in their quality. The first point may result in a selection bias in that we only focus on those inventions which are patentable. This may lead to an underestimation of our results. However, as Griliches suggests (p. 1669), this problem can be taken care of by industry dummies, which are included in our regressions. The second point refers to the problem of adverse selection. If not all inventions are patented, this may lead to adverse selection effects if, in fear of disclosure, only those inventions are patented that are of less value to the firm. Then, our results would show that the patents owned by the owner-manager may be of less value as compared to the patents owned by the firm as the legal entity. This refers to the third point that patents differ greatly in quality. Citing Frederic Scherer, Griliches (p. 1669) suggests that for this problem one tries to invoke the help of the “law of large numbers”, where the significance of any sampled patent can be interpreted as random variable with some probability distribution. However, we think that our dataset, in particular the number of patents owned by the owner-manager, is too small to satisfy the law of large numbers. If the most valuable patents are owned by the firm and not by the owner-manager as the key inventor, our results would be more questionable. However, the question remains if the founder and owner-manager of the firm should own the patents with lower quality as compared to those owned by the firm. In further research we consider this problem by measuring the quality of patents for example by the number of citations of each patent and whether or not the patents are applied for at the European Patent Office (Harhoff et al., 2008). Finally, the increase of complex and discrete technologies fosters the growth of patent thickets (v. Graevenitz et al., 2008). Thus, patents owned by the owner-manager and those owned by the firm could be interrelated. 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 et al., 2003).

Another limitation of our study lays in the skewness of the number of patents. While most owner-managers only own one or two patents, there are some firms where the owner-manager owns more than 50 patents. Thus, our results could be biased by outliers. Thus, we ran our regressions and dropped the outliers. First, we dropped the firm where the owner-manager owns 79 patents. Then we dropped the observations with the 5 (10) highest numbers of patents owned by the owner-manager. The regression coefficient of the variable `SHAREHOLDER PATENTS` declined from the original value in model III -0.137 (z-value 2.32) to -0.115 (2.72) without the highest outlier. Dropping five outliers the coefficient

reaches the value -0.114 (2.63) and for the ten outliers we find -0.108 (2.24). Only if we drop all the firms with the 35 highest observations in owner patents, the coefficient is statistically insignificant.

Finally, we used different measures for firm size such as revenues and the number of employees but could not find different results.

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. We placed this framework in the context of the acquisition of entrepreneurial firms with the owner-manager as the key inventor and owner of firm specific and intangible assets – firm specific human capital. With respect to the hold-up 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 (Audretsch et al., 2009; Audretsch/Lehmann, 2007). However, related literature on the success of acquisitions of entrepreneurial firms by larger incumbents shows that post-deal performance often suffers due to insufficient autonomy granted to the individual acquired key inventor (Colombo et al., 2010).

Our results may help to understand why some firms are taken over while others are not. One might argue that owner-managers who are willing to be taken over should transfer ownership of their patents from themselves to the firm. However, this does not solve the problem of the acquirer that the manager-owner as the key inventor leaves the company after the acquisition or exhibits poor performance. Further research should focus more on the key inventor in entrepreneurial firms and put more weight on accurate measures of the quality of intangible assets to shed more light on the matching among entrepreneurial firms as targets and large incumbents as acquirers to give better advice for win-win situations for both parties in that “The winner are – both, the acquirer and the target”.

This study is one of the first showing that the human capital and specific knowledge embodied in the key decision maker and key inventor – the owner-manager – negatively shape the likelihood of being a takeover target. It adds to the literature in that post-merger failure due to underinvestment of the key inventor after the acquisition may be anticipated by

incumbent firms thus lowering the takeover probability for those firms where the owner-manager is also the owner of patents.

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 (70.13)	0	475	1.5880
Shareholder Patents	0.451 (1.49)	0	11	2.84 (9.30)	0	79	4.2423***
Firm Age	28.60 (28.49)	2.91	133.06	29.50 (31.89)	1.99	189	0.2394
Stock Market Time	236.14 (124.06)	14.56	459	331.83 (162.59)	53.04	547	5.9485***
Firm Size	869.80 (4433.54)	2.44	40726	1882.20 (17006.21)	0.74	217698	0.9256
Performance	-0.814 (5.73)	-51.99	1.7	-0.118 (1.69)	-19.79	4.11	1.1439
Industry Disturbance	0.637 (0.48)	0	1	0.814 (0.39)	0	1	3.1728***
Growth-Resource Imbalance	0.121 (0.33)	0	1	0.125 (0.33)	0	1	0.1146
Leverage	8.55 (58.23)	-10.13	555	2.64 (12.50)	-25.17	145	-0.9615
Liquidity	0.641 (0.23)	0.04	1	0.597 (0.23)	0.01	1	-1.5816
Growth	0.225 (0.52)	-0.5	3.99	0.181 (0.66)	-0.53	10.42	-0.6565

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	Stock Market Time	Firm Size	Performance	Leverage	Liquidity	Growth
Firm Patents	1.0000								
Shareholder Patents	0.2574	1.0000							
Firm Age	0.3956	-0.0999	1.0000						
Stock Market Time	0.0778	0.0055	0.1664	1.0000					
Firm Size	0.0842	-0.0286	0.0468	-0.0023	1.0000				
Performance	0.0402	-0.0025	0.0093	0.0357	0.0180	1.0000			
Leverage	-0.0281	-0.0294	0.0384	-0.0128	0.0682	-0.9185	1.0000		
Liquidity	-0.0098	0.0386	-0.1535	-0.1942	0.1228	0.0383	-0.0343	1.0000	
Growth	-0.0248	-0.0306	-0.0337	-0.2137	-0.0033	0.0244	-0.0163	0.0755	1.0000

Table 3: Regression Results

Variables	Model I	Model II	Model III
Firm Patents	0.0026554 (1.06)		0.0043596 (1.39)
Shareholder Patents		-0.1224712 ** (-2.23)	-0.1371573 ** (-2.32)
Firm Age	0.0010989 (0.15)	0.0016569 (0.23)	-0.000881 (-0.12)
Stock Market Time	0.0435977 *** (6.11)	0.0430108 *** (6.13)	0.0436654 *** (6.16)
Stock Market Time squared	-0.0000971 *** (-6.55)	-0.0000957 *** (-6.61)	-0.0000972 *** (-6.61)
Firm Size	-0.0000102 (-1.51)	-9.44e-06 (-1.40)	-0.0000106 (-1.58)
Performance	-0.0755444 (-0.63)	-0.0857191 (-0.69)	-0.092615 (-0.73)
Industry-Dummies	Yes	Yes	Yes
Industry Disturbance	-2.869884 *** (-4.24)	-2.792347 *** (-4.21)	-2.851072 *** (-4.21)
Growth-Resource Imbalance	0.4488158 (0.85)	0.346445 (0.67)	0.4295996 (0.82)
Leverage	0.0029854 (0.15)	0.0012023 (0.06)	0.0007562 (0.04)
Liquidity	1.092651 (1.37)	1.118863 (1.41)	1.119457 (1.39)
Growth	0.0084151 (0.05)	-0.0118882 (-0.07)	-0.0109761 (-0.06)
Intercept	-3.082644 ** (-2.42)	-2.820234 ** (-2.17)	-2.961318 ** (-2.27)
Pseudo R2	0.3705	0.3789	0.3834
Log pseudo LL	-132.69996	-130.94204	-129.9819

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

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