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Staged financing of start-ups

Peter Witt · German Brachtendorf

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Abstract From a theoretical perspective, staged financing of start-ups mainly serves to reduce agency risks for investors dealing with founders. This risk reduction is partly offset by the transaction costs caused by staged financing. From the perspective of founders, staging can reduce the cost of equity, but it also increases the share of external company and market risks they have to bear. Our empirical study of a sample of German start-ups confirms the importance of transaction costs and shifting external risk for staging decisions, but does not support agency theoretical explanations of staged financing.

Keywords Entrepreneurial finance · Staging · Venture capital · Cost of capital
JEL Classifiation Numbers G 32 · M 13

1 Forms and effects of staged financing: A survey of the existing literature

The terms and conditions of venture capital financing of start-ups have long been a subject of academic studies in the U.S. (Sapienza 1989; Sahlmann 1990; Bygrave and Timmons 1992; Sapienza and Gupta 1994) as well as in German speaking countries (Albach 1983; Zemke 1995; Wupperfeld 1996; Schefczyk and Gerpott 1998; Bascha and Walz 2002; Brettel 2002; Welpe 2004; Reißig-Thust

P. Witt (✉) · G. Brachtendorf
WHU, Otto Beisheim School of Management,
Chair for Entrepreneurship, Burgplatz 2,
56179 Vallendar, Germany
e-mail: pwitt@whu.edu

G. Brachtendorf
e-mail: german.brachtendorf@gmx.de

2003; Schefczyk 2004; Fingerle 2005). The term "staged financing" describes a transaction in which outside investors provide in several installments the total amount of external equity financing that a start-up needs to cover investments and initial losses (Gompers 1995; Kaplan and Strömberg 2003). These outside investors could be business angels, venture capitalists, corporate venture capital firms, or large companies.

Typically, the management team of the start-up consists of the founders owning larger equity stakes in the company themselves. In this paper, we will only investigate venture capital financing. Rather than paying out all the money upfront, venture capitalists frequently agree with the management team of the company on several payments over a certain time period, i.e., staged financing. The staging of the total payment can take two different forms. The first form, which is called "staggering" or "staging of payments per financing round", refers to the staggered provision of funds which have been agreed on in a single round or contract of equity financing. The term "financing round" refers to a bundle of contractual clauses that set the conditions for the provision of an equity investment by a venture capital firm in a company. The second form, which is called "staging", indicates the existence of multiple rounds of start-up financing. While payments per round could be paid out immediately and completely, the venture capital firm provides the total amount of external equity in multiple rounds, i.e., sequences of newly negotiated financing contracts. In a new round of financing, both parties set separate, not previously fixed conditions for the equity investment.

The basic idea behind staggering is to tie further payments of an equity investment to milestones that the start-up has to reach before the venture capitalist pays out the next installment (Block and Macmillan 1985, p 184). Such milestones can be sales targets, stages of new product development, the acquisition of customers, or the completion of the entrepreneurial team. A similar mechanism works with staging. On the one hand, staging gives a venture capital firm real options. If a start-up fails to reach one or several of the milestones that were agreed upon in the financing contract, the venture capitalist is entitled not to engage in another round of financing or to offer the next round at less favorable terms for the start-up (larger equity stake per Euro invested). On the other hand, if the start-up reaches the contractually set milestones, it is not automatically entitled to a new round. Rather, the milestones set a basis for the negotiations of terms and conditions of the next round of financing, especially regarding the equity stakes that the founders hand over to the venture capital firm in exchange for financial investments in their company. In the empirical part of this paper, we will show descriptive evidence on both phenomena, staggering and staging. In the hypotheses to be tested, we will only investigate staging; i.e., the variable to measure the extent of staged financing will then always be the number of financing rounds.

So far, academic research on staged financing of start-ups has led to many theoretical models but only few large-scale, multivariate empirical studies.

In one of those studies, Reißig-Thust (2003) investigated the investment controlling instruments and processes of 49 German venture capital firms. The study was conducted in 2002. The author perceives staging as one possible controlling instrument for outside equity investors. Interestingly, only 42.1% of all venture capitalists who took part in the survey actively used staged financing in their investment contracts, while almost all respondents said that staging was a good instrument to reduce agency problems and set performance incentives for founder-managers in start-ups.

In the U.S., three studies with large samples and multivariate statistical analysis have been published so far. Gompers (1995) used data of the Venture Economics database. This database comprises 4,000 companies and is run by the US National Venture Capital Association in collaboration with Venture Economics. The author analyzed a sample of 794 companies that received equity investments from venture capital firms in 2,134 rounds of financing between 1961 and 1992. He investigated the relation between agency risks and staging. The study used the age of the start-up as a proxy for information asymmetries and thus agency risks. The ratio of intangible to tangible assets served as another proxy for agency risks, i.e., the extent to which a venture capital firm can recoup its investments in a start-up in the case of failure. The study found that the start-ups' age indeed positively correlates with the volume of the financing rounds. The extent of staging decreased with the perceived agency costs. Similarly, the magnitude of potential revenues from liquidation had a significant positive influence on the volume per financing round.

Shepherd and Zacharakis (2002) also investigated which factors determine the volume of a financing round. For their empirical study, the authors also made use of the Venture Economics database. The sample of Shepherd and Zacharakis (2002) includes 9,214 rounds of financing. The authors use the number of earlier rounds to estimate agency risks – in this case the degree of trust that has developed between the founders of the start-up and the outside equity investors. Trust is assumed to reduce the agency costs of the financing contracts. The results of the empirical analysis show that trust can indeed reduce costs; i.e., the volume of financing rounds increased with the number of financing rounds that had been completed by the same partners earlier.

Kaplan and Strömberg (2003) empirically studied 213 investments of venture capital firms in 119 start-ups in the U.S. Their focus is on the relation between staging and other instruments to protect investors. The authors asked 14 venture capital firms about the contractual details of their equity investments in start-ups. In particular, the study aimed to find out if and how contractual clauses change in the process of proceeding from one round of financing to the next one. Empirically, the authors can show that the investors' control rights (e.g., board seats and information rights) significantly increase with their equity stake in the portfolio company over the different financing rounds. At the same time, the number of additional rights that mainly serve to protect the venture capital firm from agency risks and external company risks (e.g., liquidation preferences, exit clauses or veto rights for new investors) decreases.

2 Theoretical explanations for staged financing and formulation of hypotheses

2.1 Theories on sharing and shifting external risks

In each and every start-up financing transaction, venture capitalists have to bear external risks, i.e., influences that originate from outside the firm and thus cannot be reduced or fully eliminated either by the founders or by the investors. We will call them external company risks. Examples of such risks are the non-approval of innovative products by official authorities like the U.S. Food and Drug Administration (FDA), the introduction of more efficient substitution technologies to the market by competitors, or macroeconomic recessions leading to shrinking demand on many markets. All these influences are external in the sense that the company cannot control them. Staggering and staging can both help venture capital firms to shift the external company risks, at least partly, back to the founders of the start-up who typically also own part of their company's equity. By agreeing on multiple rounds of financing or by staggering, venture capital firms can avoid fully bearing the individual company risks. They get the opportunity to terminate investments in companies that are adversely affected by external influences.

By staging the financing transaction, the venture capitalist can postpone the decision as to which company should get most money. The value of the shares it receives increases with the degree of staging. At the same time, the price to be paid per share also rises. Therefore, the main effect is a reduction in risk. The larger the perceived external company risks, the more staged financing can improve the overall risk position of the venture capitalist. In case of a successful development of the firm, a venture capital firm will ask for smaller portions of the start-up's equity in exchange for a certain amount of financing. In case of a less successful development, the venture capitalist either terminates the investment or pays less per share. In terms of option theory, the venture capitalist receives a real option to abandon, i.e., the opportunity to invest only in those start-ups that have been successful in earlier rounds of financing, and a real option to shrink, i.e., to pay less money for a given investment. The flexibility of these real options has a positive value that increases with the magnitude and the likelihood of external company risks (Kulatilaka and Trigeorgis 1994).

For the founders of a start-up, staged financing can also be beneficial. As it reduces the amount of external company risks that are shifted to the venture capital firm (or, from another perspective, increases the amount of external company risks that the venture capital firm can shift back to the founders), staging reduces the cost of equity. External company risks decrease over time, some of them resolve completely. Equity financing by venture capital is less expensive if founders raise it in the later stages of the development process of the start-up because the risk premium that venture capitalists charge becomes smaller. Brachtendorf and Witt (2004) have suggested a related inventory model of venture capital financing.

2.2 Principal agent theories

In the literature on entrepreneurial finance in general and staged financing in particular, applications of principal agent theory are common (see Admati and Pfleiderer 1994; Hellmann 1994; Bergemann and Hege 1998; Neher 1999; Cornelli and Yosha 2003). While there are other theories that can be applied to staging, like the theories on sharing and shifting external risks as well as transaction cost theories that we shall further explore in this paper, the major reason for the prominence of principal agent type explanations for staging is the obvious existence of information asymmetries and conflicts of interest between the parties.

Both factors are the main building blocks for agency constellations. The venture capitalist is the principal who looks for protection against two types of problems. A qualification risk refers to the risk of investing in the wrong teams and companies. It occurs whenever the venture capitalist responds to an uncertainty about the qualification of the agent, i.e., the founders of the start-up that the venture capital firm invests its money in, by offering low financial investments per share, thus systematically attracting less qualified teams. A behavioral risk depicts the risk to suffer from losses due to opportunistic behavior by the agent (Sapienza and Gupta 1994). Behavioral risks can occur because the venture capitalist cannot observe the actions of the founders when they run the business. These actions cannot be inferred from the economic development of the venture either, because this development is largely dependent on external influences (Reißig-Thust 2003, pp 66–68; Welpe 2004, pp 64–65; Fingerle 2005, 105). So the risk of the venture capital firm is twofold. The founders could either be less qualified to run the company and create value than the venture capitalist expects (qualification risk) or they could pursue interests that deviate from those of the venture capitalist, i.e., behave opportunistically (behavioral risk).

Agency problems increase the risk premium that venture capital firms demand when they finance start-ups. In the field of entrepreneurial finance, a multitude of behavioral risks exist (Bascha and Walz 2002, p 7). Real examples of opportunistic behavior by founders reducing the wealth position of venture capitalists are technologically driven preferences to continue work on economically worthless projects (Admati and Pfleiderer 1994; Hellmann 1994; Bergemann and Hege 1998), the renegotiation of financing contracts with the threat to exit from the management team in the start-up (Neher 1999), high administrative costs for the founders' perquisites (Bergemann and Hege 1998; Reißig-Thust 2003, p 66), and the utilization of the start-up by founders to build up management experience that they can later use to gain higher salaries as employees after their start-up failed (Franck and Opitz 2001; Cornelli and Yosha 2003).

To limit behavioral risks, venture capital firms typically demand information and control rights. Examples are conversion rights for shares, veto rights for investment decisions, covenants, and board seats (Hellmann 1998, p 54; Sapienza and Gupta 1994, pp 1620–1622; Fingerle 2005, pp 110–126). Venture capital

firms may also give the founders additional financial incentives to align the interests. From a theoretical perspective, staged financing is especially effective in limiting opportunistic behavior by the founders of the start-up. If such behavior becomes visible or if the start-up misses milestones, the venture capitalist can stop financing the company. This is a serious threat to the founders because a failure to secure the next round of financing with existing investors frequently leads to the liquidation of the start-up. Staging also mitigates potential hold-up problems, i.e., founders threatening to leave the company and take all the human capital with them. As the inalienable human capital of the founders becomes alienable over time, i.e., gets more and more embodied into the start-up's physical assets, staging reduces the potential payoff of a hold-up strategy for the founders (Fingerle 2005, p 125).

Qualification risks occur when venture capital firms finance start-ups that are run by insufficiently qualified management teams. Despite personal discussions with the founders and due diligence procedures, outside investors can never perfectly screen the managerial expertise and the technology experience of the founding team ex ante. As the founders of the start-up cannot cure their personal qualification deficits themselves, at least not in the short run, monitoring instruments and incentive mechanisms are not feasible. One obvious thing the venture capitalist can do is to use its board representation to replace unqualified founder-managers by newly hired external managers, if possible. In a similar way, staged financing can reduce the adverse effects of qualification risks for the venture capitalist. If these deficits are the cause for the start-up missing milestones, the venture capital firm can terminate all financing activities in the respective firm, thus limiting its financial loss. Alternatively, it can improve the conditions of the investment in a next round of financing for itself. Improved conditions, typically a larger equity share for a given amount of financing, are only helpful for the venture capitalist if the entrepreneurial team is qualified enough to ensure the survival of the start-up and realize at least some increases in the value of the shares.

2.3 Transaction cost theories

The process of financing a start-up with equity from a venture capital firm is costly. In addition to the direct cost of equity, which corresponds to the number of shares that the original owners of the firm give away to the venture capital firm in exchange for new financial means, the process causes transaction costs. Typical categories of transaction costs are search costs, preparation costs, negotiation costs, costs of obtaining legally binding agreements, control costs, and adaptation costs. Transaction costs are not only relevant in theoretical models. The process of preparing and finalizing equity investment transactions absorbs financial resources as well as the time and effort of both the venture capital firm and the start-up. As this process has to take place for each round of financing, staging produces higher transaction costs than equity investments in one installment with just one contract.

There is a multitude of transaction costs for both the founders and the venture capitalist. Founders incur search costs to find a suitable venture capitalist willing to finance the company and perhaps also willing to give advice and support to the management team. Search costs largely vary in practice, depending on the type of venture capital firm (Reißig-Thust 2003, pp 66–70), the personal networks of the founders (Witt 2004), and the start-up's reputation. Costs for the preparation of the financing transaction on the side of the start-up originate from the writing, the sending, and the presentation of the business plan. Some of the founders' transaction costs are cash expenses, for example, for traveling and meetings, for the services of lawyers and attorneys, or for due diligence services provided by accountants. More difficult to measure in financial terms are opportunity costs. In practice, it is not uncommon that the management team of a start-up spends up to 80% of their time to close a deal with a venture capital firm in the final negotiation phase. This time is lost for other managerial duties and thus involves opportunity costs. In other words, the transaction costs borne by the founders reduce the value of the shares of their company.

The venture capitalists bear the preparation costs for the inspection of the business plan, first contacts with the founding team, and company presentations. The total amount of the transaction costs arising from negotiations and concluding a legally binding contract depends on the duration and the complexity of the deal. Similar to the situation of the founders, one part of the venture capitalists' transaction costs are cash expenses; the other part are opportunity costs. The total transaction costs translate into demands for a higher return on the investment and thus into higher costs of capital for the start-up.

The more rounds of financing both parties agree on, the more frequent the negotiations that have to take place, the more the required contracts and the higher the transaction costs of the deal for both the parties. Expenses for a due diligence of the start-up, e.g., by accountants or attorneys, also belong to the transaction costs of finalizing an agreement. Even after the financing contract has been signed, additional transaction costs may emerge. Examples are the costs of payment controls, the costs of monitoring the additional services that the venture capitalist has promised to provide to the start-up, and the costs for changes or amendments to the contract. Such amendments and the corresponding renegotiations of the contract terms become necessary when important external factors change or when one of the two partners has serious complaints about the fulfillment of the earlier contract (Kaplan/Strömberg 2003, p 275).

In the empirical part of this paper, we will focus on the transaction costs of the founders assuming that the venture capital firm can shift most or even all its transaction costs back to the start-up via reduced company valuations.

2.4 Formulation of hypotheses

All three theoretical approaches to staged financing that we discussed so far are based on an institutional economics perspective on entrepreneurial finance. Our goal is to use this perspective, which is very common in the theoretical

literature as well as in existing empirical work on the subject, to derive four hypotheses. These hypotheses refer to the correlation between some independent variables and the number of financing rounds as a proxy for the degree of staged financing, our dependent variable. The hypotheses deliberately leave out staggering and exclusively focus on staging.

In selecting the independent variables, we strictly relied on the three theories on staged financing presented above. In other words, we expect external company risks, agency costs in the form of qualifications risks and behavioral risks, as well as transaction costs to have an effect on the staging decisions taken by venture capitalists or agreed upon in negotiations between a venture capital firm and the founders of the start-up to be financed. We shall test the hypotheses with multivariate regressions on a cross-sectional data set. Whereas we implicitly assume causal relationships between the independent variables and the number of financing rounds, we shall only be able to test and empirically measure correlations between variables, not causality.

Hypothesis 1 is directly related to the theories on sharing and shifting external risks. The staging of start-up financing is expected to be more attractive for venture capitalists if the perceived external company risks are substantial. Staging allows equity investors to limit their exposure to external risks and to shift parts of those risks back to the founders of the start-up. From the perspective of the entrepreneurs, this risk shifting can also be attractive because it reduces the cost of equity. We derive hypotheses 2 and 3 from the principal agent theories on entrepreneurial finance. From an agency perspective, we expect venture capital firms to use staging to protect themselves against the qualification and behavioral risks that potentially emerge when investing in start-ups. We expect staged financing to be applied more frequently with higher perceived qualification risks of the management team and with increasing fear of the venture capitalists regarding behavioral risks. Hypothesis 4 summarizes our discussion of transaction cost theories on staged financing. Venture capitalists and founders of start-ups should make use of staged financing less frequently the higher the transaction costs of a contractually agreed new round of financing rise. The four hypotheses are:

H1: The number of financing rounds increases with the external company risks.
H2: The number of financing rounds increases with the qualification risks of the founders.
H3: The number of financing rounds increases with the behavioral risks of the founders.
H4: The number of financing rounds decreases with the transaction costs of a round of financing.

3 Empirical results

3.1 Design of the survey and sample

The empirical study this section will report on is based on a pre-tested questionnaire, which was sent out to 834 German companies that were founded

after the year 1993 (and which are thus, to our understanding, young enough to still be termed "start-ups"). All firms that we contacted are legally registered in Germany and have been financed by outside equity investors, mostly venture capitalists. Other investors in our sample were corporate venture capital firms and business angels. Earlier empirical studies on staged financing of start-ups have typically chosen venture capital firms as their informants (examples for this procedure are Schefczyk 2004; Reißig-Thust 2003), not the founders of the start-ups.

Collecting data on staged financing from start-ups and not from venture capitalists has advantages and disadvantages. The entrepreneurs' perception of agency costs or transaction costs to be borne by the venture capital firm may be biased. If it is the venture capitalists who ultimately pay these costs, their answers may be less biased than those of entrepreneurs. But we would argue that start-ups pay the agency costs and the transaction costs of venture capital financing because a venture capital firm can include them in its contract terms. If this is the case, start-ups are better prepared to answer questions concerning these costs. Ideally, empirical research on staged financing could use data from both parties to check if there are significant differences in the perception of external risks, agency costs, and transaction costs. Unfortunately, requesting pairs of informants, i.e., the venture capital firm and the start-up it has invested in, to answer the same questionnaire, largely reduces response rates and thus sample size.

We identified the companies, the names of their founders, as well as the founders' e-mail addresses in a manual search of different databases. The starting point were the web pages of the German association of venture capital firms ("Bundesverband der Kapitalbeteiligungsgesellschaften BVK"). Inspecting the web pages of the venture capital firms that are listed as members of the BVK, we could identify start-ups with venture capital investments. We completed the results of this search with data from press reports and magazines (Handelsblatt, Finance, Going Public, etc.), and from information on the web pages of start-ups themselves.

After several pre-tests with industry experts, founders, and venture capitalists, we sent out the questionnaire in the form of a PDF file via personalized e-mail to all 834 companies in our uniquely created data set. Respondents could send back their answers to the questionnaire by fax or by regular mail. The survey with all reminder mails took place from April to July 2002. In total, we received 90 completed and usable questionnaires, which is a response rate of 10.8%. As the total set of German start-ups with venture capital backing is unknown, and the response rate is not too large, our sample may not be representative . Still, we could find no significant non-response bias in the sense of differences between the respondents who answered early and those who answered late (Armstrong and Overton 1977). One start-up had reached break-even shortly after foundation and, therefore, had no further need for equity financing. We excluded this company from our sample. For the empirical analyses, data from 89 start-ups remained. The "key informants" of our study according to their individual assessment (Bagozzi et al. 1991), which we

validated by making spot checks by telephone calls to the companies, are members of the founding team and individual founders who still serve on the management board (75%) or members of the current management board who did not found the company but joined later (25%).

3.2 Descriptive results

The 89 start-ups in our sample were founded between 1994 and 2001. Two thirds of them were established in the years 1999 and 2000. At the time of our survey, 52 of the companies in the sample were joint stock corporations under German law ("Aktiengesellschaft"), two of them with a stock exchange listing. 35 had chosen the legal form of a German private limited liability company ("GmbH"), and two were using mixed legal forms ("GmbH & Co. KG"). 84 of the start-ups in our sample are legally and economically independent, i.e., do not belong to a larger group. Four firms had been liquidated already or were in the process of liquidation at the time of our survey. One sample firm had been acquired by another company in a recent trade sale. If we split up the sample into the companies' industries, a pronounced high-tech bias in the sample becomes visible. Strongly represented industries are internet and software (20 firms), biotechnology (18 firms), as well as engineering technology and related high tech products (16 firms). Other industries in the sample are IT services (12 firms), telecommunication (9 firms), medical devices (6 firms), as well as media, financial services, industry, and others (2 firms each). 88 of the start-ups that participated in our empirical study were willing to answer questions concerning the total amounts of external financing. In total, the start-ups included in this survey had a total need for external equity financing of 922 million Euro. The average total financing need per firm is 10 million Euro, the median is 6 million Euro. The amount of equity provided by outside investors ranges from 0.15 million Euro to 70 million Euro. Not surprisingly, start-ups from the biotechnology sector have a significantly higher need for external funding. The number of financing rounds that the individual start-ups realized ranges from one to five. Most frequently, we find three rounds of financing (37 firms). The median for the number of financing rounds per firm is three, the mean value is 2.7. With respect to the number of rounds, there are no significant differences between industries. Table 1 summarizes some of the major descriptive characteristics of our sample.

For a total of 207 financing rounds, we received detailed data on the contents of the contracts that were arranged by outside investors and founders. One hundred and thirteen rounds of financing in our sample are pure equity transactions. In 27 rounds, a mezzanine type of investment took place, e.g., loans to the start-up granted by shareholders. The remaining 67 transactions were characterized by mixed forms of debt and equity financing. On average, over all 207 rounds of financing, equity investments accounted for two thirds of the financing volume. Just 5% of the financing volume was mezzanine.

Eighty seven companies in our sample were willing to disclose for their 196 rounds of financing how many payments were made per investment (staggering).

Table 1 Need for external finance (capital need) and number of financing rounds per company per industry

Industry	Number of rounds		Capital need (TEuro)	
	Mean (σ)	n	Mean(σ)	n
Biotechnology	3.00(1.138)	18	17,215(16,837)	17
Medical devices/health care	2.17(0.753)	6	5,608(4,878)	6
Telecommunication	2.78(0.972)	9	14,931(13,411)	9
Media/entertainment	3.50(0.707)	2	5,000.	2
Financial services	3.00(0.000)	2	5,053(1,489)	2
IT services	2.75(0.965)	12	5,335(4,339)	12
Internet/software	2.70(0.923)	20	6,895(5,153)	20
Engineering technology and related high-tech products	2.31(1.078)	16	7,204(10,366)	16
Industry/industrial services (no high tech)	3.50(0.707)	2	40,000(42,426)	2
Others	2.00(1.414)	2	1,075(1,308)	2
Total	2.69(1.018)	89	10,088(19,013)	88

In 102 rounds (52%), the investors provided the capital in one up-front payment. 40 rounds were split up into two payments, 29 rounds used three payments and 22 rounds, used three payments and four. In our sample, we also have individual cases where the staging of payments led to six, eight, and even ten installments. The mean number of payments per round is 1.94; the median is 1. These descriptive results are interesting because they differ from earlier empirical evidence of Kaplan and Strömberg (2003) for the U.S. In their sample, no more than 15% of all financing transactions come along with more than one installment. Our results indicate that staggering may be more common in Germany than it is in the U.S.

For those contracts in our sample that actually included staged financing based on specified targets, we find very different types of milestones. Most frequently, investors make new rounds of financing dependent on the progress in the technological development of products (55.7% of all contracts with milestones). Similarly frequent, targets are set for sales as well as for the number of customers or the number of letters of intent by potential customers. Less important in our sample are milestones referring to patents that have been filed or to the number of employees. Interestingly, this is also true for industries in which patents are perceived to be of the utmost importance, e.g., biotechnology. Under the heading "other milestones" we collected targets like completion of the management team, reaching profitability, or meeting the cost of targets. Table 2 shows the types of milestones that we could identify in our sample. The table also indicates in how many individual contracts each type of milestone has been used.

3.3 Methodology of the empirical analysis

The variables being used in the hypotheses cannot be measured directly. Therefore, they need to be defined as constructs, or latent variables, that are measured

Table 2 Types of milestones

Type of milestone	#	In %[a]
Technological development	44	55.7
Sales	32	40.5
Number of customers/letters of intent	24	30.4
Other milestones	24	30.4
Market entry/service online	18	22.8
Patents	8	10.1
Number of employees	5	6.3

[a]Multiple answers were possible

by a couple of directly observable indicators. All our constructs have reflective indicators with 5 point Likert scales for each indicator variable. To perform the confirmatory factor analysis, we used the software package AMOS 4.01.

To measure the external company risks of a start-up, we used three different latent variables: the intensity of competition in the industry, the dynamics of the technological development in the industry (technology dynamics), and the frequency of changes in customer needs (market dynamics). The respondents gave their subjective estimates for external company risks. As the three variables measuring external company risk are constructs themselves, several indicators measure each. In doing so, we relied on indicators that have been proven valid in other empirical studies (Ernst 2001, p 182 Jaworski and Kohli 1993, pp 68–69).

We measured the construct "intensity of competition" by five indicators: "competitors can offer everything that we can offer", "the competition in our industry is fierce", "our industry is characterized by tough price competition", "we get to know new actions taken by competitors almost every day", and "our competitors are relatively weak" (reverse coding). After eliminating the first indicator, the values for the validity of the total factor are good (Cronbach alpha of 0.71). Only the value for the average variance included (0.41) lies below 0.5, which is set as a minimum value by some authors (e.g., Homburg and Giering 1996). Looking at the individual indicators, we get different results. For two indicators, the reliability values are fairly low. We still refrained from eliminating those two indicators because they have been used successfully in other empirical studies and because a reduction of the number of indicators included did not significantly improve the results.

For the factor, "technology dynamics", we again selected five pre-validated indicators: "in our industry, major technological changes are rare" (reverse coding), "it is difficult to forecast where our industry will stand in 2–3 years' time", "in our industry, technologies change very rapidly", "technological changes create large opportunities in our industry", "many new products in our industry only become possible after technological breakthrough innovations". The measurement of construct validity showed that one indicator, the fourth one, had to be excluded to get acceptable validity measures (Cronbach alpha of 0.72).

For the factor "market dynamics", we used three pre-validated indicators. Unfortunately, the factor analysis produced no satisfactory results for this construct. Eliminating indicators was not feasible either. Therefore, we decided to

drop the factor "market dynamics" and only measure external company risks by the two factors "intensity of competition" and "technology dynamics".

Qualification risks correspond to the level of experience in the entrepreneurial team. This experience can be managerial and technological. Relevant technology experience stems from the founders' previous jobs in science or in the start-up's current industry. Both are relevant for the start-up's chances of success. We measured qualification risk by the two indicators "managerial experience" and "industry experience", both counted in years per person as assessed by the founders themselves.

To measure behavioral risks, we focused on conflicts of interest between the venture capitalist and the founders. From previous studies on agency problems in entrepreneurial finance (Reißig-Thust 2003, pp 66–71), we derived five potential goals of founders that deviate from the value maximization goal of the venture capital firm and can therefore lead to conflicts of interest: high monthly salaries for the management team, the collection of entrepreneurial experience to later make a better career, fun, independence, and pursuing technological hobbies. While the scales of the individual indicators are ordinal, we still calculated the mean of all five indicator variables to measure the construct "conflicts of interest".

To obtain a proxy for the transaction costs per round of financing, we decided to use three indicators: real cash expenditures, opportunity costs of time for the management team, and the founders' subjective estimates of the total transaction costs on the side of the founders. On average, the start-ups in our sample spent 68 top management workdays per round of financing and had average cash expenses of 35,000 Euro per round. Particularly important are the subjective estimates for total transaction costs because this subjective estimate largely affects the decision to choose staged financing. In our empirical study, we aggregated the subjectively estimated founders' transaction costs of several rounds of financing per company to one mean value. To make the questionnaire easy to answer for our respondents, we focused on the transaction costs of preparing and finalizing an investment contract. A shortcoming of this approach is the reduction of the measurement to ex ante transaction costs, i.e., costs for the preparation and the realization of the financial transaction. Further components of transaction costs like cost of control, cost of adaptations, and cost to terminate a transaction are left out, although they may be substantial in some cases. The empirical analysis of the data showed high correlations between all indicators to measure transaction costs. Therefore, we ran the regressions with just one variable for the construct "transaction costs", the subjective estimates of total transaction costs. Figure 1 summarizes the measurement model and the hypotheses.

3.4 Results of multivariate hypotheses testing

In the hypotheses to be tested, the dependent variable is a count variable. Applying a linear regression model under these circumstances can cause

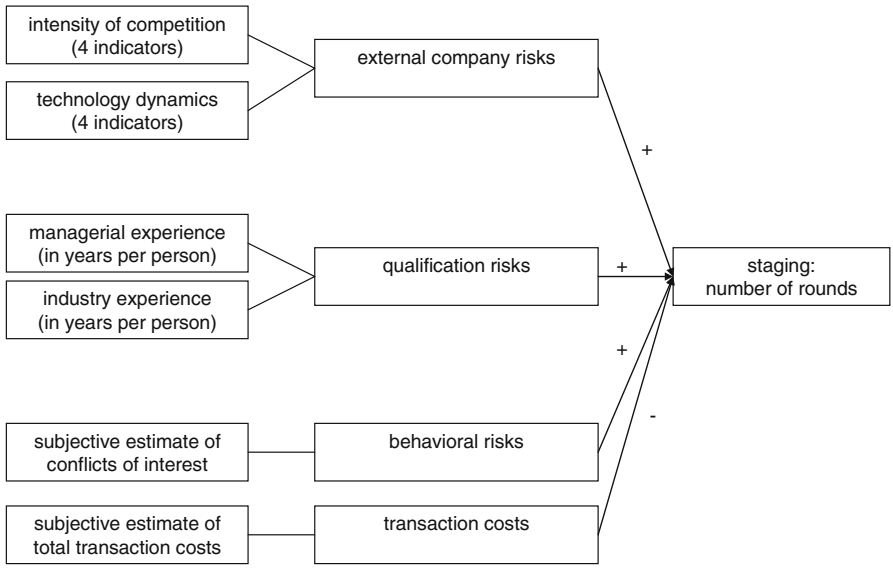

Fig. 1 The model

methodological problems because negative estimation values may occur while count variables always have to be non-negative integer. Therefore, a Poisson regression model is better suited to test the hypotheses (Greene 2002, p 740). In such a regression, the estimation function for the dependent variable is of exponential form. The preferable estimation method for Poisson models is the Maximum Likelihood method. To apply it, we need to specify the distribution of the dependent variable, given the independent variables.

In its basic form, the Poisson regression assumes a Poisson distribution for the dependent variable. As the means and the variances of the distribution were not equal for our data, thus deviating from the assumption of a Poisson distribution, we used Quasi-ML estimates and measured the validity of the estimation with a Pseudo-R^2 and a corrected $\bar{R}^2$ (Wooldridge 2001, p 653). An analysis of the residuals allowed us to evaluate the overall validity of the Poisson regression. To test the hypotheses, we checked whether the Pearson residuals were normally distributed (Cameron and Trivedi 1998, p 145); Wald tests and Quasi Likelihood Ratio (QLR) tests measured the goodness of fit of the estimation function (Greene 2002, p 742). To validate the individual regression coefficients, we applied *t*-tests. As the standard assumption of equal means and variances was violated for our data, we transformed the simple error terms into GLM standard error terms (Greene 2002, p 484; Wooldridge 2001, pp 651–653). For the Poisson regression, we used the software package EViews 4.0, and for all other analyses the statistics software SPSS for Windows in version 11.5.1. Table 3 presents the results of the Poisson regression.

The results of the Poisson regression indicate that the intensity of competition in the respective industry has a significant positive effect on the number

Table 3 Results of the Poisson regression

Variable	Expected sign	Estimation
Intensity of competition	+	0.176*** (0.065)
Technology dynamics	+	−0.059 (0.066)
Managerial experience	−	0.004 (0.003)
Industry experience	−	0.001 (0.002)
Conflicts of interest	+	0.116 (0.089)
Subjectively estimated transaction cost	−	−0.159***(0.045)
Pseudo R^2		0.060
$\bar{R}^2$		0.389
σ^2		0.247
QLR		57.152
p-value		0.000
n		72

The table shows the coefficients and, in brackets, the GLM standard errors. *Significant at the 10% level, **Significant at the 5% level, *** Significant at the 1% level.

of financing rounds. More intense competition means more external company risk, which induces more frequent utilization of staged financing. With respect to technology dynamics, we can find no significant effect on the number of financing rounds. We conclude that the results of the empirical analysis give partial support to hypothesis 1. In our study, the founders' managerial and industry experience measures qualification risks. The results show that neither of the two has a significant impact on the number of financing rounds. Therefore, we have to reject hypothesis 2. Hypothesis 3 also has to be rejected. Whenever conflicts of interest prevail, the number of financing rounds is empirically higher than in cases with no such conflicts of interest, but the differences are statistically insignificant. Finally, the empirical analysis finds a clear and significantly negative relationship between the transaction costs of the start-ups and the number of financing rounds. The more expensive the staging is in terms of transaction costs, the less frequently do the investors and founders make use of it. We conclude that our data support hypothesis 4.

The Poisson regression is characterized by a notable underdispersion. Therefore, an assessment of the validity of the estimates requires further tests. To do so, we have conducted OLS regressions. Multicollinearity turned out not to be a problem in the OLS regressions; the VIF values are all under three, and most of them are clearly below two. The residuals are normally distributed. Due to the logical ordering of the sample firms, autocorrelation can be ruled out. Table 4 shows the results of the OLS regressions.

The OLS regression produces similar results as the Poisson regression. Once again, we see clear support for hypothesis 4. Hypothesis 1 does not have to be rejected, but the relationship is slightly less significant than before. Just as in the Poisson estimation, we have to reject hypotheses 2 and 3 in the OLS regression. The empirical findings are interesting because they are only partly in line with widely used and commonly accepted theoretical explanations of staging decisions. First, we do find a negative relationship between the amount of transaction costs and the number of financing rounds. Second, the more (external) risks the company faces, the more frequently do venture capital firms and founders rely

Table 4 Results of the OLS regression

Variable	Expected sign	Estimation
Intensity of competition	+	0.403* (0.163)
Technology dynamics	+	−0.108 (0.165)
Managerial experience	−	0.017* (0.009)
Industry experience	−	0.002 (0.007)
Conflicts of interest	+	0.300 (0.236)
Subjectively estimated transaction cost	−	−0.340*** (0.115)
$\bar{R}^2$		0.438
F		7.910
p-value		0.000
n		72

on staging. But third, principal agent theory fails to explain staging decisions in our sample.

Although we strongly feel that these findings are important for the further development of the theories on entrepreneurial finance, we need to point at some methodological limitations of the empirical study presented in this paper. First, the analysis is based on cross-sectional data; i.e., it uses a static approach to explain the number of financing rounds being chosen in start-up financing decisions. In our theoretical model, the relevant parameters determining the number of financing rounds are set at the foundation date, i.e., at the beginning of the financing process. In other words, the founders need to have laid out their financing strategy very early. In practice, dynamic planning approaches may be more common. In reaction to observable developments in company risks and behavioral risks, founders may wish to revise earlier plans and financing decisions at later stages in the financing process. Our analysis does not capture these dynamic effects.

The static approach chosen to formulate our hypotheses on staged financing leads to a second methodological restriction. By asking our informants to make subjective estimates on the competitive environment of their start-up at the date of foundation, which may have been up to 8 years ago, we run the risk of getting answers based on seriously biased individual memories. Another critical assumption relates to the informational structure. Our theory implicitly assumes that increasing the number of financing rounds is advantageous if the benefits for all the parties involved are larger than the transaction costs incurred. This approach does not take into consideration that new information could come up in the process of financing the start-up. Then, more rounds of financing with correspondingly smaller volumes per round may not be favorable to everyone. Rather, the optimal number of the rounds could depend on the type and the timing of new information.

4 Conclusions

Our empirical analysis using a sample of 89 German start-ups confirms the importance of transaction costs and of external risk sharing motives for staging

decisions in entrepreneurial finance. But, rather surprisingly, our results do not lend support to the commonly used and little disputed agency theories on staging. It seems that in German start-ups, investors mainly make use of staged financing to shift some of their equity investment risk to the founders. In doing so, they reduce the cost of equity, at least if the transaction costs of staging are not so high that they offset the gains from lower risks. The venture capital firms in our sample do not use staged financing to reduce the qualification risks and the behavioral risks induced by an investment in a team of potentially ill-qualified or opportunistically behaving founders. This empirical finding could simply indicate that the existing literature on entrepreneurial finance overstates the importance of agency problems. In an alternative explanation, agency problems between venture capitalists and founders of start-ups exist, but instruments other than staged financing, e.g., reporting systems and board seats for investors, can eliminate them more effectively and cheaper.

In future studies on staged financing of start-ups, researchers could try to conduct longitudinal studies or studies on panel data. This methodology would make it easier to estimate the risk situation of a start-up and its changes over time. Another potential extension of the work presented here is a dyadic design of the survey. To estimate conflicts of interest, behavioral risks, and qualification risks, an empirical study could try to ask both parties involved in a deal, founders and venture capital firms. After having compared the subjective estimates on agency costs, transaction costs, and external risks as perceived by venture capitalists and founders, a more reliable measurement of the variables becomes possible. We hasten to add that such a dyadic design is demanding. It requires the identification of investor-start-up-pairs and the willingness of both partners to participate in the survey. Our personal experience suggests that it may be difficult to come up with a sufficiently large sample size using such a methodological design.

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Dr. German Brachtendorf is assistant to the managing director at Sparkasse Hanau, Germany. He holds a degree in business administration from FernUniversität Hagen and received his Ph.D. degree in 2004 from WHU, Otto Beisheim School of Management, where he was a research assistant at the Chair for Entrepreneurship. Prior to his academic career, he worked in a bank for several years. Dr. Brachtendorf's main research interest is entrepreneurial finance. He has published in refereed academic journals like R D Management, Die Betriebswirtschaft, and Kredit and Kapital.

Dr. Peter Witt is the Otto Beisheim Professor of Entrepreneurship and the academic director of the center for family owned businesses at WHU, Otto Beisheim School of Management in Vallendar. He holds a degree in economics from the University of Bonn. He received his Ph.D. degree in business administration in 1996 at WHU and his habilitation degree from Humboldt University in 2002. Professor Witt's research interests are entrepreneurial finance, company valuation, and corporate governance. He has published in refereed academic journals like Management International Review, Entrepreneurship and Regional Development, and R D Management.