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Abstract

This article analyzes the exit decision in the European venture capital market, studying *when to exit* and how it interacts with the *exit form*. The paper emphasizes the impact of asymmetric information on the divestment decision. Our model considers the impact of characteristics of the venture capital investor, characteristics of the investment and contracting variables on the exit decision. Our results show that venture capitalists associated with financial institutions have quicker exits, a result which is stronger for trade-sales exits. In addition, our results highlight the importance of the contracting variables on the exit decision. An unexpected but interesting result is that the presence in the board of directors leads to longer investment duration.

Keywords: Asymmetric information, venture capital, trade sales, IPO, write-offs, exit decision, competing risks model.

JEL classification: C24, G24, G32, G38, K22

1 Introduction

Although there exists a significant literature on venture capital investment, the most part is related to the initial and business development phases of the investment. There has been relatively fewer works on the divestment decision. Most of the existent studies on the exit decision focus on IPOs. This is explained by the fact that IPOs are the exit form which is more relevant in the US and the one associated with higher returns. In addition, the information on IPOs is easy to obtain, which facilitates empirical analysis on the subject.

In the particular case of Europe, where trade sales are the most important exit form, the study of the venture capital exit decision has been even more neglected. This paper analyzes the divestment decision in the European venture capital market using data obtained through questionnaires. We study two important dimensions of the exit decision: *when to exit* (the duration of the investment) and *how to exit* (which form of exit to use). These two aspects of the exit decision are interrelated and therefore they should be studied together. However, the literature on the exit decision has analyzed either the duration of the investment or the exit form, with the notable exception of Giot and Schwienbacher (2007) who consider simultaneously the two dimensions. Our paper is another contribution in this direction since we explore the interactions between the two dimensions of the exit decision.

Our analysis takes into account the impact of asymmetric information in venture capital markets. Venture capitalists play an important role in reducing the asymmetry of information in venture capital markets, and this should have an impact both on the investment and the divestment decisions (Amit et al, 1999). We study whether factors such as the type of venture capital investment, aspects related to the venture capitalist and the characteristics of the venture capital financial contract influence the duration of the investment and the exit strategy.

Our work is most related with the articles that analyze the time dimension of the exit decision. The duration of the venture capital investment was analyzed by Gompers (1995), Cumming and MacIntosh (2001) and by Giot and Schwienbacher (2007). The exit time to IPO has also been explored by authors such as Lerner (1994) and Gompers (1996).

Gompers (1995) explores issues related with asymmetric information, monitoring and stage financing of venture capital investments. Gompers emphasizes three important mechanisms of control in venture capital investments: the use of convertible securities, the syndication of the investments and stage financing. He argues that stage financing allows the venture capitalist to obtain information and monitor the investee firm, maintaining the option to abandon the project. Thus one should expect shorter funding durations (i.e., higher monitoring intensity) when informational asymmetries are higher. Gompers studies whether there exists a relationship between the duration of each financing round and the tangibility of assets, the market-to-book-ratio and the R&D intensity, variables which are related to the degree of asymmetric information (the first one negatively, the last two positively). His results confirm the predictions from agency theory as the duration of each financing round decreases with the market-to-book-ratio and the

R&D intensity but increases with the ratio of tangible assets to total assets and the age of the investee firm.

Cumming and MacIntosh (2001) develop a simple theoretical model to analyze the optimal duration of the venture capital investment. As Gompers (1995) they emphasize the role of the venture capitalist in monitoring the investee firm and argue that their value is higher when informational asymmetries are significant. The optimal duration of the venture capital investment is such that the projected marginal value added is smaller or equal to the projected marginal cost. They use the model to predict the theoretical effect of several factors (stage of the firm at first investment, capital available to the venture capital industry, whether exit was preplanned or not and whether the exit was made in response to an unsolicited offer or not) on the investment duration and test empirically their predictions using data for the US and Canada. They conclude that their theoretical framework is less likely to hold in Canada than in the US, which supports the view that institutional factors have distorted investment duration in Canada. In addition, their study shows that, in the US, investments in early stage investee firms have a smaller expected duration and that increases in the availability of venture capital decrease the venture capital investment duration.

Giot and Schwienbacher (2007) also study the duration of the venture capital investment but considering simultaneously the type of exit route (IPO, trade sales and liquidation). They model the time to exit using survival analysis (which had already been used by Gompers (1995) and Cumming and MacIntosh (2001)). However, since they were interested in exploring the various forms of exit, they use competing risk models. In their analysis different forms of exit may have different conditional exit rates (hazard functions). One interesting conclusion they reach is that the conditional exit rate is not monotonous. The hazard function at first shows a relatively sharp increase but, after a certain point, it is slowly decreasing. In addition, the exact shape of the curve depends on the exit form (the hump shape is more pronounced for IPOs). Another important conclusion is that the industry of the investee firm affects the time to exit. For example, biotech and internet firms have the fastest IPO exit, however biotech firms are the slowest to liquidate while the internet firms are the fastest.

It should be noted that Cumming and MacIntosh (2001) analyze the total duration of the venture capital investment whereas Gompers (1995) studies the duration of each financing round. On the other hand, Giot and Schwienbacher (2007) study the time to exit for the different exit forms in each financing round. In this paper we also analyze the total duration of venture capital investments as Cumming and MacIntosh (2001) but additionally we study how the time to exit interacts with the exit strategy.

Our work is also related with the literature on the exit form. Some recent papers have examined the various forms of exit. Schwienbacher (2002) analyzes the exit forms in the US and six european countries. He studies the impact that the characteristics of the venture capital firm and the use of several monitoring mechanisms have on the various exit strategies. His study reveals substantial differences between the US and European venture capital markets and shows that the monitoring mechanisms have a significant impact on the probability of an IPO being used as exit route. On the other hand, Cumming and MacIntosh (2002) try to explore whether there exists an optimal pattern of exit depending on the quality of the investee firm, the nature of its assets and the duration of the venture capital investment, concluding that IPO are the most important exit form for high quality firms. The determinants of the exit form and whether the exit occurred with success or not has also been studied by Nahata (2004) and Hege, Palomino and Schwienbacher (2003). Nahata (2004) studies the determinants of IPOs, trade sales and write-offs, confirming the importance of the venture capitalist reputation, the syndication size and the composition and strategic objectives of the venture capital investors. Additionally the exits with success are also influenced by characteristics related with the investee firm, such as the stage of development, industry conditions and the presence of bank investors in the syndicate.

Das, Jagannathan and Sarin (2003) perform an extensive analysis of venture capitalist exits, computing cumulative exit probabilities and return on venture capital investments for various types of investments. They argue that the high risk premium of venture capital investments is explained by the fact that these investments are highly non-tradable and also because they include the compensation of the venture capitalist for their role in monitoring and helping in the management of the investee firm. Among other thing, they conclude that high-tech investments have an higher probability of exiting with success; late stage investments have higher exit probabilities and shorter durations; and investments in the new economy sectors have shorter durations.

Our work is also guided by the extensive literature suggesting that venture capital investments plays an important role in reducing informational asymmetries and agency cost (e.g. Sahlman (1990), Hellmann (1998), Gompers and Lerner (1999b), among others).

In this paper we use Cumming and MacIntosh (2001) theoretical model to guide us in the analysis of the impact of several variables on the timing of exit, but as Giot and Schwienbacher (2007) we explore how time to exit varies with the exit strategy by using competing risk models. Our work differs from Giot and Schwienbacher (2007) in terms of the data used. Giot and Schwienbacher have data on individual venture capital investments and their exit time and form. On the contrary, our data set only gives us aggregated information about each venture capital firm (such as average investment duration, percentage of each exit form, percentage of high-tech investments). However, like them, we consider the interaction of investment duration and exit strategy. By using the fraction of each exit type as the status variable we are able to obtain different hazard functions for the various exit forms. Another important distinction is that we study the total investment duration whereas Giot and Schwienbacher (2007) analyze the time to exit in each financing round.

This paper is organized as follows. In Section 2 we present an adapted model of optimal duration which will help us in predicting the impact of the various determinants. In Section 3 we analyze the expected impact of several determinants on the time to exit of venture capital investment and how it interacts with the various forms of exit. Sections 4 and 5 present the data and the methodology used, respectively. In Section 6 we present and discuss the results of our empirical analysis. Finally, Section 7 concludes the paper.

2 A model of optimal duration

The venture capitalist is much more than a simple financial intermediary. Venture capitalists are highly specialized investors who add value to new ventures by monitoring and participating in the investee's strategic decision making. However, venture capital investments are characterized by a limited horizon, thus the venture capitalist has to decide *when to exit* and *how to exit.* The exit decision is extremely important for venture capitalists, because it is through the exit that they cash out their return on the investment.

Our analysis is based on the model proposed by Cumming and MacIntosh (2001) to which we add another decision variable: the type of exit. The venture capitalist chooses the exit time,

T, the type of exit, s, and the level of effort, e, so as solve the following problem:

$$\max_{T,s,e} \quad PVA(T, s, e, \mathbf{x}) - PC(T, s, e, \mathbf{z}) \tag{1}$$

where PVA is the projected value added, PC is the projected cost, T is the duration of the investment, s is the exit form, e is the level of effort of the venture capitalist, $\mathbf{x}$ and $\mathbf{z}$ are the vectors of internal and external factors which influence PVA and PC, respectively.

As Cumming and MacIntosh (2001) we interpret the level of effort, e, as everything that the venture capitalist does to add value to the firm. The projected value added depends on the initial investment and the expected exit value. The projected cost includes all present and future direct costs associated with the process of adding value to the firm as well as the opportunity cost of capital.

Like Shalman (1990), Gompers (1995), Wang and Zhou (2004), we assume stage financing. In each round of financing the venture capitalist reevaluates the businesses prospects and analyzes whether to continue financing it or not, giving exit options to the venture capitalist. When the venture capitalist decides to continue financing the investment he is keeping alive the option to abandon the investment, reevaluating the value of this option at certain moments of the investment horizon.

When the venture capitalist evaluates whether he should exit or maintain the investment for another period, he compares the increase in the projected value added by staying another period with the increase in the projected costs by staying during that period of time. If the additional value added is larger than the projected marginal cost, the venture capitalist should keep the investment, otherwise he should exit. Thus, the optimal duration of the investment, T^*, is such that the projected marginal value added is smaller or equal to the projected marginal cost (equality is not imposed as the venture capitalist only reevaluates the investment at discrete periods of time):

$$PMVA\left(T^*, e(T^*), s(T^*), \mathbf{x}(T)\right) \leq PMC\left(T^*, e(T^*), s(T^*), \mathbf{z}(T)\right)$$

The relationship between $PMVA$ and PMC is illustrated in Figure 1. The $PMVA$ function is decreasing with T. At the beginning of the investment, the value added of the venture capitalist

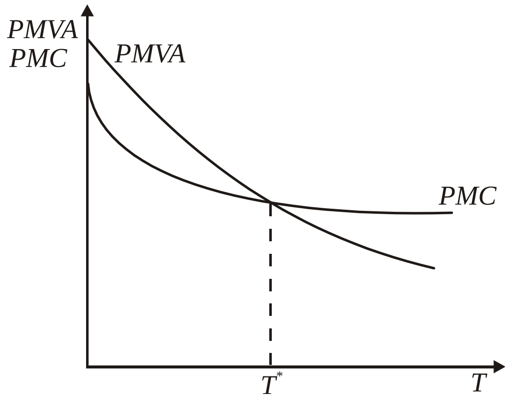

Figure 1: Optimal duration of the venture capital investment (adapted from Cumming and MacIntosh (2001)).

to the investee firm is higher. Over time the venture capitalist know-how is transferred to the firm which decreases the value added of the venture capitalist. The PMC function is also decreasing. When the investment starts the intensity of effort is much higher than latter on. However (MacIntosh, 1994 and Cumming and MacIntosh 2001) suggest that the PMC curve is less steep than the $PMVA$ one. This happens because a large fraction of the costs, including monitoring costs, are still present in late stages of the investment.

The previous analysis indicates the expected optimal duration. Over time, as new information arrives, the two curves may shift and thus the actual investment duration may differ from the expected one at the time when the first investment occurs.

Since we are particularly interested in exploring the effect of asymmetric information on the divestment decision, let us study how asymmetric information influences the previous analysis. When we speak of asymmetry of information in venture capital investment we may be thinking about: *(i)* the asymmetry of information and agency problems between the venture capitalist and the investee firm; *(ii)* the asymmetry of information between the venture capitalist and the third party buyer and *(iii)* the post-acquisition agency problems and asymmetric information between the third party buyer and the investee firm. The first type of asymmetry of information is particularly relevant in determining the optimal monitoring intensity (thus it will influence the optimal level of effort) and it is behind Gompers (1995) analysis of the duration of each financing round. On the other hand, for the purpose of the divestment decision the two last types of asymmetry of information are more relevant as the third party buyer willingness to pay to acquire the firm depends on these forms of asymmetric information. If there exists a high degree of asymmetry of information, venture capitalists will be unable to sell the investment for its true worth. Since the degree of asymmetry of information is expected to decrease over time, we would expect that venture capitalists keep their investment for a longer period when the degree of asymmetry of information is high so as to partially eliminate the informational problems.

Figure 2 illustrates the impact of an increase in the degree of asymmetric information on the optimal duration of the investment. With higher asymmetry of information we expect the projected marginal value added as well as projected marginal cost curves to shift upwards. However one expects the shift to be larger for the projected marginal value added (that is, venture capitalists have a competitive advantage in investing in firms where the agency and asymmetric information problems are higher). Consequently one expects larger durations when there exists an higher degree of asymmetric information.

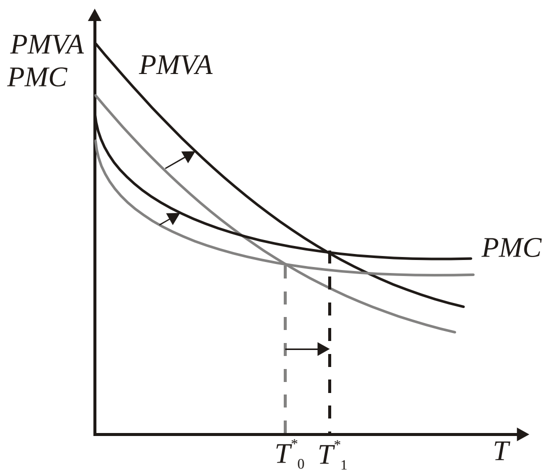

Figure 2: Impact of the degree of asymmetric information on the optimal duration of the investment.

Our previous analysis, emphasizes the role of the degree of asymmetric information on the optimal investment duration. However, there exists another aspect that needs to be taken into account: the degree of uncertainty of the investment and the speed of resolution of this uncertainty. With stage financing we expect that projects with a more rapid resolution of uncertainty (for example, the success or not of the product development is known quicker) to have shorter durations.

3 The determinants of time to exit and type of exit

The objective of this study is to analyze both the duration of venture capital investments and the type of exit, studying the interaction between these two aspects of the exit decision. We consider three exit forms: trade sales, IPOs and write-offs, which are the exit types with greater expression in Europe. We consider several determinants which may be divided into the following categories: characteristics of the venture capitalist (age of the investor, education level, whether it is or not related with financial institutions); type of venture capital investment (early stage investment versus late stage investment; high-tech versus non-high tech); and contracting variables (use of convertible securities, the number of reports required to the investee firm, participation in the board of directors, whether syndication is used or not). We also analyze the effect of the exit having been pre-planned or not. Next we discuss the expected impact of each one of the determinants.

3.1 Characteristics of the venture capital investor

In this paper we analyze the influence of some characteristics of the venture capitalist on the investment duration and exit type: the age of the venture capital firm, the education level of the venture capitalist and whether the venture capitalist is related or not to a financial institution.

3.1.1 Age of venture capital firm

The age of the venture capital firm influences the use of premature exits to signal the quality of the venture capital firm. As the venture capital firm becomes older, its quality becomes better known by the investors. Thus venture capitalists will use less often early exits to signal their quality and consequently duration of the investments are expected to be larger. This effect is consistent with the grandstanding theory presented by Gompers (1996) and it is particularly relevant for IPOs.

However there exists another effect which might affect duration: the learning by doing effect. On the one hand, as venture capitalists experience increases, the projected marginal costs will be lower and the marginal value added will be higher as venture capitalist will be able to provide better advice and guidance. This leads us to expect longer durations. On the other hand, venture capitalists with more experience may be able to solve the informational problems quicker and to identify sooner projects which are not viable and projects which are high flyers. In other words, one expects the projected marginal value added curve to become steeper as experience increases, leading to shorter durations. Since learning by doing has two opposite effects, its total impact on the investment duration is ambiguous. However, experience has a clearly positive effect on the value of the investee firm, and consequently we expect a larger proportion of exits through IPO and trade sales as experiences increases. In addition, unsuccessful projects should have shorter durations as experience increases since venture capitalists will identify quicker that the project is not viable.

3.1.2 Level of education

The level of education is expected to have the same type of effects on investment duration than the age of the venture capital firm. Education can be interpreted as a signal of the venture capitalist quality. More educated venture capitalists will use less often premature exits to signal their quality. Thus higher education should be associated with longer durations. Moreover, venture capitalist with higher education will provide better advice and guidance which tends to increase the optimal duration. However, more educated venture capitalists will also be able to solve quicker the informational problems and to identify sooner the profitability of the project, which implies shorter durations. The total effect of education is a priori ambiguous, but we hypothesize that the grandstanding effect is overwhelmed by the affect of education on the capacity to solve informational and uncertainty problems.

3.1.3 Association with financial institution

The impact of the venture capitalist being or not associated with a financial institution depends on what we assume about the relative skills of this type of investors and on the effect of increased venture capital skills on the exit decision. Gompers (1995) argues that banks may not have the skills needed to evaluate projects involving highly intangible assets and significant ex-ante uncertainty. On the other hand, specialized venture capitalists have precisely a competitive advantage in this type of activity and consequently they are expected to have better venture capitalist skills. Gompers (1995) argument applies well in the US, where the venture capital market is more developed. In Europe, where the venture capital market is still in its infancy, venture capitalists associated with financial institutions may be in advantage as they already possess monitoring experience, even though not specialized in venture capital investments. In other words, in Europe, we expect venture capitalists associated with financial institutions to be the ones with greater skills in reducing informational asymmetries. In addition, venture capitalist associated with banks have a larger network of contacts, which facilitates the task of finding potential buyers in trade sales exits.

The other important link to predict the effect of the venture capitalist being associated with a financial institution, is the effect of an increase in skills on the duration and type of exit. As in the case of education, we expect better skills to be associated with lower marginal costs and higher marginal value added, which implies longer duration of the investment. However we also expect that venture capitalist with more skills we be able to identify sooner if the project is viable or not and to solve quicker the informational problems (i.e., to increase the slope of the projected marginal value added). As a consequence the effect on duration is ambiguous. However we hypothesize that the effect of increased skills on the capacity to solve informational problems dominates the remaining effects, leading us to expect shorter durations. In addition, it should be noted that better skills should imply an higher proportion of successful exits.

3.2 Type of Venture Capital Investment

There exist several types of venture capital investments which may differ, among other thing, on the stage of development of the investee firm and on whether the investee is a high-tech firm or not.

3.2.1 Stage of development of the investee firm

In our analysis we distinguish between early stage and late stage investments. The early stage investments include seed and start-up investments while the late stage investments aggregates development and expansion and replacement/refinancing investments.

As mentioned previously by authors such as Gompers (1995) and Cumming and MacIntosh (2001), the early stage investee firms are the ones with higher levels of asymmetry of information as well as the ones with higher uncertainty levels regarding future returns. Consequently these type of firms are the ones where venture capital financing has more value added and where it is more likely to occur as it is difficult to obtain financing through other alternatives.

The participation of the venture capitalist in the investee firm certifies the quality of the firm to outsiders (Shalman, 1990; Gompers and Lerner, 1999a). The longer is the duration of the investment, the longer is the monitoring and disciplinary action of the venture capitalist on the investee firm, thus the higher will be the certification value (Barry et al, 1990; Megginson and Weiss, 1991, Cumming and MacIntosh, 2001). As such, the higher the degree of asymmetry of information the longer should be the duration of the venture capital investment, as the venture capitalist will try to use duration to certify the quality of the investee firm. Since the degree of asymmetry of information is higher for early stage firms one expects that the earlier is the stage of the investee firm the longer is the duration of the investment. One should notice that the type of investment also influences the costs of the venture capitalist. One expects higher projected marginal cost for early stage investments, as monitoring is more intense for this type of firms (Gompers,1995). However, if we compare the impact in the projected marginal value added and projected marginal costs, the first one is higher, which leads us to expect longer durations (see the analysis in Section 2 and Figure 2).

However there exists another effect which plays in the opposite direction. The early stage investments are the ones with higher levels of uncertainty. The actual return of an early stage investment is highly variable (the investment may turn out to be a huge success but it may also be a complete failure). This fact, combined with stage financing, implies that many investments will have a short duration just because when venture capitalists reevaluate the investment they conclude that the investment is not profitable (this reevaluation process takes into account the information received during the previous rounds of investment). According to this effect one expects that early stage investments have shorter durations. Cumming and MacIntosh (2001) denote this last effect by culling effect. As a consequence the impact of early stage investment on the time to exit depends on whether the asymmetric information impact is smaller or larger that the culling effect.

One should notice that if we distinguish the divestment according to the exit form, one may be able to predict better which of the two effects dominates. For example, if the exit form is a liquidation one should expect duration to be shorter for early stage investments as this would capture the large fraction of investments which reveal to be unsuccessful relatively soon. Similarly, since IPO's are especially attractive for extremely successful projects, and there exist a fraction of the investments which are rapidly identified as such, it may well be that early stage investment have shorter duration when the exit vehicle is an IPO. However one should notice that the ability of the new owner to resolve the information asymmetry is lower when the exit occurs through an IPO, which may lead us to the opposite conclusion.

3.2.2 Investment in high-technology firms

The levels of asymmetry of information are higher in high-tech firm due to the nature of their business. High-tech firms possess highly specialized and intangible assets, which are more likely to be poorly evaluated by potential buyers (Wynant and Hatch, 1991; Hart and Moore, 1994; Noe and Rebello, 1996). The projected marginal value added by the venture capitalist is expected to be higher for high-tech investments. On the other hand, we also expect the monitoring and contracting costs to be higher for high-tech investment. Once again we hypothesize that the shift is larger for projected marginal value added, which implies that high-tech investments should have longer durations (see Figure 2).

There is one factor which leads to an effect in the opposite direction. High-tech investments are likely to have technological complementaries to the technologies of strategic acquirors. Thus the pool of potential buyers is likely to be larger for high-tech investments. This may imply a shorter investment duration, particularly if the exit is done through trade sales or secondary sales. One should also mention that this shortening effect may vary considerably across industries as the time to develop a technology varies a lot from industry to industry. For example, this shortening effect may be substantially larger in the computer industry investments than in medicine.

Overall we hypothesize that duration is larger for high-tech investments, which means that the asymmetric information effect dominates the effect of technological complementaries.

3.3 Contracting variables

The time to exit and the exit route are affected by the characteristics of the venture capital financial contract and by the intensity of monitoring by the venture capitalist. Our previous analysis suggests that these variables are endogenous variables: they are chosen by the venture capitalist taking into account his own characteristics as well as the investment characteristics. However, the exit decision and the contracting and monitoring decisions are not simultaneous. The contracting variables and, to a large extent, the monitoring variables are decided at the time the venture capitalist analyzes whether to concede or not additional financing to the investee firm. If the venture capitalist provides additional financing, the type of financial contract written at the beginning of the financing round may influence the exit decision which occurs latter on. Consequently, exit is affected by contracting and monitoring variables decided at the beginning of the financing round and in previous financing rounds.

Financial contracts are affected by many of the exogenous variables considered in our study. But they are influenced by variables which are not included in our study, such as the objectives of the venture capitalist and the objectives of the management team. Therefore these variables will have explanatory power behind the one already captured by the exogenous variables. For this reason, we decided to also include contracting variables in our analysis. Schwienbacher (2002) also used these variables to verify whether they have an impact on the selection of the exit strategy.

3.3.1 Convertible securities

The use of convertible securities can be justified by the existence of potential conflicts of interest between the venture capitalist and the entrepreneur. If the venture capitalist holds either convertible debt or convertible preferred stock he will be more protected against the downside risk of the investment, while keeping the benefits in the case of great success. On the other hand, the entrepreneur is expected to retain a larger share of the final value of the investee firm than with straight equity financing, since one expects the venture capitalist to require less common shares after conversion than without convertible securities. This will give the entrepreneur incentives to work harder, which will increase the probability of the firm being a success, increasing the probability of exit through IPO.

Since convertible securities induce higher effort by the entrepreneur, they help aligning the interests of the entrepreneur with the interests of other investors and may speed up the resolution of the uncertainty, leading to shorter durations.

3.3.2 Reporting requirements and presence in the board of directors

The reporting requirements and the presence of the venture capitalist in the board of directors are forms of the venture capitalist monitoring the entrepreneurs on a discrete basis. By doing so the venture capitalist will be able to avoid, or at least reduce, private benefit activities by the entrepreneur. In addition, by being better informed the venture capitalists will be able to provide better advice and guidance to the investee firm, which increases the venture capitalists value added.

The fact that venture capitalists are better informed about what is going on in the investee firm may lead them to force liquidation earlier, when the investee firm is not doing well (if there was no monitoring the entrepreneur might try to continue the project so as to receive private benefits). This implies shorter durations of the venture capital investments when they occur through liquidations. We also expect shorter duration when the investee firm is successful as an increase in the venture capitalist effort should imply a quicker resolution of the informational problems.

3.3.3 Syndication

Many venture capital deals are syndicated. The existing literature suggest that larger syndicates increase the pool of contacts which facilitates exit through trade sales. Moreover it is also a signal of quality of the investment, thus it also facilitates exit through IPO. Finally, we expect the syndicate value added to be larger, since its members might have complementary skills.

Consequently, our hypothesis is that as the percentage of investments with syndication increases, the time to exit decreases both for trade sales and IPO.

3.4 Pre-planned exits

With this variable we intend to capture the effect of the exit having been pre-planned on the investment duration. Authors such as Gladstone and Gladstone (2002) and Hall and Hofer (1993) defend that the investment exit should be pre-planned and defined in the initial investment decision. Cumming and MacIntosh (2001) argues that pre-planned exits are more likely when the anticipated duration of the investment is short.

Our hypothesis is that the duration of the investment is shorter when the exit was pre-planned. This hypothesis only applies to successful exits.

4 Data

The data was obtained through a questionnaire to European venture capital firms. The list of firms to which the questionnaire was sent was obtained from the European Venture Capital Association (EVCA) Members Directory in 2003 and 2004. To complete this list we also analyzed the internet sites of the venture capital associations of the countries with firms registered as members of the EVCA, so as to identify whether there were venture capital firms who were not members of the EVCA.

Our sample includes firms from 20 countries: Germany, Austria, Belgium, Denmark. Slovenia, Spain, Estonia, Finland, France, Greece, Hungary, Italy, Luxembourg, Norway, Poland, Portugal, United Kingdom, Czech Republic, Sweden and Switzerland.

The questionnaire was sent to 1338 firms between November 2004 and May 2005[1], with 153 positive answers[2]. However, we excluded 7 of these answers from our set, as they did not satisfy the criteria for our analysis.

Obviously one should be aware that there may exist some selection bias. It is quite natural that venture capitalists are unwilling to answer questions which they consider more secretive. This fact should be taken into account in the interpretation of the results.

Taking into account the answers obtained and the objectives of our study we constructed the variables described in Table 1. The descriptive statistics and the correlation matrix associated with variables used is presented in Tables 2 and 3 in the Appendix.

5 Methodology

As previous studies on the duration of venture capital investments, our statistical analysis relies on survival analysis. In particular, we use the competing risks model which is adequate to model time in one state when exit is to a number of competing states.

Before explaining the competing risks model, let us summarize some important concepts in survival analysis. We are interested in the behavior of the time to exit, T. The time to exit is a

[1] The questionnaire was sent through the internet, using the tool SurveyMonkey.com – Web Based Survey Evaluation System. This tool is frequently used by firms specialized in the collection of information and it has been analyzed and recommended by Gordon (2002).

[2] There were 157 firms who refused to answer because they did not have time to do so or because they followed a policy of not answering any questionnaire. Our answer rate of 10.91% is similar to the ones typically obtained in this type of survey.

Table 1: Description of the variables.

Variable	Description
Age	Age of the venture capital firm in 2005
Graduate	Dummy variable where 1=Graduate and 0=Undergraduate
FinInst	Dummy variable, equal to 1 if venture capital firm related with financial institution, and it is equal to 0 otherwise.
EarlyStage	Percentage of early stage investments (seed and startup investments)
HighTech	Percentage of hightech investments (communication, computer, electronic components, biotechnology, health and medicine)
Convertibles	Percentage of times where convertible securities were used
Reports	Average number of reports presented by the investee firms
Board	Percentage of times that venture capital firm was present in Board of Directors
Syndication	Percentage of investments with syndication
Preplanned	Dummy variable equal to 1 if exit was preplanned, equal to 0 otherwise
Duration	Average investment duration (in years)
IPO	Percentage of exits through IPOs
TradeSale	Percentage of exits through trade sales
WriteOffs	Percentage of exits through write-off

random variable and its behavior can be captured by its density function function $f(t)$ or by its cumulative distribution function $F(t) = \Pr[T \leq t] = \int_0^t f(u)du$. Curiously, in survival analysis it is more common to describe the behavior of T using the *survivor function*, $S(t)$, which gives the probability that duration is longer than t, that is $S(t) = P(T > t) = 1 - F(t)$. Another key concept in survival analysis is the *hazard function*, $h(t)$. The hazard function indicates the conditional exit rate and it is given by:

$$h(t) = \lim_{\Delta t \to 0} \frac{P(t \leq T \leq t + \Delta t | T \geq t)}{\Delta t} = -\frac{\frac{dS}{dt}}{S_t} = \frac{f(t)}{S(t)} \tag{2}$$

Although the correct interpretation of $h(t)$ is the conditional exit rate, $h(t)$ is frequently interpreted as the conditional probability of exit. This interpretation is correct in discrete time applications, as long as one computes the conditional probability of exit for $\Delta t = 1$. In this case, $h(t)$ gives us the probability of exit occurring in the next period of time, given that exit has not occurred yet. A final related function is the *cumulative hazard function*, $H(t) = \int_0^t h(u)du$.

In regression analysis of duration we assume that the hazard and related functions vary across individuals depending on their characteristics. Let $\mathbf{X} = (X_1,\ X_2, \cdots, X_k)$ be the vector of k explanatory variables, now we denote the hazard function by $h(t, \mathbf{X})$, the survivor function by $S(t, \mathbf{X})$, and so on. There are two types of models that can be used: the proportional hazard models (PH) and the accelerated time failure models (AFT).

In a proportional hazard model, the hazard rate can be decomposed into two separate functions:

$$h(t, \mathbf{X}) = h_0(t, \boldsymbol{\alpha})\phi(\mathbf{X}, \boldsymbol{\beta})$$

where $h_0(t, \boldsymbol{\alpha})$ is the baseline hazard function which is a function of t alone and $\phi(\mathbf{X}, \boldsymbol{\beta})$ is a function of the k explanatory variables variables alone (α and $\boldsymbol{\beta}$ are parameters to be estimated). Usually one considers $\phi(\mathbf{X}, \boldsymbol{\beta}) = \exp(\mathbf{X}'\boldsymbol{\beta})$, thus

$$h(t, \mathbf{X}) = h_0(t, \boldsymbol{\alpha}) \exp\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k\right) \tag{3}$$

There are different PH models depending on the assumptions about the baseline hazard function, $h_0(t, \boldsymbol{\alpha})$. The Weibull and the Gompertz regression models are parametric PH models with baseline hazards given by $\alpha t^{\alpha-1}$ and $e^{\alpha t}$, respectively. On the other hand, the Cox proportional hazard model estimates the parameters $\boldsymbol{\beta}$ without specifying the baseline hazard, it is a semi-parametric PH model. In a PH model, each regression coefficient indicates the proportional effect on the hazard rate of absolute changes in the corresponding covariate.

We may also consider specifications of $h(t, \mathbf{X})$ that do not have the proportional hazards property, such as the log-logistic model, the lognormal model or the generalized Gamma model.

The accelerated failure time specification, assumes a linear relationship between the log of the survival time and the explanatory variables:

$$\ln T = \mathbf{X}'\boldsymbol{\beta}^* + u \quad \Leftrightarrow \quad T = \exp(\mathbf{X}'\boldsymbol{\beta}^*)v$$

where $v = e^u$. Different distributions for u lead to different AFT models. For instance, if u follows a normal distribution, then T follows a log-normal distribution. When u follows the log Gamma distribution T is distributed according to the generalized Gamma. In terms of interpretation, an AFT regression coefficient indicates the proportionate change in survival time when the corresponding explanatory variable changes by one unit. The Weibull distribution, $h_0(t, \alpha) = \alpha t^{\alpha-1}$, is the only distribution for which both PH and AFT assumptions apply (the Weibull distribution correspond to assuming that u follows an extreme value distribution with two parameters), and one can show that $\beta_k^* = -\beta_k/\alpha$. The previous papers on venture capital investments duration have all used the AFT specification. To ease the comparison of our results with existing ones we also use the AFT specification.

Let us now consider the competing risk model (CRM), where exit time may be one of m different types of exit. In a CRM with m types of exit, there are $m+1$ states $\{0, 1, \cdots, m\}$, where 0 is the initial state (investment is active) and $\{1, \cdots, m\}$ are possible destination states. One can interpret the CRM as a latent variables model with $(T_1, \cdots, T_m)$ denoting the time to exit to each destination and T_c denoting the time of censoring (if investment is still active at the end of the observation period). What we observe is one duration, T, which is given by:

$$T = \min(T_1, \cdots, T_m, T_c)$$

That is we just observe the shortest of the latent durations, the remaining durations are censored. The idea of the competing risks model is to estimate destination-specific hazard rates.

Let $h_j(t, \mathbf{X})$ denote the hazard function for exit type j. If one assumes independence of the hazards, as most empirical studies do, one can show that $h(t, \mathbf{X}) = \sum_{j=1}^{m} h_j(t, \mathbf{X})$ and $S(t, \mathbf{X}) = \prod_{j=1}^{m} S_j(t, \mathbf{X})$. Moreover the log-likelihood function can be written as the sum of the log-likelihood functions for each destination. Hence one can maximize the overall log-likelihood function by maximizing separately the m log-likelihood functions.

If we had data on individual investments we would define status variables, δ^j, indicating whether the venture capitalist exited the investment through destination j ($\delta^j = 1$ if exit of type j occurred, $\delta^j = 0$ otherwise). In our case we use the percentage of a given exit type as the status variable. Our status variable can vary between 0 and 1 and indicates to what extent exit occurred through that particular exit form.

As explained above we may choose among several density functions. Some density functions correspond to monotonic hazard functions. For instance, the Weibull hazard function is monotonic (increasing when $\alpha > 1$, decreasing when $\alpha < 1$ and constant for $\alpha = 1$). If one is not sure about the shape of the hazard function it is preferable to use flexible functional forms. The generalized Gamma density function allows for non-monotonic hazards. This density function depends on three parameters, κ, σ and μ and it is defined as follows:

$$f(t, z, \sigma) = \begin{cases} \frac{\gamma^{\gamma}}{\sigma t \sqrt{\gamma} \Gamma(\gamma)} \exp(z\sqrt{\gamma} - u) & \text{if } \kappa \neq 0 \\ \frac{1}{\sigma t \sqrt{2\pi}} \exp(-z^2/2) & \text{if } \kappa = 0 \end{cases}$$

where $\gamma = |\kappa|^{-2}$, $z = sign(\kappa)\,(\ln(T) - \mu)\,/\sigma$ and $u = \gamma \exp(|k|z)$. Parameters κ and σ affect the shape of the hazard function and allow flexibility. For example, when $\kappa = 0$ the lognormal model results, when $\kappa = 1$ we obtain the Weibull function and when $\kappa = \sigma$ then one gets the standard Gamma distribution. The explanatory variables affect the density function through $\mu = \mathbf{X}'\boldsymbol{\beta}^*$. For observation i we have:

$$\begin{aligned} \mu_{ij} \quad = \quad & \beta_0^* + \beta_{1,j}^* Age_i + \beta_{2,j}^* Graduate_i + \beta_{3,j}^* FinInst_i + \beta_{4,j}^* EarlyStage_i + \\ & \beta_{5,j}^* HighTech_i + \beta_{6,j}^* Convertibles_i + \beta_{7,j}^* Reports_i + \beta_{8,j}^* Board_i + \\ & \beta_{9,j}^* Syndication_i + \beta_{10,j}^* Preplanned_i \end{aligned}$$

where j is the exit type: IPO, trade sales or write-offs.

The AFT specification is equivalent to $T = \exp(\mathbf{X}'\boldsymbol{\beta}^*) \exp(u)$. If individual i and j are identical except in the k characteristic, and they have the same u, then

$$\frac{T_i}{T_j} = \exp\left(\beta_k^* \left(X_{ik} - X_{jk}\right)\right).$$

Moreover, if $X_{ik} - X_{jk} = 1$, i.e. there is a unit change in X_k, then $T_i/T_j = \exp(\beta_k^*)$. The exponentiated coefficient $\exp(\beta_k^*)$ is called the *time ratio*. Note that their interpretation is particularly adjusted for dummy variables. One can also compute *relative time ratios* by comparing time ratios for different variables.

6 Empirical results

As explained above the generalized Gamma density function allows for non-monotonic hazards and it encompasses many density functions as particular cases, thus we decided to use it. We tested some restrictions on the parameters of the generalized Gamma density function, such as $\kappa = 1$ and $\kappa = 0$, to check whether a more restrictive density function was appropriate. Our results show that for IPOs and write-offs the hypothesis that $\kappa = 1$ (density function is Weibull) cannot be rejected at the 10% level but for trade sales this hypothesis is clearly rejected, confirming that we should use the more flexible generalized Gamma density function. We also tested whether it was adequate to assume the proportional hazard assumption. Overall our results show that the proportional hazard assumption cannot be rejected although there is signs of small deviations in one or two variables (depending on the exit form). The empirical results, assuming the generalized Gamma density function, are presented in Table 4 in the Appendix.[3]

Figure 3 represents the hazard functions for IPOs, trade sales and write-offs evaluated at the covariates means. The figure shows that the shape of the hazard functions are quite different. The hazard function for the IPOs is increasing and convex (the hazard rate grows at an increasing rate). For write-offs the hazard rate is also increasing, but it grows at a much lower rate than the hazard rate for IPOs. On the other hand, the hazard function for trade sales has a shape similar to a logistic function (first it grows at an increasing rate but latter on it grows at a decreasing rate). The trade sales hazard rate levels out for exit time around 7-8. The fact that the hazard rate for trade sales is higher than the hazard rate for IPOs for small durations but lower for longer durations, suggests that the exit time for trade sales has much higher variability than the exit time for IPOs (some trade sales exits occur very early while other only occur after a very long time).[4]

Let us now analyze the impact of each determinant on the time to exit. The age of the venture capital investor only has a statistically significant impact in the trade sales duration. This regression shows that venture capitalists with more experience have investments with slightly longer durations, which is supportive of the grandstanding theory. In the remaining regressions the age of the venture capitalist does not have a significant impact on the time to exit. From a theoretical point of view one knows that there are various effects which play in opposite

[3] We also estimated the model assuming the Weibull distribution. The results were very similar to the ones obtained with the generalized Gamma. The main difference was in the TradeSale regression, where the variable age was not statistically significant. In addition, we estimated the competing risks model using the semi-parametric Cox PH model. Again the results were qualitatively similar.

[4] It should be noted that Giot and Schwienbacher (2007) obtained non-monotonic hazard functions (first increasing and then decreasing) for all the exit forms. We believe that the discrepancy in the results is due to the fact that our data is aggregated at the venture capitalist level (our duration is average duration for the venture capitalist).

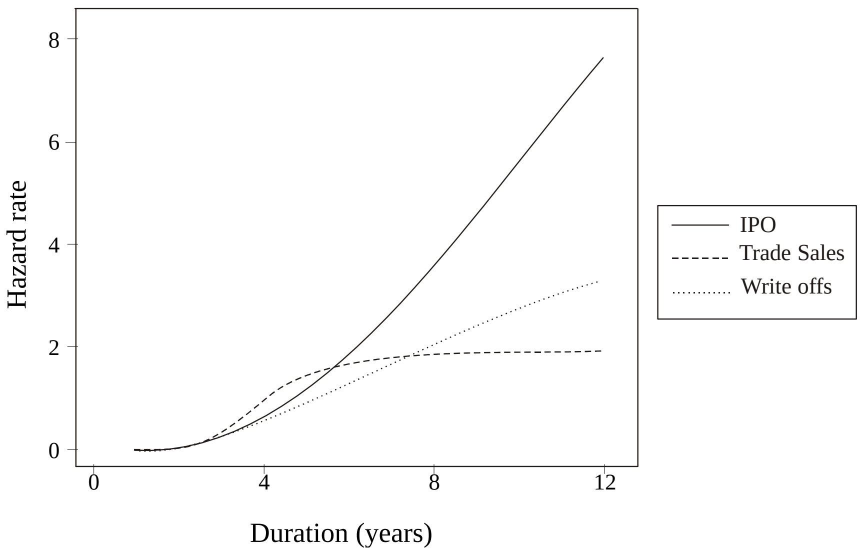

Figure 3: Hazard functions for IPO, trade sales and write-offs (evaluated at covariates means).

directions, thus the total effect is a priori ambiguous. Our results show that the various effects tend to cancel each other. Similarly, the level of education of the venture capitalist does not have a statistically significant impact on venture capital investments duration. However, it should be noted that the sign of the coefficients is consistent with the idea that better educated venture capitalists are able to solve quicker the informational problems.

The venture capital investor characteristic which has a more significant impact on the time to exit is the association with financial institutions. If the venture capitalist is associated with a financial institution then the time to exit decreases for all types of exit. For example, in the regression where IPOs are used as the exit form, venture capitalists associated with financial institutions have a time to exit which is equal to 85% ($e^{-0.16}$) of the time to exit of venture capitalist not associated with financial institutions, thus they have a substantially faster exit. The impact is higher for trade sales, where the time ratio is 0.77 ($e^{-0.261}$), followed by IPOs and, finally, by write-offs. One possible explanation for this result is the fact that venture capitalist associated with banks have a larger network of contacts, which facilitates the task of finding potential buyers in trade sales exits. They may also have larger experience with stock market operations, facilitating the exit through IPOs. Our results support the idea that, in Europe, venture capitalists associated with financial institutions may be in advantage with respect to the remaining ones.

The impact of the venture capitalist being associated with a financial institution on the hazard function of the various exit forms is illustrated in the left panel of Figure 4 in the Appendix. This figure shows that venture capitalists associated with financial institutions have higher conditional exit rates, which implies shorter durations, for all types of exit.

The variables associated with the type of venture capital investment (EarlyStage and High-Tech) do not have a statistically significant impact on the time to exit for any exit form. However the signs of the coefficients are always positive, which is consistent with our theoretical model. We believe that the lack of statistical significance is due to the characteristics of our data. For example, regarding the HighTech variable we now believe that it is important to separate investments according to the various industries that are commonly classified as high-tech (unfortunately, this fact was not clear to us when we made the questionnaire). The reason is that different high-tech industries may have very different speeds of uncertainty resolution, leading to very different dynamics of exit. In other words, high-tech investments all have a high degree of asymmetry of information but one cannot forget that they might have very different speeds of uncertainty resolution, depending on the industry. In this regard, Cumming and MacIntosh (2001) and Giot and Schwienbacher (2007) regressions had a better specification.

On the contrary, the set of contracting variables seems to be particularly important to explain venture capital duration. The average number of reports, the percentage of investment where the venture capitalist is present in the Board of Directors and the percentage of syndicated investments all have a statistically significant impact on the time to exit of the various exit forms. On the other hand, the percentage of times that convertibles are used does not have a significant impact on duration.

The duration of the investment decreases with the number of reports for all exits forms, an effect which is supportive of our theoretical predictions. This result is illustrated in the right panel of Figure 4, which compares the hazard functions when the average number of reports is equal to 2 with when it is equal to 12. Increasing the number of reports leads to an higher conditional hazard rate, thus a faster exit, for all exit forms. As monitoring increases we expect venture capitalists to be better informed about the investee firm prospects and to solve quicker the informational problems, leading to shorter durations.

However, the impact of the percentage of times that the venture capitalist is present in the board of directors on duration is positive. This is precisely the opposite of what we expected, since the presence in the board of directors corresponds to higher monitoring and higher capacity to influence the investee firm's decisions. One possible interpretation for this unexpected result is that by being present in the board of directors, the venture capitalist ends up loosing some of its independence. The venture capitalist might be more easily influenced by the entrepreneurs point of view. This may lead to longer durations.

As expected, an increase in the percentage of syndicated investments decreases the time to exit for all exit forms. Syndicated investments signal the quality of the investment, increase the pool of contacts, and add more value to the investment as member may have complementary skills. Hence, syndication facilitates exit. Our result is consistent with the one obtained by Giot and Schwienbacher (2007) who concluded that larger syndicates sizes decrease the time to exit in each round (the result was stronger for the duration of the first round).

Finally, our result show that an increase in the percentage of pre-planned exits leads to significantly shorter durations. Cumming and MacIntosh (2001) obtained a similar results, but the coefficient was statistically significant only for the combined US-Canada sample.

7 Conclusions

In this article we studied the divestment decision in the European venture capital market considering two dimensions: when to exit (duration of the investment) and how to exit (which form of exit to use). Our empirical analysis is based on data obtained through questionnaires to venture capital firms. In order to analyze simultaneously when to exit and how to exit we used competing risks models.

Our study provides three significant contributions to the literature on venture capital exits. The first one is that this is the first study to apply the competing risks model to model the total duration of venture capital investments. This rigorous statistical methodology has been previously used to model the time to exit in each investment round, but no similar study has been done for total duration of the venture capital investment. The second contribution of our study is that it is the first study that analyzes the two dimensions of the exit decision in the European venture capital market. Finally, our study highlights the importance of the contracting variables and the association of the venture capitalist to financial institutions.

Moreover, our theoretical analysis, although inspired in previous studies, adds a number of new insights on the impact of several determinants. In particular, it emphasizes that one should consider two important aspects: *(i)* the role of the degree of asymmetric information on the optimal duration, and *(ii)* the degree of uncertainty and the speed of resolution of this uncertainty. Our empirical analysis does not properly address the second aspect, but our results indirectly suggest that it is important to do so. In addition, it calls attention for the need of including variables related to the venture capitalist characteristics, the investment characteristics and the financial contract characteristics.

One important result is that in Europe venture capitalists associated with financial firms have faster exits for all exit forms. This result is stronger for trade sales exits, suggesting that in Europe, venture capitalists associated with banks have larger network of contacts, which facilitates the task of finding potential buyers in trade sales exists.

A second interesting result is that the contracting variables have a significant impact on the exit decision. As expected, increases in the number of reports and on the percentage of syndicated investments lead to shorter durations for all exit forms. However, regarding the impact of the percentage of times that the venture capitalist is present in the board of directors on exit we obtained an unexpected positive coefficient. Our explanation for this surprising result is that by being present in the board of directors the venture capitalist ends up loosing some of its independence, making it more difficult to end the venture capitalist involvement with the investee firm.

A final and expected result is that pre-planned exits lead to significantly shorter durations.

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Appendix

Table 2: Descriptive statistics.

	Average	Std. Deviation	Minimum	Maximum
Duration	4.040	1.820	2	12
IPO	0.128	0.218	0.000	1.000
TradeSales	0.470	0.331	0.000	1.000
WriteOffs	0.193	0.264	0.000	1.000
Age	15.160	23.147	2	161
Graduate	0.630	0.485	0	1
FinInst	0.130	0.341	0	1
EarlyStage	0.337	0.351	0.000	1.000
HighTech	0.553	0.424	0.000	1.000
Convertibles	0.246	0.307	0.000	1.000
Reports	9.270	3.664	2	15
Board	0.192	0.290	0.000	1.000
Syndication	0.590	0.410	0.000	1.000
Preplanned	0.800	0.405	0	1

Table 3: Correlation matrix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Duration	1													
(2) IPO	0.067	1												
(3) TradeSales	0.022	–0.354[a]	1											
(4) WriteOffs	–0.122	–0.137	–0450[a]	1										
(5) Age	0.131	–0.078	–0.063	0.009	1									
(6) Graduate	0.056	0.058	0.011	–0.001	0.062	1								
(7) FinInst	–0.164	–0.144	0.220[b]	–0.216[b]	0.126	–0.192[b]	1							
(8) EarlyStage	0.061	0.195	–0.067	0.265[b]	–0.067	0.056	–0.087	1						
(9) HighTech	0.017	0.165	–0.055	0.346[a]	–0.217[a]	0.037	–0.152	0.646[a]	1					
(10) Convertibles	0.037	–0.081	0.128	–0.010	0.110	0.011	–0.013	–0.188[b]	–0.082	1				
(11) Reports	–0.308[a]	–0.084	–0.163	0.189	–0.137	–0.051	–0.025	–0.021	0.073	–0.016	1			
(12) Board	0.133	–0.069	0.089	–0.027	–0.021	0.081	0.064	–0.013	–0.020	0.115	–0.086	1		
(13) Syndication	–0.092	0.178	–0.012	0.212	–0.180	0.163	–0.047	0.364[a]	0.557[a]	0.026	–0.110	–0.067	1	
(14) Preplanned	–0.220	0.115	0.142	–0.353[a]	–0.218	–0.317[a]	0.101	0.073	–0.033	–0.010	0.007	0.008	–0.117	1

In parentheses we present the values of the z-statistics for each variable. The tests statistics are significant at the following levels: a – 1%; b – 5%.

Table 4: Empirical results for the competing risks model.

	State Variable		
Potential Determinants	IPO	Trade-Sales	Write-offs
Characteristics of venture capital investor			
Age	–0.000	0.002	0.000
	(–0.207)	$(2.502)^a$	(0.003)
Graduate	–0.009	–0.015	0.014
	(–0.191)	(–0.372)	(0.262)
FinInst	–0.160	–0.261	–0.124
	$(–2.282)^b$	$(–4.961)^a$	$(–1.498)^d$
Type of venture capital investment			
EarlyStage	0.044	0.043	0.048
	(0.479)	(0.599)	(0.458)
HighTech	0.109	0.079	0.017
	(1.159)	(1.081)	(0.155)
Contracting variables			
Convertibles	–0.057	–0.074	–0.080
	(–0.674)	(–1.149)	(–0.877)
Reports	–0.023	–0.034	–0.036
	$(–3.247)^a$	$(–6.027)^a$	$(–4.263)^a$
Board	0.372	0.105	0.350
	$(4.027)^a$	$(1.739)^c$	$(3.613)^a$
Syndication	–0.160	–0.131	–0.141
	$(–1.534)^d$	$(–1.739)^c$	(–1.208)
Preplanned	–0.527	–0.167	–0.229
	$(–5.634)^a$	$(–2.624)^a$	$(–1.649)^c$
Chi–Squared	65.82^a	44.09^a	44.92^a
Log Likelihood	–31.53	–16.71	–48.81

In parentheses we present the values of the z-statistics for each variable. The tests statistics are significant at the following levels: a – 1%; b – 5%; c – 10%; d – 15%.

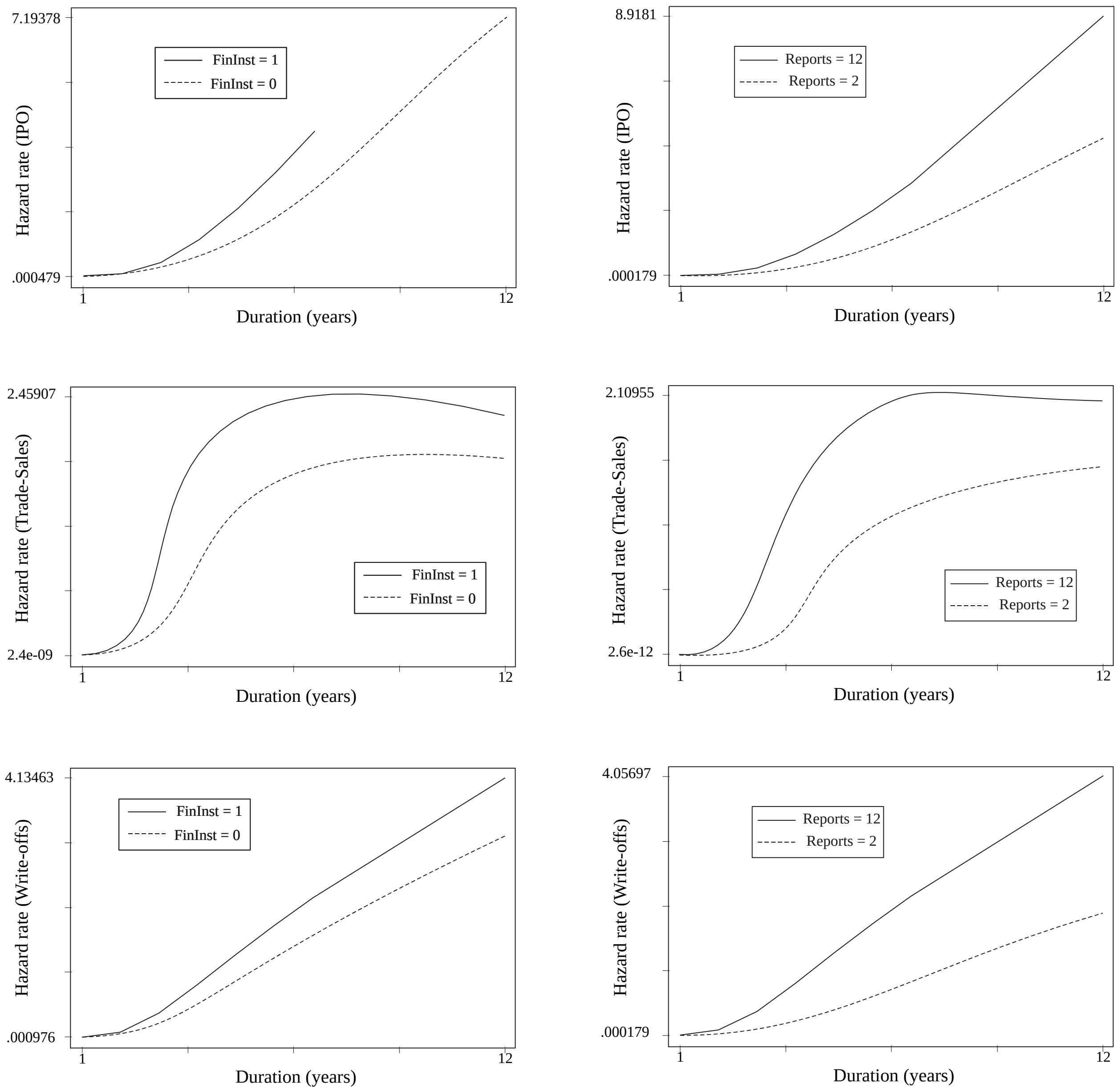

Figure 4: Impact on the hazard functions of being related with a financial institution (left panel) and of the number of reports (right panel). The figure shows the hazard functions for the IPO (top panel), trade sales (middle panel) and write-offs (bottom panel).