

VENTURE CAPITAL AND THE USE OF CONVERTIBLE SECURITIES AND CONTROL RIGHTS COVENANTS: A FUZZY SET APPROACH



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ABSTRACT

Although venture capital is considered crucial for promoting economic development and innovation, not much has been done regarding the use of complex financing contracts in venture capital backed investments. In this study we investigate the use of convertible securities and control rights covenants for a sample of 15 Portuguese venture capital firms. We use a relatively new methodology in business and management sciences – fuzzy set Qualitative Comparative Analysis – that considers both quantitative and qualitative factors for obtaining a solution that best fits the empirical data. Our results show that the use of convertible securities is affected by the anticipated severity of double-sided moral hazard problems. On the other hand, only a weak support is provided to the agency predictions regarding the use of control right covenants. Interestingly, the results reveal that convertible securities, unlike control rights covenants, are the most apt instruments to reduce costly double-sided incentive problems of a venture capital relationship.

KEY WORDS

venture capital, convertible securities, control right covenants, agency costs, fuzzy set theory

JEL CODES

C10, G24, G32

1 INTRODUCTION

There is a consensus that Venture Capital plays a catalytic role in promoting innovation (Kortum and Lerner, 2001), in contributing for economic growth and in fostering labour force capabilities by opening career opportunities to

high-qualified individuals (Smith and Estibals, 2011; Christofidis and Debande, 2001; Anderson and Napier, 2007; Bascha and Walz, 2002).

Given the important role played by Venture Capital in providing financing resources to

new technology and entrepreneurial firms, it is crucial to investigate what are the determinants for the optimal design of financing contracts established between Venture Capital firms and their portfolio of firms.

Schmidt (2003) suggests that the predominance of convertible securities on Venture capital backed investments is due to the existence of double-sided moral hazard problems. Repullo and Suarez (2004) define the double-sided moral hazard as the financing problem that arises when the efforts that both venture capitalist and entrepreneur have to commit for the expansion of the project are unobservable at the start-up stage. Repullo and Suarez (2004) and Schmidt (2003) contend that convertible securities provide a powerful incentive mechanism that can induce both entrepreneur and venture capitalist to commit effort at the start-up stage and to invest efficiently at the expansion stage. Indeed, the incentive mechanism embedded in the conversion option ensures that the venture capitalist will invest at the expansion-stage if he/she exercises his/her conversion rights and this only happens if both venture capitalist and the entrepreneur put in the efficient amount of effort at the start-up stage. Therefore, as authors such as Schmidt (2003), Repullo and Suarez (2004), Gompers and Lerner (1996), Gompers (1997), Hellmann (1998) point out, convertible securities in venture capital financing strictly outperform any standard debt-equity contract.

On the other hand, extensive literature (e.g. Gompers, 1995; Gompers, 1997; Bergemann and Hege, 1998; Baker and Gompers, 2003; Sahlman, 1990; Lerner, 1995; Gorman and Sahlman, 1989; Smith, 2005; Schwienbacher, 2008) argues that the inclusion of explicit control right covenants in venture capital agreements allow for reduction of excessive conflicts of interest between venture capitalist and entrepreneur. More importantly, these authors contend that the mitigation of the conflicts of interests between venture capitalist and the entrepreneur cannot rely solely of the use of a particular financing instrument. Specifically, Gompers (1997) emphasises that, although many theories of financial instruments have

focused on optimal control allocation, the use of cash-flow rights – such as convertible preferred stocks or convertible debt – to resolve control rights allocation is deemed not to be optimal in the venture capital context. According to authors like Gompers (1997), Hellmann (1998) and Kaplan and Strömberg (2003), while convertible securities should be used to assure an optimal allocation of cash-flow rights, control rights covenants are better suited to solve conflicts of interest related to corporate control. In particular, a number of authors argue that the inclusion of contractual covenants in venture capital financing is particularly important to resolve disagreements regarding optimal exit strategies (Cumming, 2008; Kaplan and Strömberg, 2003; Smith, 2005; Bienz and Walz, 2010; Schwienbacher, 2008).

As pointed out by Gompers (1997), venture capital projects – characterised by extreme uncertainty, severe asymmetry of information and potentially high rewards – provide a unique perspective to assess the role of financing contracting and corporate control. Nevertheless, existing empirical studies tend to focus on the role played by individual rather than multiple contractual features in resolving issues regarding the allocation of cash-flow rights or corporate control rights. In this regard, this paper is novel in a number of ways. First, it provides a comprehensive empirical investigation of cost-effective contractual mechanisms (such as convertible securities and control rights covenants) that are expected to reduce the double-sided incentives in venture capital investments. Second, to our best knowledge, it is the first study that uses qualitative and quantitative methodology – the fuzzy set Qualitative Comparative Analysis (fsQCA) – to assess the effect of convertible securities and control right covenants in mitigating double-sided incentive problems arising from venture capital-backed investments. The fsQCA is a particularly well-suited methodology for this study because it considers not only the impact of individual factors (as in the traditional regression analysis) but most importantly it takes into account the effect of combinations of factors that shape the design of venture

capital contracts. Moreover, fsQCA considers both qualitative and quantitative sources of data in order to convey a more insightful account of the issues that influence the design of cost-effective contracts. To this extent, in order to run our model we use both quantitative data – generated by the questionnaire survey – and qualitative data that is rooted on a comprehensive review of the extant literature on venture capital financing. Finally, this study focuses on a sample of venture capital firms operating in the Portuguese market which, albeit an expanding market, has not been well investigated by the existing empirical literature.

Our results reveal that convertible securities are more likely to be used when the severity of double-sided incentive problems is particularly stringent. This result provides strong support to the agency cost theory proposed by Schmidt (2003), Gompers and Lerner (1996), Gompers (1997), Hellmann (1998), among others. On the other hand, only a weak support is found for the use of control rights covenants to reduce double-sided incentive costs. Interestingly, although not consistent with broad agency predictions, this evidence corroborates theoretical predictions that deviate from the traditional

corporate finance view. Indeed, a recent stream of literature suggests that, in the particular context of Venture Capital settings, the use of control rights covenants is required not necessarily to decrease principal-agent conflicts of interest, but rather to increase value-creation opportunities (e.g. Manigart et al., 2002; Wright and Robbie, 1998) or to reduce idiosyncratic risks associated to non-diversified venture capital portfolios (e.g. Wright and Robbie, 1998; Yoshikawa et al., 2004). Therefore, our paper provides a significant contribution to ongoing research regarding the different role played by financing instruments (namely, convertible bonds and convertible preferred shares) and by the use of control rights covenants in the specific context of Venture Capital.

The remainder of the paper is structured as follows. In the next section, we provide an overview of theoretical predictions and empirical evidence regarding the use of convertible securities and control rights covenants in Venture Capital contracts. Section 3 outlines the methodology, sample and data used in this study. Section 4 presents the results and discusses their implications. Finally, Section 5 presents the conclusions of this study and suggests future research paths.

2 LITERATURE REVIEW

Venture Capital firms are considered to have a positive effect on the backed firms' productivity (Croce et al., 2013) and growth (Davila et al., 2003), to be able to enhance the backed firms' operational and financial performance (Alperovych and Hübner, 2013; Gompers and Lerner, 2004) and to promote the backed firms' innovation (Gompers and Lerner, 2004; Kortum and Lerner, 2001). Additionally, authors such as Park et al. (2015) and Lockett et al. (2008) point out that Venture Capital firms contribute for enhancing the internationalisation prospects of venture capital-backed projects.

In the same context, Gorman and Sahlman (1989) list six ways in which Venture Capital firms can support new ventures. Thus, according to these authors Venture Capital firms assist

entrepreneurs in getting additional financing, in developing both strategic and operational planning, in recruiting the management team, in fostering networks with potential customers and suppliers and in resolving compensation issues. Considering the substantial contribution of Venture Capital in promoting and developing new ventures, it is crucial to examine what are the optimal features in Venture Capital financing instruments and control mechanisms that allow for the reduction of inherent financing costs.

According to Schmidt (2003) the predominance of convertible securities on investments backed by Venture Capital can be explained by the existence of a double-sided moral hazard problem. Double-sided moral hazard occurs

when actions from the agent (entrepreneur) cannot be observed by the principal (venture capitalist) or verified by third parties (e.g. courts). To this extent, Schmidt (2003) points out that the success of highpotential entrepreneurial firms depends not only on the quality of the project and the effort exerted by the entrepreneur but also on the commitment of the venture capitalist to actively manage the projects they finance¹. Therefore, there should be a mechanism to induce both venture capitalist and entrepreneur to undertake effort and therefore curb the double-sided moral hazard issues. Convertible securities act as such mechanism because on one hand, the venture capitalist will invest and exercise his conversion rights only if the entrepreneur commits sufficient effort to the project and on the other hand, the entrepreneur will commit sufficient effort only if the investor is actively involved not only on the financing but also on the management of the enterprise. According to Schmidt (2003), the latter explains why convertible instruments are very popular among venture capital financing and uncommon when the funding of small firms is made by banks or other passive investors. Bascha and Walz (2002) show that, for the German venture capital market, convertible securities (namely, convertible debt and convertible preferred shares) are used when the severity of agency problems is particularly high. Furthermore, their results are in line with theoretical predictions (Schmidt, 2003; Gompers, 1997; Hellmann, 1998) that convertible securities, unlike traditional mix of equity-debt financing, allow the optimal allocation of cash flow rights. Other strand of the literature (e.g. Marx, 1998; Berglof, 1994; Schwienbacher, 2008; Cumming, 2008; Arcot, 2014) emphasises that convertible securities allow for a reduction of conflicts between investors and entrepreneurs because it leads to a more efficient allocation of control rights, namely, the right to decide on exit strategy. Indeed, these authors argue that because entrepreneurs derive private benefits

from staying independent and remaining in control of their company after exit, they prefer exit through IPOs even when trade sale or write-off are more efficient strategies for the venture capitalist. Convertible options that are exercisable at different re-financing stages of the project would allow the allocation of control rights to the right persons. However, Gompers (1997), Hellmann (1998), Schmidt (2003), Kaplan and Strömberg (2003), Cumming (2005) among others, emphasise that convertible securities play a distinctive role from control rights covenants because they permit the de-coupling of the payoff from the control problem and allow double-sided monetary incentives to be dealt separately from control incentives. To this extent, this strand of literature suggests that conflict of interests between Venture capitalist with claims over residual equity rights and the entrepreneur who controls the value of those rights (Jensen and Meckling, 1976; Kaplan and Strömberg, 2003; Sapienza et al., 1996; Admati and Pfleiderer, 1994) can be mitigated by the inclusion of additional control rights covenants. In an extensive review of current Venture Capital literature, Yoshikawa et al. (2004) point out that, Venture capitalists protect their claims over residual equity rights by closely monitoring the management of the venture firm through the use of such mechanisms as investment staging (Bergemann and Hege, 1998; Gompers, 1995), active monitoring in the boardroom (Lerner, 1995; Gompers, 1997; Baker and Gompers, 2003), operational control (Gorman and Sahlman, 1989; Gompers, 1997; Baker and Gompers, 2003) and even shareholders agreements that allow the venture capitalist to replace the entrepreneur with outside managers (Sahlman, 1990; Gompers, 1997; Baker and Gompers, 2003). Additionally, Cumming (2008), Kaplan and Strömberg (2003), Smith (2005), Bienz and Walz (2010), Schwienbacher (2008) amongst others, show that the inclusion of specific contractual rights protect venture capitalist claims over exit decisions. We can

¹Some of the efforts committed by the entrepreneur can be described as his/her endeavours to build up the company, to engage in RandD and develop the product, to set up the production facilities and to market the product. On the other hand, the venture capitalist commits effort by advising on strategic decisions, helping to find key employees and to design suitable compensation packages for them, contacting key suppliers and customers and even by getting involved in day-to-day operations of the company (Schmidt, 2003; Hellmann and Puri, 2002).

therefore assume that these control rights mechanisms will dilute the entrepreneur incentives to incur in excessive risks and will align his/her interests with the interests of the venture capitalist. This in turn will lead to a desirable reduction in agency costs.

In line with existing literature we consider five potential causal conditions that might lead to the exacerbation of moral hazard problems. These are: the age and size of the Venture Capital firm (Bascha and Walz, 2002; Kaplan and Strömberg, 2003; Norton and Tenenbaum, 1993), the ownership structure of the Venture Capital firm – i.e. whether is privately or publicly held (Bascha and Walz, 2002), life stage of Venture Capital investment portfolio (Gompers, 1995, 1997; Bascha and Walz, 2002) and the venture capitalist's expected rate of return (Bascha and Walz, 2002; Gompers, 1995, 1997; Gupta and Sapienza, 1992; Manigart et al., 2002). According to these authors, younger and smaller VC firms, that are privately held and that invest primarily in seed and start up projects for which high returns are expected, are more likely to be exposed to excessive agency problems. Specifically, Bascha and Walz (2002), Kaplan and Strömberg (2003) and Norton and Tenenbaum (1993) argue that less experienced and smaller VC firms will face more asymmetries of information regarding the entrepreneur ability to pursue a successful venture which will exacerbate agency issues. On the other

hand, Bascha and Walz (2002) stress that privately owned, unlike public VC firms, tend to invest in riskier activities for which higher returns are expected. Moreover, the uncertainty regarding the success of the venture capital investment tends to be exacerbated for early stage projects (i.e. seed and start up projects) (Gompers, 1995, 1997; Bascha and Walz, 2002) and for investments with particularly high expected returns (Bascha and Walz, 2002; Gompers, 1995, 1997; Gupta and Sapienza, 1992; Manigart et al., 2002). The increase of investment uncertainty is likely to increase the conflicting incentives between the investor and the entrepreneur. Against this background, we test the hypothesis that smaller and younger VC that are privately held and that invest in early stage projects for which higher rates of return are expected are more likely to include convertible securities to finance their portfolio in order to curb agency problems. In line with the arguments by Gompers (1995), Gompers (1997), Gompers and Lerner (2001), Cumming (2008), Kaplan and Strömberg (2003) and Smith (2005), among others, we also test the hypothesis that firms with these characteristics are more likely to include additional covenants in their shareholders' agreements in order to allow the optimal allocation of control rights. Tab. 5 shows the predicted relationships between the causal conditions and the two outcomes vis-à-vis the supporting literature.

3 METHODOLOGY

In this study we use a relatively new methodology in social sciences² – the fuzzy set Qualitative Comparative Analysis (Fuzzy set QCA) – that considers the impact of both quantitative and qualitative factors on the occurrence of the outcome. Moreover, as pointed out by Ragin (2000) QCA incorporates the concept of equifinality in which alternative causal conditions can produce the same outcome. Schneider and Wagemann (2012) also refer to the concept

of conjunctural causation, stressing that QCA takes into account that the occurrence of the outcome is more often than not dependent on combinations of causal conditions rather than on the effects of single conditions acting in isolation of one another. Unlike conventional quantitative analysis, QCA does not focus on the linear relationship between variables but on the presence or absence of causal conditions that are necessary or sufficient for

²Smithson (1987) was the first to provide a comprehensive application of fuzzy sets to social sciences. Nevertheless, only Ragin (2000) developed an analytic system – Qualitative Comparative Analysis – that allows the application of basic principles of fuzzy set analysis to social sciences phenomena.

the occurrence of the outcome (Schneider and Wagemann, 2012). Therefore, fsQCA methodology allows the separation of sufficient from necessary conditions which is impossible in conventional statistical tools, such as regression analysis, that rely on the existence of symmetric correlational measures or in other words in the presence of both necessary and sufficient conditions. Moreover, through Boolean algebra and algorithms, QCA reduces a large number of multiple causal conditions to a smaller number of combinations that lead to the outcome, therefore treating the cases (i.e. combinations of causal conditions) as a whole and not as a set of individual variables as in the conventional variable-based approach (Meneses et al., 2016; Felício et al., 2016). Considering the exploratory perspective of this study and its focus on investigating possible combinations of determinants for the choice of cost-effective contractual mechanisms in Venture Capital investments, this methodology is deemed most suitable for obtaining robust results³. We apply this methodology to a sample of Venture Capital companies from Portugal. Although Portuguese venture capital market is relatively small, it has been expanding considerably in recent years. According to CMVM (Market Securities and Exchange Commission) venture capital activity annual reports, the value under management for Portuguese venture capital funds rose on average 12% per year from 2013 to 2016 (CMVM, 2013, 2014, 2015, 2016). In 2016, this value increased by 11.3% (CMVM, 2016) surpassing the value of 8.8% that corresponds to the increase in European Venture Capital funds' value under management for the same year (Wijngaarde et al., 2018). The fast growing pace of Portuguese market together with the cross-border relevancy of venture capital contract design topic were the underpinning motives to focus on a relatively not well-known market in this study. The surveyed companies were selected from SABI (Iberian Balance sheet Analysis System) database according to their activity code. The survey was conducted during

the first half of August 2016 and from an initial database of 29 companies, two companies were excluded, as they were no longer active. From the remaining 27 companies, we have collected responses from 15 companies, which corresponds to a response rate of 55.55%. The survey was comprised of a questionnaire sent to the CEO or to a fund manager of these companies. The questions were designed in order to obtain information regarding the prevalence of convertible securities (namely, convertible preferred shares and convertible bonds) in Venture Capital backed investments and of control rights mechanisms (namely, refinancing options, exit options and additional restrictive covenants) that allow venture capitalists to closely manage their portfolio of firms. Furthermore, additional questions were included to obtain information about the characteristics of Venture Capital firms (i.e. size, age, and ownership structure) and their portfolio of firms (predominance of seed and start-ups projects and of high return claims), which are considered in the literature as able to exacerbate moral hazard problems. The questions aiming to assess the importance of convertible securities and control right covenants in Venture Capital contracts and the predominance of seed and start up investments on the Venture Capital portfolio were set on a 7-point Likert scale spanning from 1: not important to 7: very important. Tab. 6 shows the survey questionnaire used in this study.

Apart from ownership structure (that we consider as a binary variable), we calibrate our remaining four causal conditions and two alternative outcomes into fuzzy sets. A fuzzy set can be seen as a continuous variable that is purposely calibrated to indicate the degree of membership in a well-defined and specified set (Ragin, 2008). We adopt the indirect method of calibration that allows us to group the initial data from the questionnaire into six-value fuzzy scale. Thus, we are able to consider the quantitative variation evident in the raw data from the questionnaire avoiding the restriction to three

³In recent years, an increasing number of studies in the area of business and management sciences have used fsQCA in their empirical analysis. Among others, there are the studies by Meneses et al. (2016) on brand creation, Felício et al. (2016) on SME internationalisation, Coduras et al. (2016) and Beynon et al. (2016) on global entrepreneurship and Chaparro-Peláez et al. (2016) on e-commerce.

qualitative anchors i.e. 1 for full membership, 0 for full non-membership and 0.5 for maximum ambiguity point – which characterises the direct method of calibration (Rawlance, 2010). For Venture Capital firms' age and size, we attribute a score of 0 for firms with less than one year and with less than five Venture Capital projects in their portfolio (respectively) and a score of 1 for firms with more than ten years and more than one hundred Venture Capital projects in their portfolio (respectively). The intermediate scores were concomitantly allocated to the intermediate ranges. We use a similar procedure to calibrate the Venture Capitalist's expectation of return on seed and start-up investments. Thus, we attribute a score of 0 to expected returns below 10% and a score of 1 to expected returns above 30%. Intermediate codes were then allocated in tandem with the intermediate ranges. To calibrate the condition of life stage of Venture Capital investment portfolio we transformed the initial raw date of degree of importance of this condition into percentiles. We then calibrate these percentiles into a six-value fuzzy set in which fully in the membership set corresponds to values above the 85th percentile, mostly but not fully in the membership set corresponds to values between 75th and 85th percentiles range, more in than out the membership set corresponds to values between 55th and 75th percentiles range, more out than in the membership set corresponds to values between 35th and 55th percentiles range, mostly but not fully out of the membership set corresponds to values between 20th and 35th percentiles range and finally fully out the membership set corresponds to values below the 20th percentile.

According to Ragin (2008) indirect method should be used when it is not possible to precisely specify key benchmarks but only provide a broad classification of cases. Ideally, calibration thresholds should be set based on extant theoretical knowledge. However, as the literature related to Venture Capital does not provide guidance on what theoretically should

be the thresholds for the different degrees of membership, we use percentile ranges similar to ones used in previous studies that rely on fuzzy set methods (e.g. Lewellyn and Muller-Kahle, 2015; Jordan, 2012). To calibrate the two outcome sets, the convertible securities and the inclusion of control rights, first we relied on Boolean algebra to combine the several sets of contractual mechanisms such as convertible options and exit/refinancing options and other control rights (e.g. participation in the day-to-day management of VC-backed firms and inclusion of tag/drag along rights⁴) into these two outcome sets. According to Ragin (2008) two or more fuzzy sets can be compounded through the logical *and* (intersection of sets) or joined together through the logical *or* (union of sets). Specifically, if the final set is deemed to represent the intersection of two or more fuzzy sets, the score attributed to this set is the minimum membership score of each case in the sets that are combined together. On the other hand, if the joined set represents the union of two or more component sets, the score attributed to the former set is the maximum membership score of each case in the component sets (Ragin, 2008). In this study, we consider the use of convertible options on Venture Capital financing contracts as the union between the predominance of convertible bonds and the predominance of convertible preferred shares sets. Additionally, we consider the set, inclusion of control rights covenants in Venture Capital shareholder's agreements, as the intersection between inclusion of exit and refinancing options combined with the inclusion of more restrictive covenants such as drag/tag along options or covenants that allow the Venture Capitalist to participate in the day-to-day management Venture Capital-backed investment. As with project's life-cycle condition, initial Likert scale data is transformed into percentiles and the qualitative fuzzy set codes are allocated accordingly. Tab. 1 describes each causal condition and shows how each condition is calibrated into fuzzy set

⁴Tag along provision grants the Venture Capitalist the right (but not the obligation) to have his shares bought on the same terms (including price) as the entrepreneur. Drag along provision grants the Venture Capitalist the right to force the entrepreneur to sell his shares on the same terms as the VC if the latter decides to sell his shares (BVCA, 2007).

Tab. 1: Causal conditions – Description, labelling and fuzzy set calibration method

Causal conditions	Labels	Meaning	Linguistic scale	Calibration	
				Fuzzy code	Survey scale*
Private	priv	Legal status of firms: private, public or private/public	Fully in	1	private
			Fully out	0	public, private/public
Expected return	expret	VC return expectations for seed and start up projects	Full membership	1	> 30%
			Mostly but not fully in	0.8	25%–30%
			More in than out	0.6	20%–25%
			More out than in	0.4	15%–20%
			Mostly but not fully out	0.2	10%–15%
			Full non-membership	0	0%–10%
Seed or start up stage	seedstartup	Propensity of VC firms to invest in seed/start up projects	Full membership	1	> 85th
			Mostly but not fully in	0.8	75th to 85th
			More in that out	0.6	55th to 75th
			More out than in	0.4	35th to 55th
			Mostly but not fully out	0.2	20th to 35th
			Full non-membership	0	< 20th
Age	age	Number of years of activity for VC firm	Full membership	1	> 10
			Mostly but not fully in	0.8	8–10
			More in than out	0.6	6–7
			More out than in	0.4	4–5
			Mostly but not fully out	0.2	2–3
			Fully non-membership	0	0–1
Size	size	Number of projects founded by VC firm at certain point in time	Full membership	1	> 100
			Mostly but not fully in	0.8	61–100
			More in than out	0.6	31–60
			More out than in	0.4	11–30
			Mostly but not fully out	0.2	6–10
			Fully non-membership	0	0–5

*) In the case of life-cycle the questionnaire 7-points Likert scale was converted into percentiles.

codes. Tab. 2 summarizes the application of the Boolean algebra and the calibration into fuzzy set codes for the two outcome sets: inclusion of convertible securities and inclusion of control rights covenants. Tab. 3 presents the distribution of fuzzy set codes for each causal conditions and outcome sets after calibration.

Tab. 3 reveals that the propensity to include convertible securities is high for the VC firms surveyed (only 2 out of 15 cases have a fuzzy code below 0.6). On the other hand, VC firms show higher diversity regarding the use of control right covenants. Thus, there are 5 firms with a fuzzy code below 0.6 and 6 firms with fuzzy code of 1 indicating a consistent use of covenants in their financing contracts. Most of the VC firms expect high returns on their early

stage investments (11 out of 15 firms expect returns higher than 31% corresponding to fuzzy set scales above 0.6). In one case the VC firm indicates very low expected returns. However, this firm is likely not to invest in early stage projects (fuzzy code for seedstartup variable is 0). There is high dispersion regarding the life cycle of projects funded by the surveyed firms. Thus, while 5 firms are most likely not to fund early stage projects (fuzzy code = 0), 10 firms reveal that they invest considerably in seed and start up projects (fuzzy codes higher than 0.6). A significant number of VC firms are in activity for more than 10 years (10 firms have a “full membership” fuzzy score indicating that they were established more than 10 years before) and only one firm is operating for a shorter period

Tab. 2: Outcome sets – Boolean expression, labelling, description and fuzzy set calibration method

Convertible Securities			Control Rights Covenants		
Boolean expression*	Convertible preferred shares + Convertible bounds		Boolean expression*	Exit options × Refinancing options + Additional covenants	
Label	conv		Label	contrig	
Meaning	Propensity of VC firm to use convertible bonds or convertible preferred stocks in its financing contracts		Meaning	Propensity of VC firm to include control rights covenants in its financing contracts	
Linguistic scale	Percentile	Fuzzy code	Linguistic scale	Percentile	Fuzzy code
Full membership	> 85th	1	Full membership	> 85th	1
Mostly but not fully in	75th to 85th	0.8	Mostly but not fully in	75th to 85th	0.8
More in than out	55th to 75th	0.6	More in than out	55th to 75th	0.6
More out than in	35th to 55th	0.4	More out than in	35th to 55th	0.4
Mostly but not fully out	20th to 35th	0.2	Mostly but not fully out	20th to 35th	0.2
Full non-membership	< 20th	0	Full non-membership	< 20th	0

*) The signs + and × stand for the logical *or* and the logical *and*, respectively.

of less than 3 years. Finally, most of the firms are small (13 out of 15 firms have a fuzzy score below 0.6) and privately held (only one firms in the sample is state owned).

Tab. 3: Fuzzy code for each condition and each outcome across VC firms (cases)

Cases	conv	contrig	expret	seed-startup	age	size	priv
1	0.6	0.2	1	1	1	0.8	0
2	1	1	1	0	1	0.4	1
3	0.8	1	0.2	0.8	1	0.4	1
4	1	1	0.8	1	0.8	0.2	1
5	0.6	0.6	0.6	0.6	1	0.2	1
6	0.4	0.4	0	0	0.6	0.4	1
7	0.6	0.6	0.4	0.6	0.8	0.2	1
8	0.2	0.6	0.6	0	1	0.2	1
9	0.6	0.2	1	0	0.2	0.2	1
10	0.8	0.4	0.6	0.6	1	0.2	1
11	0.8	0.8	0.2	0.8	1	0.4	1
12	0.8	1	0.8	0	1	0.2	1
13	0.8	1	0.8	0.6	0.6	0.4	1
14	0.8	1	0.6	0.8	1	0.2	1
15	1	0.2	1	1	1	0.6	1

After calibration, the fsQCA procedure involves three main steps (Ragin, 2000; Ragin, 2006). The first step is the construction of a truth table. The rows in the true table list display all the possible combinations of causal conditions. As it was explained above, this study uses 5 causal conditions. Therefore, there are a total of $2^5 = 32$ possible combinations on the true table list for both outcomes (Ragin, 2006). The second step is to set a frequency threshold so that around 80% of the sample in the analysis is considered in the final result (Greckhamer et al., 2013). Ragin (2008) suggests that for small sample studies the frequency threshold should be set at a minimum of 1 in order to keep all the empirically observable combinations to maximise diversity and coverage. To this extent, in the fuzzy set estimation we kept all the combinations that had at least 1 observable case. The third step is to define a consistency cut-off point. Ragin (2000, 2006) defines consistency as the degree to which cases exhibiting a causal or combinations of causal conditions agree with (or are included in) the outcome set. Although the minimum value for consistency cut-off recommended by Ragin (2006) is 0.75, we use a value of 0.9 for the consistency threshold in order to increase the overall consistency of the results. The final step is to choose one of the

three solutions provided by the fsQCA estimation: complex solution, parsimonious solution or intermediate solution. As pointed out by Legault Tremblay (2015) complex solutions rely on fewer assumptions but produce exhaustive final combinations that might be difficult to interpret. On the other hand, both parsimonious and intermediate solutions produce more concise results. However, parsimonious solution considers hypothetical and empirically absent combinations and the intermediate solution is based on theoretical knowledge that allows the researcher to discern which hypothetical combinations are plausible (Legault Tremblay, 2015). As it was pointed out above in the discussion of the literature, there are some causal conditions (characteristics from venture capital firms and their portfolio of firms) that are likely to have

an impact on the decision to use convertible securities and/or control rights covenants on venture capital-backed contracts. However, extant literature does not predict whether the presence of a given causal condition might have greater impact than others on the occurrence of the outcome nor what would be the effect of considering multiple combinations of causal conditions. In order to obtain results that reflect our data as closely as possible, avoiding therefore the reliance on relatively subjective assumptions, the findings reported are restricted to the complex solution from the fsQCA 2.0 software⁵. As pointed out by Schneider and Wagemann (2012) the complex solution is the more adequate solution when there is no a priori “theory-guided hunches” about the effects of causal conditions on the occurrence of the outcome⁶.

4 RESULTS

Tab. 4 (I) reports the complex solution from the fuzzy set Qualitative Comparative Analysis regarding the inclusion of convertible securities in venture capital-backed contracts. The results show that there are three configurations of the causal conditions (represented by C1, C2 and C3) that are sufficient to explain the inclusion of convertible securities in venture capital-backed contracts. Thus, small and private venture capital firms that are active for longer periods of time combined with either higher investment return expectations or investment in risky, early cycle enterprises are more likely to include convertible securities as a state contingency mechanism to curb double-sided moral hazard problems. These results provide support to our first hypothesis that private firms investing in riskier projects and with higher return claims use more often flexible, state contingent mechanisms like convertible securities. However, in contrary to theoretical predictions the

results show that, more experienced Portuguese venture capitalist firms rather than younger, less experienced firms are more likely to use these more complex financial contracts. This evidence is however in line with Bascha and Walz’s (2002) findings for the German Venture Capital market.

The third configuration comprising the complex solution reveal that more experienced, private firms combined with investments made in riskier projects and with higher return claims tend to use more often convertible options in their contracts. These results are also consistent with the agency costs predictions. Overall these results covered 74% of the outcome instances demonstrating that well over two thirds of the outcome conditions are explained by the configurations of the causal conditions. This reveals the empirical relevance of these configurations in determining the outcome. Moreover, the overall consistency value of 95% shows that

⁵The fsQCA 2.0 software uses the Quine-McCluskey algorithm to logically minimize the several combinations in the true table to obtain the solution sets (Ragin, 2010).

⁶Although preferred due to theoretical considerations, the complex solution presented in Tab. 4 does not differ from the intermediate solution obtained in this study. The intermediate solution considers configurations that were not empirically observed but may occur in other settings (Thomann and Maggetti, 2017). Thus, the inferences made in this study, on the basis of the complex solution are externally valid i.e. their ability to be generalised to a broader universe of cases is not hindered (Cook and Campbell, 1979).

these configurations are indeed in agreement with the set outcome (Ragin, 2006). On the other hand, all configurations have unique coverage well over zero (0.06 to 0.17) which according to Schneider and Wagemann (2012) make them deemed for interpretation.

Tab. 4 (II) reports the complex solution for the inclusion of additional control rights covenants in the shareholders' agreement. Only one configuration is sufficient to explain the inclusion of control rights covenants (represented by CR). Like in the case of convertible securities, small, private and more experienced venture capital firms are more likely to use control rights covenants. However, contradicting our second hypothesis, the evidence shows that the use of control rights mechanisms is not related with the life-stage of the investment project or with the return rate expected by Venture Capitalist on this investment project. Therefore, as suggested in the literature (e.g. Gompers, 1997; Bascha and Walz, 2002; Jensen and Meckling, 1976; Kaplan and Strömberg, 2003; Sapienza et al., 1996; Admati and Pfleiderer, 1994), it seems that convertible securities, by allowing the decoupling of payoff from control mechanisms, play a different role from covenants in curbing double-sided incentives from venture capitalists and related portfolio of firms. Interestingly, although the evidence contradicts the use of control rights for highly uncertain, early-stage projects for which Venture capitalists demand higher required returns, it suggests that private,

smaller and more experienced firms are more likely to resource to control rights that allow them to more closely manage their financed-backed projects. Thus, although not supporting double-sided incentives theory, this result seems to be in line with Yoshikawa et al. (2004) and Wright and Robbie (1998) evidence that smaller venture capital portfolios with more specialized investments (namely, by technology and by industry) require a more direct and active monitoring from the venture capitalist. Moreover, this result is also consistent with value-creation theory that argues that post-investment direct monitoring by the Venture Capitalist creates value namely by helping to identify additional business opportunities (Manigart et al., 2002; Bhidé, 2000) or by providing the enterprise with more effective managerial skills (Wright and Robbie, 1998). Thus, this result points to new paths for further empirical research on venture capital market. Indeed, future empirical research should examine whether the use of control rights covenants by private, more experienced venture capital firms with less diversified portfolios is primarily due to the need to reduce idiosyncratic risk arisen from investment specialization and/or due to the desire to increase value-creation opportunities. This would provide a significant contribution to the analysis of the different roles played by convertible options and by control rights covenants on the design of optimal financing contracts in the Venture Capital setting.

5 CONCLUSION

In this study we examine the use of convertible securities and control rights covenants in Venture Capital contracts when double-sided moral hazard problems are particularly stringent. We focus on a stream of literature (e.g. Schmidt, 2003; Bascha and Walz, 2002; Gompers, 1995; Gompers, 1997; Bergemann and Hege, 1998; Baker and Gompers, 2003; Sahlman, 1990; Lerner, 1995; Gorman and Sahlman, 1989) that argues that both convertible securities and control rights covenants can be used to mitigate excessive agency costs. A number of authors

such as Gompers (1997), Hellmann (1998) and Kaplan and Strömberg (2003) emphasise that the role played by convertible securities is different from that of control rights covenants, as the former allow for the de-coupling of cash-flows rights from control rights. To investigate how excessive double-sided incentive problems affect the decision of using convertible securities or including control rights covenants in Venture Capital contracts, we use an innovative methodology – fuzzy set Qualitative Comparative Analysis – that considers the impact of

Tab. 4: Truth table solution for convertible securities and inclusion of control covenants models

(I) Model: conv = f(priv, expret, seedstartup, size, age)			
Algorithm: Quine-McCluskey			
Complex solution			
Frequency cut-off: 1.000000			
Consistency cut-off: 0.909091			
	Raw coverage	Unique coverage	Consistency
priv*seedstartup*~size*age	0.518519	0.111111	1.000000
priv*expret*~size*age	0.574074	0.166667	0.939394
priv*expret*seedstartup*age	0.462963	0.055556	1.000000
Solution coverage: 0.740741			
Solution consistency: 0.952381			
(II) Model: contrig = f(priv,expret,seedstartup,size,age)			
Algorithm: Quine-McCluskey			
Complex solution			
Frequency cut-off: 1.000000			
Consistency cut-off: 0.909091			
	Raw coverage	Unique coverage	Consistency
priv*~size*age	0.780000	0.780000	0.847826
Solution coverage: 0.780000			
Solution consistency: 0.847826			

Note: The tilde sign “~” is used to indicate negation of the causal condition, i.e. ~size indicates small firms (negation of membership in large firms set)

both qualitative and quantitative factors on the design of these contracts. This methodology is innovative and particularly suited to this type of exploratory study as current theoretical predictions do not shed light neither on the importance of each specific cause for agency conflicts nor on the impact that a combination of these causes might have on the choice of cost-effective contracting mechanisms in the Venture Capital setting. Our results for the Portuguese Venture Capital market show that, in line with the literature, convertible securities contribute for the reduction of double-sided moral hazard incentives. A weak support to

the agency predictions is however found for the use of control rights covenants in Venture Capital contracts. Our evidence suggests that the use of control rights covenants in Venture Capital contracts might be rather influenced by the desire of Venture capitalist to increase value-creation opportunities (Manigart et al., 2002; Wright and Robbie, 1998) or to reduce idiosyncratic risks (Yoshikawa et al., 2004; Wright and Robbie, 1998). We therefore suggest that future empirical research on Venture Capital should address the different roles that financial instruments and control rights mechanisms play on the design of optimal contracts.

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7 ANNEX

Tab. 5: Predicted relationships between response and explanatory variables and related supporting literature

Causal Conditions	Expected sign	Convertible Securities	Expected sign	Control Right Covenants
		Supporting literature		Supporting literature
Age	(–)	Bascha and Walz (2002), Kaplan and Strömberg (2003), Norton and Tenenbaum (1993), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(–)	Kaplan and Strömberg (2003), Norton and Tenenbaum (1993), Hellmann (1998), Schmidt (2003), Cumming (2005)
Size	(–)	Bascha and Walz (2002), Kaplan and Strömberg (2003), Norton and Tenenbaum (1993), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(–)	Kaplan and Strömberg (2003), Norton and Tenenbaum (1993), Hellmann (1998), Schmidt (2003), Cumming (2005)
Expected return	(+)	Bascha and Walz (2002), Gompers (1995, 1997), Gupta and Sapienza (1992), Manigart et al. (2002), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(+)	Gompers (1995, 1997), Bergemann and Hege (1998), Gupta and Sapienza (1992), Manigart et al. (2002), Hellmann (1998), Schmidt (2003), Cumming (2005)
Seed/Start-up stage	(+)	Gompers (1995, 1997), Bascha and Walz (2002), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(+)	Gompers (1995, 1997), Bergemann and Hege (1998), Hellmann (1998), Schmidt (2003), Cumming (2005)
Private	(+)	Bascha and Walz (2002), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(+)	Hellmann (1998), Schmidt (2003), Cumming (2005)

Tab. 6: Survey Questionnaire to Venture Capital CEOs or Venture Capital Fund Managers

1. What type is the ownership structure of your firm?							
Private							
Public							
Public-private agency							
2. What is the number of years of activity of your firm?							
0–1							
2–3							
4–5							
6–7							
8–10							
More than 10							
3. On average, what is the importance of the allocation of venture capital funds to the following stages of investments life cycle? (1 = not important, 7 = very important)							
Seed	1	2	3	4	5	6	7
Start-up							
Growth and Expansion							
4. What is the probability of the following activity sectors being funded by venture capital from your firm? (1 = very improbable, 7 = very probable)							
IT	1	2	3	4	5	6	7
Finance							
Hospitality and Food Service							
Health							
Energy							
Industrial technology							
Other (which?)							
5. What is the relevance of the following criteria in the selection of your investment projects? (1 = not important, 7 = very important)							
Management skills of the incumbent	1	2	3	4	5	6	7
Entrepreneurship and communication skills of the incumbent							
Technological innovation							
Commercial viability of the project							
Environmental impact of the project							
Management skills of the incumbent							
6. What are the expected return rates of investment for seed or start-up projects?							
0%–10%							
10%–15%							
15%–20%							
20%–25%							
25%–30%							
More than 30%							
7. What are the expected return rates of investment for growth/expansion projects?							
0%–10%							
10%–15%							
15%–20%							
20%–25%							
25%–30%							
More than 30%							
8. What is the importance of the following financing structures used by your firm to fund venture capital investments? (1 = very improbable, 7 = very probable)							
100% equity: common shares	1	2	3	4	5	6	7
100% equity: preferred shares							
Equity (common shares) and debt							
Convertible bonds							
Convertible preferred shares							
Others (which?)							
9. What is the degree of intervention of the venture capital firm on the management of the incumbent? (1 = not important, 7 = very important)							
Specified in the shareholders' agreement (SHA)	1	2	3	4	5	6	7
Member of the board of directors of incumbent							
Exercise of refinancing options during the life of the project							
Inclusion of exit options in the investment contract							
Involvement in day-to-day management of the incumbent							
Other (which?)							
10. On average, at any single point in time, what is the number of projects funded by the venture capital company?							
0–5							
6–10							
11–30							
31–60							
61–100							
More than 100							
11. What is the most probable academic degree of a venture capital manager in your firm?							
Bachelor							
MSc							
PhD							
Professional diploma							
12. What is the most probable age bracket of a venture capital manager in your firm?							
20–30 years							
31–35 years							
36–40 years							
41–45 years							
46–50 years							
More than 50 years							

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