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Is Venture Capital Performance Affected by Recessions? Evidence from the UK Venture Capital Trust Scheme

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Abstract. This paper seeks to explore whether firms that have received VC investment are subject to the same recessionary pressures as other small firms, or if receipt of VC incurs resilience to macroeconomic turbulence. It examines the survival and exit patterns of UK venture capital investments during the Great Recession of 2008-9, and compares these patterns to the dot-com boom and bust of 1999-2001. Using a dataset of over 5000 investments made by UK Venture Capital Trusts (VCT) from 1995-2009, the paper uses using Cox survival models to examine the impact of macroeconomic turbulence on duration of investment. The paper finds that in contrast to high exit rates during the dot-com period, firms receiving VCT investment were significantly been less likely to exit by failure or other means during the recession of 2008-9.

Keywords: recessions, venture capital, survival, venture capital trusts, investment duration.

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1. Introduction

Recessions are periods of economic contraction that pose particular challenges to smaller firms. These firms are more vulnerable to failure during recessions, increasing the risk of further economic damage (Disney et al. 2003; Döpke, et al. 2005; Crawford et al 2013). At the same time small firms play an important role in job creation (Barnes & Haskel 2002; Neumark et al. 2011) and have been identified in business and policy circles as potential drivers of economic recovery and ongoing stable growth (see HM Treasury 2009; National Economic Council 2011; Cowling et al 2015). While small firms contribute to job creation overall, some small firms have the potential for rapid, disproportionate growth (Acs et al. 2008; Henrekson & Johansson 2009; Coad et al 2014). These high growth firms have been a topic of increasing interest in recent years (BERR 2008; Europe INNOVA 2010), with the development of rapidly growing firms perceived to be a means of generating growth in countries in recession and recovery.

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One characteristic associated with rapid firm growth is the presence or receipt of venture capital. Venture capital (VC) is an efficient means of delivering growth capital to firms and sectors that show considerable promise, while in the process generating sizeable returns for investors (Gompers & Lerner 2004; Engel 2002; Hellmann & Stiglitz 2000; De Clercq & Dimov 2004; Giot & Schwienbacher 2007; Puri & Zarutskie 2012). VC-backed firms are particularly interesting in that they have been identified as potential high-growth firms but may not yet have begun to achieve this rapid growth, but it is not clear in the literature how these firms fare in recessionary periods. This paper fills this gap by addressing how VC-backed firms respond to periods of macroeconomic turbulence. It does so using a unique dataset of firms receiving investment through the UK Venture Capital Trust scheme over a fifteen year period.

This paper makes two main contributions to knowledge about venture capital and survival during periods of recession. Its primary contribution is to explore whether small firms that receive VC are subject to the same rates of failure as seen by the broader population of firms that have not received similar investment. Given that firms receiving VC are selected for growth potential (Hege et al. 2003; Mason & Stark 2004; Diller & Kaserer 2009) it is important to understand whether the recession affects all firms or only those that perhaps otherwise might be at risk of failure.

A second contribution is to highlight the different impact of macroeconomic fluctuations on different parts of the economy. It has been widely documented that recessions have different characteristics (Geroski & Gregg 1997; Dow 2000) but the specific effects of different macroeconomic events on firms at the micro level has been an area for further exploration. This paper contrasts the response of VC-backed firms to the recent recession with their response to the dot-com bubble and bust of the late 1990s and early 2000s. The paper suggests that because recessions are not identical that the characteristics of firms disrupted by the recession will also be different, and that the crises of the dot-com bubble caused greater disruption to VC-backed firms than the more severe recession affecting the entire economy.

The second section of this paper discusses the theoretical context of the paper, specifically focusing on the impact of recessions on survival of small firms, and contrasting that with the literature on venture capital and factors in VC contributing to firm survival. The third section discusses the empirical context of the VCT scheme and dataset, and discusses the Cox partial likelihood survival technique used for the analysis. The fourth section presents the empirical results, and the final section concludes by discussing and summarising the findings of the paper.

2. The Impact of Recessions and Venture Capital on Firm Survival

Recessions are complex and unique macroeconomic events, but there are general trends that can be identified regarding their effects on firms in the economy. One frequent consequence of recessions is an increase in firm failure or liquidation. A number of studies (Higson et al. 2002, 2004; Disney et al. 2003; Döpke et al. 2005; Bhattacharjee et al. 2009) have found that firms are more likely to exit the marketplace in recessionary periods. Of the firms affected by recession, evidence suggests that small and medium-sized firms tend to have lower survival, (Storey & Wynarczyk 1996; Everett & Watson 1998; Disney et al. 2003; Buccellato & Scheffel 2011). Indeed, evidence on the 2008/9 recession by Frankish et al. (2010) found a rise in business closures in the period around the recession, though the level of closures is was not as high as that of the recession of the early 1990s.

While small firms face higher risks of mortality during recessions, it is difficult to clearly identify the firms that are most likely to be affected. Geroski & Gregg (1997, p.58) found it difficult to use individual variables to predict which firms in their sample would be particularly badly affected. However, while severity of the recession may not be easy to predict, there are some factors emerging from the firm survival literature (see Caves 1998 for an extensive review) which do appear to increase risk during recession. Young firms, which generally have higher rates of mortality (Phillips & Kirchhoff 1989; Storey & Wynarczyk 1996; Thornhill & Amit 2003; Saridakis et al. 2007), are particularly likely to fail in recessionary periods. In addition, given that recessions often negatively affect firms' ability to access finance (Gertler & Gilchrist 1991; Berger & Udell 2002) firms that are financially constrained may be more greatly affected (Guariglia 1999; Campello et al. 2010).

While the factors above appear to contribute negatively to firm survival, previous growth experience has been identified to positively impact firm survival. Firms that have been through rapid growth or are in the process of growing rapidly have been found by numerous studies to be resilient to recessionary pressures (Higson et al. 2004; Halabisky et al. 2006; Holzl & Huber 2009; Henrekson & Johansson 2009). One explanation for these results links the resilience of these high-growth firms during recessions to a Schumpeterian 'creative destruction' effect as inefficient, declining industries struggle and efficient firms in new, growing sectors flourish (Caballero & Hammour 1994, 1996; Aghion & Saint-Paul 1998; Davis et al. 1998; Holzl & Huber 2009). An alternate explanation seen in Thornhill & Amit (2003) would be that high-growth firms already have the resources and capabilities to grow and deal with rapid changes, while older and less efficient firms are less able to deal with the pressures brought on by the recession.

2.1. Venture Capital, Recessions and Firm Survival

In the context of recession, there is relatively little evidence on the survival and performance of firms that have received venture capital. Firms that have received VC are unusual cases for recessions in that they are often small, young firms that prior to investment were financially constrained (Bottazzi & Da Rin 2002; De Clercq and Dimov 2003; Schwienbacher 2005), and by receiving VC have been selected for their high growth potential. Consequently these firms show characteristics of several risk factors discussed above that increase probability of failure during recessions.

Yet by virtue of receiving VC these firms also demonstrate a number of characteristics that also increase their odds of survival. Firstly, firms that receive VC demonstrate considerable selection effects, having gone through a vigorous screening and selection process to verify the quality of the firm's managers, accounts and business model (Hege et al. 2003; Diller & Kaserer 2009; Kirsch et al. 2009). VC also means that firms have a range of advantages over their rivals that increase their chance of survival: it improves firms' access to capital[2] (Gompers & Lerner 2004); provides certification of a firm's quality (Hsu 2004), contribute to management talent via value addition (Steier & Greenwood 1995; Hellmann 1998); enhancing credibility and helping to access networks (Gorman & Sahlman 1989; Sorenson & Stuart 2001; Manigart et al. 2002). Each of these factors[3] increases a firm's general performance or probability of survival.

In addition to those factors, the discussion above highlights that high growth firms appear to be able to successfully weather recessions. This therefore poses an interesting challenge between two strands of literature. On one hand firms receiving VC have characteristics that should render them particularly vulnerable to recessionary pressures. At the same time these firms also have characteristics that tend to render them more resilient as well. Given the selection effects and perceived benefits of VC, we therefore hypothesise that:

H1: Failure rates for VC-backed firms during the recent recession will not be significantly greater than for those of the other years prior to the recession.

In discussing the literature on firms in recessions, it is easy to forget that recessions are not generic phenomena but instead unique events. For example, the recessions in the UK of 1979-1982, 1990-1992 and 2008-2009 each had different causes (though these causes themselves are often debated.) The 1979-1982 recession was at least partially caused by the OPEC oil crisis (Dow 2000);

2. Block & Sandner (2009) finds that mean size of funding rounds for US firms has decreased during the recent recession, and suggest that even the presence of VC may result in a funding gap for mature investments firms that are near to exit.
3. See Musso & Schiavo (2008); Carpenter & Petersen (2002) for access to capital; Delmar & Shane (2004) for certification; and Littunen (2000) for credibility and networks

the recession of the early 1990s was a result of the overextension of debt during the consumer boom of the 1980s (Shrieves & Dahl 1995); and the most recent recession was spurred by global credit crises stemming from the US property market (see Longstaff 2010 and Ivashina & Scharfstein 2010). Consequently it may be expected that the impacts on firms in different parts of the economy will also be unique.

In line with the discussion of VC in recessions above, we can also examine whether macroeconomic shocks have had different impacts on the survival of equity-backed firms. In this case we can compare the effects of mortality in the 2008-2009 recession with that of the dot-com boom and bust of 2000-2001[4]. While the general effect of recessions on VC-backed firms is not clear, the level of mortality for firms in the dot-com bubble is well documented (see Goldfarb et al. 2007; Wagner & Cockburn 2010; Grilli 2010). The dot-com bubble itself originated from a vast overestimation of the consumer expenditure, which resulted in highly overvalued IPOs and ultimately a shakeout in the market that disproportionately affected the types of firms likely to receive VC – that is, high-potential, technology based firms. In contrast, the Great Recession stemmed from macroeconomic credit shocks that reverberated through the economy and did not specifically impact the firms likely to receive VC; in fact Lee et al (2014) find that less innovative firms were more likely to be impacted by the cyclical effects of the recession. Both the recent recession and dot-com bust represented macroeconomic shocks, but we can hypothesise that the impact of the dot-com bubble, which specifically impacted high-tech firms and other firms likely to receive VC, was more significant in terms of mortality than the broader macroeconomic effects of the later recession:

H2: Survival rates for VC-backed firms during the dot-com bust of 2000-2001 will be lower than for the firms during the recession of 2007-2009.

2.2. Age and Syndication

In addition to the effects of the recession on exit patterns we can also explore the characteristics of VC-backed firms and VC investment patterns during recessions. One important variable is age. It is well documented that young firms are more likely to fail than older firms, both in and out of recession (Mata & Portugal 1994; Storey & Wynarczyk 1996; Disney et al. 2003); However there has been some evidence for recessions that challenges this widely-held view: (Boeri & Bellmann 1995; Ilmakunnas & Topi 1999) find that firms become more responsive to external shocks as they age. This finding has been explained by

4. While the dot-com bust ended in a short recession in the US (partially in conjunction with the aftermath of the events of 9/11), the UK suffered an economic slowdown but did not technically enter recession.

Thornhill & Amit (2003) by the suggestion that younger firms are more likely to fail because they lack relevant appropriate resources and capabilities, while older firms fail because they lack the innovativeness or ability to respond to macroeconomic turbulence. De Clercq and Dimov (2003) find that VCs typically tend to invest in younger firms. We may then investigate whether the age effects for young firms are outweighed by the funding and other value addition activities provided by venture capitalists:

H3: Firm age is negatively associated with mortality during the recession.

Distribution of ownership has also been indicated as a potential factor contributing to survival. In the context of recessions (Geroski & Gregg 1996) find that firms with more diffuse ownership structures were more vulnerable to recessionary pressures. They hypothesise that firms with more complicated ownership and governance may decrease firms' ability to deal with radical changes in their environment, while firms with concentrated ownership can address these changes more easily. However for VC-backed firms there is a considerable literature addressing syndication of VC investments, the process in which multiple equity investors join to invest in a given firm, and much of the literature finds a positive association between number of syndication partners and firm success (see Lockett & Wright 2001 and De Clercq & Dimov 2004). In light of this perceived tension, we examine the impact of diffuse equity investor structure on the dataset.

H4: Syndication is negatively associated with mortality during the recession.

2.3. Other Exits in Recessionary Periods

In addition to the question of survival, another relevant question to what happens to firms and investments that do not fail in the recession. Given that VCs are by definition seeking exit opportunities for their investments (Kaplan & Schoar 2005; Hochberg et al. 2007), it is unclear how markets for exit[5] have responded during the recent recession. The UK historically has had limited opportunities for exit via IPO, and traditionally the most profitable mode of exit has been trade sale or acquisition (Murray 1994, 1995; Lockett et al. 2002). The introduction of the Alternative Investment Market in 1995 was partially intended to provide a means

5. In recent years a growing literature has addressed the ambiguities in the use of terms such as 'survival' and 'failure' (Carter & Auken 2006; Wennberg et al. 2010; Balcaen et al. 2011). These terms may be challenging to use because firms may exit the market for any number of reasons beyond liquidation (for instance acquisition or positive winding up of the company). For the purposes of this study failure refers specifically to liquidation or bankruptcy, while 'exit' is used in the sense in which it is used in the venture capital literature, for the end of an investment in a firm.

for exit, but it has typically resulted fundraising from AIM serving as an additional funding round rather than a means of generating disproportionate returns (Khurshed et al. 2005; Revest & Sapio 2011). If the already limited means to exit disappear during times of recession, firms may need to demonstrate what Geroski & Gregg (1997, p.58) term a 'pit stop' effect, in which firms bide their time in recession, waiting and configuring their resources for growth once the recession ends. This concept may be extended to VC-backed firms by hypothesising that in recession VC-backed firms may be forced to avoid plans for exit and instead wait for recovery before seeking exit:

H5: Non-failure investment exits such as trade sales and market sales will be less common during the recession.

3. Empirical Methods

3.1. The Venture Capital Trust Scheme

This paper focuses on data drawn from the Venture Capital Trust (VCT) scheme. This programme has been the largest single public early-stage equity investment intervention in the EU, having raised over £3 billion since its creation in 1995. As such it represents an under-examined but crucial element to the UK's small firm finance environment. VCTs are independent, London Stock Exchange-listed companies that are created by and carry the branding of the fund managers that operate them (see Cumming 2003 for a more detailed discussion of their structure). They are funded not by institutional investors but by individual consumer investors, who are able to claim back 20-40% of the value of their investment in VCTs against other tax burdens.

The trusts are managed by professional fund managers, under the supervision of independent boards of directors. Many VCT fund managers also run traditional venture capital or other small cap funds, often pooling money between different funds to make investments. The scope and scale of investments that can be made by the trusts are limited in terms of maximum size of investment (£1m); maximum size of firms receiving funding (£15m in gross assets, though this has changed over time); and sector (investments in asset-backed sectors such as agriculture and nursing homes are prohibited). Investments must be in firms that are unquoted or listed on the Alternative Investment Market, and must be held for a fixed period following the investment in order to qualify.

The details of the scheme's rules have changed numerous times since the scheme's creation. This emphasises a tension originally discussed by Cumming (2003), who identifies inefficiencies in the statutory approach to contracting in the VCT scheme as compared to the limited partnerships and covenants in the

private VC sector in the US and elsewhere. Evaluations of the scheme have been mixed: Boyns et al. (2003) identify a number of benefits to firms and broader investing capacity. Cowling et al. (2008) find that VCT-backed firms tend to under-perform against a matched-pair sample, but find an overall net economic benefit from the scheme.

3.2. Data

The data used in this paper is drawn from a unique dataset of all VCT investments. All VCTs must be listed on the London Stock Exchange as a condition for their tax accreditation, which makes them subject to disclosure rules of public companies. The dataset therefore provides a unique perspective of a complete sample of exits for equity investments across a broad sample of equity backed firms in the UK economy.

The data were hand collected from approximately 1800 documents representing over 161 VCTs (including some that were proposed but never fully launched). The dataset provides investment-level data on 5128 investments in 1832 unique firms, worth a total of approximately £2.5 billion. The investments were made from late 1995 (when the first VCTs were launched) to the end of 2009. Of these investments, 1514 had been exited as of the end of the 2009 financial year.

3.3. Variables

The variables used in this study are summarised in Table 1. The key dependent variable is the duration of the investment. The survival time was calculated for all investments in the sample that had reached exit. The duration of survival (*duration*) is calculated in months, with the month of the initial investment set at 0 and the value of the variable being equal to the number of months since investment. The survival time is censored to the right as of April 2010, the final point of data collection.

Table 1 – Descriptions of variables

duration	Duration of investment, in months
writeoff	Equals 1 if the firm receiving the investment was liquidated or went bankrupt prior to making any returns
trade_sale	Equals 1 if the investment was exited via the acquisition of the firm by another company or management group
market_sale	Equals 1 if the investment was exited via a sale of shares on AIM or the LSE
logMSCI	Log of the MSCI Index for the UK for the year of investment
dotcom	Equals 1 if investment was exited in the dot-com bust of 2000 and 2001
recession	Equals 1 if the investment was exited from 2007-2009
init_invest	Value of the initial investment made by the VCT in the firm
exit_net	Total net value of exit
firm_age	Age of the firm, in months (to correspond to *duration*)
syndication	Number of VCTs investing in a firm
earlystage_inv	Equals 1 if the firm did not have its main product on the market at time of investment and were using their investment to further develop and invest in a new product
expansion_inv	Equals 1 if the firm already had products on the market and were using the investments to fund further growth.
aim_inv	Equals 1 if the an investments was part of a share offering on the AIM market
mbo_inv	Equals 1 if the firm received its initial investment in support of a management buy-out
health	Equals 1 if the firm was in a medical or health-related sector
software	Equals 1 if the firm was in a software or IT-services related sector
hardware	Equals 1 if the firm was in a technology related sector
media	Equals 1 if the firm was in a media-related sector
services	Equals 1 if the firm was in a services or support-related sector
industrial	Equals 1 if the firm was operating in non-technology intensive manufacturing or heavy industry

The other key variable for this analysis is the type of exit. For this analysis these were categorised as write-offs, trade sales, and market sales. Write-offs (*writeoff*) were cases where the investment was written off once a firm had been liquidated or gone bankrupt. Trade sales (*trade_sale*) refer to exit via acquisition of the firm by another business. Market sales (*market_sale*) refer to exits via either the Alternative Investment Market (AIM) or (much less frequently) the London Stock Exchange[6].

To consider the impact of the overall macroeconomy we use three variables: to index the national economic situation we use the log of the UK Morgan Stanley Capital Index (MSCI), *logMSCI,* , which serves as a standardised proxy for national economic performance (see Cumming 2007). We also create dummy variables for exits during the two macroeconomic phenomena in the time period covered: the dot-com boom of 1999-2000 (*dotcom*) and the recession of 2007-2009 (*recession*). Other variables for analysing the hypotheses include the age of the firm at time of investment (*firm_age*) and syndication (*syndication*),

6. The dataset there are only 16 investments in 8 firms that ultimately allowed an exit on the London Stock Exchange. This is too small a sample size to be examined on its own so these have been considered in the context of other market exits.

calculated as number of VCT funds investing in a given firm. A number of control variables were used as well. These included the size of the initial investment (*init_invest*) and net value of the exit from the investment, where applicable (*exit_net*). Dummies were used to control for the type of initial investments made in the firms. These dummies included early stage investments in firms with no product yet on the market (*earlystage_inv*); investments in firms with a product already on the market (*expansion_inv*); investments in firms listed on the AIM market (*aim_inv*); and investments initially made in a management buy out or similar deal (*mbo_inv*). Finally a number of sectoral dummies[7] were used, capturing investments in firms focusing on health and biotechnology (*health*), software and computer systems (*software*); technology and hardware (*hardware*), media (*media*), services including firm support and retail (*services*) and manufacturing and heavy industry (*industrial*).

Following from the hypotheses Table 2 lists the hypothesised signs for each of the standard variables.

Table 2: Main variables with hypothesised signs

	Expected sign	Expected sign for trade_sale and market_sale
recession (H1)	-	-
dotcom (H2)	+	+
logMSCI	-	+
firm_age (H3)	-	+
syndication (H4)	-	+
init_invest	-	+
exit_net	?	?

3.4. Quantitative Method

The empirical analysis uses survival methods (Kiefer 1988) for tracking the duration of the investments. The main benefit of survival analysis is that it allows us to consider not just if firms will fail (as could be considered with logistic models and discriminant analysis) but also when the firm fails. This means that an investment that is exited after six months is able to be considered differently from one that is exited after five years (Jain & Kini 2000). In this way survival

7. These dummies were captured from hand-coded data based on the Industry Classification Benchmark (ICB) sectoral classification system, which allows for some of the software/ hardware distinctions seen in the categories. Full details of sectoral breakdowns are available from the author upon request.

analysis allows us to examine the conditional probability of failure, assuming that the firm has survived to the present. This is useful because it means that we can then examine right-censored data (where the event hasn't happened yet) as well as time-series data with different time horizons.

This approach is particularly helpful for the case of equity investments used here. Because our dataset represents investments over a fifteen-year period, most investments have not yet exited but each represents a slightly different timeframe. For instance there are different investment profiles for: an investment made in 1996 and exited by trade sale in 2001; an investment made in 2000 and exited by liquidation in 2008; and an investment made in 2005 that had not been exited as of 2010. This technique allows us to directly compare these investments and to examine the impact of the recessions on the firms allowing for these differences in time.

For the analysis I compute non-parametric estimates of survival and hazard probabilities, which allows me to compare the duration and risk profiles of firms undergoing different types of exits. The survival probability describes the proportion of firms receiving VCT investment that are not exited in each successive time period. It provides the likelihood that a randomly selected firm will fail, or else be exited, beyond a certain time period.

For this paper the Cox hazard model is used to identify variables that influence the likelihood that a firm receiving investment will exit profitably or fail. Let *T* be a random variable that describes the instant when the exit occurs. The hazard function *h(t)* is the conditional failure rate defined as the probability of failure during a very small time interval assuming the firm has survived to the starting point of that interval. The hazard function can also be defined in terms of the probability density function and the cumulative distribution function. The hazard function is:

$$[1] h(t; X) = f(t; X)/(1 - F(t; X))$$

where in the context of this examination $F(t; X)$ is the probability that the investment with characteristics X will have been exited before time t and $f(t;X)$ is the probability density function. There are several forms of hazard models that differ in their assumptions regarding the relationship between the hazard rate and the covariates. The general form of the hazard model is:

$$[2] h(t; X) = h0(t)\exp(X\beta)$$

Where $ho(t)$ is the baseline hazard function and ß the vector of model parameters. Different hazard models generate hazard functions with varying shapes (Kalbfleisch & Prentice 2002). For the purposes of this analysis we use the accelerated failure time (AFT) model (Hensler et al. 1997). This model is useful in that the impact of changes in independent variables (such as the

macroeconomy) can differ according to the length of the holding of the investment.

The log-logistic baseline hazard model is selected since the distribution of exits is likely to be non-monotonic. The dependent variable is the number of months that the VCT holds the investment from the month of initial investment to the month of divestment. Model parameters are estimated using the maximum likelihood method. Positive coefficients indicate factors that increase the duration of holding, and therefore decrease the probability of exit, whether by failure or by generation of positive returns.

4. Empirical Results

4.1. Summary Statistics

Our examination of dynamics of the VCT sector begins by examining the general characteristics of the exits made by VCTs. Table 3 presents the distribution of variables across the dataset. The means of binary variables represent the percentage that are coded for '1'. These results show that the mean duration of an investment is approximately 40 months, or approximately 3.5 years before exit. AIM investments make up the largest share of investments overall, although exits via AIM make up a considerably smaller proportion.

Table 3 – Descriptive Statistics

Variable	**Obs**	**Mean**	**Std. Dev.**
duration	1506	40.246	24.448
writeoff	5132	0.082	0.275
tradesale	5132	0.113	0.317
marketsale	5132	0.119	0.324
logMSCI	5132	7.349	0.159
recession	5132	0.090	0.422
dotcom	5132	0.013	0.115
firm_age	4166	69.710	282.178
syndication	5128	5.834	4.793
init_invest	5128	402,982	383907.1
exit_net	1370	108,274	838598.4
earlystage_inv	5132	0.137	0.344
expansion_inv	5132	0.206	0.404
aiminv	5132	0.504	0.500
mbo	5132	0.086	0.280
health	5132	0.102	0.303
software	5132	0.127	0.333
hardware	5132	0.068	0.252
media	5132	0.068	0.252
support	5132	0.294	0.456
industrial	5132	0.163	0.367

Table 3 also shows the proportion of the investments seen in the dataset. For instance we see that the mean duration for the length of an investment is approximately 40 months. The mean age of a firm at the receipt of investment is approximately 70 months, or nearly 6 years. The summary statistics show that there are comparatively a smaller number of failures than either of the other two types of exit, which would not otherwise be expected. We also see that while AIM investments make up the largest share of investments, exits via the secondary markets make up a considerably smaller share of exits.

Table 4 – Type of Exit by Year

Year	Market Sale	Trade Sale	Writeoff	Total
1997	2	0	1	3
1998	4	6	5	15
1999	5	13	7	25
2000	26	9	7	42
2001	20	25	38	83
2002	24	15	64	103
2003	25	32	62	119
2004	77	57	51	185
2005	91	64	40	195
2006	119	63	19	201
2007	99	70	13	182
2008	40	90	23	153
2009	42	47	52	141
2010	12	30	10	62
Total	586	521	392	1,499

Note: 2010 figures include exits to 30 April 2010.

From this we can explore H1 and H2 by examining annual trends in exit, as shown in Table 4. From this we can see that there was a sharp increase in write-offs in 2009, and at the same time a decrease in trade sales in the same year, while market sales remained constant. We can also see the overall numbers of exits were not large during the dot-com boom, and the figures for failures and other exits increased during the growth period of the mid 2000s.

4.2. Analysis of Hazard Curves

Before we begin the survival analysis it is useful to compare the hazard functions for the three different forms of exit. Figures 1-3 show these hazard curves. Figure 1 shows the hazard curve for write-off exits, which grows gradually over the duration of the investment. Figure 2 shows the curve for trade sale exits, which grows steeply and then remains at a high level from approximately 75 months. The curve in Figure 3 shows the market sale result, which is much gentler and peaks at approximately 50 months. These show that the pathways to exit are clearly distinct, validating the separate calculation of the survival analysis and indicating the potential for disruption to each curve in the context of macroeconomic fluctuations.

Figure 1 – Hazard curve for Write-off exits

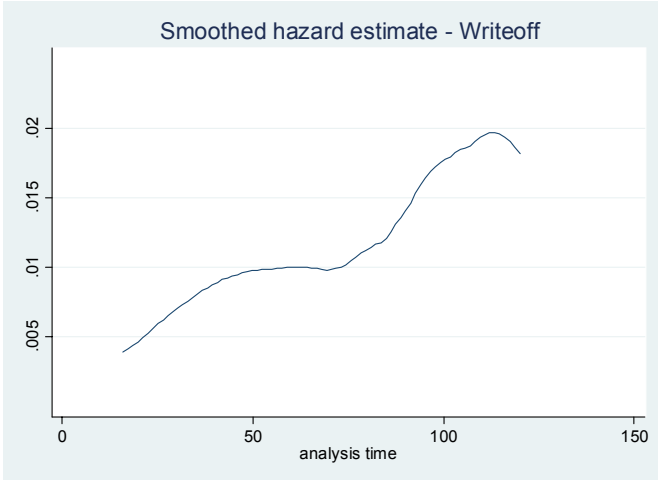


Figure 2 - Hazard curve for Trade Sale exits

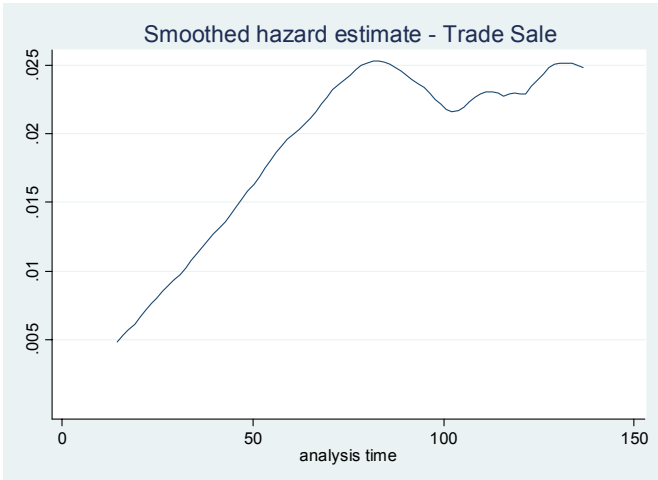
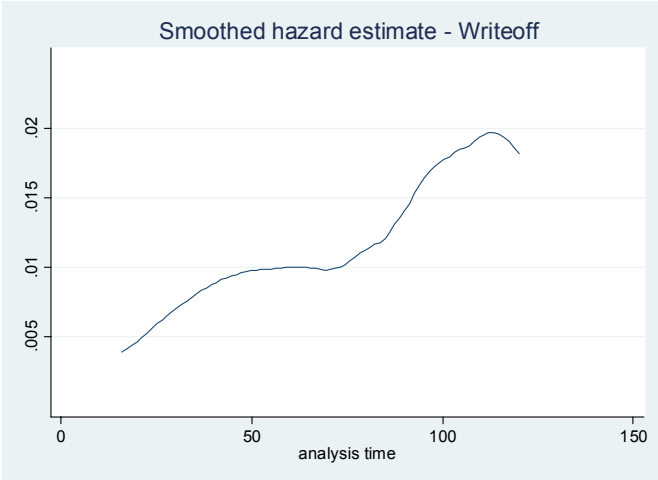


Figure 3 – Hazard curve for Market Sale exits



4.3. Estimation of Cox Hazard Models

Table 5 shows the results of a Cox survival model for investments ending in write-off, with the investment duration as the dependent variable. The failure rate includes 322 cases in which an investment was liquidated. The table shows four equations. On the left hand side of the table is the equation that only has the standard investment variables *firm_age*, *syndication*, *init_invest*, *exit_net*, *logMSCI* and dummies for *dotcom* and *recession*. The second equation includes these variables and dummy variables for sector. The third equation includes the standard investment variables and dummy variables controlling for type of investment. The right-hand equation includes the main set of variables and all control variables.

Table 5 – Analysis of risk of exiting VCT investment via write-off

	Hazard ratio	p-value					
Model	1		2		3		4	
firm_age	0.002**	0.037	0.002***	0.005	0.002**	0.015	0.002**	0.037
syndication	-0.037*	0.083	-0.044**	0.031	-0.025	0.229	-0.037*	0.083
recession	-0.681***	0.000	-0.748***	0.000	-0.726***	0.000	-0.782***	0.000
dotcom	1.149***	0.000	1.185***	0.000	1.317***	0.000	1.261***	0.000
logMSCI	-2.301***	0.000	-2.423***	0.000	-2.570***	0.000	-2.646***	0.000
init_invest	-0.472***	0.000	-0.551***	0.000	-0.550***	0.000	-0.603***	0.000
exit_net	0.000***	0.000	0.000***	0.000	-0.000***	0.000	-0.000	0.000
health			-0.749***	0.005			-0.924***	0.001
software			0.356*	0.051			-0.002	0.992
hardware			0.167	0.412			-0.153	0.470
media			0.473**	0.02			0.223	0.293
support			-0.063	0.702			-0.180	0.293
earlystage_inv					1.128***	0.008	1.179***	0.007
expanion_inv					0.920**	0.033	0.883**	0.042
aiminv					0.360	0.431	0.542	0.209
mbo					0.352	0.399	0.285	0.527
N events	322		322		322		322	
Log-likelihood	-1765.825		-1751.389		-1746.612		-1736.491	
chi-squared	0.000		0.000		0.000		0.000	

Note: * significant at 10% level; ** significant at 5% level; *** significant at 1% level

Each of equations in Table 5 is significant. In all of them *recession* is strongly negative and *dotcom* is highly positive, as hypothesised. These findings support H1 and H2, respectively. *firm_age* is significant but very weakly positive, which does not clearly support the hypothesis that younger firms are more likely to fail in H3. *syndication* gives ambiguous results depending on the model, making it difficult to draw any clear conclusion other than that it did not obviously support H4. logMSCI is strongly and significantly negative, indicating that liquidations will increase when the economy declines. Size of initial investment is negatively associated with likelihood of failure, confirming our expected sign indicated in Table 2.

The inclusion of control variables generates some other interesting results. Only firms in the healthcare sector are less likely to fail, which is somewhat surprising as biotechnology firms (which are included in this grouping) are widely understood to be more risky. Examining investment type shows that early stage and expansion stage investments face higher mortality risks.

Tables 6 and 7 presents the results for the same models as Table 5, but instead examine the other means to exit, trade sales and market sales. Table 6 examines

risk of exit for market sales (those sales made via AIM or the London Stock Exchange), and the models are significant. The results indicate fewer exits during the recent recession and more during the dot-com period, as hypothesised in Table 2. *syndication* is positive and significant for this case, which is likely due to the subscription nature of share offerings, where more than one investor buys shares. There are no consistent results for the sector controls. There are significant results for investment type, though these results likely simply reflect the higher proportion of AIM investments, which may then exited on the same market. Size of initial investment is negatively associated with market exit, which indicates that investments in AIM-listed firms tend to be smaller (again because of the subscription process, which means larger investments are less likely).

Table 6 – Analysis of risk of exiting VCT investment via market sale

	Hazard ratio	p-value					
Model	1		2		3		4	
firm_age	0.001	0.102	0.001*	0.077	0.000	0.728	0.000	0.793
syndication	0.121***	0.000	0.123***	0.000	0.075***	0.000	0.08***	0.000
recession	-1.472***	0.000	-1.469***	0.000	-1.196***	0.000	-1.196***	0.000
dotcom	0.731***	0.000	0.783***	0.000	0.518***	0.004	0.564***	0.002
logMSCI	-0.074	0.832	-0.042	0.904	-0.05	0.886	-0.021	0.953
init_invest	-0.553***	0.000	-0.547***	0.000	-0.409***	0.000	-0.4***	0.000
exit_net	0.000***	0.868	0.000***	0.901	0.000**	0.028	0.000**	0.021
health			0.415**	0.014			0.210	0.223
software			0.000	0.999			-0.096	0.602
hardware			0.347	0.114			0.38*	0.093
media			0.248	0.226			0.094	0.646
support			0.278*	0.052			-0.01	0.945
earlystage_inv					-0.692*	0.061	-0.778**	0.038
expansion_inv					-0.898**	0.018	-0.919**	0.016
aiminv					0.953***	0.001	0.921***	0.002
mbo					-1.087**	0.015	-1.101**	0.015
N events	410		410		410		410	
Log-likelihood	-2396.7277		-2391.8172		-2318.207		-2315.125	
chi-squared	0.000		0.000		0.000		0.000	

Note: * significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table 7 – Analysis of risk of exiting VCT investment via trade sale

	Hazard ratio	p-value					
Model	1		2		3		4	
firm_age	0.002***	0.002	0.002***	0.001	0.002***	0.000	0.003***	0.000
syndication	-0.016	0.326	-0.017	0.309	0.022	0.202	0.026	0.125
recession	-0.556***	0.001	-0.507***	0.004	-0.645***	0.000	-0.575***	0.002
dotcom	0.676***	0.000	0.695***	0.000	0.743***	0.000	0.814***	0.000
logMSCI	0.167	0.653	0.157	0.678	0.366	0.330	0.191	0.619
init_invest	0.177**	0.019	0.169**	0.024	0.029	0.691	0.016	0.823
exit_net	0.000***	0.000	0.000***	0.000	0.000***	0.000	0.000***	0.000
health			-0.228	0.297			0.057	0.807
software			-0.117	0.529			0.12	0.556
hardware			-1.075***	0.001			-0.851**	0.010
media			-0.319	0.180			-0.329	0.186
support			-0.023	0.869			0.211	0.169
earlystage_inv					-0.535**	0.035	-0.322	0.227
expansion_inv					-0.078	0.743	0.04	0.869
aiminv					-0.936***	0.000	-0.890***	0.001
mbo					0.092	0.701	0.255	0.309
N events	332		332		332		332	
Log-likelihood	-1892.1606		-1883.3708		-1872.405		-1863.609	
chi-squared	0.000		0.000		0.000		0.000	

Note: * significant at 10% level; ** significant at 5% level; *** significant at 1% level

The results in Table 7 show the likelihood of exits for trade sales or acquisitions. The same trends for the *recession* and *dotcom* periods are present here as with the market exits, supporting H5. There is an interesting and rather unexpected significant, slightly positive effect for firm age. There are strong negative results for technology or hardware firms, as well as negative results for AIM investments (which serves as the opposite to the effect seen above for market sales in that AIM investments often have a means of exit and may not seek trade sales).

5. Conclusion

This paper has examined the performance of UK equity-backed firms during the recent recession and the dot-com boom and bust. It has addressed the question of whether firms that have received VC or similar equity investment follow the trends of other small firms during recessions, or whether they are less likely to be

affected by recession because they have characteristics of VC-backed firms that typically improve survival.

The key conclusions of this paper are that VC-backed firms did not show increased risk of failure during the recent recession but in fact showed were less likely to exit in this period. This suggests that the survival and benefits associated with receiving VC funding outweigh the systemic risks of facing all small, young firms during recessionary times. Indeed, the risk of failure for VC-backed firms was higher during dot-com bubble, which was economically much less severe than the recession of 2008/9. The considerably higher risk of failure for VC-backed firms during the dot-com bust (which was much less severe for the macroeconomy) supports the notion that the affected elements of the economy vary greatly between recessions or other economic disruptions. The examination of non-failure exits suggests that all exit types appear to share common patterns during these macroeconomic disruptions. This implies that the impact of broader macroeconomic trends may have broader impact on the operations and prospects for these firms than the measures used here have been able to observe.

The paper also examines the effects of firm age and investment syndication on survival and exit rates. It finds ambiguous results for the impact of age on survival and exits. Older firms were found to have higher risks of both failure and of exit via trade sale. However the small effect size suggests that age may not be as important of a factor for VC-backed firms compared to the broader population that has not already been through the selection process that VC-backed firms have experienced. The paper also finds that distribution of ownership or syndication does not appear to have a significant impact on failure rates. It does show a positive impact on market exits, though this result may be explained by factors specific to investments on the AIM market.

This paper makes contributions to our understanding of the relationship between venture-capital backed firms and the broader macroeconomy. The findings have several implications: they illustrate the unique characteristics of VC-backed firms, but it remains unclear whether the resilience during recessions seen here was already present in the firms when they received investment, or whether there was a value-addition effect. These findings suggest interesting avenues for research on how the macroeconomy impacts VC-backed firms and other high-growth firms, and how these firms use periods of recession as to prepare themselves for growth after periods of macroeconomic turbulence have ended.

This paper does have a number of limitations and drawbacks. While it measures firms' resilience there are a number of other factors that could potentially explain this, including selection effects, managerial skill, and value-added support from VCs to overcome the financial crises. Our inability to capture these factors and others in our data means that our ability to directly explain these are limited. Another limitation is the use of VCT data – whilst, as we argue, VCT is a useful proxy for VC investment, it remains a distinct subset of the broader

sector. Consequently there is scope for further work in this area to better understand how growing firms deal with broad macroeconomic fluctuations.

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