Resources and Signalling to attract Venture Capital:

University Spin-Outs in the UK

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Abstract

This study explores why some university spin-outs (USOs) are able to attract first venture capital (VC) investment. Furthermore, factors including first VC investment are associated with USO's superior firm performance. The resource-based view (RBV) of the firm is replicated and extended with signalling theory. VC firms (supply-side) seeking to reduce uncertainty and information asymmetry problems request positive 'signals' from entrepreneurs and firms (demand-side). Entrepreneurs can provide such 'signals of quality' relating to their own as well as their firms' resources. Hypotheses were derived accordingly.

This is the first nationwide study using cross-sectional data from British USOs on a firm and founder level related to attracting first VC investment and firm performance. A population of 505 British USOs founded between 1990 and 2007 that were still active in 2008 was identified. Founders of 125 USOs participated in an online survey (25% response rate). No response biases were detected. Secondary data sources provided information on financing and performance. Hypotheses were tested with regression techniques.

Key findings on the attraction of first VC investment support the joint framework of the RBV of the firm and signalling theory. The most prominent signals of quality were experienced and reputable founding teams (specific human capital), network links to VC investors (networks), firm-owned IP, patented IP (intellectual capital) and founders who were professor (general human capital). USOs with public backed equity (finance) avoided an 'equity gap' when seeking less than £500,000 of VC. USOs with radical innovation (intellectual capital) were less likely to attract generalist VC firms.

Key findings on factors related to superior firm performance suggest the importance of USO's internal resources as implied by the RBV of the firm. Strategic alliances (networks) and USOs with VC investment reported superior firm performance. However, generalist VC firms performed better than industry specialists. VC investment reduced the direct influence of experienced and reputable founding teams (specific human capital) and founders who were professors (general human capital) related to firm performance. Former important signals to attract first VC investment such as patented IP, firm-owned IP (intellectual capital) and public backed equity investments (finance) were not related to firm performance.

Best practices and recommendations on how USOs can overcome barriers to attracting first VC investment and achieve superior firm performance are made for several practitioner groups. Limitations and areas of future research are discussed.

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List of Abbreviations

BVCA	British venture capital and private equity association
IP	Intellectual property
IPO	Initial public offering
M&A	Merger and acquisition
RBV	Resource-based view
TTO	Technology transfer office
USO	University spin-out
VC	Venture capital

Statement of Copyright

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In loving memory of Gisela Schmitz, née Frey

Chapter 1: Introduction

1.1 Introduction

Economies with small reserves of natural resources or shrinking industrial manufacturing sectors are highly dependent on knowledge-based business opportunities in order to generate growth, employment and wealth (Stam and Garnsey, 2006). Several issues are at the centre of an ongoing debate about building knowledge-based economies. Education and academic research are regarded as crucial sources of new knowledge, technologies and innovation (Foray, 2004). Entrepreneurship is considered an effective vehicle to commercialize knowledge in order to bring it to the market place (Audretsch and Thurik, 2001). Further, external financing and business expertise from private venture capital (VC) investors are commonly regarded as valuable resources and crucial drivers of entrepreneurship in growing new knowledge-based and innovative businesses (Gompers and Lerner, 2006).

This study contributes to the general debate about building knowledge-based economies by exploring VC financing and the performance of university spin-outs (USOs) and their founding academic entrepreneurs (Lockett *et al*., 2003; Wright *et al*., 2006). USOs can be defined as firms which are founded in order to exploit the business opportunities to be gained by commercializing the intellectual property (IP) of academic research (Shane, 2004a). Most USOs are active in sectors related to technology transfer from natural science research in biology, chemistry, engineering and computer sciences (Steffensen *et al*., 2000; Mowery and Shane, 2002). USOs are originally owned by their founding academic entrepreneurs and their university of origin (Nicolaou and Birley, 2003a; Lockett *et al*., 2005).

The formation of USOs has been strongly encouraged by public policy makers in the UK since the late 1990s in order to develop a knowledge- and innovation-driven economy which grows and increases employment. British universities aim to generate revenue streams by having ownership in their spin-outs (Lockett and Wright, 2005). However, there is evidence that the development and performance of USOs in the UK depend on the availability of financing and business expertise (Lockett *et al*., 2002; Wright *et al*., 2006). Two specific debates on the barriers that constrain access to these resources, as well as their influence on USO development and performance, are the subject of this thesis.

The first debate relates to what factors influence USOs' ability to attract first external investments in the form of VC which can provide finance as well as business expertise. This debate is subject to identify factors which can explain the co-ordination between the demand and supply of VC investment, despite risks resulting from uncertainty and asymmetric information when valuating new firms (Stiglitz, 1985; Sanders and Boivie, 2004). The second debate relates to what factors, including the ability to attract first VC investment, lead to superior firm performance of USOs.

Section 1.2 discusses both debates within the context of USOs in the UK. It illustrates the specific research setting of this study which explores USO formation and development in the UK between 1990 and 2008. Thereafter, Section 1.3 discusses gaps in the knowledge base related to academic studies on both debates. Section 1.4 introduces the focus, purpose and contribution of this study to both debates. Finally, Section 1.5 provides an overview of the forthcoming chapters.

1.2 Context for USO Development and Financing in the UK

1.2.1 USO Formation in the UK

Figure 1 shows the formation of USOs in the UK between 1980 and 2007[1]. Their rapid rise in the middle of the 1990s relates to a combination of the new economy boom and increasing political support. USOs were particularly encouraged by the British government's introduction of the white paper 'Our Competitive Future' in 1998. It aimed to duplicate the successful American model of entrepreneurially active researchers with a supportive legal infrastructure assigning IP rights from publically funded research to university and researchers (DTI, 1999; Birchall, 2007)[2]. This initiative sought to transfer the excellence of research at British universities into the commercial domain in order to grow a successful innovation driven knowledge-based economy (Sainsbury, 2007).

[1] The data for this figure has been obtained from the venture capital data base Library House in 2007. Public sources lack systematic data on the USO population in the UK (see e.g. DTI, 1999; Lambert, 2003). UNICO representing all Technology Transfer Offices (TTOs) in the UK was contacted for this research but was unable to provide more accurate data. Library House's data can also be regarded as a representative source as it was recently used and acknowledged in the public policy Sainsbury Review (2007) on USO activities in the UK.

[2] Introduced by the Bay-Dole Act in the US in 1980 (Shane, 2004a,b).

Figure 1: USO Formations in the UK between 1980 and 2007 (Source: Library House, 2007)

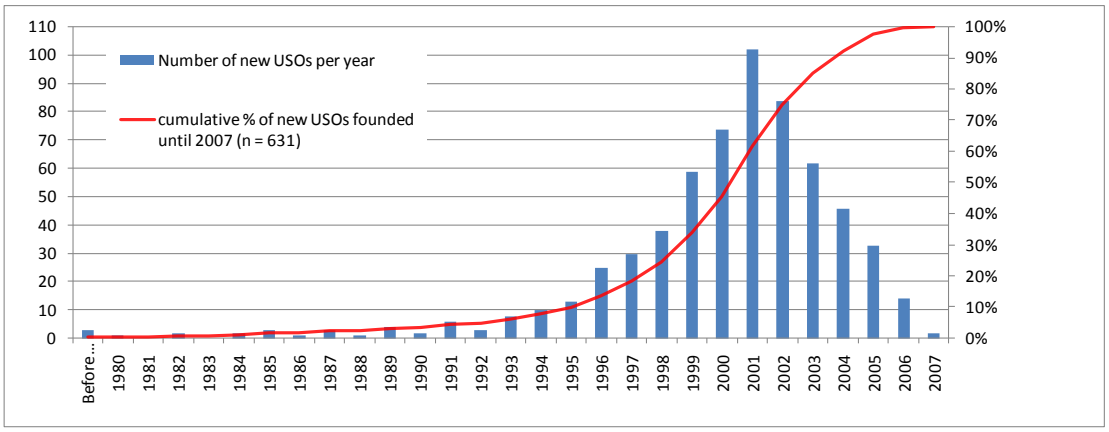
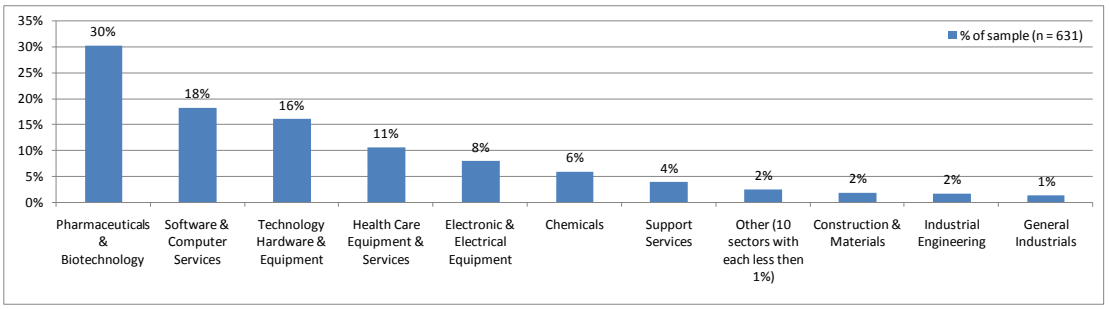


Figure 2 shows that most USOs are active in high-technology sectors, indicating commercialization of research in the natural sciences which are at the heart of a knowledge-based economy (Stam and Garnsey, 2006, 2007).

Figure 2: Sectors and Industries of USOs in the UK until 2007 (Source: Library House, 2007)



Universities see USOs as an additional source of income from commercializing their IP. Traditionally, universities have relied more on licensing their IP to generate these returns (Bray and Lee, 2000; Shane, 2004b). However, markets for selling novel and innovative IP are often imperfect due to technological uncertainties and difficulties in assessing the commercial value (Arrow, 1962). As a consequence, universities cannot always expect to receive an attractive market price when selling licences to established companies. By contrast, USOs aim to bring the IP directly to the market in the form of products and services. The success of this approach depends on the development and performance of USOs.

A change in the legal framework is a necessary requirement for USOs to emerge and develop. Research into the developmental stages of USOs shows that the availability of, and

access to resources of finance and business expertise, are of great importance in their development and growth (Ndonzuau *et al*., 2002; Vohora *et al*., 2004). These resource needs are typical for all new firms. Failure to attract them can lead to inferior levels of performance (Lockett and Wright, 2005; Gompers and Lerner, 2006).

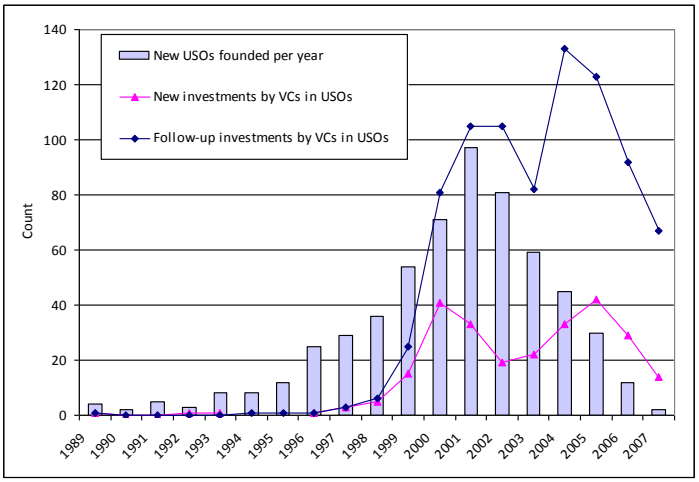
The two major public stakeholders in USOs, government and universities, recognise and address this (Acworth, 2008). First, full-time academics need guidance throughout the commercialization process, especially in relation to business, entrepreneurial and legal expertise. Consequently, a nationwide scheme to establish Technology Transfer Offices (TTOs) launched across universities in the UK. By 2003, 125 British universities which generated revenues from IP had TTOs. These TTOs are organized in nationwide associations such as UNICO and AURIL (Wright *et al*., 2006). Second, the financing of new ventures based on academic research was a key issue from the beginning. The year 1998 saw the launch of the University Challenge Seed Fund to facilitate the creation and development of new spin-outs (Abreu *et al*., 2008).

Although both measures by public stakeholders in combination with the new economy boom of the late 1990s increased the quantity of spin-outs until 2001, criticism about the quality of spin-outs emerged. Two public policy reviews (Lambert, 2003; Sainsbury, 2007) questioned the quality rather than the quantity of USOs. This was based on the fact that there was a lack of commercial success stories (Library_House, 2007). They attributed this failure to missing links between USOs and the private sector needed to develop a stronger commercial orientation and performance. The Lambert Review (2003) especially saw VC investors as the solution to creating more commercially successful USOs. The financing of the development and performance of USOs is discussed in the following sections with a special focus on the VC market in the UK.

1.2.2 Barriers to USO Development and Performance: Financing

Figure 3 shows that VC involvement in first and follow-up investment rounds was prominent until about 2006, given the total formation of USOs between 1980 and 2007. The importance of VC financing is now analysed by comparing the characteristics of two major types of financing available to USOs in the UK.

Figure 3: USO Formation and Venture Capital Investment between 1989 and 2007 (Source: Library House, 2007; n = 599)



Financial resources are generally regarded as crucial for new firms such as USOs to develop (Westhead and Storey, 1997; Astebro and Bernhardt, 2003). However, their availability for USOs depends highly on the type of finance. If academic entrepreneurs have insufficient internal finance for their USOs, they have the choice between two major forms of external finance. These are summarised in Table 1.

Table 1: Types of External Finance (Based on Berger and Udell, 1998)

	Debt Finance	**Equity Finance**
Selected providers:	Banks	Business angels, Venture Capital
Costs of obtaining external finance:	Interest rate	Ownership share of equity in entrepreneur's firm
Securities, guarantees:	Collateral Diligence of credit record	Due diligence based on investors' specific investment criteria
General time of investment:	Later stage	Early stage depends highly on specialisation of provider)
Event of business success:	Full repayment of interest rates Entrepreneur receive all residual cash-flows	Entrepreneur and investors share residual cash-flows accordingly
Event of business failure:	Bank looses interest payment Entrepreneur looses collateral	Entrepreneur and investors share losses accordingly
General risk profile:	Low risk capital	High risk capital

Debt finance is borrowed capital that is typically provided by banks in the form of credit and loans. In return for borrowing capital, entrepreneurs have to agree with the bank on a repayment schedule at an interest rate. Banks require collateral, such as property owned by the entrepreneur, as a guarantee in case the entrepreneur defaults the repayment schedule. If the entrepreneur defaults, as in the case of a bankruptcy, the collateral is transferred to the bank (Dollinger, 2003). The level of the interest rates and the collateral required by the bank are subject to a risk assessment. Because new firms, especially in high technology sectors, usually have a high likelihood of failure (Freeman *et al*., 1983; Audretsch, 1991) academic entrepreneurs have to expect that banks will charge high interest rates and have high collateral requirements. Banks are not specialized in financing firms with high-risk capital (Berger and Udell, 1998) and therefore ration their credit (Jaffee and Russell, 1976; Stiglitz and Weiss, 1981).

Equity investments present an alternative source for external finance. Equity investors receive, in return for their investment, a share of the ownership. All owners of a firm, such as the founders, management and equity investors, share residual cash-flows or losses according to their percentage of the firm's ownership (Dollinger, 2003). Additionally, all equity sharing parties can exercise control rights and influence managerial decision-making. Equity investors are thus able to take higher risks compared to credit offering banks that can only passively rely on the interest schedule and collateral agreement (Timmons and Spinelli, 2003).

Business angels are informal equity investors who are usually wealthy individuals investing their own money. The scope of funding as well as the investment expertise is thus highly determined by the individual characteristics of the business angel (Mason and Harrison, 1997, 2000).

Formal equity investors like VC firms manage larger funds provided by institutional investors such as insurance or pension funds. These funds are used to invest in attractive businesses to generate substantial returns (Gompers and Lerner, 1998; 2001, 2006). VC firms are attractive to new USOs because they are specialized to take on the higher levels of risk involved in investing in young firms (Winton and Yerramilli, 2008).

To hedge their investment risks, VC investors individually negotiate a share of equity ownership in their investees (Tyebjee and Bruno, 1986; Amit *et al*., 1990). Part of this negotiation process is also a thorough due diligence process to identify investment opportunities with an attractive risk and return relationship (Wright and Robbie, 1996;

Zacharakis and Meyer, 1998). In order to reduce risk and uncertainty in their investment decision, VC investors examine the business plans of investment-seeking firm. Business plans usually include an executive summary on the business concept and model, the target market and projections, the firm's competitive advantage, the financing and costs of running the business, the financial plan and profitability estimates, the founding team's composition as well as the desired financing along with equity shares and exit strategy for investors (DTI, 1996; Timmons and Spinelli, 2003). VC investors reduce their risk in setting up contractual incentives to achieve the optimal commitment of their investees (Sahlman, 1990; Berglof, 1994; Gompers and Lerner, 1996). Often investors specialise in sectors and industries or geographic regions (Florida and Smith, 1993; Mason and Harrison, 2002b; Myint *et al.*, 2005). Very frequently, new CEOs are appointed by VC investors to substitute for founding entrepreneurs in the more management intensive stages of growth (Rosenstein *et al*., 1993; Wasserman, 2003). Popular exit strategies for VC investors include quoting their investees on a stock market or selling them on (Cumming and MacIntosh, 2003; Gompers and Lerner, 2006). This is in order to generate their competitive returns in converting their equity ownership into cash. Therefore, VC investors pursue a strong commercially guided growth strategy in order to increase the market value of their investees.

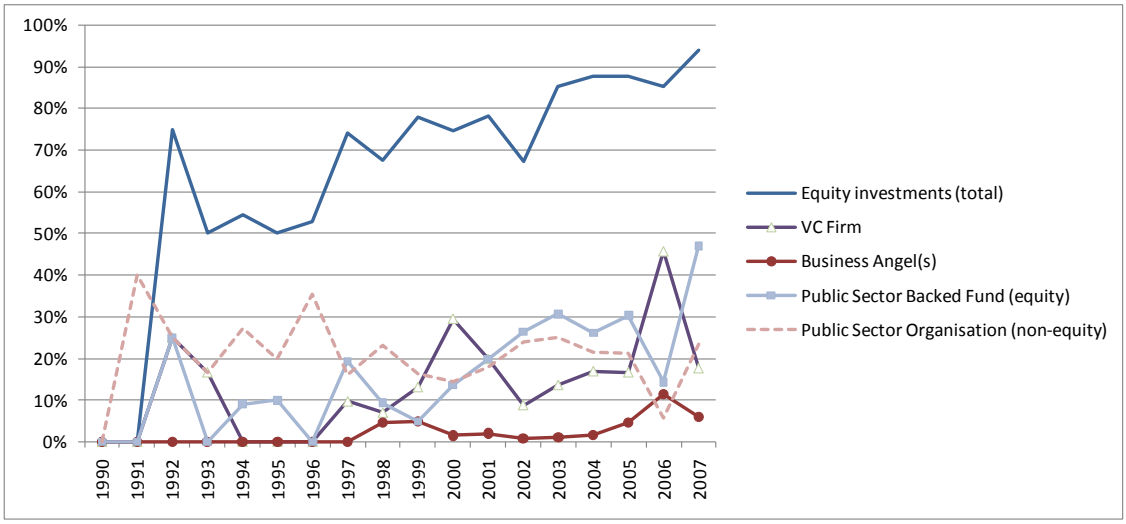
For these reasons, VC investors were seen by the Lambert Report (2003) as highly influential and beneficial to the formation of USOs: 'Venture capitalists have made it possible for research projects that once could only be financed by big companies to be spun out and developed in new start-up companies' (2003: 11). The report further claims that it is '[...] easier to attract private investment into early stage seed funding for spinouts. Private finance provides an important quality measure and should be used to decide which spinouts to pursue wherever possible' (2003: 62). VC investors are thus regarded by policy makers as being capable of separating and identifying those USOs of high quality of commercial prospects. VC investors shall accordingly trigger the superior firm performance of USOs with the help of substantial financial resources. Furthermore, VC investors are regarded as very effective in adding managerial skills and business expertise to their investees (Timmons and Spinelli, 2003). In consequence, driven by public policy there are high expectations of how VC investment can transform the commercial success of USOs. It appears that the demand for VC investment is often not met by the supply in the UK. This is discussed in the next section.

1.2.2.1 VC Market for USOs in the UK: 'Equity gap' (Supply-side) vs. 'Investment Readiness' (Demand-side)

The previous section has shown that there is a strong demand for VC finance by public policy makers, TTOs and USOs (Wright *et al*., 2006). However, there is an important debate on a particular barrier affecting the development of USOs and their ability to attract VC investment. The debate is twofold. USOs may suffer from a lack of VC because of the supply-side, leading to an i.e. 'equity gap'. Alternatively, the demand-side may fail to produce attractive investment opportunities to VCs and therefore reflects a lack of 'investment readiness'.

Figure 4 shows that the frequency of VC finance in the first external investment rounds was, with the exception of 2006, lower than at its peak in 2000, which was likely due to the new economy boom.

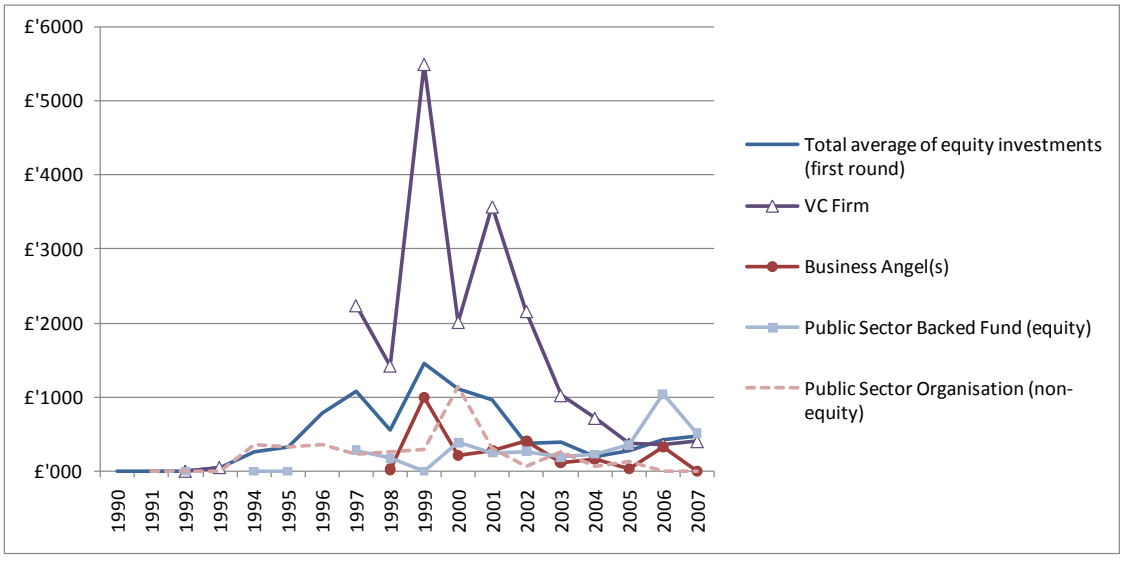
Figure 4: Share of Equity Funding Types in First Finance Rounds of USOs per Year in the UK (Source: Library House, 2007; n = 599 USOs)



The overall increase of USOs' ability to attract equity investment needs also to be linked to equity funds which are backed by the public sector. These public schemes aimed to reduce the 'equity gap' such as to reduce risk for follow-on investment by private VC investors (Wright *et al*., 2006). Further, non-equity public support in the form of grants and awards remain a common support scheme.

The latest policy report by Sainsbury (2007) argued that VC investors are reluctant to take the risk of supplying sufficient investments to USOs. The resulting 'equity gap' (Wright *et al.*, 2006) affects early stage investments between £250,000 and £2 million (Sainsbury Report, 2007). The identified 'equity gap' is highlighted by studies into the supply side. Although the British VC industry is the largest in Europe and the second largest in the world to the US, VC investors in the UK are likely to hesitate to get involved with USOs. Research by Murray and Lott (1995) and Lockett *et al*. (2002) repeatedly asserted that VC investors in the UK are generally sceptical about investing in high-technology start-up companies. High levels of uncertainty regarding the success of the technology and its market size substantially increase the risk to VC investors by becoming involved (Brierley, 2001). The need for thorough due diligence increases the fixed costs of VC investors. As a consequence, only a larger scope of investments between £250,000 and £2 million are likely to be feasible. However, a report by Library House (2007) and the data in Figure 5 show that the average amount of first round VC investments in USOs has been steadily falling since 2001.

Figure 5: Average Amount (in thousand £) of Investment in the First Round by Equity Providers in USOs (Source: Library House, 2007; n = 599 USOs)[3]



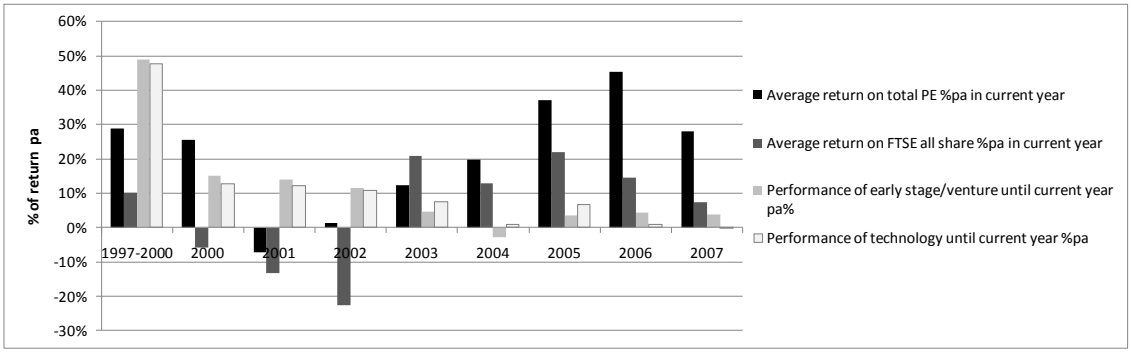
In response to claims that the VC supply is the dominant reason for a market mismatch, VC investors stress that USOs on the demand-side often fail to meet their investment criteria (Vohora *et al.*, 2004). The lack of USOs' 'investment readiness' relates,

[3] No reliable data was available to calculate the average amount (in thousand £) of investment in the first round by VC firms between 1993 and 1997

according to Mason and Harrison (2001), to three issues. First, entrepreneurs are often not prepared to share ownership and control with an external investor. Second, entrepreneurs often fail to present a business case and business plan of adequate quality (Vohora *et al*., 2004). Finally, entrepreneurs frequently fail to show 'investability' in meeting the necessary requirements of investors. Mason and Harrison (2001) criticise public policy programmes aimed at educating entrepreneurs on how to attract VC investment because they fail to take into consideration the third dimension of 'investment readiness'. They do not focus sufficiently on identifying the commercial attractiveness of new business ideas. VC investors prefer to focus on business development and therefore want investees who are looking to exploit commercially viable business ideas which generate high returns.

Evidence that VC investors fail to generate substantial returns from investing in early stage and high-technology firms in the UK is presented Figure 6. This shows continuously poor returns on investments in early stage technology companies (Connell, 2007). The disappointing performance record is thus likely to affect VC investors' willingness to invest in USOs.

Figure 6: Average Annual Rate Return of Investment (%) in Private Equity (PE), FTSE All Share, Early Stage VC Investment and VC Investment in Technology (Source: BVCA (2000-2007)

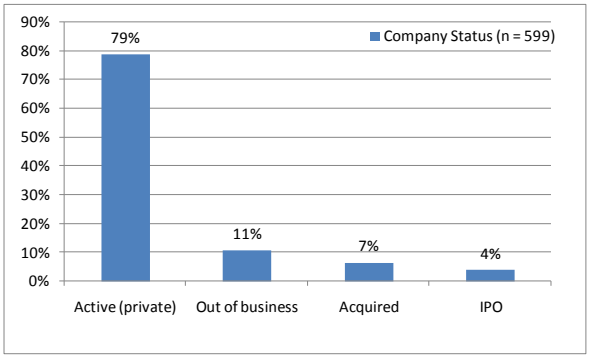


1.2.3 USO Firm Performance in the UK

Complicating the debate on USOs' development is the central question of how to measure firm performance. Young high-technology firms to which most USOs belong rarely report profits due to their research and development intensive business models (Lambert, 2003). Moreover, because of long technology-to-market times (Sainsbury, 2007) turnover figures are also difficult to assess in a population of young USOs.

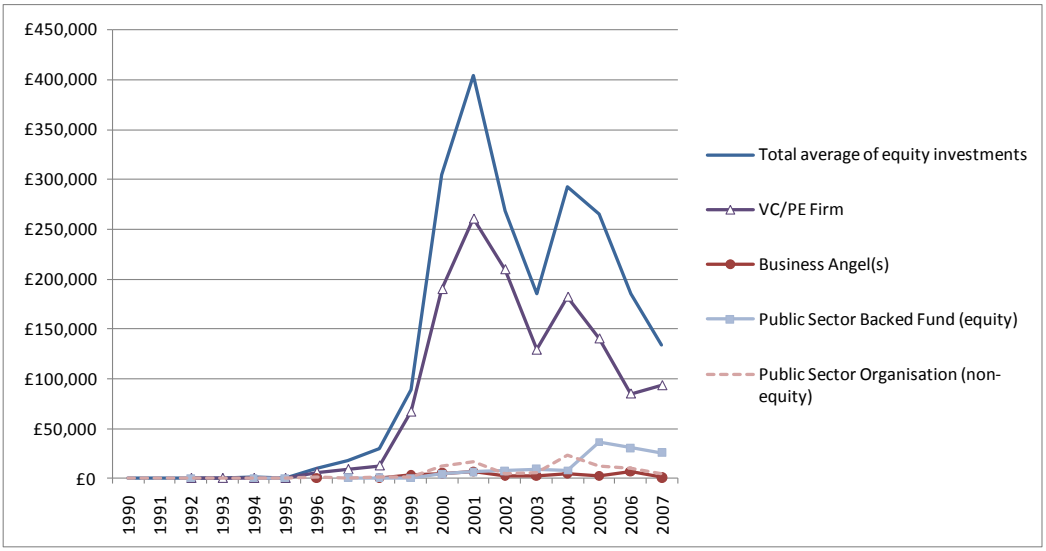
Data on USOs' company status reported by Library House (2007), and shown in Figure 7, reveals that only a minority of USOs were quoted on a stock market with initial public offerings (IPOs) or became subject to mergers and acquisitions (M&As). Only 11% of USOs in the sample of Library House are out of business. Crucially, the rare events of IPOs and M&As are likely to reduce the interest of VC investors as they depend on these exit options in order to generate substantial returns (Mohnen *et al*., 2008).

Figure 7: Company Status of USOs in 2007 (Source: Library House, 2007)



Given the relatively early stage of the population of USOs in the UK, their ability to attract financing can be an alternative measure of their development and an indicator of firm performance potential (Vohora *et al*., 2004). Especially, because the ability to attract VC investment is likely to influence future firm performance due to the substantial resources of finance and business expertise combined with strictly commercial goals. However, Figure 8 shows that the total annual average amount of equity investments attracted has been decreasing since the end of the new economy boom.

Figure 8: Total Annual Average Amount of Equity Investments (in thousand £) in British USOs (Source: Library House, 2007; n = 599 USOs)



Nevertheless, VC investments remain substantially higher than those of alternative equity providers. The high average of VC investments also fuels expectations that VC investments can positively influence USO performance (Wright *et al*., 2006).

Unfortunately, public policy reports on USO development in the UK are unable to provide a firm-level analysis of USO firm performance. Public policy reports like Lambert (2003) and Sainsbury (2007) have no representative firm-level statistics on USO performance related to measures like turnover, revenue, employment or employment change. Reports aimed at VC investors, like that of Library House (2007), continue to emphasise statistics on survival, IPO and M&A statistics. Due to the small population of USOs which achieved M&As and IPOs a huge amount of information on firms' performance of independent USOs is not adequately addressed. Therefore, the assessment of USO firm performance in the UK is still in a controversial and at an early stage which requires further research. It is to this assessment that this study contributes.

1.3 Gaps in the Knowledge Base

Several gaps in the knowledge base, relating to the take-up of first VC investment and the performance of USOs, were identified by this study. They are summarized below and discussed in more detail in Chapter 2.

The body of literature on USOs' ability to take-up first VC investment is just emerging and is therefore predominantly exploratory (Rothaermel *et al.*, 2007). The qualitative methods of case studies and interviews are mostly used to collect anecdotal evidence on this phenomenon. These insights are often used to build new theories. They relate to an array of factors and resources that are characteristic for USOs seeking first VC investment as well as characterizing the supply side of VC. However, due to their exploratory nature, previous studies rarely replicate, integrate and extend established theoretical insights. This leads to a substantial gap in the knowledge base. To close this gap a theoretical framework needs to be established that integrates the available body of literature and links it to related work on financing start-ups. In particular, a theoretical framework is needed that incorporates both a demand and supply side perspective in order to explore market coordination between USOs and VC investors. Hypotheses can then be derived in order to explore what factors are related to USOs' ability to attract first VC investment. Further,

these hypotheses need to be empirically tested. Accordingly, quantitative data needs to be collected on firm and founder level in order to generate representative cross-sectional samples and conduct multivariate statistical analyses. This approach has rarely been used in previous studies on the VC financing of USOs. These major gaps in knowledge are further discussed in Section 2.2.

Similar to the body of literature on the take-up of first VC investment, USO firm performance studies are still in an emerging and exploratory stage. Qualitative methods such as case studies or interviews were commonly used to collect, analyse and organise evidence. The resulting emphasis on building theories has generated a gap in the knowledge base as previous studies rarely replicated, integrated and extended established theories. Hence, only a few studies are available that test hypotheses empirically in order to identify what factors and resources relate to USOs and their superior firm performance. More research is required to identify whether internal resources and capabilities help young firms to adapt successfully to their environment. Additionally, the importance of first VC investment in leading USOs to superior firm performance has been only conceptually addressed rather than been supported by statistical evidence. Only a few studies are currently available that use representative cross-sectional samples and multivariate statistical analyses to test these hypotheses. The resulting gaps in the knowledge base on factors related to USO firm performance are discussed in more detail in Section 2.5.

1.4 Focus, Purpose and Contribution

This study focuses on two debates related to the development of USOs. The first debate focuses on what factors relate to USOs' ability to attract a first round of VC investment. The second debate focuses on what factors drive USO firm performance and whether VC-funded USOs report superior performance. Both debates are relevant to academic research on entrepreneurship as well as practitioners in the context of commercialising IP from academic research.

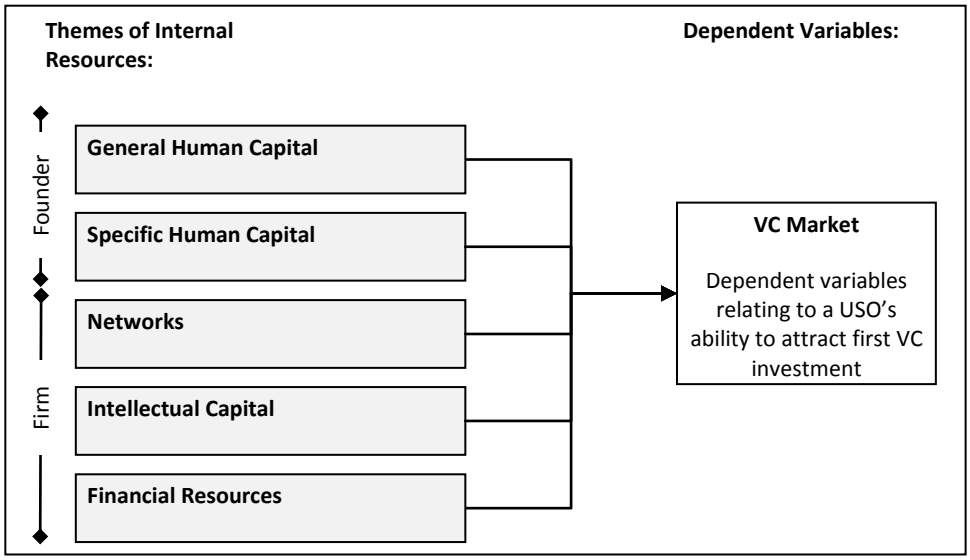
The purpose of this study is to address the identified substantial gaps in the knowledge base in previous academic research as introduced in Section 1.3. They are further discussed in more detail in Chapter 2. By contrast to predominantly exploratory earlier research, this study replicates, integrates and extends theoretical frameworks in

order to derive and empirically test hypotheses on what factors of USOs relate to the take-up of first VC investment and superior firm performance in light of this investment.

This study contributes to theory development. It replicates the RBV to identify which themes of initial resources characterize USOs seeking first VC investment. Using the RBV as a base theory, additional emerging resource-based theories are integrated. These include general and specific human capital that characterize the founding entrepreneurs as well as networks, intellectual capital and finance that characterize the firm. In addition to this demand-side perspective the RBV is extended using signalling theory in order to incorporate the supply-side perspective of VC investors, thus explaining market co-ordination. This integrative theoretical framework argues that the identified themes of resources are signals of quality which reduce VC investors' risks which, in turn, influences their investment decisions. Figure 9 summarizes the theoretical framework that is used to explore the first research question:

Research Question 1: *Which resources of university spin-outs (USOs) are signals of quality and attract first venture capital (VC) investment?*

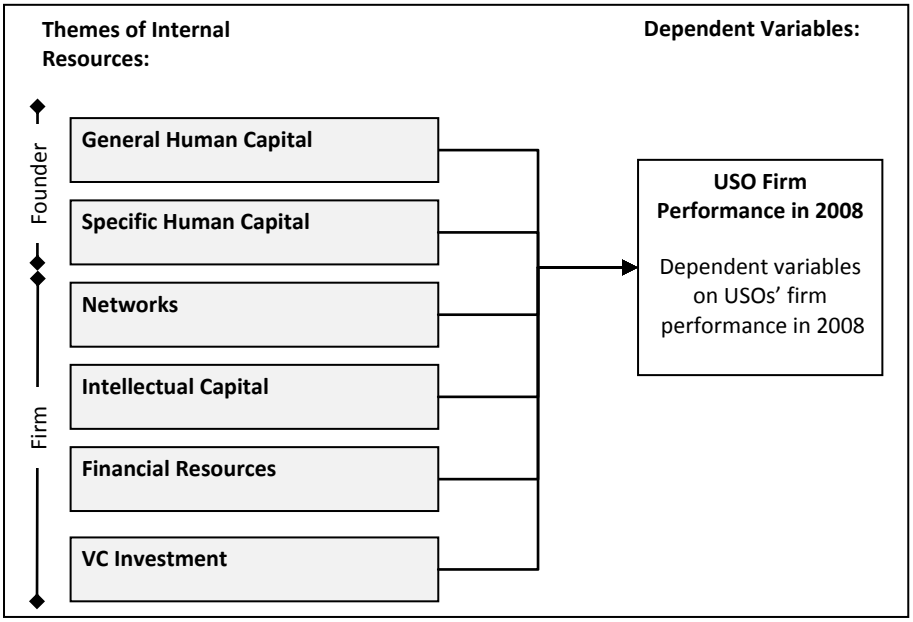
Figure 9: Overview of Theoretical Framework on the Attraction of first VC Investment



In order to investigate USO firm performance, in the light of VC investment this study also replicates the RBV. It is used to demonstrate that the internal resources of founders and their new firms can adapt to external influences and drive firm performance. Because of VC investors' unique combination of financial resources and business expertise it is argued that USOs with VC investment report superior firm performance. Figure 10 summarizes this theoretical framework by exploring the second research question:

Research Question 2: *Do VC funded USOs report superior firm performance?*

Figure 10: Overview of Theoretical Framework on USO Firm Performance



In addition to its contributions to theory, Table 2 summarizes further areas of contribution reflecting the study's relevance to research on entrepreneurship (Low and MacMillan, 1988). These are discussed below.

Table 2: Dimensions of Contributions to the Knowledge Base

Dimensions:	**Contributions:**
Theory:	- Replication of the RBV of the firm. Integration of resource themes (general and specific human capital, networks, intellectual capital and finance) to characterize USOs and their demand for VC investment and firm performance potential. - Extension of the RBV of the firm with signalling theory to provide a supply-side perspective in order to explain co-ordination on the VC market despite constraints of uncertainty and asymmetric information.
Level of analysis and related types of variables:	- Lead entrepreneur: general and specific human capital of founding academic entrepreneurs (all independent variables). - Firm level: firm age (control variable), networks, intellectual capital, finance (all independent variables), VC investment, firm performance (dependent variables). - External environment: sector, region, relative market size (all control variables).
Research setting, Data and Timeframe:	- Cross-sectional sample of 125 USOs founded between 1990 and 2007 and still active in 2008 in the UK. - Sample represents 20% of the total population. - Individual negotiations to access secondary data identifying population and firm level information. - Collection of primary data from founders of USOs as key informants with a custom online survey (Response rate of valid respondents = 25%). - Response bias tests confirmed the sample was similar to the population.
Methodology:	- Positivist paradigm: Test of hypotheses derived from theoretical framework in a quantitative study using multivariate analysis techniques in order to identify the relationships between independent and dependent variables. - Face and content validity of measures, pilot interviews and study. Adoption of variables and measures from previous studies to replicate hypotheses. - Assumptions of multivariate techniques are met to achieve reliable, valid findings that can be generalized. Logistic and multinominal logit regression analysis is used for categorical dependent variables. Tobit and OLS linear regression analysis is used for continuous variables. - Array of dependent variables for conducting sensitivity analysis of hypotheses testing.

Table 2 (Continued)**:** Dimensions of Contributions to the Knowledge Base	
Dimensions:	**Contributions:**
Methodology (Continued):	- Dependent variables measuring the attraction of first VC investment: Likelihood of attracting First VC Investment (yes, no); Number of First VC Offers (number; none, one, two or more); Number of First VC Investments (number; none, one, two or more); First VC Investment Amount (amount (£'); none, £1 to £500,000, > £500,000); Investor Types Relating to First VC Investment (no VC, Generalist VC, Specialist VC). - Dependent variables measuring USO firm performance: Total Number of External Investment Rounds Attracted Until 2008; Total Amount of External Investment (£'s) Attracted Until 2008; Likelihood of Product Launch to the Market Until 2008; Book Value of Total Assets (£'s) Until 2008; Number of Employees in the USOs in 2008; Absolute Employment Change between Founding Year and 2008; Composite Measure of Firm Performance.
Implications and recom-mendations	- Implications and best practice suggestions practitioners which are concerned about the barriers USOs face in attracting first VC investment and achieving superior firm performance: academic entrepreneurs, universities and their TTOs, VC investors as well as public policy makers. - Suggestions for areas of future academic research.

This is the first study on VC financing and firm performance of USOs to combine founder, firm and external levels of analysis. Founding academic entrepreneurs' general and specific human capital (independent variables) was measured. On a firm level, firm age (control variable), networks, intellectual capital, finance (all independent variables), VC investment, firm performance (dependent variables) were also measured. Furthermore, external environment measures related to sector, region and relative market size (control variables) were measured.

The research setting contributes to the understanding of new firm development in the context of USO development in the UK. This study contributes by being the first with a cross-sectional sample of 125 USOs founded between 1990 and 2007 and still active in 2008 in the UK. Secondary sources comprise respected data bases such as Companies House, Library House and FAME which were used to identify the population of 505 British USOs founded between 1990 and 2007 and still active in 2008. In addition, primary data was collected using an online survey with a response rate of 25%. The final valid sample of 125 USOs thus represents one in five USOs of the identified population in the UK. Response bias tests ensured that findings were representative and could be generalized.

The positivist paradigm contributes by testing replicated and new hypotheses derived from a theoretical framework. Multivariate regression techniques were used to analyze the relationship between a set of independent variables and a dependent variable. To increase the robustness of the results measures of the variables were replicated from previous studies were possible. Furthermore, a range of dependent variables as shown in Table 4 were used to conduct sensitivity analysis. The choice of regression techniques was based on the characteristics of the dependent variable. Logistic and multinominal regression analysis was used for categorical dependent variables. Tobit and OLS linear regressions analysis was used for continuous variables. The assumptions of the used regression techniques were met. Tests for face and content validity, robustness as well as common methods bias of measures were reported. Pilot interviews and a pilot study were conducted before the primary data collection. Therefore, contributions and implications of this study are based on a sound methodology leading to generalisable and representative results that can be replicated and tested in future studies.

Finally, this study contributes to improved practitioner understanding of USO development. Four major practitioner groups including public policy makers, academic entrepreneurs, universities and VC investors are addressed and provided with specific implications derived from this study.

1.5 Structure of the Remainder of the Thesis

Chapter 2 identifies prominent gaps in the knowledge base. Thereafter theoretical insights are reviewed to build theoretical frameworks from which hypotheses are derived. This is done for each of the two identified research questions.

Chapter 3 discusses the methodology of this study including issues of research philosophy, methods of data collection, response bias tests, variable operationalisation as well as assumptions and preparations for multivariate data analysis.

Chapter 4 tests the earlier derived sets of hypotheses exploring the first research question on the attraction of first VC investment. Multivariate data analysis is used for hypotheses testing. Sensitivity analysis was conducted using an array of dependent variables measuring the attraction of first VC investment.

Chapter 5 tests the earlier derived sets of hypotheses exploring the second research question on superior firm performance and the influence of first VC investment. Multivariate data analysis is used for hypotheses testing. Sensitivity analysis is conducted using an array of dependent variables measuring USO firm performance.

Chapter 6 concludes major findings, contributions to theory, research implications and limitations of the study. Specific implications are made for practitioners including academic entrepreneurs, universities, policy makers and VC investors.

Chapter 2: Gaps in the Knowledge Base, Theoretical Insights and Derivation of Hypotheses

2.1 Introduction

This chapter identifies gaps in the knowledge base, develops theoretical insights and derives hypotheses to explore the two presented research questions. Gaps in the knowledge base are identified by a review of the body of literature on the attraction of first VC investment and the firm performance of USOs. Theoretical insights are replicated, integrated and extended in order to develop theoretical frameworks to derive hypotheses.

2.2 Gaps in the Knowledge Base: Attraction of First VC Investment

The starting point in the debate on USOs' ability to attract VC investment is the identification of a demand for VC investment. Early research on the formation and development of USOs in Table 3 highlights that VC investments are in great demand in order to enhance growth and are a necessary requirement for promoting entrepreneurial exploitation of academic research (Roberts and Malone, 1996). This relates to VC investors' ability to generate growth with substantial investments as well as business expertise, which are both demanded by USOs aiming for high growth strategies (Steffensen *et al*., 2000).

In particular, the business knowledge needed to commercially exploit business opportunities is a scarce resource within USOs and their founders due to their academic background (Ndonzuau *et al*., 2002). The added value of VC is generated by combining high risk finance with managerial skills, for example, building new management teams in order to lead firms to sustained growth and success. In consequence, Lockett *et al*. (2003) find that USOs in regional clusters with high levels of VC investment activities benefit overproportionally, leading to greater numbers of USOs as well as USOs achieving IPOs (Powers and McDougall, 2005).

Table 3: Studies Exploring Factors Associated with the Take-up of First VC Investment by USOs

Author(s)	Research Question(s)	Theory (ies)	Methodology	Dependent Variable(s)	Sample Size and Context	Findings
Roberts and Malone (1996)	What are the guides in spinning off new companies from R&D organizations?	Exploratory and descriptive study, no theories, no hypotheses tested	Qualitative case studies, demand-side perspective	n/a	8 R&D organizations, US	- The spin-off process is more difficult in environments where VC investors and entrepreneurial commitment is lacking. - VC investors get involved as early as the evaluation stage but more likely wait until seed funding requests from USOs. - VC investors prefer protected (i.e. patented) technology. - VC investors prefer investment at business development stages. They seek control through their board of directors in order to influence executive management decision making. - VC investors seek IPO or sale as typical exit strategies to convert equity ownership in USOs into cash.
Bray and Lee (2000)	Are Licensing fees or equity positions more attractive to generate returns from technology transfer?	Exploratory	Quantitative, descriptive statistics	n/a	5 universities, US	- Reasons for equity: the flexibility for licensing managers in structuring deals, the possibility that universities still hold a value if their technology is replaced and the reduced time required to generate revenue compared to a traditional license. - A traditional license is preferred when the technology is not suitable for a spin-off company, or when the technology is one of the rare jackpot licenses that bring in millions of dollars every year. - If none of the start-ups produce a million-dollar equity sale, the financial return is similar to the range normally received from licensing. Taking equity leaves the door open for the occasional jackpot, which brings significantly more money than a standard license. - When combined with a strong program of traditional licensing, making equity in start-up companies maximizes the financial return that universities realize from their intellectual property. - VC investors increase the valuation and sale value of start-ups.

Table 3 (Continued)**:** Studies Exploring Factors Associated with the Take-up of First VC Investment by USOs						
Author(s)	**Research Question(s)**	**Theory (ies)**	**Methodology**	**Dependent Variable(s)**	**Sample Size and Context**	**Findings**
Chiesa and Piccaluga (2000)	What are the profiles, opportunities, and obstacles faced by spin-off companies in Italy?	Exploratory and descriptive study, no theories, no hypotheses tested	Quantitative survey, descriptive statistics, demand-side perspective	n/a	48 USOs, Italy	- Personal financial resources are regarded as most important, VC investment as least. However, the need for VC investment and other institutional investment rise rapidly in growth periods. - Inability to secure external funding is a strong barrier to growth and opportunity exploitation. - An additional identified barrier to growth is the lack of resources in entrepreneurial and managerial skills.
Steffensen *et al*. (2000)	What factors facilitate or prevent the formation of new spin-offs from research centres?	Exploratory	Qualitative, Case Study	n/a	6 of the 19 spin-offs from the 55 research centres at the University of New Mexico (UNM) in 1997, US	- Few conflicts between spin-off and parent. However, lengthy negotiations about IP rights are required. - Spin-offs represent an important mechanism for technology transfer, as a spin-off is typically founded around a core technological innovation that was initially developed at the parent organization. - University administrators and community leaders envision a future technopolis (technology city), but achieving this goal will be difficult, given the lack of infrastructure, entrepreneurship and venture capital in the Albuquerque region.
Mason and Harrison (2001)	Critical review of public policies on educating entrepreneurs to become 'investment read'	Exploratory and descriptive study, no theories, no hypotheses tested	Qualitative, review of policy propositions and investment guidelines	n/a	n/a	- Investment readiness is based on three dimensions: 1) Entrepreneur's attitude to equity investment and willingness to share ownership and control. 2) Entrepreneur's ability to present the business case and quality of business plan. 3) 'Investability': meeting the requirements of investors such as capability of entrepreneur/team, business and market position, potential return and exit expectations. - Investment readiness is about business development. - Public awareness programmes need to stress 'investability'

Table 3 (Continued)**:** Studies Exploring Factors Associated with the Take-up of First VC Investment by USOs						
Author(s)	**Research Question(s)**	**Theory (ies)**	**Methodology**	**Dependent Variable(s)**	**Sample Size and Context**	**Findings**
Birley (2002)	Which issues are faced by organisations when attempting to commercialize their Intellectual Property?	Theory building	Qualitative case study, interviews	n/a	Case study of Imperial College London, UK	- Three types of spinouts: Orthodox, hybrid and technology, with the hybrid being the most common and most complicated - The inventor and multiple stakeholders, such as the university, can face conflicts of interest, when allocating of equity to third parties such as VC investors. - A transparent policy on managing IP ownership is required for successful commercial exploitation of IP from academic research.
Lockett *et al*. (2002)	Do UK venture capitalists still have a bias against investment in new technology firms?	Exploratory and descriptive study, no theories	Quantitative survey, descriptive statistics	n/a	60 VC firms, UK	- General increase in the importance of technology investments by generalist VC firms (<50% of total portfolio are technology investments). - VC investors are interested in access to IP and complementary resources; especially, via inter-firm networks. - Government policies to promote technology start-ups (including USOs) are frequently aimed at providing incentives to VC investment. VC demand may be increased by USO formations. - UK VC firms remain biased against early stage technology companies.
Ndonzuau *et al*. (2002)	What are the stages and issues in the creation of university spin-offs according to public and academic authorities?	Theory building	Qualitative, Interviews with technology transfer related personnel at 15 universities in different countries	n/a	15 Universities: 2x Finland, 1 x Sweden, 1 x Netherlands, 2 x Belgium, 1 x France, 2 x Israel, 4 x USA, 1 x Canada	- Stage 1: to generate business ideas from research, academic culture, internal identification. - Stage 2: to finalize new venture projects including issues of IP protection, development of the business idea and financing. - Stage 3: to launch spin-off firms, ensure access to resources and manage relationship with university. - Stage 4: to strengthen the creation of economic value by spin-off firms in managing risk and trajectories.

Table 3 (Continued)**:** Studies Exploring Factors Associated with the Take-up of First VC Investment by USOs						
Author(s)	**Research Question(s)**	**Theory (ies)**	**Methodology**	**Dependent Variable(s)**	**Sample Size and Context**	**Findings**
Shane and Stuart (2002)	How do initial resource endowments affect the performance of new ventures?	Social Capital / Network Theory, RBV	Quantitative study, event history analysis, interviews with founders and survey of R&D managers, demand-side perspective	Venture capital, Survival, IPO	145 USOs from MIT, US	- Founder's direct and indirect relationships with venture investors help new ventures to receive VC funding and to avoid failure. - Founder team's industry experience and patent effectiveness have positive effect on IPO, VC funding rate and negative effect on failure. - Technology endowment increases the likelihood of IPOs and decreases the likelihood of failure.
Lockett *et al*. (2003)	Which strategies are used by technology transfer/business development officers to promote the creation of spin-out companies?	Theory building	Quantitative survey, descriptive statistics, Mann-Whitney non-parametric tests between 9 established universities and 'new' universities	n/a	57 UK Universities	- More successful universities have clearer strategies for spinning out companies and the use of surrogate entrepreneurs. - More successful universities have greater expertise and networks that may be important in fostering spin-out companies. However, the role of the academic inventor was not found to differ between the more and less successful universities. - Equity ownership was more widely distributed among the members of the spin-out company from more successful universities. - The boundary between an investor of financial capital and an investor of human capital is becoming increasingly blurred.
Nicolaou and Birley (2003)	What mechanisms generate different types of university spinout structures?	Social Capital / Network Theory	Conceptual	n/a	n/a	- Trichotomous categorization of university spinouts as orthodox, hybrid or technology spinouts. - The academic's rootedness in a network of exo-institutional and endo-institutional ties influences the type of spinout initiated. - Networks provide feedback effects and generate legitimacy in entrepreneurial actions. Venture capitalists are more inclined to invest in companies that they know or have been referred to by trusted sources to alleviate informational asymmetry problems.

Table 3 (Continued)**:** Studies Exploring Factors Associated with the Take-up of First VC Investment by USOs						
Author(s)	**Research Question(s)**	**Theory (ies)**	**Methodology**	**Dependent Variable(s)**	**Sample Size and Context**	**Findings**
Vohora *et al*. (2004)	How do USOs progress through different stages to compete in the commercial market?	Exploratory and descriptive study, no theories, no hypotheses tested, theory building	Qualitative case studies	n/a	9 USOs from 7 universities, UK	- USOs go through five distinct phases of activity in their development: the research phase, opportunity framing phase, pre-Organisation phase, re-orientation phase, and sustainable returns phase. - At the intersection between phases, USOs face 'critical junctures' in terms of the resources and capabilities for the next phase: opportunity recognition, entrepreneurial commitment, credibility and sustainability. - Critical juncture of 'credibility' includes the need to attract external investment. - VC investors complain about lack of 'investment readiness'. Many USOs underestimate the importance of market size and commercial prospects that are relevant to VC investors.
De Coster and Butler (2005)	How to assess new technology venture spin-offs from universities?	Theory building	Qualitative analysis and descriptive statistics derived from information provided by the business plan and interview with key personnel.	n/a	14 university spin-offs and 14 company spinoffs, UK	- Assessment criteria categories: technological and commercial risk; level of product innovation; how it satisfies a market sector; market timeliness; fitness into a family of products; longevity of product/process line; previous record of technical innovation; intellectual property rights.
Lockett and Wright (2005)	What is the impact of university resources and routines as well as capabilities on the creation of spin-out companies?	RBV	Quantitative, mail questionnaire survey conducted over a 2-year period, Poisson Regression	Number of USOs formed in 2002	48 universities, UK	- The number of spin-out companies created and the number of spin-out companies created with equity investment are significantly positively associated with expenditure on intellectual property protection, the business development capabilities of technology transfer offices and the royalty regime of the university. - A key constraint on the development of spin-outs is reported by technology transfer offices to be access to venture capital finance.

Table 3 (Continued)**:** Studies Exploring Factors Associated with the Take-up of First VC Investment by USOs						
Author(s):	**Research Question(s):**	**Theory (ies):**	**Methodology:**	**Dependent Variable(s):**	**Sample Size and Context:**	**Findings:**
Powers and McDougall, 2005	What resources influence the number of new USOs formed as well as the number of IPOs?	RBV	Quantitative, secondary, negative binominal regression	Number of USOs formed; Number of USOs with IPO	120 universities, US	- Industry R&D, faculty quality, TTO age and amount of VC investment are significant and positively associated with the number of USOs as well as USOs achieving an IPO.
Wright *et al*. (2006)	What problems do USOs face when trying to access VC investment?	Pecking-order Theory	Quantitative survey of TTOs and VC investors, demand and supply-side perspective	n/a	124 TTOs, UK	- Venture capital is the most common resource constraint for USOs according to TTOs in the UK. - Venture capital is perceived by TTOs representing their USOs to be more important than internal funds. - A mismatch between the demand and supply side of the VC market for USOs is identified. - In line with the pecking order theory, venture capitalists prefer to invest after the seed stage. They are unwilling to take on the risk of investing in early stage USOs due to uncertainty and informational asymmetries.
Clarysse *et al*. (2007)	Does the formal technology transfer from a public research organization influence the amount of capital a spin-off raises at start-up, and does it increase in capital post start-up?	RBV, Pecking Order Theory	Quantitative OLS regression	Capital raised within 18 months of start-up	135 Spin-offs 40 x Belgium; 31 x Germany; 17 x France; 29 x Italy; 28 x UK)	- Spin-offs with formal technology transfer start with a larger amount of capital but subsequently do not raise more capital than spin-offs without formal technology transfer.

Table 3 (Continued)**:** Studies Exploring Factors Associated with the Take-up of First VC Investment by USOs						
Author(s):	**Research Question(s):**	**Theory (ies):**	**Methodology:**	**Dependent Variable(s):**	**Sample Size and Context:**	**Findings:**
Mosey and Wright (2007)	What structural social capital is in place at the start of new venture development for academic entrepreneurs with different levels of prior business ownership experience? What new ties are developed during the early stages of new venture development by academic entrepreneurs with different levels of prior business ownership experience? What is the nature of the resources gained through the social networks of academic entrepreneurs with different levels of prior business ownership experience at the early stages of venture development? What governance mechanisms are utilized by academic entrepreneurs with different levels of prior business ownership experience to access resources through social networks at the early stages of venture development? What is the influence of discipline-based and industrial experience aspects of human capital, the degree of success of previous ventures and the nature of the university incubator environment on the ability of academic entrepreneurs with different levels of prior business ownership experience to develop social networks and access resources through social networks at the early stages of venture development?	Human Capital Theory, Social Capital / Network Theory, Theory building	Qualitative, Multiple case studies, 44 interviews with academics, business development officers and head of schools involved in new venture creation process	n/a	24 academics 6 nascent entrepreneurs, 12 novice entrepreneurs, 6 habitual entrepreneurs), UK	- Entrepreneurs with prior business ownership experience have broader social networks and are more effective in developing network ties. Less experienced entrepreneurs likely encounter structural holes between their scientific research networks and industry networks. - Support initiatives help attract industry partners for novice entrepreneurs from engineering and the material sciences but academics based within biological sciences encounter greater difficulties building such ties. - Regardless of academic discipline, business ownership experience appears essential to learn to build relationships with experienced managers and potential equity investors.

Table 3 (Continued)**:** Studies Exploring Factors Associated with the Take-up of First VC Investment by USOs						
Author(s):	**Research Question(s):**	**Theory (ies):**	**Methodology:**	**Dependent Variable(s):**	**Sample Size and Context:**	**Findings:**
Rothaermel *et al*. (2007)	What are the major themes of research in the literature on university entrepreneurship?	Theory building	Literature review of 173 articles on USOs	n/a	n/a	- The literature on university entrepreneurship is rapidly expanding, in both the United States and Europe but is also fairly fragmented regarding the use of theories and choices of methodologies. - Four major research streams emerge: i) The entrepreneurial research university. ii) Productivity of technology transfer offices. iii) New firm creation and development. iv) Environmental context and networks of innovation influencing the formation and development of USOs. - The study of new firm creation can be leveraged to address one of the most important and vexing questions in strategic management today: where do capabilities come from? - Need for multidisciplinary perspectives to study new firm development.

The strength of the above studies is to underline the conceptual importance of VC investments for the growth of USOs. Their qualitative and descriptive methodology provides an overview of anecdotal evidence describing the process of USO formation and development as well as justifying a strong demand for VC investment to optimize the process. However, the weakness of these studies is that they rarely investigate systematically, or in a theory driven manner, the difficulties and barriers that USOs face when demanding VC investment. Whereas selected case studies highlight the importance of legal issues such as the protection and ownership of IP (Birley, 2002; Lockett and Wright, 2005) they fall short of a market perspective in order to explain the coordination between VC demand and supply for USOs.

More recent studies, shown in Table 3, start to address this weakness by adopting a market perspective. Wright *et al*. (2006) show, for the UK, that the demand for VC investment by USOs is commonly not met by its supply. A common explanation for this 'equity gap' is that VC investors are not willing to take the high risks related to USOs that come from their early stage risks (Lockett *et al*., 2002). Despite an increase in specialized VC firms for high-technology sectors early stage VC investments appear to fall short of their demand by USOs. De Coster and Butler (2005) attribute the reported aversion of the VC supply-side to the technological and commercial risks from the radical innovation and unproven technologies stemming from USOs, to which investors are exposed to.

The debate on how USOs can overcome VC investors' risk aversion is dominated by the thought that they have to convince investors about the credibility and performance prospects. Nicolaou and Birley (2003) identify that the relationship between USOs and VC investors is distorted by informational asymmetries that need to be resolved in order to allow a fair judgement of their future prospects. Vohora *et al*. (2004) regard this as a critical juncture in the process of USO development between entrepreneurial commitment and achieving credibility and sustainability with the help of attracting external finance. Their argument relates to the earlier work of Mason and Harrison (2001) which shows that the credibility of new firms can be achieved if they fulfil the conditions of 'investment readiness' demanded by VC investors. Accordingly, the profiles, characteristics and resources of new firms need to be associated by VC investors with leading to future success.

Correspondingly, a wide range of qualitative studies, as shown in Table 3, explore the question of which characteristics and information of USOs can reduce investment risks and attract VC investment. There is first evidence that VC investors prefer experienced

founders as well as firms with strong networks (Mosey and Wright, 2007). TTOs with links to VC investors are more likely to obtain VC investment (Roberts and Malone, 1996; Myint *et al.*, 2005; Mosey *et al.*, 2006). Firms with patented IP are also reported to obtain VC investment more often (Roberts and Malone, 1996; Shane, 2004b; Myint *et al.*, 2005).

Although this body of literature recognizes the constraints of risk, information exchange problems and the struggle for proving credibility they fall short of a sound theoretical framework which can be used to derive and test hypotheses with which to explore market coordination. None of the discussed studies use an integrative theoretical framework that allows a comparison between several important themes of resources, and their ability to enhance USOs' credibility towards VC investors. Additionally, none of the above studies uses a quantitative methodology and large samples to explore which factors are related to USOs' ability to attract VC investment.

Shane and Stuart (2002) is currently the only study that addresses these weaknesses in the context of USOs, as shown in Table 3. It explores the market co-ordination of VC investment within a quantitative study that uses a resource-based theoretical framework to derive and test hypotheses on which factors of USOs are related to attracting VC investment. It argues that the initial resources of USOs can contain the required information that VC investors need to assess risks and investment readiness in order to make an investment decision. Their major finding is that USOs with network ties to VC investors are very effective at attracting VC investment.

Therefore, the work by Shane and Stuart is a good initial point from which this study can replicate and extend a theory-driven approach in order to explore market coordination between USOs and VC investors. It is also effective at addressing current gaps in the knowledge base including a lack of a theory-driven multivariate study. The relationship between several themes of initial resources owned by USOs as independent variables and the event to attract first VC investment as dependent variable requires further investigation. Moreover, a further is gap in the knowledge base to address is whether founder or firm specific resources as units of analysis are more important in this relationship (Rothaermel *et al.*, 2007).

In order to address the identified gaps in the knowledge base the following section replicates, integrates and extends theoretical perspectives related to the attraction of first VC investment. A joint theoretical framework is developed from which hypotheses can be derived.

2.3 Theoretical Insights: Attraction of First VC Investment

2.3.1 Perspectives on the Take-up of First VC Investment

Three groups of studies with theoretical insights related to the take-up of first VC investment are discussed in this chapter. Table 4 summarizes the first and earliest group of studies, which focuses on a supply-side perspective of first VC investment (Tyebjee and Bruno, 1984). These studies show there is a renowned reluctance to invest. 'Of every 100 business plans reviewed by a venture capitalist, 10 are given serious consideration, and only one is funded' (Tyebjee and Bruno, 1986: 54).

The strength of this approach is to identify a range of investment criteria used by VC investors (Hall and Hofer, 1993) and the structure of the decision making process (Boocock and Woods, 1997). In order to assess the risk of potential investment opportunities, VC investors rely on a large variety of investment criteria which they attribute to performance prospects (MacMillan *et al*., 1985; Muzyka *et al*., 1996). A frequently cited criterion in VC investors' decision making is an attractive market-size. It serves as a proxy to VC investors in order to assess the future growth and return potential of firms pitching for investment (MacMillan *et al*., 1985). Other important criteria, highlighted in Table 4, include the qualifications and experience of founders and the firms' founding teams as well as intellectual capital in the form of patents and IP ownership.

Most studies on VC decision making, shown in Table 4, have an exploratory or a qualitative methodology. They rarely rely on theories from which hypotheses can be derived to be empirically tested. Zacharakis and Meyer (1998) question whether these findings can be generalized. Their experimental study tests how well VC investors understand and follow-up their own investment criteria. Relying on a theoretical framework based on theories in behavioural decision making (Tversky and Kahneman, 1974; Kahneman and Tversky, 1979) they find that VC investors are not very good in reflecting their decision-making process. This finding has been replicated by Levie and Gimmon (2008) who strongly state that the use of investment criteria can lead to availability biases in VC decision-making. Investment criteria need to be frequently updated reflecting the performance of VC investors' portfolio.

Table 4: Theoretical Insights Relating to the Supply-Side Perspective on the Provision of VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Tyebjee and Bruno (1984)	What defines the key step in venture capital investment activities? (1) Deal Organization (2) Deal screening: key policy variables (3) Deal evaluation: perceived risk and expected return (4) Deal structuring: price (equity relinquished), covenants to limit investors' risks (5) Post-Investment activities	Theory building	Factor analysis, regression	n/a	41 venture capitalists providing data on total of 90 deals Modal venture: start-up in electronics industry seeking $1 million (median) of outside financing, US	- Five underlying dimensions of the deal: 1) market attractiveness (size, growth, access to customers); 2) product differentiation (uniqueness, patents, technical edge, profit margin); (3) managerial capabilities (skills in marketing, management, fiancé and the references of the entrepreneur) (4); environmental threat resistance (technology life cycle, barriers to competitive entry, insensitivity to business cycles and down-side risk protection.;(5) Cash-Output Potential (future opportunities to realise capital gains by M&A, IPO). - Expected return is determined by (1) and (2) which positively influence investment decisions. - Perceived risk is determined by (3) and (4) which negatively influences investment decisions.
MacMillan *et al*. (1985)	What are venture capitalists' most important criteria used to invest in new ventures?	Theory building	Quantitative, interviews, questionnaire, Factor analysis	n/a	100 venture capitalists, US	- 'horse' (product), horse race (market), odds (financial criteria) are all necessary – but it is the 'jockey' (entrepreneur) who fundamentally determines whether the venture capitalist places a bet at all
Tyebjee and Bruno (1986)	How does one negotiate a deal with VC investors?	Theory building	Qualitative, interviews	n/a	n/a	- The price of VC is the equity share of the business given to the VC. - Valuation of a business is subject to: future earnings stream, dividend policy, sources and uses of cash, balance sheet analysis of net assets and their liquidity, and gross revenues. - New ventures have often no track-record and are subject to risk resulting in discount rates of 30% and more when VC investors evaluate the investment prospect. - VC investors bring more than financial investment if they have experience from previous investments leading to successful and rapid growing start-ups.

Table 4 (Continued)**:** Theoretical Insights Relating to the Supply-Side Perspective on the Provision of VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Hall and Hofer (1993)	What criteria do venture capitalists use to evaluate their investments?	VC Decision-Making	Qualitative, Semi-structure interviews;	n/a	4 VC with 22 investments, US	Key Criteria: - Fit with the venture firm's lending guidelines - Long-term growth and profitability of the industry in which the proposed business will operate. - Second stage of proposal assessment: the source of the business proposal played a major role in the venture capitalists' interest in the plan, with proposals previously reviewed by persons known and trusted by the venture capitalist receiving a high level of interest. - Venture capitalists attach surprisingly little importance to the entrepreneur/entrepreneurial team and the strategy of the proposed venture during these early stages of the venture evaluation process.
Muzyka *et al*. (1996)	What characteristics of investment opportunities are important to venture capitalists?	VC Decision-Making	Conjoint analysis, cluster analysis	n/a	73 interviews with venture capitalists, US	- The 'human factor' is of utmost importance. - All five management team criteria (as opposed to management competence criteria) were ranked among the first seven, product-market criteria appeared to be only moderately important, and fund and deal criteria were at the bottom of the rankings. - The venture capitalists interviewed would, as a group, prefer to select an opportunity that offers a good management team and reasonable financial and product-market characteristics, even if the opportunity does not meet the overall fund and deal requirements. Without the correct management team and a reasonable idea, good financials are meaningless because they will never be achieved. - Three groupings of venture capitalists: those primarily concerned with investing nationally, those who focus solely upon the deal, and those mainstream investors who consistently and instinctively rank the five management team criteria at the top of their list.

Table 4 (Continued)**:** Theoretical Insights Relating to the Supply-Side Perspective on the Provision of VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Boocock and Woods (1997)	What characterizes the Midland Enterprise Fund and which applications were successful?	VC Decision-Making	Qualitative, interviews	n/a	Case Study of the Midland Enterprise Fund of the East Midlands analysing 232 applications leading to three investments 26 pending, UK	- Evaluation criteria are difficult to generalise – especially, with respect to how they are weighted regarding their importance against each other. - Evaluation criteria appear to be flexible tools along the multi-staged evaluation process which investment seeking firms face when applying for VC financing.
Zacharakis and Meyer (1998)	How deeply do VC investors think about their own decision process, and are they biased?	Social judgement theory	Quantitative, Real-time decisions, controlled experiment, regression	Likelihood to invest in firm on a seven-point Likert scale	51 VC investors, US	- VCs are not good at introspecting about their own decision process - even within the confines of a controlled experiment, which greatly reduces the amount of information. - Most decision-makers would like to have all relevant information available for their decision. However, as more information becomes available, insight diminishes. - VCs are very consistent in their decision process, even though they do not necessarily understand how they make their decisions. VCs face a plethora of information when making an investment decision (i.e., business plan, outside consultants, due diligence, etc). It may be difficult for VCs to truly understand their intuitive decision process because of all the noise caused by this information overload. - Decision aides can minimize the danger of salient information (e.g., the lead entrepreneur is a winner) clouding the VC's judgement. - People have a tendency to overstate the information they believe they relied upon and to use far less information (typically three to seven factors) to make a decision than they actually think they use. - Even though VCs are experts in the new venture funding realm, their decision process has room for improvement. Almost 40% of all backed ventures fail to provide a return to the VC.

Table 4 (Continued)**:** Theoretical Insights Relating to the Supply-Side Perspective on the Provision of VC Investment						
Author(s)	**Research question(s)**	**Theory (ies)**	**Methodology**	**Dependent variable(s)**	**Sample size and context**	**Findings**
Franke *et al*. (2006)	Is there a similarity between the profile of a venture capitalist and the profile of a start-up team, and does this result in a more favourable evaluation by the venture capitalist?	Learning theory, Self-categorization theory, Social Capital / Network Theory	Quantitative, Conjoint Analysis, ordered probit	n/a	51 interviews in 26 VC firms in Germany and Austria	- Existence of this distortion due to the interaction of characteristics of VC and start-up team. - The more closely the team members' profiles resemble that of the VC with respect to two important dimensions, the better—on average—the team will be rated. - Rather strong similarity bias for the type of education: VCs who had received training both in engineering and in business gave a significantly higher rating than other VCs to teams whose members have an education partly in engineering, partly in business. - VCs who had received training in business administration only rated teams whose members also have an education only in business higher than other VCs. - A strong bias also exists with respect to the type of firm where VC and members of the venture team have gathered prior professional experience. - VCs with prior experience obtained in large firms only; these individuals tend to prefer teams whose members have largely come from a large-firm background.
Dimov and Murray (2008)	Which factors influence a VC firm's decision to undertake seed capital investments and, subsequently, the scale of such activity?	Behavioural decision making, Agency theories	Quantitative, secondary data, probit regressions	(1) the proportion and (2) the number of seed investments made by a particular VC fund	Investments made by 2949 VC funds raised worldwide between 1962 and 2002, US	- Investor age, timing of investment, and fund location are of importance. - The size of the fund and the existing number of portfolio firms exert opposite influences on the level of seed capital activity of the VC firm. - Seed activity is a valuable source of market intelligence for leading VC firms seeking proactively to identify and invest in novel technologies.

Boocock and Woods (1997) are also critical of the fact that investment criteria are difficult to generalize because different VC firms follow very individual strategies and stages when negotiating with potential investees. To date, only a few studies explore the heterogeneity of VC firms themselves, and whether their investors' human capital and experience influence their decisions and their portfolio's performance (Dimov and Shepherd, 2005; Dimov and Murray, 2008). Given this criticism, it appears to be difficult to solely rely on a supply-side perspective to explain the attraction of VC.

The second group of studies have utilized a market perspective to explore the coordination between supply (i.e. VC firms) and demand (i.e. entrepreneurs) actors relating to VC investment. These studies are summarized in Table 5. Prominent theoretical perspectives, used to explain market co-ordination, are taken from principal agent theory (Reid, 1999) and game theory (Cable and Shane, 1997): the latter perspectives both recognizing that VC firms (i.e., VC investors) and entrepreneurs (i.e., VC investees) are mutually dependent. Their individual actions and efforts affect each other's outcomes (Wijbenga and van Witteloostuijn, 2006). The degree to which they can mutually benefit from each other is constrained by an information exchange problem which affects market co-ordination. Purely theoretical studies by Elitzur and Gavious (2003b) and Fairchild (2004) show that informational asymmetries regarding the capabilities and efforts of entrepreneurs and VC investors threaten mutually beneficial outcomes. If a party can exploit such informational asymmetries to maximise its own self-interest, the other party's outcome will be adversely affected (Reid, 1999). VC investors will not invest if they cannot overcome informational asymmetries and uncertainty about the capabilities and prospects of investment opportunities, unless there are mechanisms in place to protect them and help them to reduce their risks.

As a possible solution to the information exchange problem in the VC market, the principal agent literature suggests that contracts with incentives and performance-dependent outcomes can incentivize both parties not to exploit each other (Elitzur and Gavious, 2003a; Kaplan and Stromberg, 2003). Principal agent theory and game theory both illustrate that demand and supply can be coordinated in the presence of uncertainty and informational asymmetries. Their mathematical models are of abstract but analytical strength in explaining market outcomes.

Table 5: Theoretical Insights Relating to the Market Perspective on the Attraction of VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Berglof (1994)	How do an entrepreneur and an external investor allocate revenues and control among themselves in a venture capital relationship, given that they want to liquidate their holdings in the future?	Principal Agent Theory, Contracting	Theoretical	n/a	n/a	- Standard and debt equity can play a role in contracting between investor and entrepreneur. - Standard debt contract is an effective way to prevent value decreasing actions in losing control to third parties. - The capital structure must match the financial strategy: If an IPO is the preferred exit option contracts must allow the spread of ownership.
Cable and Shane (1997)	Does the relationship between venture capitalist and investee resemble the 'prisoners' dilemma'?	Game Theory	Theoretical	n/a	n/a	- New business start-ups with VC backing depend on mutual co-operation between entrepreneurs and venture capitalists. - The probability of a co-operative relationship increases with each party's perceived time pressure. However, these pressures are likely to be greater for entrepreneurs than VC investors. - The probability of a cooperative relationship increases with each party's perceptions of the payoffs from cooperation. - The probability of a cooperative relationship increases with the quality and frequency of communication between the parties.
Reid (1999)	Can VC investor and investee relationships be modelled as principal agent relationships?	Principal-Agent Theory	Qualitative, Face to face interviews	n/a	Panel of 50 investors for the years 1988–92 cross-section of 20 paired investor-investee cases for 1993; cross-section of 14 investees for 1993, UK	- VC investors face information asymmetries when evaluating investment opportunities which constrain them in assessing their investment risks. - VC investors are principals which cannot optimally monitor the behaviour and performance of their investees (i.e. agents). - Optimizing contracts and incentives are required to reduce VC investors' investment risks.

Table 5 (Continued)**:** Theoretical Insights Relating to the Market Perspective on the Attraction of VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Osnabrug-ge (2000)	What are the investment criteria and procedures of business angels (BAs) and venture capitalists (VCs) across the full investment process?	Principal-Agent Theory	Qualitative and quantitative, descriptive statistics	n/a	40 personal interviews; 143 survey responses from business angels, 119 survey responses from VC investors	- Business angels reduce risk after investment (the incomplete contracts approach). - VC investors reduce risk before investment (the principal-agent approach).
Lockett *et al*. (2002)	Do UK venture capitalists still have a bias against investment in new technology firms?	Theory Building	Quantitative, Descriptive statistics, mean comparison	n/a	1999 survey of 60 UK venture capital firms compared to a 1991 study, UK	- Increasing importance of technology investments to VC firms - Adoption of collaborative strategies to access intellectual capital and complementary resources via inter-firm networks is particularly important - A bias is likely to remain against VC firms' involvement in the earliest (seed and start-up) stage of the technology investment cycle
Elitzur and Gavious (2003a)	What characterizes equilibrium contracts in the relationship between an entrepreneur, an angel and a VC from the seed investment made by the angel to the exit stage?	Signalling Theory, Game Theory, Principal Agent Theory	Theoretical	n/a	n/a	- Opportunistic behaviour of both the entrepreneur and VC leads to a moral hazard problem, with these two players becoming 'free riders' coasting on the investment made by the angel. - Behaviour of VCs and entrepreneurs leads to a prisoner-dilemma-like outcome. This moral hazard problem cannot be avoided but could be alleviated through governance and financing mechanisms such as stock options, staged financing, and direct oversight. - If the entrepreneur has incurred some cost in dealing with the angel, this action signals that the entrepreneur has chosen to exert a positive level of effort and that he is going for the equilibrium leading to a positive cash-out firm value. - Angel-backed firms could be seen as firms whose founders opted for a viable firm, rather than choosing to 'take the money and run.'

Table 5 (Continued)**:** Theoretical Insights Relating to the Market Perspective on the Attraction of VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Janney and Folta (2003)	How do young, publicly held technology firms contend with information asymmetry, and the hazards it introduces, to acquire the capital necessary for future growth?	Principal Agent Theory, Signalling Theory	Quantitative, secondary data, OLS regression	Cumulative abnormal returns	328 biotechnology firms with publicly traded stock between 1973 and 1998; US	- Firms issuing private equity signal to the marketplace that managers believe their growth opportunities are undervalued. - There are significant positive abnormal returns to announcements of private equity placements. - Returns are determined by the timing of previous signals. - The characteristics of the private placement signal, specifically whether private equity is bundled with research partnerships, influence the strength of the signal.
Fairchild (2004)	How can the relationship between manager and venture capitalist bargaining over the financial contract be modelled in the face of double-sided moral hazard problems?	Bargaining Theory, Contracting	Theoretical	n/a	n/a	- The allocation of cash flows depends on the combined effects of value-added services, reputation seeking, and bargaining power. - Welfare is maximized when the venture capitalist has high value-adding capabilities, the market for reputation is informational efficient, and the manager has bargaining power.
An'e (2007)	What signalling costs can resolve adverse selection between VC investors and investees?	Game Theory, Signalling Theory, Principal Agent Theory	Theoretical	n/a	n/a	- Relationship between VC investors and investees fits within a principal-agent framework. - In the asymmetric information, there exists serious adverse selection between the investor and the venture capitalist. - To eliminate this adverse selection, the investor can notice some signals to identify high-quality venture capitalist.

However, Shane and Cable (2002) assert that contractual solutions fail to be realistic. The view that entrepreneurs only accept contracts solely based on assumptions about the rationality of their decision making is questionable. Entrepreneurs are often considered to be overconfident about their own abilities (Busenitz and Barney, 1997; Camerer and Lovallo, 1999): they can make misjudgements when negotiating contracts with VC investors which are subject to future performance goals. Furthermore, contracts do not relate to complete information (Osnabrugge, 2000).

An alternative solution to purely contract based incentives, is to rely on available information which the negotiating parties can use as signals of quality to convince each other of their credible capabilities and prospects to generate mutually beneficial returns (Elitzur and Gavious, 2003a; An'e, 2007). This approach originates from Spence's signalling theory (1973) which has been an important influence on game theoretic models focusing on the causes and consequences of markets and negotiations affected by informational asymmetries (Watson, 2002; Dixit and Skeath, 2004). However, for explaining market coordination with the help of signalling theory, a better understanding of the characteristics of the demand-side is required, too, as discussed in the following paragraphs.

The third and most recent group of studies, shown in Table 6, focuses on the demand-side characteristics of firms seeking VC investment (Shane and Cable, 2002; Janney and Folta, 2003). They attempt to identify which characteristics of start-ups are more likely to attract VC investment (Beckman *et al*., 2007). These demand-side studies are often context specific. For example, several studies focus on the financing of high-tech start-ups in order to identify their needs and barriers to development. The strength of this group of studies is in replicating resource-based theoretical frameworks. Social network theory has been used to explain why new firms can attract investors despite facing high level of risk and uncertainty (Shane and Cable, 2002).

Additional resource categories, such as general and specific human capital (Beckman *et al*., 2007), networks and intellectual capital as well as financing are considered. Moreover, these insights from a demand-side perspective can be linked to the studies on the context of USOs already discussed in Section 2.2 which adopt the same perspective. Pure demand-side studies are associated with weaknesses. Section 2.2 illustrates that some studies fail to integrate different resource perspectives into a joint framework, in order to derive and test hypotheses exploring the co-ordination between supply and demand in the VC market.

Table 6: Theoretical Insights Relating to the Demand-Side Perspective on the Attraction of VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Shane and Cable (2002)	How do entrepreneurs overcome information asymmetry between themselves and potential investors to obtain financing?	Social Capital / Network Theory	Quantitative survey, logistic regression analysis	VC Investment (yes, no)	in-depth fieldwork with 50 high-technology ventures; 202 seed-stage investors, US	- Economic explanations for venture finance, which do not consider how social ties influence this process, are under-socialized and incomplete. - Organization theoretic arguments, which draw on the concept of social obligation, are over-socialized. - Direct and indirect ties between entrepreneurs and seed-stage investors influence the selection of ventures to fund through a process of information transfer.
Baum and Silverman (2004)	Do VC investors 'pick winners' or 'build winners' when making investments in high tech start-ups?	Signalling Theory, Human Capital Theory	Quantitative, secondary data, panel data time series	Amount of pre-IPO financing; revenue; R&D spending growth; number of annual patent applications; number of annual patents granted	204 Biotech start-ups, Canada	- VCs finance start-ups that have strong technology, but are at risk of failure in the short run, and so in need of management expertise. - VCs also appear to make a common attribution error overemphasizing start-ups' human capital when making their investment decisions.
Busenitz *et al*. (2005)	Do signals about the wealth and experience of the founding team serve as credible signals for the future value of a venture?	Signalling Theory	Quantitative, Event history analysis (Cox regression)	(1) out-of-business, (2) still-private, (3) merged or acquired, and (4) IPOs	183 VC-backed ventures, US	- Neither signals of value (percentage of equity held by founding team) nor signals of commitment (percentage of individual wealth invested by the founding team in their firm) have positive relationship with survival, M&A or IPOs. - Founding team's experience with VC investors has no influence on performance. - Founding teams' entrepreneurial experience has no strong influence on performance.

Table 6 (Continued)**:** Theoretical Insights Relating to the Demand-Side Perspective on the Attraction of VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Dimov and Shepherd (2005)	Is there a relationship between the education and experience of the top management teams of VC firms and the firms' performance in their portfolio?	Human Capital Theory	Quantitative, secondary data, Hierarchical OLS Regressions	'home runs' = proportion of companies added to the VC firm's portfolio in the last five years that had gone public; 'strike outs' = proportion of the same companies that had gone bankrupt.	112 VC firms that have also made at least one investment in the wireless communication industry, US	- General human capital had a positive association with the proportion of portfolio companies that went public initial public offering (IPO), however, specific human capital did not. - Specific human capital was negatively associated with the proportion of portfolio companies that went bankrupt.
Beckman *et al*. (2007)	Does the founding team composition and turnover shape an entrepreneurial firm's ability to attract venture capital and its ability to successfully complete an initial public offering?	Human Capital Theory, Social Capital / Network Theory	Quantitative, longitudinal, secondary data, event history analysis (Cox regression)	Whether and when the founding team received any amount of money from a VC; Event of IPO	161 young high-technology Firms from Silicon Valley, US	- Broad access to information by virtue of having top management team members that have worked for many different employers (diverse prior company affiliations) and have diverse prior experiences (functional diversity) tend to be associated with positive outcomes. - Entrants to and founder exits from the top management team increase the likelihood that a firm achieves an IPO. TMT exits, in turn, reduce the likelihood of achieving an IPO. - Prior human capital experience is consistently associated with positive firm outcomes. - Team experiences, composition and turnover are all important for bringing new insights to the firm and are associated with the likelihood that an entrepreneurial firm will succeed.

Table 6 (Continued)**:** Theoretical Insights Relating to the Demand-Side Perspective on the Attraction of VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Hsu (2007)	Do varied levels of prior start-up founding experience, academic training, and social capital influence the sourcing and valuation of venture capital?	Signalling Theory, Human Capital, Networks (VC demand)	Quantitative survey of early stage technology-based start-up firms	Funding via direct VC tie (probit regression); pre-money valuation (OLS regression)	149 early stage technology-based start-up firms, US	- Prior founding experience especially financially successful experience) increases both the likelihood of VC funding via a direct tie and venture valuation. - Founders' ability to recruit executives via their own social network as opposed to the VC's network) is positively associated with venture valuation. - In the emerging at the time) Internet industry, founding teams with a doctoral degree holder are more likely to be funded via a direct VC tie and receive higher valuations, suggesting a signalling effect. - The paper therefore underscores some important dimensions of heterogeneity among VC-backed entrepreneurs.
Levie and Gimmon (2008)	Why is VC investors' valuation of new business based on founders, human capital suboptimal?	Signalling Theory, Human Capital (VC market and supply)	Qualitative, semi-structured interviews	n/a	3 VC investors, 3 Business Angels; US, UK and Israel	- There is a gap between VC investors' decision-making criteria and espoused criteria. - There is extensive use of gut feeling in decision-making was supported. - VCs focus on harvest potential and de-emphasize measures of founder technology capability that predicted early survival and growth in an earlier study.

Notably, most of these studies are so exploratory and context specific that the ability to generalize from them is limited. Studies by Baum and Silverman (2004), Busenitz *et al*. (2005) and Hsu (2007) address the weakness of a pure demand-side perspective. They are the first to provide an integrative theoretical framework which links the demand-side characteristics of new firms with the information needs of the VC supply-side in order to explain market coordination. Their approach is replicated and further extended in this study.

2.3.2 Demand-Side: The Resource-Based View of the Firm (RBV)

This section develops a demand-side perspective for the take-up of first VC investment. The RBV of the firm is the base theory from which to argue that the resources of USOs are internal factors that characterize the demand-side and may influence the attraction of first VC investment.

The RBV of the firm suggests that firms seek to generate and maximize profits. The scale and scope of firms is shaped by the composition and characteristics of their internal resources (Holmstrom and Tirole, 1989). Firms have to make best use of their available internal resources in order to provide their products and services with a competitive advantage (Barney, 1991). Table 7 summarizes assumptions, conditions and implications of the RBV of the firm which are discussed below.

The first assumption is that firms' resources comprise all tangible and intangible assets, capabilities, firm attributes and information as well as knowledge which are tied to and controlled by the firm (Maijoor and Van Witteloostuijn, 1996). Second, firms within the same industry or sector differ regarding the strategic resources they control. This differentiation of internal resources explains differing outcomes by firms operating in the same industry or sector (Barney, 1991, 1995). Third, internal resources of firms are assumed to be imperfectly mobile across firms. This can be due to a variety of reasons such as natural monopolies, asset specificity or legal protection (Conner, 1991).

The RBV of the firm assigns four conditions which resources have to fulfil in order to generate a sustained competitive advantage for a firm. Resources need to be valuable, rare, imperfect to imitate and difficult to substitute (Barney, 1991). These conditions need to be considered by firms when seeking optimal strategies based on their internal resources

targeting to a sustained competitive advantage against other firms operating in their markets and industries (Spanos and Spyros, 2001).

Table 7: Resource-Based View of the Firm (RBV): Assumptions, Conditions and Implications

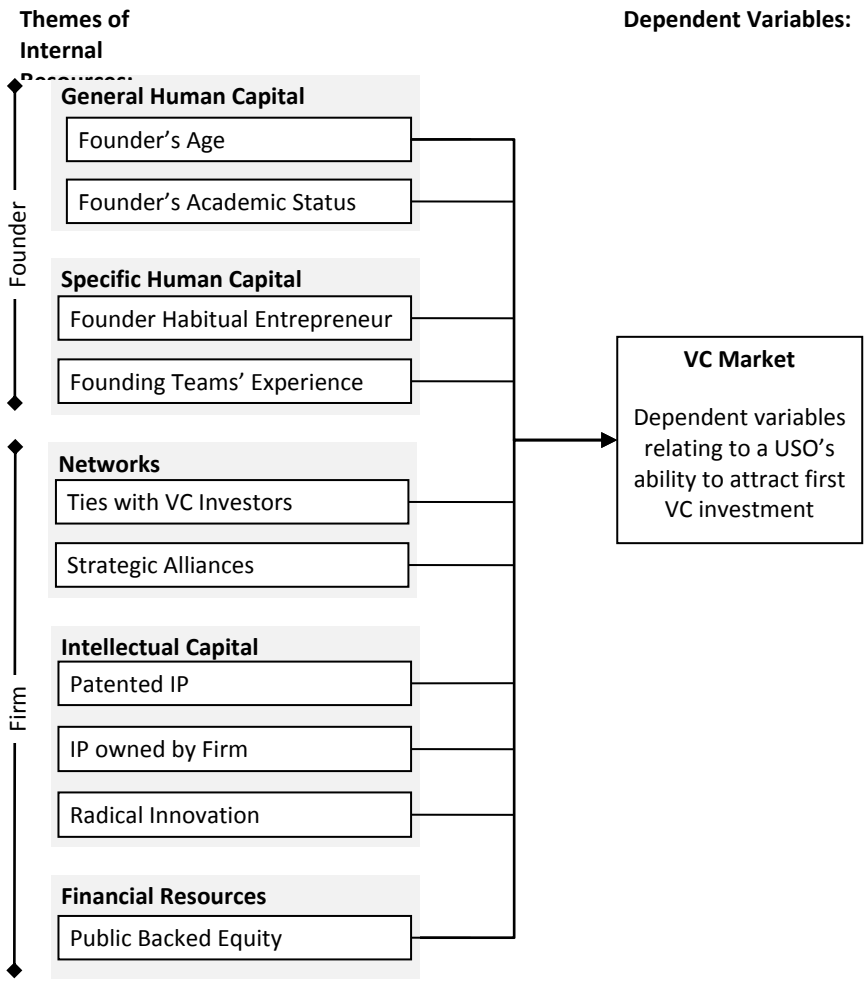
Assumptions of the RBV of the firm:	**Conditions for a sustained competitive advantage:**	**Implications of the RBV of the firm for this study:**
• Firm resources are all assets, capabilities, firm attributes, information, and knowledge controlled by a firm to conceive and implement strategies improving performance. • Firms in the same industry (or group) differ regarding the strategic resources they control. • Resources are not perfectly mobile across firms, and heterogeneity is long lasting.	• **Valuable:** They enable a firm to conceive and implement strategies to exploit opportunities or neutralise threats. • **Rare:** They are required but not equally owned and controlled by competitors. • **Imperfect to imitate:** They were first acquired or require special skills or permission to replicate. • **Substitutability:** There are no other resources available that are strategically equivalent.	• Internal resource endowments can determine firms' development, performance and may lead to a sustained competitive advantage. • The RBV is compatible with the entrepreneurial process: new firms and opportunity discovery commonly involve novel and innovative combination of unique resources. • The RBV integrates fragmented views on which initial resource endowments are related to firm performance. RBV cannot explain the market co-ordination due to missing a supply-side perspective.

The RBV of the firm can be viewed as a critical response to Porter's competitive advantage strategy. It assumes that all firms are identical regarding strategically relevant resources they control (Porter, 1987; 1991). According to Porter's view, strategies are determined only in response to external factors such as market and industry conditions. The RBV of the firm argues instead that internal resources can be the source for firms' sustained competitive advantage if they are valuable, rare, imperfect to imitate and substitute.

Different themes of resources can be integrated in the RBV of the firm characterising firms' heterogeneity as the source of performance differentials (Rumelt, 1991).

This study replicates and extends the RBV of the firm in order to explore whether some firms (and entrepreneurs) with certain resource profiles can provide 'positive signals' that increases the probability that they will obtain first VC investment. This approach is adopted from Baum and Silverman (2004), Busenitz *et al*. (2005) and Hsu (2007) as discussed in Section 2.3.1, who link a resource-based demand-side perspective as the initial point to explain market co-ordination relating to the supply of VC investment. Guided by insights from the RBV of the firm, five themes characteristic to the demand-side profile of a firm and its entrepreneur are considered to impact the ability to attract first VC investment. These themes are summarized in Figure 11. Each theme will be discussed, in turn, below.

Figure 11: Resource Themes Linked to the Attraction of First VC Investment (Research Question 1)



2.3.3 Human Capital Theory

Human capital theory originates from the discipline of economics and was initially applied to education and labour markets (Becker, 1993). It is based on the strong rationality assumption that individuals only invest in education or training if they can expect that obtaining new knowledge and skills will lead to benefits from increased levels in productivity (Becker, 1975).

The scope of this general implication of human capital theory has been broadened by relaxing the assumption of rationality in individuals' decision-making. Research in psychology and behavioural economics shows that decision-making is often situational and context specific (Kahneman and Tversky, 1979). Less conscious attributes of individuals like habits, attitudes and experiences building knowledge can also qualify as human capital (Becker, 1993). As a consequence, a distinction has been made between general and specific human capital.

2.3.3.1 General Human Capital

The general human capital of a firm relates to resources including capabilities, information and knowledge of their founders, owners and employees. These intangible assets can be distinguished according to two groups. General human capital occurs in 'non-intellectual' form including demographic characteristics such as age, parental background or gender (Ucbasaran *et al*., 2008). These characteristics are unalterable and cannot be consciously invested in. Nevertheless, they can capture the experience and capabilities of the people involved in a firm (Hambrick and Mason, 1984). Further, general human capital occurs in an 'intellectual' form, which is the result of individuals' investments in education and learning. Investment in education is strongly associated to build and strengthen abilities of problem solving, discipline, motivation and self-confidence (Cooper *et al*., 1994). Entrepreneurs' ability to identify and exploit business opportunities shaped by the organisation and leverage of general human capital (Venkataraman, 1997).

Intangible assets relating to firm owners and employees can shape firm development. The availability of experts with the education and academic experience to

exploit a technology is required to ensure the competitive advantage of knowledge-based firms (Audretsch and Lehmann, 2005a, b).

2.3.3.2 Specific Human Capital

The specific human capital of a firm relates to resources comprising the capabilities, information and knowledge of firm founders and employees. It is context specific and difficult to transfer to other contexts. Specific human capital relevant to new firms can relate to a diverse range of knowledge including technology, market, customers or sales techniques (Marvel and Lumpkin, 2007).

Firm owners with prior entrepreneurial experience are commonly regarded to have a rich collection of relevant specific human capital increasing their abilities to turn their ventures into successes. For instance, McGrath (1999) argues that experienced entrepreneurs learn from failure which will benefit the performance of their future ventures. The influence of experienced entrepreneurs on firm performance was studied more thoroughly by Westhead and Wright (1998a, b, 1999). They advocate the differentiation between different types of experienced entrepreneurs. Initial studies only compared novice and experienced (or habitual) entrepreneurs. More recently, the analysis of experienced entrepreneurs has focused upon on 'serial entrepreneurs' (i.e. entrepreneurs that only start a new firm after leaving their previous one) and 'portfolio entrepreneurs' (i.e. entrepreneurs that run two or more firms at the same time) (Ucbasaran *et al*. 2008).

Ndonzuau *et al*. (2002) and Vohora *et al*. (2004) find that academic entrepreneurs are particularly challenged not only by the recognition of commercially viable business opportunities but also in managing the growth of their venture. Previous entrepreneurial experience of academic entrepreneurs and their founding team can reduce barriers to additional resources for firm development, and promote superior firm performance (Mosey and Wright, 2007).

2.3.4 Networks

Networks are relational structures between individuals, organisations or firms (Wasserman and Faust, 1994). The social capital of networks is an important resource which can help to attract and leverage resources required for firm development (Gulati, 1998). Networks are valuable as a result from repeated social or organisational interaction leading to trust (Uzzi and Gillespie, 1999), status (Podolny, 1993) and reputation (Podolny, 1994). Networks present an alternative to market transfers in order to obtain further resources and knowledge (Nahapiet and Ghoshal, 1998). Network memberships can enable benefits from direct and indirect ties between individuals or firms which (Granovetter, 1973; Burt, 1987), which are otherwise not available.

USOs seeking finance from VC investors depend on networks to avoid disadvantages from regional clusters with less economic and VC investment activities (Mason and Harrison, 2002a). Direct ties between experienced entrepreneurs and VC investors can lead to VC investment (Shane and Cable, 2002; Shane and Stuart, 2002). Inexperienced academic entrepreneurs can benefit from indirect ties to previous USOs from the same university of origin (Myint *et al.*, 2005; Mosey *et al.*, 2006).

Strategic alliances with other organisations can attract and leverage resources required for firm development. These inter-firm networks are valuable and exclusive intangible assets resulting from voluntary agreements between firms. Alliance partners benefit from exchanging and sharing information as well as jointly develop products or services (Gulati, 1998) leading to a competitive advantage. Strategic alliances are valuable in offering a reduction in transaction costs for firms (Kogut, 1988).

2.3.5 Intellectual Capital

The knowledge-based economy sees a shift from the importance of physical assets essential to an industrial and manufacturing based economy towards the resource of intellectual capital (Stam and Garnsey, 2007). This intangible asset captures firms' innovative capabilities and abilities to process information and knowledge effectively to identify and exploit business opportunities (Nahapiet and Ghoshal, 1998). Knowledge is not

only subject to the human capital of founders and employees but is also embedded in the nature and the process of organisations which defines the intellectual capital of firms (Marshall, 1965; Arrow, 1974).

The more a firm depends on its intellectual capital to exploit a business opportunity the more it needs to defend this asset specificity in the market place. Patenting intellectual property (IP) is an important strategy to protect intellectual capital against competitors. Patents ensure that intellectual capital is difficult to imitate and substitute by competitors (Baum and Silverman, 2004). A firm with a patent has a competitive advantage on strategic factor markets (Barney, 1986).

The innovation of intellectual capital is of particular asset specificity in the context of USOs. The lead entrepreneurs (i.e. the founding academic entrepreneurs) need to develop and implement an organisational form which best embeds the knowledge to exploit the identified business opportunity (Vohora *et al*., 2004). Schumpeter (1934, 1954) argues that radical innovation can provide a firm with monopoly power and related returns. However, investing in radical innovation is very risky as there is high uncertainty regarding the potential market size and competitors' responses (von Hippel, 1988).

2.3.6 Financial Resources

The value of financial resources to new firms is subject to their individual financial needs, their individual wealth as well as their abilities to attract external financing. Financial resources can be defined as all monetary assets including firm's borrowing capacity, ability to attract equity finance (Dollinger, 2003; Timmons and Spinelli, 2003).

The availability of internal financing is subject to founders' savings and wealth. Moreover, depending on the performance of their firms, profits can be reinvested to grow the business. In practice, many owners of firms are often lack sufficient personal internal financing sources (Astebro and Bernhardt, 2003). Capital intensive young firms often lack sufficient revenues to internally finance growth and survival (Kinsella and McBrierty, 1997; Chiesa and Piccaluga, 2000). This constitutes the demand for external finance.

Section 1.2.2 highlighted that debt and equity as two important types of external financing. The provision of external finance and the amount of external finance provided is subject to the providers' willingness to take risk. Debt finance is sought by firm owners who seek to maintain control of their ventures. Firm owners have to be able to pay interest rates and provide sufficient collateral for receiving debt. Although debt financing is usually less costly to entrepreneurs than sharing ownership of the firm with an equity investor (Dollinger, 2003), new firms are often too risky for banks to invest in (Myers and Majluf, 1984). As consequence, equity investments are most valuable for young firms with high risk profiles. In addition to attracting the required financial resources to generate growth and development of new firms, equity investments are valuable for a second reason. Equity investors such as VC firms are known for providing business expertise and a commitment for achieving strong commercial objectives. Sections 1.2.2 and 2.2 highlighted that USOs can benefit from the finance and expertise by VC firms. Issues relating to the supply and market co-ordination of VC investment are discussed in the following section.

2.3.7 Supply-Side: Signalling Theory

2.3.7.1 Overview

Guided by insights from signalling theory (Spence, 1973), this study explores whether the provision of first VC investment to USOs is shaped by the demand-side profiles of USOs (and their academic entrepreneurs) and the supply-side preferences of VC investors (i.e. VC firms). Entrepreneurs and their firms (i.e. the demand-side) can provide signals which can reduce uncertainty and asymmetric information for potential VC investors (i.e. the supply-side) in order to attract first VC investment. The types and the size of previous investments signalled by firms and entrepreneurs can be critically considered and evaluated by VC investors that are seeking to reduce their exposure to risk. This additional information can also be used by VC investors to more accurately ascertain whether they can lead their investees to superior performance after investing in them.

Table 8 summarizes the market assumptions, conditions and implications of signalling theory. These issues are discussed in more detail in the following sections.

Table 8: Signalling Theory: Market Assumptions, Conditions and Implications

Market assumptions of signalling theory:	**Conditions of for firms' resources to become signals of quality:**	**Implications of signalling theory for this study:**
• Signalling co-ordinates demand and supply on markets constrained by adverse selection resulting from uncertainty and asymmetric information.	• Resource characteristics need to be alterable. • Resource characteristics must be costly to obtain (signalling costs). • Investors (supply-side) associate signalling costs (demand-side) with future performance potential. • Investors frequently update their beliefs about the association between Signalling Costs and future performance potential.	• VC investors look for observable and credible signals of quality revealing the performance prospects of investment opportunities and reducing their investment risks. • USOs' initial resource endowments can be signals of quality.

2.3.7.2 Market Assumptions: Uncertainty and Informational Asymmetries leading to Adverse Selection

VC investors are specialised in identifying and investing in young firms with high performance potential (Timmons and Spinelli, 2003). In order to maximise future returns, VC investors need to separate 'good' from 'bad' investment opportunities (An'e, 2007). VC investors struggle to make this separation in markets which are affected by uncertainty and informational asymmetries as shown in Table 9. Both constraints lead to adverse selection (Akerlof, 1970) which prevent USOs from attracting VC investment as follows.

Table 9: Market Assumptions for USOs seeking VC investment leading to Adverse Selection

Uncertainty:	**Informational asymmetries:**	**Adverse selection:**
• New USOs are like all new firms exposed to a high likelihood of failure in early years. • Technology and market specific risks increase uncertainty of USOs' survival.	• VC investors cannot perfectly observe the performance potential of finance seeking USOs. • Information on USOs' performance prospects is unobservable, incomplete or manipulated.	• If VC investors cannot differentiate between 'good' and 'bad' investment opportunities they do not invest and leave the market.

From a demand-side perspective, firms (and entrepreneurs) need to improve the flows of relevant information (i.e. signals) to VC investors in order to improve their chances of obtaining VC investment. From a supply-side perspective, VC investors request additional information from firms and entrepreneurs that have made sufficient previous investments in costly resources (e.g. education, IP, etc.). If the demand-side can anticipate that these signals fail to communicate their quality to the supply-side of VC and thus do not increase their likelihood to attract VC investment due to uncertainty and asymmetric information, they will choose not to invest in their resource base. The result is adverse selection, as the supply-side cannot separate between 'good' and 'bad' investment opportunities. Therefore, VC investors will not choose to invest and will not meet the demand for VC investment.

To resolve adverse selection it is thus important what types of signals are effective to overcome uncertainty and asymmetric information to communicate the quality of the demand-side of firms (and entrepreneurs) to the supply-side of VC investment. The theoretical framework of this study addresses this issue in the following section.

2.3.7.3 Signalling to Attract VC Finance

USOs need to provide VC investors with credible information on their future performance potential (Shane, 2004a). They need to overcome an information exchange problem which is commonly referred to as a 'principal-agent problem' (Reid, 1999; Arthurs and Busenitz, 2003). The VC investor is the principal who provides the risk-capital to an entrepreneur (i.e. the agent) in order to maximise returns (Arrow, 1991). The relationship between VC investors and entrepreneurs is particularly characterized by mutual interdependence (Cable and Shane, 1997). Both parties depend on each other to maximise their individual returns (Wijbenga and van Witteloostuijn, 2006). VC investors depend on the abilities and skills of the entrepreneur to maximise their returns, whilst entrepreneurs benefit from the financing and business expertise provided by the VC investors.

According to signalling theory, information exchange problems can be resolved if several conditions are met. Signals can be all attributes by individuals or firms which are alterable and costly to obtain (Spence, 1973). VC investors need to decide on which resources of new firms can best predict their performance prospects.

A summary of frequent investment criteria reported by VC investors is presented in Table 10. Despite definitional differences between the presented studies, their identified investment criteria can be grouped according to key resource themes as done in the final column of Table 10. Interestingly, the identified resource themes sought after by the supply-side of VC investors are similar to the resource themes identified by the demand-side perspective of the RBV of the firm as discussed in Section 2.3.2. Following the implications of signalling theory, firms (and entrepreneurs) investing in these resources (i.e. entrepreneur general and specific human capital and firm networks, intellectual capital and finance) generate signals of quality which can increase their likelihood of obtaining first VC investment.

The resulting market co-ordination mechanism is summarized in Figure 12. This effectiveness of this mechanism depends on VC investors believe that investments in internal resources of the firm and entrepreneur such as specific human capital, intellectual capital and finance reduced risk exposure and promise a higher probability of up-side gains and superior firm performance if the USO receives additional external finance.

Figure 12: Market Co-ordination between USO and VC Investor with Signalling

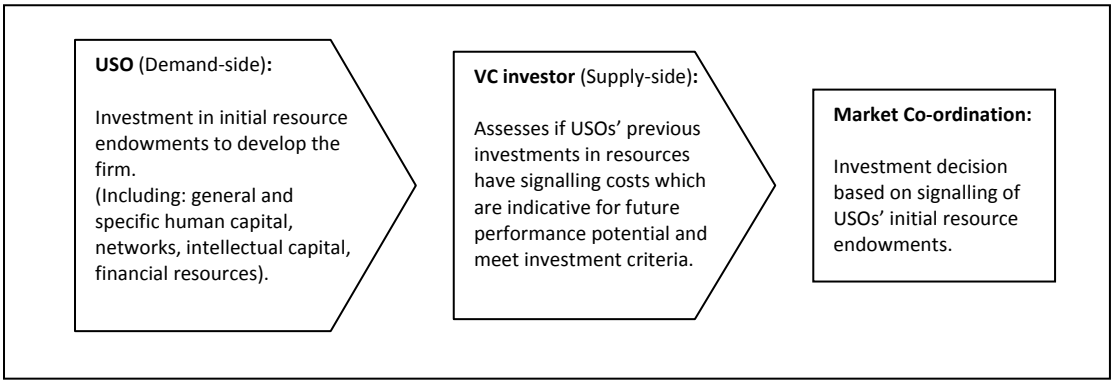


Table 10: Common Investment Criteria Reported by VC Firms (Adopted from Zacharakis and Meyer, 1998)

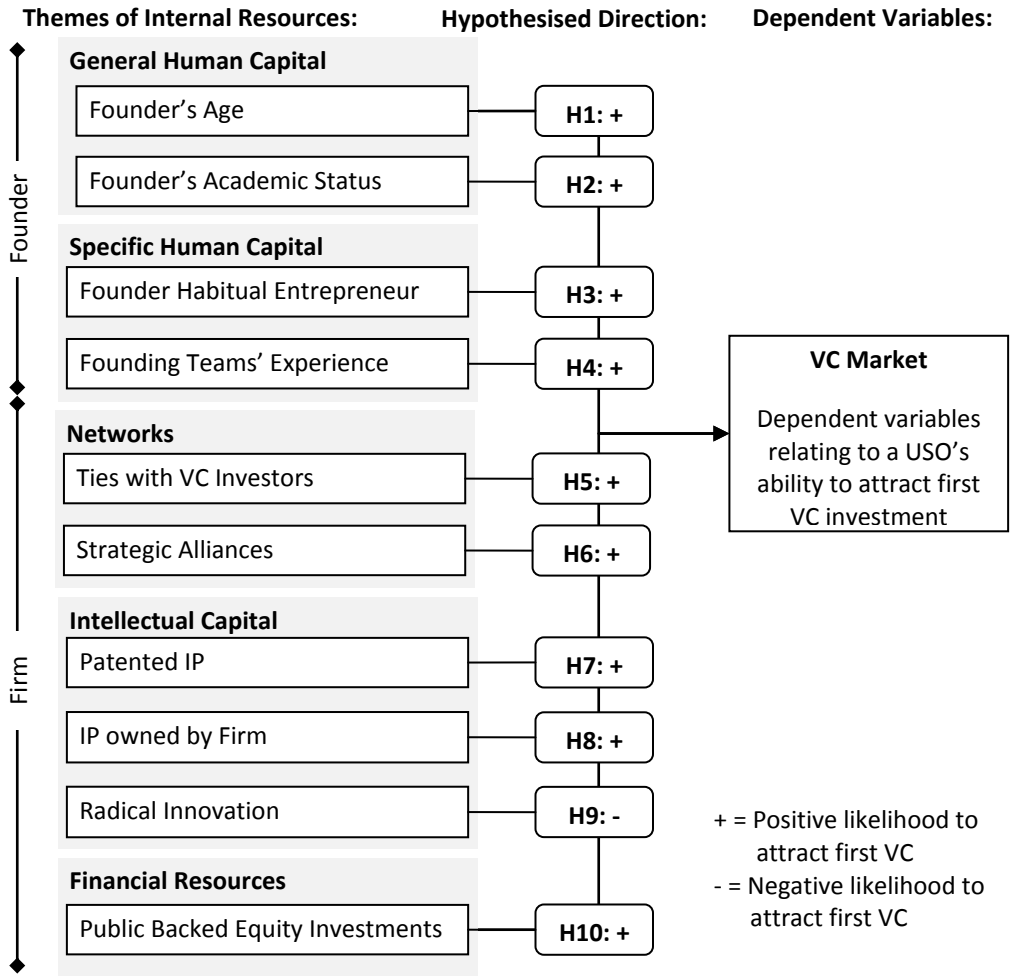
Study:	Wells (1974)	Poindexter (1976)	Tyebjee and Bruno (1984)	MacMillan *et al*. (1985)	MacMillan *et al*. (1987)	Robinson (1987)	Timmons *et al*. (1987)	Hall and Hofer (1993)	**Resources characterising the demand-side according to the RBV:**
Method:	Interviews	Questionnaire	Phone survey and questionnaire	Questionnaire	Questionnaire	Questionnaire	Unstructured interviews	Verbal protocol	
Sample Size:	8	97	46 / 41	100	67	53	47	16	
Entrepreneur/team characteristics:									General and specific human capital of founders and founding team
Management skill and experience	X	X	X	X	X	X	X	X	
Venture team				X	X	X		X	
Management stake in firm		X	X			X			
Personal motivation	X					X			
Entrepreneur personality				X					
Product/Service characteristics:									Intellectual capital of USO
Product attributes	X		X	X	X		X		
Product differentiation			X						
Proprietary	X		X	X	X		X		
Growth potential			X						
Market acceptance				X			X		
Prototype				X					
Market characteristics:									Controls for environment of USO
Market size	X		X				X	X	
Market growth	X		X	X		X	X		
Barriers to entry			X				X		
Competitive threat				X	X		X		
Venture creates new market				X					
Financial characteristics:									Finance
Cash-out method	X		X					X	
Expected ROR		X	X	X			X		
Expected risk		X							
Percentage of equity		X							
Investor provisions		X							
Size of investment	X		X						
Liquidity				X	X	X			
Other:									
References	X					X			Networks
Venture development stage		X	X						
VC investment Criteria								X	

2.4 Hypotheses Derivation: Attraction of First VC Investment

2.4.1 Overview

Guided by insights from the RBV of the firm and signalling theory, the integrated theoretical framework discussed in the previous section suggests that a firm's internal resources (i.e. entrepreneur general and specific human capital and firm networks, intellectual capital and finance) can act as signals. Appropriate latter signals can reduce a VC investor's risk exposure. Firms and entrepreneurs that provide sufficient signals relating to their internal resource profiles may, therefore, increase their chances of obtaining first VC investment. Hypotheses derived from this integrated theoretical framework are summarized in Figure 13. Each hypothesis is discussed, in turn, in the following sections.

Figure 13: Overview of Hypotheses on the Attraction of First VC Investment (Research Question 1)



2.4.2 General Human Capital

The first resource shown in Figure 13 relates to the general human capital of USOs' founders. VC investors can use this information to assess whether founders have valuable skills and experience which are required to turn their firms into successful businesses. In line with signalling theory, founders who have invested greater opportunity costs to increase their general human capital will increase their credibility towards VC investors (Hsu *et al*., 2007). Higher levels of general human capital benefits founders in their ability of problem solving, building network connections and assessing the feasibility of their venture's objectives and are valued by VC investors. Due to the absence of direct performance measurements and limited commercial track-record of new firms, VC investors often rely on inferring from information on the abilities of founders to the quality of their firms (Stuart *et al*., 1999).

In order to reduce their exposure to risk, some VC investors are more inclined to invest in older and more experienced entrepreneurs. Middle-aged entrepreneurs are often regarded more successful in securing funding due to their ability to provide collateral as well as providing a substantial credit record (Cressy and Storey, 1995). Older and more experienced entrepreneurs are also more likely to have higher levels of general human capital which help to attract further finance (Cooper *et al*., 1994).

In the context of USOs, more mature academic entrepreneurs can have a longer academic career and broader research experience in the technology or area from which the IP is derived. Founders' age may thus reflect their competence and skills in assessing the feasibility of the intellectual capital driving USOs' business model. Consequently, the following hypothesis is suggested:

Hypothesis 1: Older USO founders are more likely to attract first VC investment.

VC investors commonly prefer founders with higher levels of education (MacMillan *et al*., 1985; Levie and Gimmon, 2008). This is because education is commonly regarded as the source of knowledge, problem-solving skills, discipline, motivation and self-confidence (Cooper *et al*., 1994; Davidsson and Honig, 2003). Education is a credible signal of quality as founders face substantial opportunity costs including finance, time and career trade-offs in order to achieve a higher level of qualification. The credibility of the signalling of education

to VC investors is increased by academic status among founders of USOs (Huggins, 2008). VC investors can rely on this signal if they are not experts in the founders' field of research. The observable academic status of a founder allows also inferring to the quality of the IP which the USO seeks to commercially exploit. Shane and Stuart (2002) suggest that those academic entrepreneurs associated with the academic status of being a professor provide a signal of quality to VC investors. Accordingly, the following hypothesis is suggested:

Hypothesis 2: USO founders with higher levels of academic reputation are more likely to attract first VC investment.

2.4.3 Specific Human Capital

The second resource shown in Figure 13 relates to the specific human capital of USOs' founders. VC investors are looking for experienced entrepreneurs as they seek to identify the most adept and qualified individuals who can turn their investment into a success. In the absence of more objective data on the prospects of new firm, founders' entrepreneurial track-record is an alternative information source to make an informed judgement. VC investors are often looking for founders who possibly best understand their business model. Founders with entrepreneurial experience are more likely to have greater knowledge for understanding their technology, market and customers which helps them to control their operational risks. Founders who have proven before that they can start a new firm are thus more likely to also reduce VC investors' risk leading to the following hypothesis:

Hypothesis 3: USO founders who are experienced entrepreneurs are more likely to attract first VC investment.

Firms are seldom started by single individuals. Founders recognize the need to build a team in order to add skills they don't have themselves, but perceive as necessary to best exploit their business opportunity. Founding teams with a wide range of experiences, capabilities and skills are typically better equipped to develop and exploit new ideas (Beckman *et al*., 2007). The composition and characteristics of founding teams founding teams can thus reveal additional important information to VC investors which helps to assess the risk and return prospects of investment opportunities. A founding team with

balanced specific human capital of entrepreneurial and business experience increases expectations of superior firm performance and reduce investment risks. Founding teams with such reputable members are thus a valuable resource which can help to attract VC investors. The ability of a new firm to attract a competent founding team is consequently a credible signal to VC investors justifying the following hypothesis:

Hypothesis 4: USOs with an experienced founding team are more likely to attract first VC investment.

2.4.4 Networks

The third resource shown in Figure 13 relates to firms' networks. Founders and their new firms can utilise networks if they need to attract resources which are not freely available in the market. The attraction of VC investment is representative for a resource which is not freely available in the market place as access needs to be individually negotiated. Network links between new firms and VC investors in order to reduce uncertainty and informational asymmetries. Status and reputation within the network are generated from repeated interaction with VC investors. Because repeated interaction in networks is costly due to being repeatedly built up over time, they are a credible signal of quality to investors (Podolny, 1993; Podolny and Stuart, 1995).

Network links between universities and their USOs as well as VC investors require repeated interaction in order to mature and become effective for their members. USOs from universities with a long tradition of technology and spin-out activities can expect to have access to such networks (Birley, 2002; Nicolaou and Birley, 2003b). USOs from these universities with links to VC firms benefit from being introduced to VC investors and business advisors without first having had to establish a personal contact. This argument supports the following hypothesis:

Hypothesis 5: USOs from universities that have a strong network of previously VC funded USOs are more likely to attract first VC investment.

A second important network resource is USOs' ability to build inter-firm networks in the form of strategic alliances. Such alliances can be built between firms within the same sector

or across firms of differing but compatible factor markets. New firms benefit from strategic alliances as they can share resources and create synergies. For instance, resources which are difficult to freely obtain in the market place can be secured in forming alliances with resource providers. Consequently, these strategic alliances would reduce transaction costs compared to ongoing individual negotiations to secure access to key resources. Moreover, partners in strategic alliances benefit from increasing their market power compared to their competitors (Gulati, 1998).

Strategic alliances are also attracting VC investors. They regard an exclusive partnership by another firm in the same or a related sector as a signal of credibility which reduces their investment risk (Stuart *et al*., 1999; Chang, 2004). The following hypothesis is derived:

Hypothesis 6: USOs with alliance partners are more likely to attract first VC investment.

2.4.5 Intellectual Capital

The fourth resource shown in Figure 13 relates to firms' intellectual capital. VC investors prefer to invest in firms which can sustain their competitive advantage. A strong indicator for this competitive advantage is the legal protection of IP which drives the business model of a firm in the form of patents. Patents turn the knowledge which is embedded in the firm in order to exploit the identified business opportunity, into valuable intangible assets (Nahapiet and Ghoshal, 1998). Costly efforts for the legal protection of intangible assets in the form of patents are regarded signal commitment and credibility to VC investors. The presence of patents reduces the risk of investors as they strengthen their investees' market position. Because of their strong signal of quality, new firms with patents often also attract investors who are not experts in understanding the source of the patented inventions, products, services or processes (Hsu, 2007). These investors rely on the assumption that firms which are able to afford patents have significant capabilities and performance prospects. Thus, the following hypothesis is suggested:

Hypothesis 7: USOs with patented IP are more likely to attract first VC investment.

Firms in their early stages without long business track records have often only their IP to measure and reflect their value. In order to protect their investment, VC investors thus

prefer that the ownership of IP is directly assigned to the firm (Kaplan and Stromberg, 2003). Due to their equity share and control rights on the board of directors, VC investors can then ensure that the IP remains in the firm. For instance, founders cannot leave the firm and walk away with the IP and strip the new firm and its investors of the most important intangible asset. Consequently, IP owned by the firm protects the firm value. This is also crucial for VC investors' exit strategies. The valuation of their investees in order to sell them (M&A) or quote them on a stock exchange (IPO) is sensitive to whether the IP is owned by the firm (Cumming and MacIntosh, 2003). Therefore, the following hypothesis is derived:

Hypothesis 8: USOs with IP ownership are more likely to attract first VC investment.

Information about the degree of innovation in new firms' business models can help to reduce VC investors' risks. Sources of innovation such as new technologies, recognising and solving market inefficiencies or finding more cost-effective ways of offering established goods and services (Drucker, 1985) need to be assessed regarding their inherent risks. Investors need to decide whether these sources of innovation are too radical and therefore unlikely to be accepted by customers on the targeted market place (Gifford, 2003). In order to generate substantial returns, VC investors generally prefer not to invest in firms with too radical innovation as these often target insufficiently small markets which do not generate attractive returns. The risk of investing substantial costs and facing long time horizons to generate returns in developing products and services of radical innovation on unproven markets is unattractive to VC investors. In consequence, the following hypothesis is derived:

Hypothesis 9: USOs whose main product or service is associated with radical innovation are less likely to attract first VC investment.

2.4.6 Financial Resources

The final resource shown in Figure 13 relates to firms' financial resources. Attracting investments from markets for external finance is a major barrier to new firms. The prior ability to attract financial investment is a potential signal of enthusiasm, experience and expertise sought by VC investors.

Public backed equity funds are a form of external investment which can help USOs with high risk profiles to attract finance at an early stage. They are promoted by public policy makers to help USOs to overcome barriers to attract external financing in order to pursue the commercialisation of knowledge and IP from academic research (Wright *et al*., 2006). These barriers relate to the risk aversion of private investors such as VC investors which are reluctant to take on immature firms. The objective of public backed equity investments is thus to provide seed and early stage funding which would otherwise not be available on the market for external finance. Moreover, public backed equity investments also seek to improve USOs' investment readiness in order to prepare them to attract future funding rounds and expertise from private investors such as VC firms to improve their performance (Boadway and Tremblay, 2005). Further, public backed equity funds also increasingly seek to support USOs and their founders to obtain skills and expertise for launching their products and services to the market. Accordingly, the following hypothesis is suggested:

Hypothesis 10: USOs that have obtained publicly-backed equity funds are more likely to attract first VC investment.

2.5 Gaps in the Knowledge Base: USO Firm Performance

Numerous studies have looked at firm performance in the domain of entrepreneurship (Storey, 1994). Conversely, relatively few studies have explored research questions related to USOs' firm performance and the role of VC investment (Rothaermel *et al*., 2007; O'Shea *et al*., 2008). These are summarized in Table 11 and discussed below.

Studies on USO development frequently attribute firm performance to the question whether these new firms have optimal initial resources and investors in place (Vohora *et al*., 2004; Colombo and Piva, 2008). The relationship between USOs' internal resources and firm performances takes resource needs and capabilities of firms and their founding academic entrepreneurs into account (Lockett *et al*., 2005). This approach is replicated from the theoretical framework of the resource-based view of the firm (RBV) which implies that internal resources rather than the external environment are responsible to shape the performance prospects of new firms (Barney, 1991).

The replication of the RBV for investigating USO firm performance is often rather conceptual and exploratory. There is a lack of studies with large representative samples testing hypotheses with the help of multivariate statistics to identify which internal factors explain firm performance (Rothaermel *et al*., 2007). The operationalisation of dependent variables suffers from inconsistent approaches in measuring firm performance (Djokovic and Souitaris, 2008; O'Shea *et al*., 2008).

Studies on USO firm performance in the USA tend to measure the events of failure, successful IPOs or M&As (Shane and Stuart, 2002). American USOs report a survival rate of 68% between 1980 and 2000 (AUTM, 2001). This represents a higher survival rate than the average of new firm survival in the US (AUTM, 1991-2009). For European USOs the survival rate is even higher (Dahlstrand, 1997; Mustar, 1997) which reduces the number of available observations required to conduct a meaningful survival analysis (Clarysse *et al*., 2007). British USOs have a failure rate of 11% between 1989 and 2007. Only 4% of them achieved an IPO and 7% were merged or acquired (Library House, 2007). Survival studies are thus unlikely to adequately reflect USO firm performance in the UK. Alternative measures of firm performance as possible dependent variables are required for future studies such as the amount of funding (Clarysse *et al*., 2007), number of patents, firm growth related to revenue (Ensley and Hmieleski, 2005) or employment size (Zhang, 2009).

Table 11: Studies Exploring USO Firm Performance

Author(s):	Research Question(s):	Theory (ies):	Methodology:	Dependent Variable(s):	Sample Size and Context:	Findings:
Dahlstrand (1997)	Do spin-offs grow faster than non-spin-off firms?	Exploratory and descriptive study, no theories, no hypotheses tested	Quantitative, coded interviews, descriptive statistics, OLS Regression	Relative annual growth, Patents per year	30 USOs, 30 start-ups, Sweden	- 13% of USOs from Chalmers Institute Sweden) founded between 1960 and 1993 failed by 1993. - Spin-offs were growing significantly faster than the non-spin-offs. However, no significant difference in the inventiveness was found between the two groups. - Neither the growth nor the inventiveness could be explained by pre-spin-off variables, but it is speculated that the earlier employment within the spin-off parent has indirectly influenced the performance of the spin-off firms.
Chiesa and Piccaluga (2000)	What are the profiles, opportunities, obstacles of spin-off companies in Italy?	Exploratory and descriptive study, no theories, no hypotheses tested	Quantitative survey, descriptive statistics, demand-side perspective	Turnover, Number of employees	48 USOs, Italy	- Modest growth rates are reported. Average number of employees = 32) - Barriers to growth are lack of resources regarding external investment e.g. VC), entrepreneurial and managerial
AUTM (2001)	How many USOs founded between 2	Industry report	Quantitative, descriptive statistics	n/a	3,376 USOs, US	- Out of 3,376 USOs founded between 1980 and 2000, 68% are still in business 2001. Higher than average new firm survival in the US.
Ndonzuau *et al*. (2002)	What are the issues in the creation of university spin-offs according to public and academic authorities?	Theory building	Qualitative, interviews with technology transfer related personnel at 15 universities in different countries	n/a	15 Universities 2x Finland, 1 x Sweden, 1 x Netherlands, 2 x Belgium, 1 x France, 2 x Israel, 4 x USA, 1 x Canada)	- Four stages and related issues of USO development: - Stage 1: to generate business ideas from research; academic culture, internal identification). - Stage 2: to finalize new venture projects out of ideas protection and development of the idea, financing). - Stage 3: to launch spin-off firms from projects access to resources, relationship with university). - Stage 4: to strengthen the creation of economic value by spin-off firms relocation of risk, change trajectories).

Table 11 (Continued)**:** Studies Exploring USO Firm Performance

Author(s):	**Research Question(s):**	**Theory (ies):**	**Methodology:**	**Dependent Variable(s):**	**Sample Size and Context:**	**Findings:**
Shane and Stuart (2002)	How do initial resource endowments affect the performance of new ventures?	Testing hypotheses whether resource endowments influence venture capital funding, IPO, and failure	Quantitative study, event history analysis, interviews with founders and survey of R&D managers, demand-side perspective	VC investment; event of IPO; Survival	134 USOs from MIT, US	- Founder's direct and indirect relationships with venture investors help new ventures to receive venture capital VC) funding and to avoid failure. - Founder team's industry experience and patent effectiveness have positive effect on IPO, VC funding rate, and negative effect on failure. - Technology endowment increases the likelihood of IPO and decreases the likelihood of failure.
Vohora *et al*. (2004)	What phases and junctures characterize the development of USOs?	Theory building	Qualitative, 36 interviews of four UK spin-outs, venture partners, representatives from the universities and venture capital firms	n/a	4 USOs, UK	- USOs go through five distinct phases of activity in their development: Research Phase, Opportunity framing Phase, Pre-Organisation Phase, Re-Orientation Phase, and Sustainable Returns Phase. - At the intersection between phases, USOs face "critical junctures" in terms of the resources and capabilities for the next phase. These four junctures are opportunity recognition, entrepreneurial commitment, credibility and sustainability.
Ensley and Hmieleski (2005)	What are differences between top management teams TMT) of university-based and that of independent high-tech start-ups?	Institutional Theory, Upper Echelon Theory,	Quantitative, survey, OLS regression	Net cash flow; Revenue growth	217 managers from 102 university start-ups; 417 executives from 154 independent start-ups, US	- TMTs of university start-ups are more homogenous and have less developed dynamics. - Link between TMT variables and firm performance is weaker in university start-ups than that in independent start-ups. - University start-ups have lower performance than independent high-tech start-ups in terms of revenue growth and net cash flow.

Table 11 (Continued)**:** Studies Exploring USO Firm Performance						
Author(s):	**Research Question(s):**	**Theory (ies):**	**Methodology:**	**Dependent Variable(s):**	**Sample Size and Context:**	**Findings:**
Gompers *et al*. (2005)	Do VC backed firms spawn more new firms? How effective are established firms in spawning new firms?	Two views of the creation of venture-backed start-ups, or "entrepreneurial spawning." "Fairchild view": young firms prepare employees for entrepreneurship, educating them about the process, and exposing them to relevant networks. 'Xerox view": individuals become entrepreneurs when large bureaucratic employers do not fund their ideas.	Quantitative, Secondary data, core data for the analysis come from VentureOne.	Spawning Levels, spawning in technology industries	Sample of 15,297 founders of 5,112 venture capital-backed start-ups in the VentureOne data base of venture capital financing who received venture capital financing between 1986 and 1999.	- Controlling for firm size, patents, and industry, the most prolific spawners are originally venture-backed companies located in Silicon Valley and Massachusetts. - Undiversified firms spawn more firms. - Silicon Valley, Massachusetts, and originally venture-backed firms typically spawn firms only peripherally related to their core businesses. - Overall, entrepreneurial learning and networks appear important in creating venture-backed firms.
Grandi and Grimaldi (2005)	What organizational factors affecting the process through which new ventures are established by academics and are likely to affect their performance	Theory building	Quantitative survey, factor analysis of likert-scale response, OLS regression	Articulation of business idea Market Attractiveness of business idea	42 USOs, Italy	- Attractiveness of business idea is positively influenced by the market orientation of the academic founders as well as their frequency of interaction with external agents. - Articulation of business idea is positively affected by the role-articulation as well as prior joint experience of the academic founders.

Table 11 (Continued)**:** Studies Exploring USO Firm Performance

Author(s):	Research Question(s):	Theory (ies):	Methodology:	Dependent Variable(s):	Sample Size and Context:	Findings:
Lockett and Wright (2005)	What are the most important attributes of resource and capabilities of university and its technology transfer office TTO) in determining the creation of university spin-offs?	RBV	Quantitative, Mail questionnaire survey conducted over a 2-year period. Survey on university technology transfer activities comprising quantitative and qualitative questionnaires sent to the top 122 universities in the UK as ranked by research income; poisson regression models	The number of university spin-outs; the number of equity investments in existing spin-outs	48 UK universities; Higher Education Statistics Agency, key informant: head of the technology transfer office	- Both the number of spin-out companies created and the number of equity investments in existing spinouts are positively associated with university's expenditure on external intellectual property protection, business development capabilities of TTO, and the royalty regime of the university.
Lockett *et al*. (2005)	What are the managerial and policy implications of the rise of spin-offs at public research institutions PRIs) based on the Knowledge Based View?	RBV	Conceptual	n/a	n/a	- To understand the development of spin-offs, researchers should focus on knowledge gaps that spin-offs encounter. - Knowledge gaps can occur at various level of analysis e.g., individual, team, firm) and at various stages of venture development.
Powers and McDougall (2005)	Do particular resources predict performance of university technology transfer?	RBV	Quantitative, archival sources, Regression	Number of USOs with IPO	120 research intensive universities, US	- The level of industry R&D funding, faculty quality, the age of the technology transfer office, and the level of VC investment in a university's metropolitan statistical area are positive predictors of technology transfer performance: the number of start-ups and IPOs.

Table 11 (Continued)**:** Studies Exploring USO Firm Performance

Author(s):	Research Question(s):	Theory (ies):	Methodology:	Dependent Variable(s):	Sample Size and Context:	Findings:
Rothaermel and Thursby (2005)	How does the strength of the tie between the sponsoring university and incubator firms affect their life chances?	Agency theory, Social Capital / Network Theory	Quantitative, Multinomial logistic regression	Failure, Remaining in incubator, Graduation from incubator	79 USOs at Georgia Tech, US	- Strong ties to the sponsoring university reduce the likelihood of firm failure because of the strong intellectual property protection, quality signalling effect, and involvement of potential investors. - Strong ties, however, retard graduation from the incubator. Weak ties, such as informal interaction with faculty, do not affect outright firm failure or timely graduation.
Mosey *et al*. (2006)	RQ1: What impact will commercialisation fellowships have upon academic attitudes towards the commercialisation of research? RQ2: What human and social capital will academics gain from commercialisation fellowships? RQ3: What impact will commercialisation fellowships have upon the interaction between academic and practitioner networks?	Social Capital / Network Theory, theory building	Qualitative, interviews semi-structured open-ended questions), triangulation with secondary data	n/a	six senior academics with direct experience of a number of commercialisation initiatives; six technology transfer staff members with direct responsibility for commercialisation within the host biomedical research schools and six Medici fellows from the first cohort of 20 fellows, UK	- Fellowship programmes may have a positive impact on the commercialisation of research through the retraining of academics. - Fellows are able to act as agents of attitudinal change in their host departments and are seen to build bridges into external business networks that can provide early stage funding, market and legal information and help identify potential customers for nascent academic entrepreneurs through the enhancement of their social and human capital.

Table 11 (Continued)**:** Studies Exploring USO Firm Performance

Author(s):	**Research Question(s):**	**Theory (ies):**	**Methodology:**	**Dependent Variable(s):**	**Sample Size and Context:**	**Findings:**
Walter *et al*. (2006)	How does network capability (NC) and entrepreneurial orientation (EO) affect USO performance?	Social Capital / Network Theory	Quantitative, questionnaires, moderated hierarchical regression analyses	Sales Growth; Sales per employee; Profit attainment; Perceived Customer relationship quality; Realized competitive advantages; Securing long-term survival	149 USOs, (country of origin not disclosed)	- Spin-off's performance is positively influenced by its network capability (NC), but spin-off's entrepreneurial orientation (EO) fosters competitive advantages. - Although no direct relationship is apparent between EO and sales growth, sales per employee, or profit attainment, moderated hierarchical regression analyses reveal that NC strengthens the relationship between EO and spin-off performance. - Spin-off's organizational propensities and processes that generally enhance innovation, constructive risk taking, and proactiveness in dealing with competitors per se do not enhance growth and secure long-term survival. - NC moderates the relationship between EO and organizational performance.
Clarysse *et al*. (2007)	Does the formal technology transfer from a public research organization PRO) influence the amount of capital a spin-off raises at start-up, and does it increase in capital post start-up?	RBV, Pecking Order Theory	Quantitative, OLS regression	Capital raised within 18 months of start-up	135 Spin-offs 40 x Belgium; 31 x Germany; 17 x France; 29 x Italy; 28 x UK)	- Spin-offs with formal technology transfer start with a larger amount of capital but subsequently do not raise more capital than spin-offs without formal technology transfer.

Table 11 (Continued)**:** Studies Exploring USO Firm Performance

Author(s):	**Research Question(s):**	**Theory (ies):**	**Methodology:**	**Dependent Variable(s):**	**Sample Size and Context:**	**Findings:**
Library House (2007)	What is the quality of USOs in the UK?	n/a	Industry report	n/a	590 USOs until 2005, UK	- Size and health of the UK spin-out portfolio suggests that public policy focus on translating research into business has been highly successful in reversing the UK's historical weakness in this area. - UK universities are now producing spin-out companies of equivalent number and quality to some of the US's top institutions. - Many of British USOs have achieved substantial valuations and the best promise to revolutionise key areas of the technology sector. - Anecdotal evidence suggests a mismatch between the availability of funding for technology transfer activity including proof of concept and seed funding, as well as funding for technology incubators and science parks) and research activity. This mismatch likely results from the inappropriate development and technology transfer agendas. - 'The Super-Cluster Question': the UK should aim to create a cluster of innovation-based businesses..
Rothaermel *et al*. (2007)	What are the major themes of research in the literature on university entrepreneurship?	Theory building	Literature review of 173 articles on USOs	n/a	n/a	- The literature on university entrepreneurship is rapidly expanding, in both the United States and Europe but also fairly fragmented regarding the use of theories and choices of methodologies. - Four major research streams emerge can be identified: i) The entrepreneurial research university. ii) Productivity of technology transfer offices. iii) New firm creation and development. iv) Environmental context and networks of innovation - The study of new firm creation addresses one of the most important questions in strategic management: Where do capabilities come from? - Need for multidisciplinary perspectives.

Table 11 (Continued)**:** Studies Exploring USO Firm Performance

Author(s):	**Research Question(s):**	**Theory (ies):**	**Methodology:**	**Dependent Variable(s):**	**Sample Size and Context:**	**Findings:**
Stam and Garnsey (2007)	What determines the emergence and growth of new firms in the knowledge based economy?	n/a	Literature review	n/a	Conceptual	- Paper provides an overview of studies about scientific and technological knowledge as a source of business opportunities, and on the emergence and growth of new firms in the knowledge economy. - New knowledge in science and technology is an important and localized source of entrepreneurial opportunities. However, public and corporate sector players do not necessarily commercialize this knowledge because they lack the vision or incentives. - Corporate spin-offs are more likely to turn into these high growth firms than university spin-offs. - Empirical studies on new firm growth show that high levels of human, social and financial capital facilitate the growth of new business. - Direct and indirect government support is crucial to the growth of new technology-based firms and thus differs across countries
Colombo and Piva (2008)	What are the strengths and weaknesses of academic start-ups (ASUs) and other new technology-based firms NTBFs)?	RBV	Qualitative evidence from four theory-building case studies interviewing founders of four USOs	n/a	4 USOs, Italy	- ASUs' major relative strengths reside in the lower initial funding gap and greater investments in technical activities. - ASUs' major weakness consists of the lack of commercial knowledge: ASUs suffer from greater initial gaps in this field and encounter serious obstacles in implementing effective strategies to close them. - ASUs' choices as to the characteristics of external investors and alliance partners, and the organisation of the relations with them are influenced by the desire to mitigate appropriability hazards.

Table 11 (Continued)**:** Studies Exploring USO Firm Performance

Author(s):	Research Question(s):	Theory (ies):	Methodology:	Dependent Variable(s):	Sample Size and Context:	Findings:
Djokovic and Souitaris (2008)	What are the major themes and theories in the academic literature on spinouts from academic institutions?	n/a	Literature review	n/a	63 papers on spinouts	- Early literature has been mainly atheoretical and focused on describing the phenomenon. - Prominent theories: Network theory, evolutionary theory, resource based theory RBV), organisational theory - The phenomenon has been studied from different points of view policy level, firm level, individual level). - Macro- phenomenological studies focused on the effectiveness of spinning out as technology transfer mechanism and on spinout-support mechanisms from industry, government and university. - Micro-phenomenological studies focused on human relations and interactions during the spinout formation process and on spinout links with university and industry. - More theory driven research required.
O'Shea *et al*. (2008)	Which research streams are prominent in the current literature on USO activities?	Theory building	Literature review of articles on USOs	n/a	n/a	- Literature on USO performance is still in an emerging state. - More firm-level studies are required to identify factors leading to firm performance.
Zhang (2009)	What are the characteristics of VC funded USOs and do they perform differently compared to other firms?	Signalling Theory	Quantitative, Multivariate regression OLS, Logit), secondary data	Amount of VC in a single round of financing; Total amount of VC; whether a start-up has survived, has completed an IPO, profit; Employment size	3,633 11% USOs), US	- Venture-backed university spin-offs are concentrated in the biotechnology and information technology industries. - Spin-off tends to stay close to the university, suggesting that technology transfer through spin-offs is largely a local phenomenon. - Multivariate regression analyses show that university spin-offs have a higher survival rate but are not significantly different from other start-ups in terms of the amount of venture capital raised, the probability of completing an initial public offering IPO), the probability of making a profit, or the size of employment.

Independent variables capturing factors affecting firm performance also vary across the studies presented in Table 11. There is some evidence that founders' capabilities related to their education (Mosey and Wright, 2007) and managerial experience positively influence survival and growth of USOs (Chiesa and Piccaluga, 2000) as well as the event of achieving an IPO (Shane and Stuart, 2002; Powers and McDougall, 2005). Entrepreneurially experienced academic entrepreneurs may also increase their firms' performance in accessing networks which helps them to attract financial investment and business partners (Mosey *et al*., 2006; Mosey and Wright, 2007). Firm growth can be attributed to more heterogeneous and experienced founding teams (Ensley and Hmieleski, 2005).

In addition to founders' characteristics, firms' internal resources may also influence performance. Inter-firm networks in the form of strategic alliances (Walter *et al*., 2006). And effective network ties to VC investors can contribute to survival (Rothaermel and Thursby, 2005). Patents and their effectiveness may also determine firm performance (Shane and Stuart, 2002). Firm performance is also associated with USOs' ability to attract financial resources and VC investment in particular (Wright *et al*., 2006; Clarysse *et al*., 2007).

The strength of the above studies is to identify a range of internal resources including the units of analysis of founders and their firms which can be attributed to firm performance. The individual findings of these resource-specific studies as shown in Table 11 need yet to be integrated in a theoretical framework in order to derive hypotheses. These should than be empirically tested in by multivariate analyses to assess their relative importance in exploring research questions on what factors drive USO firm performance.

An further gap in the knowledge base is that the role of VC investment on USO firm performance has only been conceptually discussed (Chiesa and Piccaluga, 2000) and not sufficiently empirically tested. VC investment is often only associated with the event of USOs achieving IPOs (Shane and Stuart, 2002; Zhang, 2009), but there is little empirical evidence on other performance indicators like employment growth. More research is required to identify whether VC funded USOs are successful because of the quality of their initial internal resources or if the financial investment and business expertise of VC investors makes a significant difference to firm performance. This gap can be addressed if samples of cross-sectional or panel data are used which contain statistics on USOs with and without VC investment. In order to address the identified gaps in the knowledge base the following

section replicates, integrates and extends theoretical insights related to firm performance. A joint theoretical framework is developed from which hypotheses can be derived.

2.6 Theoretical Insights: Firm Performance

2.6.1 Drivers of Firm Performance: External vs. Internal Factors

This section discusses external and internal factors that can impact on firm performance. Two theoretical perspectives are contrasted. Organisational ecology relates to the importance of external factors and the RBV of the firm relates to the importance of internal factors, respectively. Thereafter, it discussed to what extent the attraction of VC investment as an additional resource relates to superior firm performance.

Studies focusing on the relation of external factors to firm performance are summarized in Table 12. Organizational ecology theorists suggest that external environmental conditions shape the survival of new firms (Stinchcombe, 1965). Consequently, most studies in Table 12 analyse the survival patterns within population of firms. They find that firms which are located in saturated market niches are associated with growing competition for limited resources (Freeman *et al*., 1983; Hannan and Freeman, 1984). Only firms with larger resource pools are thus likely to have higher survival chances (Audretsch, 1991).

Conversely, young firms with insufficient resources and a lack of legitimacy on the market place are more likely to go out of business. The resulting pattern of firm survival is referred to as a 'liability of newness' which is attributed to young firms' inability to cope with their external environment (Freeman *et al*., 1983). However, although there is evidence that external factors influence firm survival and performance it can also be observed that firms are able to adapt to their environment. In order to successfully adapt, new firms need to find an audience (e.g. customers, suppliers, alliances or business partners) which recognize their legitimacy in their market niche (Hannan *et al*., 2007).

Table 12: Firm Performance: Organisational Ecology Studies

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
(Stinchcombe, 1965)	How do social structures imprint new organisational forms and why may new firms suffer from a liability of newness?	Organisational Ecology	Conceptual	n/a	n/a	- Organisational analysis requires to systematically uncover the relations between society outside organisations with the internal life of organisations. - Organisational dynamics can be related to societal values, power structures and features of stratification. - Social structures comprise groups, institutions, laws, population characteristics, and sets of social relations that form environments of the organisation.
Freeman *et al*. (1983)	Do new firms suffer from a 'liability of newness'?	Organisational Ecology	Quantitative, survival analysis, secondary data	Survival, merger/ absorption	Semi-conductor: 1159 firms, US, 1951 to 1979; American Local Newspaper Organizations: 2,768, US, 1800 to 1975; Labour Unions: 476, US, 1860-1983	- Age dependence in organizational death rates is studied using data on three populations of organizations: national labour unions, semiconductor electronics manufacturers, and newspaper publishing companies. - Both dissolution rates and merger-absorption rates vary by age for labour unions and newspaper firms, the pat- tern of age variation differs for the two kinds of organizations. - Liability of newness is more intense for the process of dissolution than for the merger-absorption process. For labour unions, the reverse is true. - Liabilities of smallness and bigness are also identified but controlling for them does not eliminate age dependence.
(Hannan and Freeman, 1984)	What is the meaning of structural inertia?	Organisational Ecology	Conceptual	n/a	n/a	- High levels of structural inertia are a consequence of a selection process rather than a precondition for selection. - Inertial forces vary with firms' age, size and complexity.

Table 12 (Continued)**:** Firm Performance: Organisational Ecology Studies

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Audretsch (1991)	Do the technological regime and sector differences influence firm survival?	Organisational Ecology	Quantitative, secondary data	Survival	11000 firms, manufacturing industries, US	- New-firm survival is promoted by the extent of small-firm innovative activity. - The existence of substantial scale economies and a high capital-labour ratio lowers the likelihood of firm survival. - Results vary considerably with time intervals. - Market concentration promotes short-run survival, but has no impact on long-run survival.
(Hannan *et al*., 2007)	How can the research on population ecology be integrated in a new sound theoretical framework?	Organisational Ecology	Conceptual	n/a	n/a	- Ecology analysis requires new methods including non-monotonic and fuzzy logics to integrate notions of codes, clusters, labels, grades of memberships, types and categories describing organisations and implications on their interaction with their environment in order to revisit the argument for age dependency of their survival. - Audiences determine clusters and organisational forms.
Hsu *et al*. (2008)	How can typecasting and form emergence be integrated in a unified framework?	Organisational Ecology	Conceptual	n/a	n/a	- Typecasting is a producer-level theory that considers the consequences producers face for specializing versus spanning across category boundaries. - Form emergence considers the evolution of categories and how the attributes of producers entering a category shapes its likelihood of gaining legitimacy among relevant audiences. - Both theory fragments emerge from the processes audiences use to assign category memberships to producers.

This argument is further developed by Hsu *et al*. (2008) who suggest that firms can successfully adapt to their environment if their internal characteristics meet the expectations and categories of their external audience and lead to legitimacy on the market place. This process shows a close resemblance to the earlier discussed signalling theory by Spence in Section 2.3.7[4]. This argument shows that there is a constant interplay between external and internal factors which shape firms' ability to adapt to their environment and relate to performance.

The survival and performance of new firms can be shaped by several themes linked to internal factors of the entrepreneur and the firm (Storey, 1994). In addition to their initial resources, entrepreneurs can adapt to their environment if they acquire and leverage additional resources to ensure firm development. As discussed in Section 2.3.2, theorists of the RBV of the firm suggest that firms which acquire and leverage resources that are rare and non-imitable can obtain a sustained competitive advantage. The resource profile of firm and the entrepreneur can be associated with business performance, too. The themes of internal resources were already presented in Sections 2.3.3 to 2.3.6. Studies on internal factors and firm performance in Table 13 reflect these themes accordingly. Entrepreneurs general (Cooper *et al*., 1994; Gimeno *et al*., 1997) and specific human capital (Stam and Garnsey, 2007) as well as a firms networks (Stuart, 2000; Florin *et al*., 2003), intellectual capital (Garcia-Muina and Navas-Lopez, 2007) and financial resource profile (Westhead and Storey, 1997) have been found to be associated with superior firm performance. The next section shows how the attraction of VC investment can as an additional resource help new firms adapting to their environment and lead to superior firm performance.

[4] I thank Mike Hannan and Glenn Carroll for discussing similarities between mechanism of how an audience provides legitimacy to firms in organisational ecology and the implications of signalling theory that costly resources can send signals of quality to an external party in their annual seminar in Durham in December 2008.

Table 13: Firm Performance: Resource-Based View of the Firm, Human Capital and Social Capital Studies

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Cooper *et al*. (1994)	Can indicators of initial human and financial capital which are observed at the time of start-up predict the performance of new firms?	RBV	Quantitative, longitudinal, Discriminant Analysis, Logistic Regression, Multi-nominal logistic regression	(1) failure, (2) marginal survival, or (3) high growth	1053 new ventures, representative of all industry sectors and geographical regions, US	- Measures of general human capital influenced both survival and growth (except for gender, with women-owned ventures being less likely to grow, but just as likely to survive). Management know-how variables had more limited impact. - Having parents who had owned a business contributed to marginal survival, but not to growth. - Number of partners contributed to growth but not to survival. - Management level, prior employment in non-profit organizations or not having been in the labour force, and the use of professional advisors did not have significant effects. Industry-specific know-how contributed to both survival and growth. The amount of initial financial capital also contributed to both. - Using a model based upon the initial human and financial capital of the venture, it is possible to predict the performance of new ventures with some degree of confidence.
Brüderl *et al*. (1992)	Does human capital of firms influence business survival?	Human Capital Theory	Quantitative, survival analysis	Survival	1,849 business founders in Germany	- Organizational characteristics, especially number of employees and amount of capital invested, and organizational strategies, especially businesses aiming at a national market, are the most important determinants of business survival. - The human capital characteristics of the founder, especially years of schooling and work experience and industry-specific experience, show strong direct and indirect effects as well.

Table 13 (Continued)**:** Firm Performance: Resource-Based View of the Firm, Human Capital and Social Capital Studies

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Westhead and Storey (1997)	Do problems with access to finance restrict the growth of the firm at any stage?	RBV	Quantitative, interview survey, logistic regression	Problems with access to finance at any stage (yes, no); Problems with access to finance at any stage (0 = no; 1 = yes, continually)	188 independent high technology manufacturing and service firms located on and off science parks, UK	- Firms obtaining income from manufactured products were much more likely to report a continual constraint, presumably because the sums they wish to borrow are greater than those of similar businesses in the services sector. - Irrespective of our measure of technological sophistication, technologically sophisticated high technology firms were more likely to report the presence of a continual financial constraint than generally less technologically sophisticated high technology firms. - Younger firms and limited companies are more likely to report having experienced continual financial constraints. - Among high technology small firms, those with the most sophisticated technologies are the most likely to report continual financial constraints on the development of their business. Given that these firms are also the most likely to make a major economic contribution, it provides support for the view that market imperfections characterize the supply of finance in this market-place.
Gimeno *et al*. (1997)	Why do some firms survive while other firms with equal economic performance do not?	Human Capital Theory	Quantitative, Questionnaire,	Exit decision of firm; amount of money withdrawn by entrepreneur	1,547 entrepreneurs of new businesses ,U.S	- Organizational survival is not strictly a function of economic performance but also depends on a firm's own threshold of performance. - The threshold is determined by the entrepreneur's human capital characteristics, such as alternative employment opportunities, psychic income from entrepreneurship, and cost of switching to other occupations. - Strong support for the model by findings which suggest that firms with low thresholds may choose to continue or survive despite comparatively low performance.

Table 13 (Continued)**:** Firm Performance: Resource-Based View of the Firm, Human Capital and Social Capital Studies						
Author(s)	**Research question(s)**	**Theory (ies)**	**Methodology**	**Dependent variable(s)**	**Sample size and context**	**Findings**
Stuart *et al*. (1999)	How do inte-rorganizational networks of young companies affect their ability to acquire the resources necessary for survival and growth?	Social Capital / Network Theory	Quantitative, OLS regression	Market value of a firm at IPO	301 VC backed biotechnology start-ups, US	- VC backed and privately held biotechnology firms with prominent strategic alliance partners and organizational equity investors go to IPO faster and earn greater valuations at IPO than firms that lack such connections. - Much of the benefit of having prominent affiliates stems from the transfer of status that is an inherent by-product of interorganizational associations.
Stuart (2000)	What is the relationship between inter-corporate technology alliances and firm performance?	Social Capital / Network Theory	Quantitative, Poisson Regression, OLS Regression	Patent rate, Sales growth	150 semiconductor start-ups, US	- Alliances are access relationships, and therefore that the advantages which a focal firm derives from a portfolio of strategic coalitions depend upon the resource profiles of its alliance partners. - Alliances are both pathways for the exchange of resources and signals that convey social status and recognition. - Findings from models of sales growth and innovation rates in a large sample of semiconductor producers confirm that organizations with large and innovative alliance partners perform better than otherwise comparable firms that lack such partners. - Consistent with the status-transfer arguments, young and small firms benefit more from large and innovative strategic alliance partners than do old and large organizations.
Florin *et al*., 2003	How do human and social capital affect a venture's ability to accumulate financial capital during its growth stages, and then leading to an IPO?	Social Capital / Network Theory	Quantitative, Secondary Data, Three-step moderated hierarchical regression analyses	Financial Capital, Sales Growth, Return on Sales	275 ventures that went public, US	- The relationships between human resources and performance, and between financial capital and performance, both vary with the level of social resources. Social resources leverage the productivity of a venture's resource base. - Environmental conditions and geographic conditions did not affect the observed pattern of relationships.

Table 13 (Continued)**:** Firm Performance: Resource-Based View of the Firm, Human Capital and Social Capital Studies

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Garcia-Muina and Navas-Lopez (2007)	What is the relationship between technological capabilities and firm success?	RBV	Quantitative, survey, secondary data, univariate	n/a	30 biotechnology firms, Spain	- Technological activities oriented to knowledge exploration processes have more potential than those technological capabilities focused on the mere maintenance of a certain competitive advantage. - Results support criticism of certain generally accepted strategic resource evaluation criteria and the need to adopt a contingent view to the study of such issues.
Stam and Garnsey (2007)	What determines the emergence and growth of new firms in the knowledge based economy?	n/a	Literature review	n/a	Conceptual	- Corporate spin-offs are more likely to turn into these high growth firms than university spin-offs. - A review of 9 empirical studies between 1994 and 2006 on new firm growth measured in change in employment shows that high levels of human, social and financial capital are enabling endowments, facilitate the growth of new business.

2.6.2 Firm Performance: VC Investment

As highlighted in Section 2.6.1, a firm's ability to acquire additional resources can shape firm development. Table 14 summarizes studies that have explored the link between the take-up of VC finance and superior business performance. Hellman and Puri (2002) show that VC-financed firms have superior business performance due to the business expertise of VC investors in addition to the financial resources provided.

VC investors use control rights over their investees to choose experienced CEOs and built qualified management teams which enhance firm performance. Davila *et al*. (2003) find that the presence of VC investors attracts further resources including the human capital of employees, additional financing rounds and increase the value of the firm. Therefore, VC investment can have a positive multiplication effect on firm performance due to further extending the resource base (Busenitz *et al*., 2005; Hsu, 2007).

It is reasonable to assume that firms with first VC investment will generally report superior levels of performance than firms with no VC finance to leverage. However, more research is required to identify whether differences among VC investors is reflected in firm performance. Whether investees' performance can also be subject to their VC investors' degree of sector specialisation (Knockaert *et al*., 2006), status or reputation (Chang, 2004).

2.6.3 Themes of Resources Linked to Firm Performance

Firm performance is linked to external and internal environmental factors. This study specifically focuses on USO performance with regard to the internal factors relating to the resources profiles of USOs and entrepreneurs. Private VC firms located in the external environment can provide additional financial and business expertise resources to supported firms. Only USOs that signal quality through their firm and entrepreneur resource profiles can obtain private sector VC investment. This study also explores whether USOs that have obtained first VC investment report superior levels of firm performance relative to USOs that have not obtained VC investment.

Table 14: Firm Performance: VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Rosenstein *et al*. (1993)	To what extent venture capitalists add value besides money to their portfolio companies?	RBV	Quantitative, survey, descriptive statistics	n/a	162 venture-capital-backed high-tech firms located in California, Massachusetts, and Texas, US	- CEOs did not rate the value of the advice of venture capitalists any higher than that of other board members. However, those CEOs with a top-20 VC firm as the lead investor, on average, did rate the value of the advice from their venture capital board members significantly higher -but not outstandingly higher- than the advice from other outside board members. - CEOs with no top-20 as the lead investor found no significant difference between the value of the advice from venture capitalists and other outside board members. - There was a noticeable difference in the value of value-added by top-20 boards and non-top-20 boards. The areas where CEOs rated outside board members (both venture capitalists and others) most helpful were as a sounding board, interfacing with the investor group, monitoring operating performance, monitoring financial performance, recruiting/replacing the CEO, and assistance with short-term crisis. That help was rated higher for early-stage than later-stage companies.

Table 14 (Continued)**:** Firm Performance: VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Hellmann and Puri (2002)	Do VC investors play a role beyond traditional intermediaries such as professionalising start-ups with additional human resources?	Financial intermediation theory, Human capital	Quantitative, hand-collected data set of start-ups in Silicon Valley culled from a combination of survey data, interviews, and commercial data bases as well as publicly available data, secondary data triangulation	-Firm uses business and professional contacts to recruit sales and marketing personnel -Firm's venture capitalists or other financiers influence in shaping human resource management -Time from the birth of a company to the date of implementing a stock option plan -Time from the birth of a company to the first date of appointing a Vice President of sales and marketing. -Firm hired an outside CEO -Time from the birth of the company to the date of arrival of the first outside CEO.	Stratified random sample with firms no older than 10 years and more than 10 employees 173 start-up companies that are located in California's Silicon Valley	- Obtaining venture capital is related to a variety of organizational milestones, such as the formulation of human resource policies, the adoption of stock option plans, or the hiring of a VP of sales and marketing. - Firms with venture capital are also more likely and faster to replace the founder with an outsider in the position of the CEO. Interestingly, however, founders often remain with the company, even after the CEO transition. - The effect of venture capital is also particularly pronounced in the early stages of a company's development.

Table 14 (Continued)**:** Firm Performance: VC Investment						
Author(s)	**Research question(s)**	**Theory (ies)**	**Methodology**	**Dependent variable(s)**	**Sample size and context**	**Findings**
Davila *et al*. (2003)	Is there an association between the presence of VC investment and the employee growth of start-ups?	Signalling Theory	Quantitative, Rank regression	Growth measured in employment change	494 start-ups, US	- The presence of VC investors attracts potential employees despite significant information asymmetry because of the lack of public information about start-ups. - Growth is not a predictor of receiving venture funding in the future. - Positive association between headcount growth and value creation. While headcount growth is an important measure of growth in itself, this evidence has a positive association valuing start-up companies. - VC may not only act as a source of financial resources, but as a powerful mechanism to communicate the quality of a start-up.
Stuart and Sorenson (2003)	Do the same factors that enable high tech entrepreneurship also promote firm performance?	Social Capital / Network Theory	Quantitative, Event history analysis	Hazard of IPO	399 venture-backed biotech start-ups, US	- Industries cluster are important because entrepreneurs find it difficult to leverage the social ties necessary to mobilize essential resources when they reside far from those resources. - Opportunities for high tech entrepreneurship mirror the distribution of critical resources. - The same factors that enable high tech entrepreneurship, however, do not necessary promote firm performance. - Local conditions like sources of biotechnology expertise (highly-skilled labour), and venture capitalists on the location-specific founding rates and performance of biotechnology firms which promote new venture creation differ from those that maximize the performance of recently established companies. - Areas with large populations of biotech and VC firms have a 'regional advantage'; such areas experience the highest rates of biotechnology entrepreneurship. However, they show on average a lower likelihood of IPO.

Table 14 (Continued)**:** Firm Performance: VC Investment

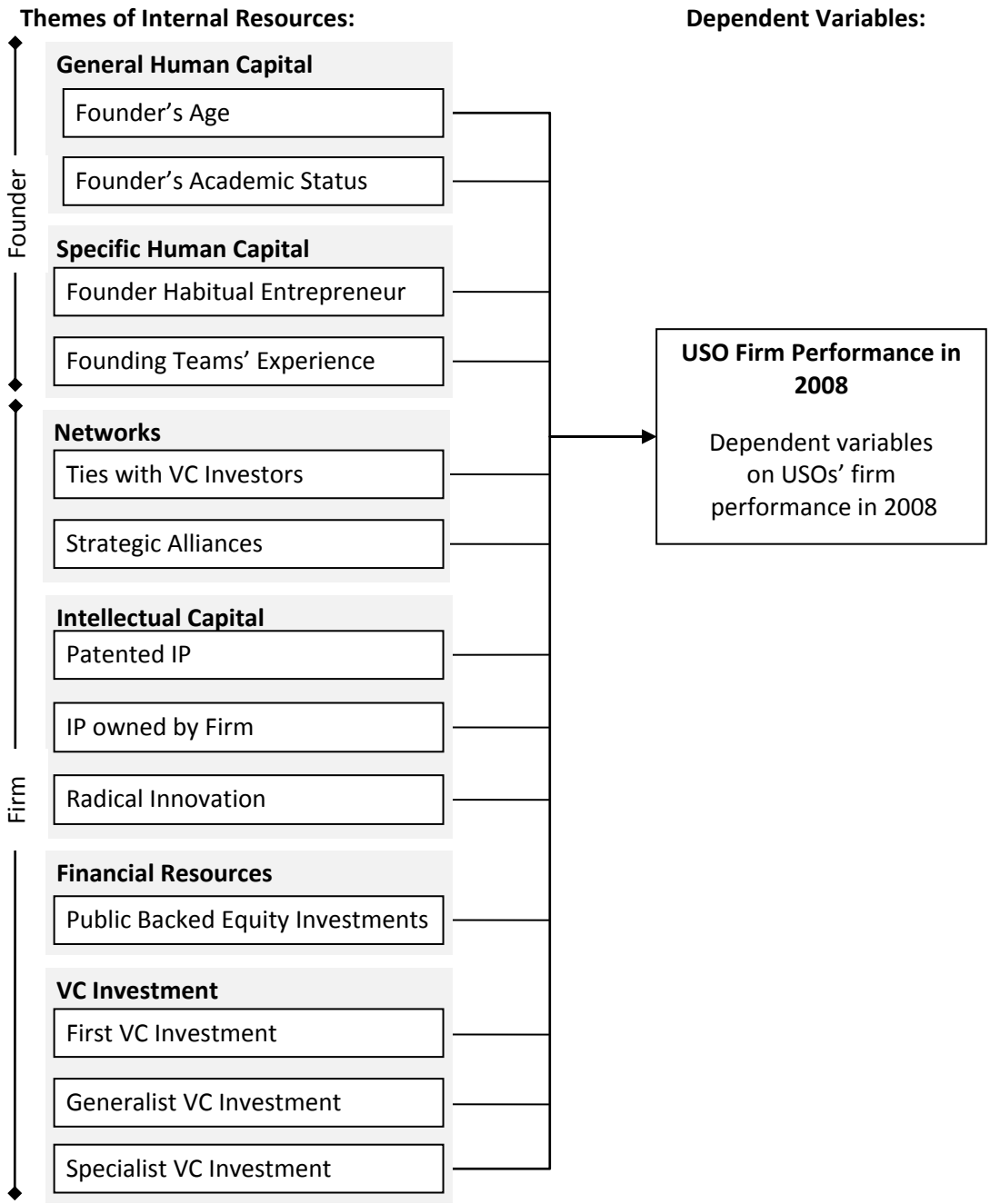
Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Chang (2004)	How do Internet start-ups' venture capital financing and strategic alliances affect these start-ups' ability to acquire the resources necessary for growth?	Organisational Ecology, Social Capital / Network Theory	Quantitative, secondary data, proportional hazard model (Cox Regression)	Time to the event of initial public offering (IPO)	1106 Internet Start-Ups between 1994 and 2000 of which 90 achieved an IPO, US	- Three factors positively influenced a start-up's time to IPO: - The better the reputations of participating venture capital firms and strategic alliance partners were, the more money a start-up raised, and the larger was the size of a start-up's network of strategic alliances.
Baum and Silverman (2004)	Do VC investors 'pick winners' or 'build winners' when making investments in high tech start-ups?	Signalling Theory, Human Capital Theory	Quantitative, secondary data, panel data time series	Amount of pre-IPO financing; year over revenue; R&D spending growth; number of annual patent applications; number of annual patents granted	204 Biotech start-ups, Canada	- VCs finance start-ups that have strong technology, but are at risk of failure in the short run, and so in need of management expertise. - VCs also appear to make a common attribution error overemphasizing start-ups' human capital when making their investment decisions.
Busenitz *et al*. (2005)	Do signal of wealth and experience of founding team serve as credible signals of the future value of a venture?	Signalling Theory (VC Market and demand-side perspective)	Quantitative, Event history analysis (Cox regression)	(1) out-of-business, (2) still-private, (3) merged or acquired, and (4) IPOs	183 VC-backed ventures, US	- Neither signals of value (percentage of equity held by founding team) nor signals of commitment (percentage of individual wealth invested by the founding team in their firm) have positive relationship with survival, M&A or IPOs. - Founding team's experience with VC has no influence on performance. - Founding teams' entrepreneurial experience has no strong influence on performance.

Table 14 (Continued)**:** Firm Performance: VC Investment

Author(s)	Research question(s)	Theory (ies)	Methodology	Dependent variable(s)	Sample size and context	Findings
Niosi and Banik (2005)	What drives the performance of biotechnology start-ups?	Social Capital / Network Theory	Quantitative, descriptive Statistics	n/a	90 quoted bio-technology start-ups (including 31 USOs), Canada	- Venture capital works best when there is an active equity market which allows investors to exit by selling their shares. - Companies in the three large Canadian cities (Montreal, Toronto and Vancouver) performed better than companies outside clusters: Advantages seem to be related to the availability of venture capital and being located in a region (i.e., province in this case). - Even though other start-ups and spin-offs may have less direct access to knowledge and technology from universities, they apparently have other linkages that make up for this shortcoming and sustain growth. - USOs show high smaller average employment growth rate (19%) than other start-ups (84%). USOs achieve on average an IPO after 4.8 years with an average amount of $12.2 million compared to other start-ups which take on average 7.2 years to achieve an IPO with an average amount of $14.6 million.
Knockaert *et al*. (2006)	Is there a relationship between the human capital and fund characteristics of venture capitalists and post-investment follow-up behaviour in early stage high-tech investments?	Human Capital Theory	Quantitative, semi-structured interviews,	Summated scale on Involvement in monitoring and value-adding activities	Stratified sample of 68 VC firms from seven regions (Cambridge/London (UK), Ile de France (France), Flanders (Belgium), North Holland (the Netherlands), Bavaria (Germany), Stockholm (Sweden), Helsinki (Finland))	- No indication that involvement in monitoring activities by the investment manager is determined by either fund or human capital characteristics. - Human capital variables were the most important: VC investors with previous consulting experience and entrepreneurial experience contribute to a higher involvement in value-adding activities. - The diversity of an investment manager's portfolio was negatively related to involvement in value-adding activities. - Investment managers of captive funds were less involved in value-adding activities.

Drawing upon evidence from firm performance studies, Figure 14 shows that six themes are assumed to be associated with USO performance in 2008. The themes relate to entrepreneur general and specific human capital as well as firm networks, intellectual capital, financial resources and VC investment. Hypotheses are derived from this framework in the following section.

Figure 14: Themes of Resources Linked to Firm Performance (Research Question 2)

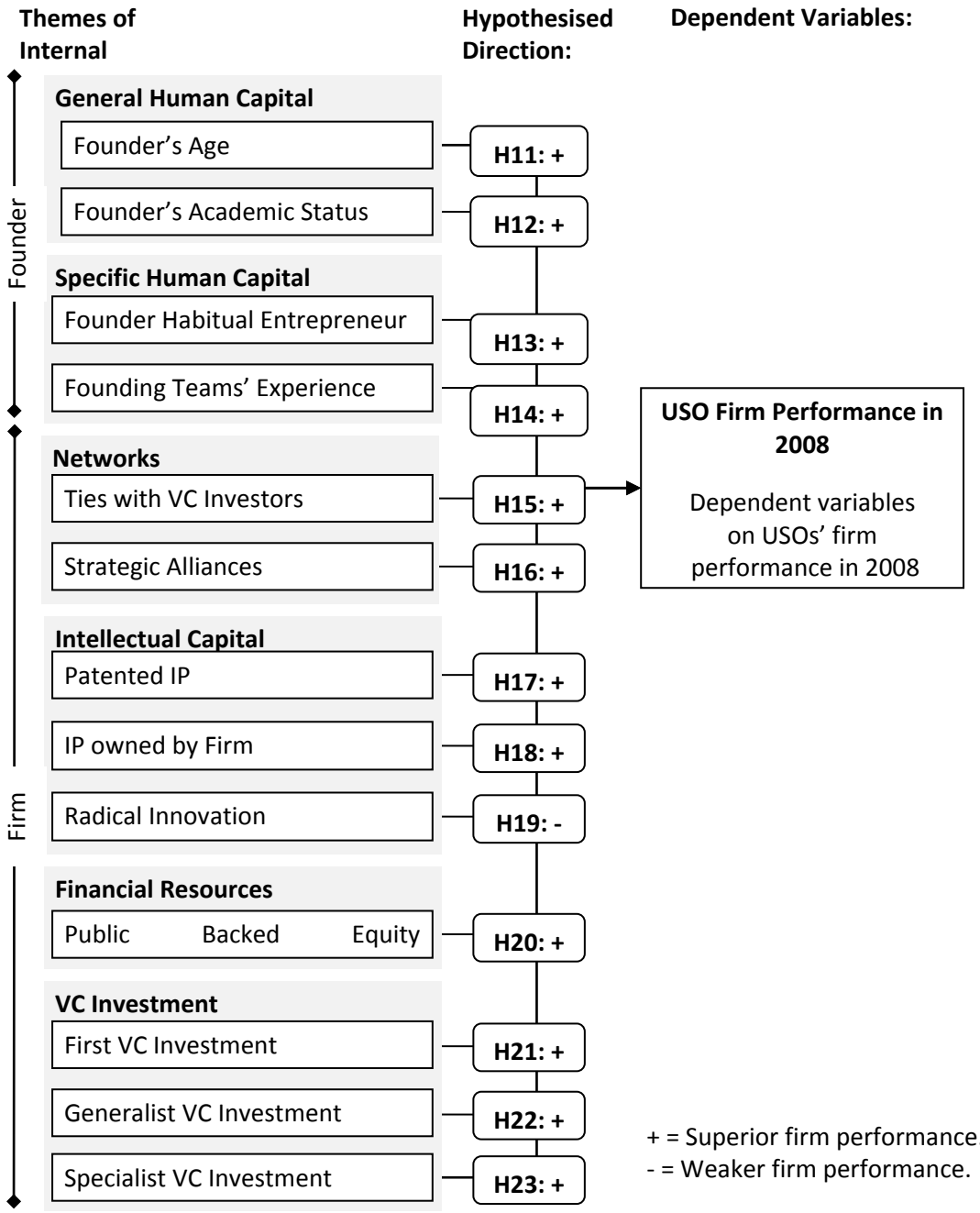


2.7 Hypotheses Derivation: USO Firm Performance

2.7.1 Overview

Figure 15 shows the earlier identified themes of initial resource endowments of USOs including VC Investment. Hypotheses regarding relationships between these independent variables and dependent variables of firm performance are derived from this framework.

Figure 15: Overview of Hypotheses on USO Firm Performance (Research Question 2)



2.7.2 General Human Capital

The first resource shown in Figure 15 relates to the general human capital of USOs' founders. More mature founders of firms are likely to have more knowledge and experience to identify and exploit business opportunities. They also have an advantage in securing additional resources. For instance, they will more likely succeed in convincing banks and investors to attract further finance to grow and maximise the performance of their firms (Astebro and Bernhardt, 2005). More mature entrepreneurs often have a higher level of education, problem solving skills and work experience which are beneficial to build up young firms and to enhance their performance (Brüderl *et al*., 1992; Cooper *et al*., 1994).

In the context of USOs, older and more experienced academic entrepreneurs are likely to have an advantage in assessing the feasibility of new business ideas depending on their technology cycle and time-to-market expectations. This experience allows them to better assess the strengths and weaknesses of the IP which is commercially exploited in the USO. In consequence, the following hypothesis is suggested:

Hypothesis 11: USOs with older founders will report superior firm performance.

Academic entrepreneurs with a higher academic status can have an advantage in attracting additional resources to enhance their firms' performance. Academic entrepreneurs who are professors can use their own reputation to attract further resources for their firms. Moreover, a senior academic position equips academic entrepreneurs with experience in managing research teams, applying for grants or conducting feasibility studies which are crucial skills in building up a new firm (Birley, 2002). These broad experiences are highly applicable and transferable in the early stages of successfully building a new venture and leading it to superior firm performance. Accordingly, the following hypothesis is suggested:

Hypothesis 12: USOs with founders with higher levels of academic reputation will report superior firm performance.

2.7.3 Specific Human Capital

The second resource shown in Figure 15 relates to the specific human capital of USOs' founders. Experienced entrepreneurs can apply their knowledge from previous businesses to manage the growth of new firms. Their experience facilitates building and extending the required resource base in order to enhance their new firms' performance. For instance Florin *et al* (2003) suggest that habitual entrepreneurs are more successful in attracting additional financial resources for their firms because of their social capital. Experienced entrepreneurs are also often more successful in attracting VC investors as well as in achieving higher valuations for their firms (Hsu, 2007).

In the context of academic entrepreneurs, Mosey and Wright (2007) suggest that less experienced academic entrepreneurs are disadvantaged due to a lack of effective network ties to attract further resources required to grow their USOs. Experienced academic entrepreneurs consequently benefit from their social networks in attracting business partners and build relationships with experienced managers and equity investors which should be positively associated with firm performance. Accordingly, the following hypothesis is derived:

Hypothesis 13: USOs with experienced entrepreneurs will report superior firm performance.

The specific human capital of the founding team is an additional resource which can lead to superior firm performance. In particular, if teams can cover a wider of range of specific skills, expertise and experience than individual founders (Beckman, 2006).

In the context of USOs, founding teams with a wide range of experiences, capabilities and skills are better equipped to develop and exploit new business ideas (Grandi and Grimaldi, 2003). They are more likely to overcome resource constraints of managerial expertise and financial resources needed for the development and superior performance of USOs. Beckmann *et al*. (2007) show that especially young high-technology firms with diverse founding teams have a positive influence on firm performance. Additionally, the availability of previous entrepreneurial experience on founding teams can help to overcome barriers to

firm performance such as completing product development, marketing and attracting additional resources (Delmar and Shane, 2004). Thus, the following hypothesis is suggested:

Hypothesis 14: USOs with an experienced founding team will report superior firm performance.

2.7.4 Networks

The third resource shown in Figure 15 relates to USOs' networks. Networks can help to secure sought-after additional resources which are required to improve the performance of new firms, but not easily obtainable on the market place (Shane and Cable, 2002; Stuart and Sorenson, 2003). For instance, USOs can benefit from the exclusive networks of their university of origin to access further financing and business expertise which can ultimately enhance their firm performance (Grandi and Grimaldi, 2005). These networks enable a beneficial interplay with the business environment and shape entrepreneurial behaviour which ultimately generate superior firm performance if this resource is effectively used (De Carolis and Saparito, 2006). Therefore, the following hypothesis is derived:

Hypothesis 15: USOs from universities that have a strong network of previously VC funded USOs will report superior firm performance.

Alliances have a range of advantages which are mainly associated with the direct or indirect access to resources, knowledge and other assets. They increase the availability of important resources, especially, if these are difficult to obtain. Alliances can reduce transaction costs and ensure a sustainable supply of required resources (Gulati, 1998). Market control is thus likely to benefit firm performance of alliance partners who distribute and share the market as well as its revenues amongst themselves. Alliances also increase legitimacy of new firms which helps them to continue to attract additional resources such as financing. Further, alliances can also increase the likelihood of launching products to the market place in utilising established and exclusive distribution networks or contacts to customers. Accordingly, the following hypothesis is suggested:

Hypothesis 16: USOs with alliance partners report superior firm performance.

2.7.5 Intellectual Capital

The fourth resource shown in Figure 15 relates to USOs' intellectual capital. This resource relates to the knowledge embedded in a firm which is required to drive its business model. In the context of USOs, academic research presents the intellectual capital which is commercialised. Firm performance is thus subject to how well intellectual capital can be translated into a working business model targeting an attractive marketplace. In order to ensure a sustained competitive advantage on a marketplace intellectual capital must be particularly difficult to imitate and substitute (Steffensen *et al*., 2000; Hand, 2001). Patenting IP can stop competitors to infringe inventions and processes. Superior firm performance can thus be associated with the competitive advantage generated by patents (Baum and Silverman, 2004). The following hypothesis is suggested, accordingly:

Hypothesis 17: USOs with patented IP will report superior firm performance.

If the patented IP is owned by the firm rather than an individual there may be a desire to maximise the economic returns in best exploiting the IP within the firm. This is because ownership generates entitlement, commitment and value (Williamson, 1991; Kasper and Streit, 1998) among the parties owning the organisation which will ultimately benefit firm performance. Further, ownership of IP by the firm also signals the value of a new venture to external parties. It can increase the likelihood to attract further financing rounds. Moreover, employees are more likely to be attracted and commit themselves to a firm which cannot suddenly be stripped of its most valuable asset (Gans *et al*., 2002; Bercovitz and Feldman, 2007). Consequently, the following hypothesis is suggested:

Hypothesis 18: USOs that own their IP will report superior firm performance.

The radicalness of innovation of the invention or process driving the business model of a firm can also influence firm performance. Radical innovation is often associated with uncertainty of size of the targeted market and the related demand for new product or service. In addition to untested business models, radical innovation attributed to new technologies can further increase the risks of generating returns. In consequence,

radicalness of innovation in a business model reflects the risk a firm's potential performance is exposed to (De Coster and Butler, 2005; Marvel and Lumpkin, 2007). Firms which require radical innovation to compete in emerging markets are more likely to fail and depend on substantial resources including financing and business expertise to establish themselves on the market (Audretsch, 1991; Audretsch and Thurik, 2001). The unpredictable nature of new markets as frequently observed in the high-technology sectors indicate an inverse relationship between the risk to take on radical innovation and the likelihood of superior firm performance (Aldrich and Fiol, 1994). The following hypothesis is derived accordingly:

Hypothesis 19: USOs whose main product or service is associated with radical innovation will report weaker firm performance.

2.7.6 Financial Resources

The fifth resource shown in Figure 15 relates to USOs' financing. The major role of financial capital in new firms is to create a buffer against random shocks as well as being the driver of growth strategies (Cooper *et al*., 1994). New firms usually have insufficient internal financing to obtain the required resources for growing their firm and maximising its performance. However, those firms which have been successful in receiving seed and early stage funding from external investors can overcome this barrier to superior firm performance. Moreover, once first external investors has been attracted, further financing are rounds more likely which will continue to enhance the development and performance of new firms (Hsu, 2007).

The availability of external financing is particularly relevant in the context of USOs. Their development and performance is highly dependent on access to financial resources to continuously extend their resource base (Vohora *et al*., 2004). Especially, USOs with long time-to-market intervals like in pharmacy and bio-technology sectors can only expect to have superior levels of performance if investors continue to back these firms over these periods. To encourage the exploitation of business opportunities from academic research public policy makers have addressed early stage financing gaps to promote an innovation driven transition into knowledge based economies (Wright *et al*., 2006). Public backed equity investments provide USOs the opportunity to attract early stage financing with a

lower risk threshold compared to private investors. They can reduce a possible equity gap on the supply-side of external investments and help to attract further financing rounds and more funding (Boadway and Tremblay, 2005). In addition to finance, public backed equity schemes are increasingly building up business expertise to support the development of USOs and enable them to launch a product or service to the market place (Mason and Harrison, 2004). In consequence, the following hypothesis is suggested:

Hypothesis 20: USOs that have obtained publicly-backed equity funds will report superior firm performance.

2.7.7 VC Investment

The final resource shown in Figure 15 relates to USOs which have attracted VC investment. VC-backed firms are generally assumed to have higher survival rates than non-VC-backed businesses (Timmons and Spinelli, 2003). VC investments are particularly attractive to new firms with capital intensive growth strategies. This is because VC investors can secure substantial amounts of financing in combination with providing a strictly commercial business expertise in order to maximise their investees' value and performance.

Hsu (2007) argues that the first attraction of VC financing can lead to a 'Matthew Effect' in further funding rounds. It implies that those firms which already attracted reputable investments have an ongoing advantage to attract more funding to address their financing needs which ultimately increases their performance. Once VC investment is attracted for the first time, further access to finance is facilitated due to VC investors' syndication networks (Lerner, 1994; Lockett and Wright, 2001).

In the context of USOs, VC investors are generally regarded as value adding and performance enhancing (Lockett *et al*., 2005). VC investors' dual role in adding finance and business expertise is particularly attractive in introducing a commercial perspective into firms started by academics who are often inexperienced in the business domain (Vohora *et al*., 2004). Moreover, VC investors can be helpful in appointing an experienced CEO to manage the growth of the firm (Hellmann and Puri, 2002). This is particularly important if the founding academic entrepreneurs' expertise can be stronger utilised in optimising research and development (Stuart and Ding, 2006; Birchall, 2007). Consequently, Anderson

et al. (2007) suggest that VC investments have generally a positive impact on USO activities and the efficiency of technology transfer. Therefore, the following hypothesis is derived:

Hypothesis 21: USOs with VC investment will report superior firm performance.

Because VC investors are able to not only influence investees with their financial resources, but also with the human capital of their business expertise, a more detailed perspective on the characteristics of VC investors in relation to their influence on firm performance of their investees is important, too. Davila *et al*. (2003) argue that VC firms' own experience and track record can influences their investees future firm performance related to their valuation and ability to attract employees.

The reputation of VC investors can particularly be attributed the human capital of the partners in a VC firm (Dimov and Shepherd, 2005). VC investors aim to employ individuals with great deal-making and value-adding skills who often entered the VC industry after extensive work experience in their industries (Bygrave and Timmons, 1992). As a result, the human capital can also be industry specific based on the experience of VC partners influencing the composition of the portfolio of investees (Knockaert *et al*., 2006). The resulting sector specialisation also allows VC firms to reduce their investment risks. Specialist VC investors are thus common in high-technology sectors (Lockett *et al*., 2002; Lockett *et al*., 2003).

Generalist VC investors may also be beneficial to the performance of new firms. They often comprise expertise regarding a range of sectors and a broader experience in developing different types of new ventures. In addition to this capability, generalist VC investors are more often operating as part of larger private equity firms which can supply greater amounts of investments than more specific investors. However, they are also more risk averse and thus only choose to invest in more mature firms which are more established in their market place.

Overall, generalist and specialist orientation of VC investors have beneficial characteristics related to superior firm performance depending on the needs of their investees with respect to financing and business expertise. In consequence, the following hypotheses are suggested:

Hypothesis 22: USOs with generalist VC investment will report superior firm performance.

Hypothesis 23: USOs with specialist VC investment will report superior firm performance.

2.8 Summary of Hypotheses

Presented hypotheses are summarized in Table 15. In Chapter 3, the positivist methodology is discussed to test the presented hypotheses.

Table 15: Summary of Hypotheses

Themes of resources:	**Hypotheses for research question 1 on first VC Investment:** Which resource endowments of USOs are signals of quality and attract first VC investment?	**Hypotheses for research question 2 on firm performance:** Do VC funded USOs report superior firm performance?
General human capital	**Hypothesis 1:** Older USO founders are more likely to attract first VC investment.	**Hypothesis 11:** USOs with older founders will report superior firm performance.
	Hypothesis 2: USO founders with higher levels of academic reputation are more likely to attract first VC investment.	**Hypothesis 12:** USOs with founders with higher levels of academic reputation will report superior firm performance.
Specific human capital	**Hypothesis 3:** USO founders who are experienced entrepreneurs are more likely to attract first VC investment.	**Hypothesis 13:** USOs with experienced entrepreneurs will report superior firm performance.
	Hypothesis 4: USOs with an experienced founding team are more likely to attract first VC investment.	**Hypothesis 14:** USOs with an experienced founding team will report superior firm performance.
Networks	**Hypothesis 5:** USOs from universities that have a strong network of previously VC funded USOs are more likely to attract first VC investment.	**Hypothesis 15:** USOs from universities that have a strong network of previously VC funded USOs will report superior firm performance.

Table 15 (Continued)**:** Summary of Hypotheses

Themes of resources:	**Hypotheses for research question 1 on first VC Investment:** Which resource endowments of USOs are signals of quality and attract first VC investment?	**Hypotheses for research question 2 on firm performance:** Do VC funded USOs report superior firm performance?
Networks (Continued)	**Hypothesis 6:** USOs with alliance partners are more likely to attract first VC investment.	**Hypothesis 16:** USOs with alliance partners report superior firm performance.
Intellectual capital	**Hypothesis 7:** USOs with patented IP are more likely to attract first VC investment.	**Hypothesis 17:** USOs with patented IP will report superior firm performance.
	Hypothesis 8: USOs with IP ownership are more likely to attract first VC investment.	**Hypothesis 18:** USOs that own their IP will report superior firm performance.
	Hypothesis 9: USOs whose main product or service is associated with radical innovation are less likely to attract first VC investment.	**Hypothesis 19:** USOs whose main product or service is associated with radical innovation will report weaker firm performance.
Financial resources	**Hypothesis 10:** USOs that have obtained publicly-backed equity funds are more likely to attract first VC investment.	**Hypothesis 20:** USOs that have obtained publicly-backed equity funds will report superior firm performance.
VC investment		**Hypothesis 21:** USOs with VC investment will report superior firm performance.
		Hypothesis 22: USOs with generalist VC investment will report superior firm performance.
		Hypothesis 23: USOs with specialist VC investment will report superior firm performance.

Chapter 3: Methodology and Data Collection

3.1 Introduction

This chapter discusses issues relating to data collection and the research methodology used to test the hypotheses presented in Chapter 2. In Section 3.2, general issues of research methodology, methods and related research paradigms are presented. Further, it is discussed why the positivistic research paradigm was chosen for this study. Section 3.3 discusses the research design with reference to the population of USOs which were founded at British universities between 1990 and 2007 and still active in 2008. Secondary data sources are used to identify the population of USOs. Primary data is collected from the owners of USOs. A structured questionnaire was designed. The questionnaire was administered through an online survey. Response bias tests were conducted between the respondents and the non-respondents to the survey. No response bias was detected. We have no reason to assume that the results from the survey cannot be generalised to the population of USOs. 'Trustworthiness' of the collected primary data relating to the validity and reliability of derived composite scales (i.e., constructs) is explored in Section 3.4. Operationalisation of the dependent and independent variables is summarized in Section 3.5. Regression techniques used to test the presented hypotheses are discussed in Section 3.6. The assumptions of regression analysis are summarized, and evidence suggests that the regression analysis assumptions have not been violated with reference to the survey data explored. An overview of the presented hypotheses and the independent variables is presented in Section 3.7.

3.2 Research Paradigm

Research relates to the search for knowledge by means of systematic investigation in order to establish facts. It can also be described as an organised inquiry in order to provide information that can be used to solve problems or help in decision making processes. Good research can be characterized by research questions which are purposeful and have a clear

focus. Further, good research needs to have plausible goals that are achieved by defensible and ethical methods of data collection and analysis (Blumberg *et al*., 2005).

The research paradigm of a study reflects the nature and approach of how research is conducted. Research paradigms can first be distinguished by their research philosophy which is captured by its methodology (Bryman, 1984). When formulating their research methodology, researchers need to address what can be regarded as appropriate knowledge about the social world within they are exploring their research questions of interest (Creswell, 1994). Such considerations are referred to as epistemology. They include whether the events of interest are objectively observable and measurable or require a subjective perspective to be captured. Further, researchers need to define the relationship between themselves and their environment including the events, organisations or individuals of interest for their study. These are considerations of ontology (Bryman and Bell, 2003). They reflect whether researchers regard themselves as external and independent to their subject of interest or whether their subjective perspective influences the research.

Research methods are the second aspect of a research paradigm (Bryman, 1984). They are the techniques used to gather and analyse data in a study. The choice of a research method relates to the above epistemological and ontological considerations as well as practical issues of measurement, availability and access of data. Research methods are subject to the choice of the research design which determines what and how data is collected to appropriately explore identified research questions. Research methods can generally be distinguished between gathering and analysing quantitative or qualitative data.

Two prominent research paradigms with generally opposing methodologies and choices of methods are positivism and social constructivism[5]. Both are applicable to research in social sciences. They are discussed below. It is then argued why the paradigm of positivism was chosen for this study.

The research paradigm of positivism assumes in its understanding of the world (i.e. ontology) that the environment and the events of interest are objective and external and independent of the researcher (Bryman and Bell, 2003). Accordingly, the extraction of valid knowledge explaining the events of interest (i.e. epistemology) requires them to be

[5] Social constructivism can also be referred to as interpretivism in the literature.

objectively observable and measureable. This research philosophy is commonly referred to as the scientific method. It follows the principal of deduction. This implies that all premises and reasons must be valid in order to generate true conclusions. The deductive process relates to theory as the starting point which is used to derive hypotheses. To test these hypotheses empirically, data needs to be collected in order to generate are representative sample along with using with valid and reliable measurements. The findings of whether hypotheses are supported or rejected are used to revise and develop the present body of theory. As a result of these methodological considerations, positivism relies on quantitative research methods such as surveys. These ensure a standardised collection of data across a larger group of participants while minimising the subjective influence of the researcher.

The strength of positivism is that relationships and possible causalities between independent and dependent variables can be tested which are hypothesised from an established theoretical framework. However, for exploiting the strength of the positivist paradigm to test hypotheses and their directions, sufficiently large and representative samples are required to ensure an objective perspective on the phenomena of interest in order to generate valid knowledge. Objectivity and generalisability demanded by a positivist methodology also require that methods and measurements can be replicated. However, positivism can be criticised that its assumptions of objectivity and quantifiable measurements are too artificial in a social science context. Further criticism relates to that the interaction of social entities is too complex and dynamic for it to be captured by generalisable theories and laws. In order to generate reliable and generalisable results from positivist research, issues of objectivity, validity, reliability, replicability and causality need therefore to be thoroughly addressed and justified.

The contrasting paradigm to positivism is social constructivism (Bryman and Bell, 2003). Its ontology assumes that the understanding of the environment and its events are socially constructed and subjective from the researcher's point of view. Valid knowledge depends according to the epistemological characteristic of social constructivism, on the researcher's individual and subjective perceptions of the phenomena of interest. Hence, no objective observations and measurements of the relevant phenomena are possible. Social constructivism is about theory building. The resulting approach is inductive in generating valid knowledge. Induction is necessary to generate enough knowledge to establish a new theoretical perspective which can then be used to derive hypotheses and later test them following a positivist paradigm. The social constructivist methodology regards the

researcher as a necessary and involved member of the data collection and interpretation process. This is also reflected in the qualitative research methods of choice which are applied in social constructivist studies. The researcher actively engages usually through means of interviews with individual participants or focus groups. The aim of the researcher is to adapt to and interpret the subjective perspective of the participants.

The strength of social constructivism is that complex contexts can be addressed in learning from the perspective of those individuals who are part of the subject being studied. The flexibility in capturing and processing qualitative insights of participants improves the understanding of a complex matters by aspects perceptions, feelings and attitudes. The inductive approach is suitable to build new theories which can then be used to derive specific hypotheses to be tested in quantitative studies. The weakness of social constructivism is that the subjective perspective of the researcher can be an inappropriate bias and very difficult to replicate. This leads to problems of generalising findings and a lack of transparency how these findings were established.

This study will explore the research questions presented in Chapter 1. To explore them, this study replicates, integrates and extends previous theories relating to the take-up of first venture capital, and the firm performance of USOs. The hypotheses derived from the theoretical frameworks discussed in Chapter 2 are empirically tested. Using an on-line survey, primary data was collected from the key owners and decision-makers in USOs. The survey was administered to the population of USOs. The structured questionnaire administered to key owners and decision-makers collected information relating to several dependent, independent and control variables. The profiles of respondents and non-respondents to the survey were monitored. No significant response bias was detected. A representative sample of respondents was collected, which enables results from the survey to be generalised to the population of USOs. Regression analysis is used to test the presented hypotheses (Gill and Johnson, 2002). A representative sample of USOs is needed in order to generalise findings for the population. Following these requirements and implications of the positivist paradigm increases the realism of this study and its findings.

A qualitative approach was not pursued in this study as the focus and purpose of this study implies a positivist methodology. The aim of this study is to replicate, integrate and extend theories which are then used to derive hypotheses. Further, the identified research questions relate to explaining relationships between independent and dependent variables

with the goal of achieving generalisable findings. Moreover, Chapter 2 has shown that gaps in the knowledge base are rather related to too few quantitative studies investigating the take-up of VC investment and USO firm performance. However, the extensive insights from social constructivist studies were used to identify patters appropriate measurements for this study. They provided valuable information for choosing theoretical insights from which theoretical frameworks were built and hypotheses were derived.

In summary, the choice of a positivist paradigm for this study is motivated by replicating, integrating and extending existing theories in order to derive hypotheses on relationships between variables which are empirically tested. In order to generalise findings from a sample to its population, objective, replicable and quantitative measurements are required. Further, because subjective perceptions and qualitative issues are not addressed by the research questions the positivist paradigm is chosen over social constructivism.

3.3 Research Design

3.3.1 Overview

The population of USOs in Britain founded between 1990 and 2007 and still active by 2008 was identified. The chosen time interval relates to a high USO formation period in the UK (Sainsbury, 2007; Abreu *et al*., 2008).

Several data sources were used to identify the population of USOs that were founded between 1990 and 2007 and were still active by 2008. Information relating to firm names and addresses was collected from Library House, Financial Analysis Made Easy (FAME) and Companies House. A population of 505 USOs was identified. Information relating to key issues (i.e., when the USO received its first venture capital investment) is not publicly available. There is a need to collect primary data from the founders and key decision-makers in USOs. A structured questionnaire was designed. Using an on-line survey, the questionnaire was sent to founders and key decision-makers in the 505 USOs. In total, information was gathered from 125 valid respondents in USOs. Stages in the data collection process are discussed in more detail in the following sections.

3.3.2 Secondary Data

Secondary data is required for determining the size of the population of USOs. Further, it is used to identify the contact details of the founding academic entrepreneurs required for an online survey. Secondary data has the advantage of being consistent and non-subjective when operationalising variables which can also be replicated in future studies.

All secondary data sources are shown in Table 16. The Library House private data base was used to identify the population of USO[6,7]. This data base held data on 599 USOs from British Universities. In total, 515 USOs were founded between 1990 and 1997 and were still active by 2008. This data base covers founders' identity and email contacts as well as a wide range of firm-level data such as the financing history, business models and business profiles.

Table 16: Sources of Secondary Data

	Content Description	**Access**	**Link**	**Timeframe of data collection**
Library House	Identification of firms as USOs, funding types and amount over time, sector, business model and profile, Founders' contact details, Strategic Alliances	Private, access individually negotiated for this study	www.Libraryhouse.net	2007-2008
Companies House	Information on company status (active, out of business) registry number, sector	Public online access	www.companieshouse.gov.uk	2007-2008

[6] The chairman of the head organisation of Technology Transfer Offices at British Universities (UNICO) was interviewed for this research to consult the availability of public data bases with firm-level information of the required population of USOs. UNICO explained that they only collect aggregate information on a university-level. Further, they were not aware of a public source which would identify firm-level characteristics of USOs in the UK.

[7] Access to Library House Data would have not been secured without the substantial financial support by the Northern Leadership Academy (NLA) which awarded a Doctorial Fellowship for this research project in 2007.

Table 16 (Continued)**:** Sources of Secondary Data				
	Content Description	**Access**	**Link**	**Timeframe of data collection**
FAME	General annual accounting information: Balance Sheet, Profit and Loss, Cashflow Statement, Investor Profiles	Durham University Subscription	Bureau van Dijk (www.bvdep.com) via Durham University Library	2007-2008
BVCA Member Directory	Data base on VC investors' characteristics including their investment preferences, funding scope and region.	Private, access individually negotiated for this study	www.bvca.co.uk	2007-2008

Three additional secondary data sources were used. The private FAME data base provides annual accounting information on firms in the UK, provided market size and firm performance data. The public data base Companies House contains firm registries along with the company status and sectors provided the registry number of each USO. The data base of the private association of British Venture Capital and Private Equity (BVCA) was used to identify investment preferences of VC investors in the UK.

3.3.3 Primary Data

A population of 505 USOs was identified. This population presents the sampling frame for the primary data collection from the founding academic entrepreneurs. The collection of primary data is motivated as follows. The dependent variables relating to first VC investment and firm performance require the collection of independent and control variables which predate these events. Additional information relating to the firm and the founding academic entrepreneurs can be gathered using a survey for the collection of primary data. The reliability of data from a primary survey can be verified by information published in secondary data bases.

Table 17 summarizes the initial population and the number of USOs. The online survey was administered between 12.2.2008 and 1.3.2008. Information was gathered from valid respondents in 125 USOs. Ten USOs had to be excluded due to being out of business by 2008 or having been founded before the year 1990. The survey had a valid response rate of 25%. A recent study by Cycyota and Harrison (2006) which compares the response rates of 231 mailed studies contacting top executives of small and medium enterprises between 1992 and 2003 show similar response rates.

Table 17: Population, Sample and Response Rate of Survey

	n
Population of USOs founded between 1990 and 2007 in the UK which was still active (i.e. private, IPO or M&A) by 2008 as obtained from Library House.	515
Non valid respondents of USOs outside the sampling frame.	10 (9 USOs out of business by 2008; 1 USO founded before 1990)
Valid sampling frame.	505
Number of USOs whose founders could be successfully contacted by email.	364
Valid number of USOs of whose founders could be successfully contacted by email, corrected for 10 non valid respondents outside the sampling frame.	354
Valid respondents by number of USOs.	125
Number of valid non-respondent USOs	515 - 10 - 125 = 380
Valid response rate	125/505 = 25%

An online format was chosen as the most useful option of delivery considering the difficulties in generating a sample of sufficient size and representativeness, as well as issues of time and costs required to collect the data (DeVaus, 1996). The online survey was generated and hosted on the platform 'www.surveymonkey.com' and invitations to participate in the survey were sent out by email. This option of delivery is associated with several advantages over traditional postal survey (Erdos, 1974; Kinnear and Taylor, 1996). The choice of an online survey with email invitations was also motivated by the participants of interest (Saunders *et al*., 2007). Because many academic entrepreneurs split their time

between working for their USO and their academic role, contacting them by email provided a quick and effective means to achieve a good response rate.

3.3.3.1 Generalisability: Response Bias Tests

Response bias tests were conducted to detect whether evidence from the survey of USO can be generalised to the population of USOs that were founded between 1990 and 1997 and were still active by 2008. The profiles of the 125 valid USO respondents and the 380 valid USO non-respondents were compared.

With reference to continuous variables, non-parametric Mann-Whitney 'U' tests were conducted between valid respondents and non-respondents. Table 18 shows no significant difference between the valid respondents and non-respondents for firm age, total disclosed funding, funding events, year of most recent investment, total average of years until first external investment, number of previous USOs from university of origin as well as number of previous USOs from university of origin.

With reference to categorical variables, non-parametric Chi-Square tests were conducted between valid respondents and non-respondents. This technique requires that not more than 20% of categories should have an expected frequency of less than five observations (Hair *et al*., 2006). Table 19 shows no significant differences between respondents and non-respondents for individual and grouped regions across the UK. The sector of USOs based on the FTSE index categories and the universities of origin of the USOs show no significant differences. No significant differences were found when grouping universities regarding their membership of the Russell Group (2009) which is an association of twenty major research-intensive universities of the UK which was formed in 1994. No response bias is observed for the 'Golden Triangle' which comprises the universities of Cambridge, Oxford as well as the London based ones of Imperial College, King's College London, University College London, University of Cambridge, University of Oxford with a strong worldwide reputation for academic excellence as well as frequent technology transfer and USO activities (Birley, 2002; Acworth, 2008). Therefore, based on the above evidence, there is no significant reason to suggest that information from the survey cannot be generalised to the population.

Table 18: Response Bias Test (Mann Whitney U) for Continuous Variables

	Valid Respondents				Non-Respondents				Response-Bias Test	
	n	**Mean**	**SD**	**Median**	**n**	**Mean**	**SD**	**Median**	**Mann-Whitney 'U' statistic**	**Significance level (p)**
Firm Age in 2008	125	6.82	2.91	7	380	6.32	3.27	6	2355	0.420
Total Disclosed Funding ('000 £) until 2008	99	24651.36	82017.17	1470	295	12540.77	32621.46	1545	14410.5	0.845
Funding events (all types) until 2008	125	5.82	7.41	3	380	5.93	7.59	3	23229.5	0.423
Year of most recent investment	125	2002.29	3.14	2003	380	2002.56	3.247	2003	22830	0.151
Total Average of Years until first external investment	125	1.51	1.58	1	380	1.284	1.56445	1	22351.5	0.283
Number of previous USOs from the university of origin	125	12.66	11.5	9	380	14.49	13.91	10	23383.5	0.493
Number of previous USOs from the university of origin with VC funding	125	5.67	6.62	3	380	6.26	7.037	3	24245	0.928

Table 19: Response Bias Test (Chi-Square) for Categorical Variables

		Valid Respondents		Non-Respondents		Response Bias Test	
Variable	**Categories**	**n**	**%**	**n**	**%**	**Chi^2 Statistic**	**Significance level (p)**
Individual Regions from which USOs originated between 1990 and 2007	East Midlands	6	4.80%	27	7.11%	16.872	0.112
	Eastern	7	5.60%	49	12.89%		
	London	24	19.20%	66	17.37%		
	North East	6	4.80%	18	4.74%		
	North West	11	8.80%	25	6.58%		
	Northern Ireland	9	7.20%	10	2.63%		
	Scotland	22	17.60%	57	15.00%		
	South East	14	11.20%	44	11.58%		
	South West	3	2.40%	25	6.58%		
	Wales	2	1.60%	10	2.63%		
	West Midlands	6	4.80%	18	4.74%		
	Yorkshire	15	12.00%	31	8.16%		
	Total	125	100.00%	380	100.00%		
Grouped Regions from which USOs originated between 1990 and 2007	Midlands	11	8.80%	39	10.26%	7.450	0.189
	Eastern	11	8.80%	56	14.74%		
	London	19	15.20%	58	15.26%		
	North	30	24.00%	72	18.95%		
	NIR, Wales and Scotland	34	27.20%	75	19.74%		
	South	20	16.00%	80	21.05%		
	Total	125	100.00%	380	100.00%		

Table 19 (Continued): Response Bias Test (Chi-Square) for Categorical Variables

		Valid Respondents		Non-Respondents		Response Bias Test	
Variable	**Categories**	**n**	**%**	**n**	**%**	**Chi^2 Statistic**	**Significance level (p)**
Sectors (FTSE Index) to which USOs belong between 1990 and 2007	Pharmaceuticals & Biotechnology	35	28.00%	114	30.00%	0.968	0.995
	Software & Computer Services	23	18.40%	70	18.42%		
	Technology Hardware & Equipment	19	15.20%	56	14.74%		
	Other	15	12.00%	35	9.21%		
	Health Care Equipment & Services	13	10.40%	41	10.79%		
	Electronic & Electrical Equipment	9	7.20%	28	7.37%		
	Chemicals	6	4.80%	21	5.53%		
	Support Services	5	4.00%	15	3.95%		
	Total	125	100.00%	380	100.00%		

Table 19 (Continued): Response Bias Test (Chi-Square) for Categorical Variables

		Valid Respondents		Non-Respondents		Response Bias Test	
Variable	**Categories**	**n**	**%**	**n**	**%**	**Chi^2 Statistic**	**Significance level (p)**
Universities of origin from which USOs originated between 1990 and 2007	Imperial College [a, b]	14	0.11	38	10.00%	20.38	0.312
	University of Edinburgh [b]	10	0.02	11	2.89%		
	University of Manchester [b]	8	0.05	9	2.37%		
	University of Oxford [a, b]	8	0.05	7	1.84%		
	University of Cambridge [a, b]	7	0.03	14	3.68%		
	University of Sheffield [b]	7	0.02	19	5.00%		
	Newcastle University [b]	6	0.06	45	11.84%		
	Queen's University Belfast [b]	6	0.08	22	5.79%		
	University College London [a, b]	4	0.02	13	3.42%		
	University of Southampton [b]	4	0.06	20	5.26%		
	University of Warwick [b]	4	0.02	13	3.42%		
	University of York	4	0.06	24	6.32%		
	Loughborough University	3	0.06	9	2.37%		
	University of Leeds [b]	3	0.03	10	2.63%		
	University of Bristol [b]	2	0.02	12	3.16%		
	University of Nottingham [b]	2	0.03	11	2.89%		
	University of Strathclyde	2	0.03	10	2.63%		
	Other universities with five to ten USOs between 1990 and 2007	25	0.20	63	16.58%		
	Other universities with one to four USOs between 1990 and 2007	6	0.05	30	7.89%		
	Total	125	100.00%	380	100.00%		

[a] = University member of 'Golden Triangle'; [b] = University member of Russell Group

Table 19 (Continued): Response Bias Test (Chi-Square) for Categorical Variables

		Valid Respondents		Non-Respondents		Response Bias Test	
Variable	**Categories**	**n**	**%**	**n**	**%**	**Chi^2 Statistic**	**Significance level (p)**
Grouped universities of origin from which USOs originated between 1990 and 2007	Russell Group (excluding 'Golden Triangle')[8]	58	46.40%	149	39.21%	2.106	0.349
	Golden Triangle[9]	35	28.00%	126	33.16%		
	Other	32	25.60%	105	27.63%		
	Total	125	100.00%	380	100.00%		
First Venture Capital Investment in USOs between 1990 and 2007	Yes	60	48.00%	166	43.68%	0.745	0.388
	No	65	52.00%	214	56.32%		
	Total	125	100.00%	380	100.00%		
Attraction of Public Backed Equity between 1990 and 2007	Yes	54	43.20%	156	41.05%	0.184	0.688
	No	71	56.80%	224	58.95%		
	Total	125	100.00%	380	100.00%		

[8] Russell Group members relate to: Cardiff University, Newcastle University, Queen's University Belfast, University of Birmingham, University of Bristol, University of Edinburgh, University of Glasgow, University of Leeds, University of Manchester, University of Nottingham, University of Sheffield, University of Southampton and University of Warwick.

[9] Golden Triangle members relate to: Imperial College, King's College London, University College London, University of Cambridge and the University of Oxford.

3.3.3.2 Questionnaire Design

The questionnaire was designed to collect data from the founding academic entrepreneurs of USOs, who are regarded as the key informants. Information relating to the entrepreneur, firm, financing profile and business performance was consistently collected. The questionnaire was divided into several sections. The first section related to the founders' characteristics, information on their founding teams and their previous entrepreneurial experience prior to starting the surveyed firm. Further sections covered firm-level information on initial resource endowments prior to receiving external equity funding as well as the consequences associated with receiving investment. The questionnaire is presented in Section 1 of the Appendix.

To facilitate statistical analysis most questions had a closed format. Participants could choose between several alternative response categories (e.g. 'no', part-time' or 'full-time'), binary choices (e.g. 'yes' or 'no') or Likert scales (i.e. an ordinal scale ranging from 'strongly disagree', 'disagree', 'neither', 'disagree' or 'strongly agree'). A major advantage of such closed questions is that they can be quickly and consistently answered by the participants (DeVaus, 1996).

A pilot study considered content and face validity. For the pilot study, forty-two academic entrepreneurs were contacted by email. The pilot study was an online survey which took place between the 10th and 19th of December 2008. Ten respondents (20% response rate) completed the survey. Changes as a result of analysing the pilot study include adding additional instructions to remind participants if questions were related to the status of the USO before first attracting VC investment rather than the status of the USO in 2008. Whereas the order of the questions remained unchanged after the pilot study more subsections were created to avoid too many questions on one page in order to increase the response rate.

3.4 'Trustworthiness' of the Data: Validity and Reliability

3.4.1 Validity

Validity implies that the phenomenon of interest is accurately captured by a question and their response options. A first important form of validity is face validity. Face validity implies that questions and their response options 'look right' in the sense of capturing the phenomenon they are supposed to measure. Useful approaches to generate face validity comprise the replication of previous measurements, academic and expert opinions as well as pilot studies. In addition, several practitioner focused conferences on USO and start-up financing were attended to access the views of entrepreneurs, investors and policy makers[10]. Pilot studies for this research included pilot interviews with three academic entrepreneurs and two technology transfer office representatives. Further, the previously reported online pilot study was used to ensure validity used to ensure that participants understand the questions and provide meaningful and valid responses.

[10] List of practitioner workshops and conferences on academic entrepreneurship attended throughout the course of this research:

Date:	Event Organiser:	Subject of Event:
24/10/2006	Durham University Graduate School	The Academic Entrepreneur
31/10/2006	Durham University Graduate School	Business Plans
15/01/2007	Bridge Club North	Academic Entrepreneurship...Moving Knowledge Forward - Steve Caughey, managing director of Arjuna Technologies
06/02/2007	Durham University Graduate School	Running Your Own Show: a beginners guide!
12/02/2007	Bridge Club North	Becoming an Academic Entrepreneur - Are you ready to kick-start your business idea?
20/02/2007	Durham University Graduate School	Intellectual Property? Why didn't I think of that?
19/03/2007	Bridge Club North	Academic Entrepreneurship...Moving Knowledge Forward - BioNet Sponsored Event - Gary Todd, UK Haptics
14/05/2007	Bridge Club North	Academic Entrepreneurship...Moving Knowledge Forward - In Conversation With...Dr Wenfeng Lin of Clarizon
23/10/2007	Durham University Graduate School	The Academic Entrepreneur
14/04/2008	Connect North East	Start-ups and USOs from Sweden
16/04 - 18/04/2008	Durham University Graduate School	Durham Enterprise School
17/11/2008	BVCA	BVCA Spin-Out Event
09/02/2009	British Library	Research Resources on Entrepreneurship and Panel Discussion on USOs

The pilot study was also used to test whether questions using multiple items have construct validity. Construct validity ensures that the different dimensions which are suggested by the multiple items in response to a single but multifaceted question are all sufficiently related (Frankfort-Nachmias and Nachmias, 1992). In this study the questions to measure founding team experience and reputation as well as radical innovation are based on scales with multiple items. The construct validity of these scales is detected by a Principal Component Analysis (PCA). This statistical technique shows whether all items are sufficiently related to the same construct. It identifies which items are highly correlated with one another, and can be considered a single valid construct. The results of the PCA for the used multi-item scales are discussed in Section 3.5.

Two diagnostics are reported to ensure that assumptions of the PCA are met. The first diagnostic relates to the Bartlett test for sphericity. It determines whether the items in the scale are sufficiently correlated using a chi^2 statistic to test significance (Hair *et al*. 2006). Significance levels of 0.1 or less ensure that correlations among the items are not due to sampling error. The second diagnostic relates to the Kaiser-Meyer-Olkin (KMO) as a measure of sampling adequacy based on the inter-correlations among the items in the scale. The KMO can take values between 0 and 1 which reflect the appropriateness of the PCA. Smaller values indicate that variables have too little in common to conduct a PCA. The following labels are rules of thumb to interpret the values of KMO: 0.00 to 0.49 = 'unacceptable'; 0.50 to 0.59 = 'miserable'; 0.60 to 0.69 = 'mediocre'; 0.70 to 0.79 = 'middling'; 0.80 to 0.89 = 'meritorious'; 0.90 to 1.00 = 'marvellous'.

3.4.2 Reliability

Reliability implies that questions within multi-tem scales repeatedly capture the same phenomenon. External reliability relates to the consistency of a measure over time (Bryman and Cramer, 1999). This approach to generate reliability is often impractical for most research in the social sciences (de Vaus, 1996). This study focuses on previously tested measures where possible.

Internal reliability needs to be statistically determined when multiple items are used to build a scale in order to measure and capture the same construct (Bryman and Cramer,

1999). The internal reliability of a scale can be measured with reference to its Cronbach's alpha score, which relates to the average inter-item within the scale (Oppenheim, 1992). Cronbach alpha scores of 0.6 are acceptable in exploratory studies. Presented scales relating to independent variables identified by PCA models have Cronbach alpha scores of at least 0.6.

3.4.3 Common Methods Bias

Common methods bias can occur when the dependent and independent variables are gathered from the same data source (i.e., survey) (Podsakoff and Organ, 1986). This problem can be reduced. The control and independent variables in all models forthcoming in Chapter 4 present a well balanced mix from primary and secondary data sources. The online survey was also designed to encourage participants to respond to all questions without biases. This was ensured by participants' anonymity, a clear structure of the questionnaire along with factual and closed questions (Podsakoff *et al*., 2003). The online format of the survey guided the participant only through relevant questions ensured a sensible length of the questionnaire to prevent respondents suffering from boredom and fatigue (Lindell and Whitney, 2001).

In addition, a Harman single factor test was conducted (Podsakoff *et al*., 2003). All dependent and independent variables were introduced into an exploratory factor analysis. The unrotated factor solution is summarized in Tables 20 to 22. Fifteen factors were identified. No single factor 'explained' the majority of the variance in the model. The Harman single factor test suggests this study does not suffer from common methods bias.

Table 20: Common Methods Bias Test (Harman Single Factor): Factors Determining First VC Investment

Component	Eigenvalue	Difference	Proportion	Cumulative %
FirmAge	2.04	0.39	0.14	13.63%
Independent Firm	1.66	0.14	0.11	24.67%
PharmaBiotechSector	1.51	0.10	0.10	34.77%
OxCamLonRegion	1.41	0.24	0.09	44.20%
RelativeMarketSize	1.18	0.16	0.08	52.04%
AgeFounder	1.02	0.03	0.07	58.84%
FounderProfessor	0.99	0.08	0.07	65.42%
FounderHabitualEntrepreneur	0.91	0.04	0.06	71.50%
FoundingTeamReputation	0.87	0.11	0.06	77.30%
VCNetwork	0.76	0.05	0.05	82.35%
StrategicAlliances	0.70	0.14	0.05	87.04%
PatentedIP	0.56	0.01	0.04	90.76%
FirmOwnsIP	0.55	0.06	0.04	94.40%
InnovationRadicalness	0.49	0.14	0.03	97.66%
PublicBackedEquity	0.35	.	0.02	100.00%

Table 21: Common Methods Bias Test (Harman Single Factor): Factors Determining Firm Performance Including First VC Investment

Component	Eigenvalue	Difference	Proportion	Cumulative %
FirmAge	2.26	0.55	0.14	14.11%
Independent Firm	1.70	0.15	0.11	24.76%
PharmaBiotecSector	1.56	0.13	0.10	34.49%
OxCamLonRegion	1.43	0.24	0.09	43.42%
RelativeMarketSize	1.19	0.08	0.07	50.88%
AgeFounder	1.12	0.13	0.07	57.85%
FounderProfessor	0.99	0.05	0.06	64.03%
FounderHabitualEntrepreneur	0.94	0.03	0.06	69.88%
FoundingTeamReputation	0.90	0.14	0.06	75.52%
VCNetwork	0.76	0.04	0.05	80.25%
StrategicAlliances	0.72	0.11	0.04	84.74%
PatentedIP	0.61	0.05	0.04	88.54%
FirmOwnsIP	0.56	0.04	0.03	92.04%
InnovationRadicalness	0.52	0.11	0.03	95.26%
PublicBackedEquity	0.41	0.06	0.03	97.81%
FirstVC	0.35	.	0.02	100.00%

Table 22: Common Methods Bias Test (Harman Single Factor): Factors Determining Firm Performance Including Types of First VC Investment

Component	Eigenvalue	Difference	Proportion	Cumulative %
FirmAge	2.19	0.48	0.13	12.87%
Independent Firm	1.70	0.11	0.10	22.90%
PharmaBiotecSector	1.59	0.16	0.09	32.26%
OxCamLonRegion	1.43	0.05	0.08	40.68%
RelativeMarketSize	1.38	0.20	0.08	48.78%
AgeFounder	1.18	0.13	0.07	55.69%
FounderProfessor	1.04	0.05	0.06	61.82%
FounderHabitualEntrepreneur	0.99	0.07	0.06	67.62%
FoundingTeamReputation	0.92	0.04	0.05	73.01%
VCNetwork	0.88	0.12	0.05	78.18%
StrategicAlliances	0.76	0.05	0.04	82.63%
PatentedIP	0.71	0.14	0.04	86.80%
FirmOwnsIP	0.56	0.01	0.03	90.12%
InnovationRadicalness	0.56	0.05	0.03	93.39%
PublicBackedEquity	0.50	0.17	0.03	96.35%
GeneralistVC	0.34	0.05	0.02	98.33%
SpecialistVC	0.28	.	0.02	100.00%

3.5 Variable Operationalisation

3.5.1 Dependent Variables

3.5.1.1 Dependent Variables for First VC Investment

Eight dependent variables relating to first VC investment in USOs by 2008 were collected, and they are summarized in Table 23. This table illustrates the name of each dependent variable, the data source (i.e. primary or secondary data) and a brief description of the variable. Further, the questions related to measurements from the survey are shown followed by their response categories and coding. References for replicated dependent variables are indicated.

Table 23: Dependent Variables Relating to First VC Investment by 2008

Dependent Variables	**Source of Data**	**Description**	**Question (if Primary Data)**	**Response Categories and Coding**	**Used before in**
First VC investment (yes or no)	Primary Data; Secondary Data: Library House	Whether a USO attracted a first round of VC investment until 2008.	Please provide the distribution of equity ownership in your company Time 1: Immediately after your company first received outside equity investment.	Ownership percentage of first VC investment (0-100%) Recoded into two categories for the event of first VC Investment: 1 = Yes, if ownership percentage of first VC investment 1% or greater; 0 = No, if ownership percentage of first VC investment is 0%	Shane and Stuart (2002)
Number of first VC investment offers	Primary Data	Number of first VC investment offers attracted by a USO until 2008.	How many venture capitalists made a formal offer to invest in your company?	Continuous number of first VC Offers	
Number of first VC investment offers (multinominal)	Primary Data	Nominal categories of number of first VC investment offers attracted by a USO until 2008.	How many venture capitalists made a formal offer to invest in your company?	Continuous number of first offers recoded into three categories: 0 = No VC; 1 = One Offer; 2 = Two or more offers	
Number of first VC investments	Primary Data	Number of first VC investments attracted by a USO until 2008.	How many venture capitalists have invested in your company?	Continuous number of first VC Investments	Lerner (1994); Sorenson and Stuart (2001)

Table 23 (Continued)**:** Dependent Variables Measuring First VC Investment in USOs by 2008

Dependent Variables	**Source of Data**	**Description**	**Question (if Primary Data)**	**Response Categories and Coding**	**Used before in**
Number of first VC investments (multinominal)	Primary Data	Nominal categories of number of first VC investments attracted by a USO until 2008.	How many venture capitalists have invested in your company?	Continuous number of first offers recoded into three categories: 0 = No VC; 1 = One Investment; 2 = Two or more Investments	
Amount of first VC investment (£)	Primary Data	Amount of first VC investments attracted by a USO until 2008.		Continuous amount of first VC Investments	Lerner (1994); Sorenson and Stuart (2001)
Amount of first VC investments (£) (multinominal)	Primary Data	Nominal categories of amount of first VC investments attracted by a USO until 2008.		Continuous amount number of first offers recoded into three categories: 0 = No VC; 1 = £1 to £500,000; 2 = More than £500,000	
VC Investor Types	Secondary Data: BVCA	Nominal categories whether a USO attracted no first VC, Generalist or Specialist VC investment until 2008. VC investors are regarded as specialists if more than half of their portfolio of investees relates to a single sector or industry.		Three categories: 0 =No VC; 1 = GeneralistVC; 2 = SpecialistVC	Murray and Lott, (1995); Lockett *et al*. (2002)

3.5.1.2 Dependent Variables for USO Firm Performance

Seven dependent variables relating to USO firm performance was collected from secondary data sources. They are summarized in Table 24.

Table 24: Dependent Variables Relating to USOs Firm Performance until 2008

Dependent Variables	Source of Data	Description	Coding	Used before in
Total Number of External Investment Rounds	Secondary Data: Library House	Total number of all funding rounds received from all types of external investors (incl. VC investment, public backed equity, business angels, grants and awards) until 2008.	Continuous	Vohora *et al*. (2004)
Total Amount of External Investment (£)	Secondary Data: Library House	Total amount of all external funding received from all types of external investors (incl. VC investment, public backed equity, business angels, grants and awards) until 2008.	Continuous	
Product Launch (yes or no)	Secondary Data: Library House	Whether USO has been able to launch the first product or service to the market by 2008.	Categories of Product Launch: 1 = Yes; 0 = No	De Coster and Butler (2005)
Book Value of Total Assets (£)	Secondary Data: FAME	Value of total assets in USO in 2008.	Continuous	Gompers and Lerner (2006)
Number Employees	Secondary Data: FAME, Library House	Number of employees in 2008.	Continuous	Davidsson *et al*. (2006)
Employment Change	Secondary Data: FAME, Library House	Change in employment between founding year and 2008.	Continuous	Davidsson *et al*. (2006); Davila *et al*. (2003)
Composite Measure of Firm Performance	Secondary Data: FAME, Library House	Factor score: Total Number of Funding Rounds, Total Amount of Funding, Book Value of Total Assets, Number of Employees, Employment Change.	Continuous	

A composite performance variable was computed. A PCA model was computed with reference to six dependent variables relating to the total number of funding rounds, total amount of funding, product launch, total assets, employment size and employment growth. Table 25 shows the correlation matrix relating to the 6 dependent variables. To satisfy the assumptions of PCA analysis, the product launch variable had to be removed from the analysis. A single component that explained 65% of the variance is summarized in Table 26. Components scores relating to this composite performance variable were considered as an additional dependent variable.

Table 25: Correlation Table of Dependent Variables Measuring USOs' Firm Performance

	(1)	(2)	(3)	(4)	(5)	(6)
Total Number of Funding Rounds	1					
Total Amount of Funding	0.54***	1				
Product Launch	-0.22*	0	1			
Total Assets	0.35***	0.63***	0.16†	1		
Employment Size	0.36***	0.65***	0.15	0.68***	1	
Employment Growth	0.31***	0.62***	0.17†	0.57***	0.81***	1

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 26: PCA Model Relating to Composite Measure for USOs' Firm Performance

Extraction Method: Principal Component Analysis.		
	Component	Communality (h2)
Total Number of Funding Rounds	0.591	0.349
Total Amount of Funding	0.859	0.738
Total Assets	0.811	0.658
Employment Size	0.893	0.797
Employment Growth	0.844	0.712
Sums of squares of the component loadings	3.255	2.242
Percent of variance	65.080	
Cumulative percent of variance	65.080	
Diagnostics for sufficient correlations:		
Bartlett test of sphericity (Chi^2)	362.27***	
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0.78 (Middling)	

3.5.2 Independent Variables

This section presents all independent variables which are used to test their hypothesised relationships with the dependent variables of USOs' ability to attract first VC investment and firm performance by 2008. For this reason all independent variables of USOs with VC investment are measured at a point in time prior to their first VC investment. USOs without VC investment report their most recent measures in 2008. This approach allows identifying whether the same potential signals of quality which can attract first VC investment have a positive relationship with firm performance.

The following subsections introduce the independent variables in blocks of their resource categories starting with general and specific human capital, networks, intellectual capital as well as finance. For independent variables with measures which are derived from multi-item scale their statistical tests of principal component analysis (PCA) for construct validity and Cronbach's Alpha for internal robustness are reported. Where possible measures are replicated or extended based on previous studies.

3.5.2.1 Independent Variables Measuring General Human Capital

Two variables relating to founders general human capital were operationalized. The first variable in Table 27 relates to the age of the founding academic entrepreneur when they started the USO. This variable relates to previous investment in education and experience. The second variable relates to the academic status of the founder being a professor when the firm was founded.

3.5.2.2 Independent Variables Measuring Specific Human Capital

Two variables relating to founders specific human capital were operationalized. The first variable in Table 28 relates to the previous business ownership experience of respondents.

Table 27: Independent Variables Measuring General Human Capital

Independent Variables	**Source of Data**	**Description**	**Question (if primary data)**	**Response Categories and Coding**	**Used before in**
AgeFounder	Primary Data	Age of the founder when they founded the firm.	Your year of birth:	Continuous	(Aldrich, 1999)
FounderProfessor	Secondary Data: Library House	Academic status of the founder being a professor when they founded the firm.		Yes = 1, No = 0	Shane and Stuart (2002)

Table 28: Independent Variables Measuring Specific Human Capital

Independent Variables	**Source of Data**	**Description**	**Question (if primary data)**	**Response Categories and Coding**	**Used before in**
FounderHabitual Entrepreneur	Primary Data	Previous business ownership experience.	Did you found other companies before this one? Did any of your co-founders have previous business experience?	Yes = 1, No = 0	Shane and Stuart (2002); Hsu (2007) Shane and Cable (2002); Baum and Silverman (2004)
Founding TeamReputation	Primary Data	Founding team experience and reputation (valid and reliable multi-item construct relating to component scores.	Please indicate how much you agree with the following statements concerning your founding team: • At least one member of the team had founded a successful company before. • We expected our team would be credible to potential investors. • A trusted third party believed our team could successfully start a company. • We thought that our team's experience would be attractive to potential investors.	Strongly disagree = 1, Disagree = 2 , Neither agree nor disagree = 3, Agree = 4; Strongly agree = 5	Shane and Cable (2002)

Table 29: PCA Model Relating to Founding Teams' Previous Entrepreneurial and Business Experience

Question and items	**Component**	**Communality (h2)**
Please indicate how much you agree with the following statements concerning your founding team.	1	
At least one member of the team had founded a successful company before.	0.694	0.482
We expected our team would be credible to potential investors.	0.963	0.927
A trusted third party believed our team could successfully start a company.	0.93	0.865
We thought that our team's experience would be attractive to potential investors.	0.965	0.931
Sums of squares of the component loadings	3.205	2.706
Percent of variance	80.121	
Cumulative percent of variance	80.121	
Diagnostics for sufficient correlations:		
Bartlett test of sphericity (Chi^2)	544.02***	
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0.81 (Meritorious)	
Robustness:		
Cronbach's Alpha Based on Standardized Items	0.91	

A distinction is made between habitual founders with prior business ownership experience and novice entrepreneurs with no prior business ownership experience. The second variable relates to the founding teams previous entrepreneurial and business experience as well as reputation. Respondents were presented with four questions (Cable and Shane, 2002), and they were asked to rank their responses to each item on a 1 (strongly disagree) to 5 (strongly agree) scale. A PCA model was computed with reference to the four items. Table 29 shows that a single valid component was identified. The latter scale had a Cronbach's alpha of 0.91. Component scores relating to this founding teams previous entrepreneurial and business experience as well as reputation component were included in the presented regression models.

3.5.2.3 Independent Variables Measuring Networks

Two variables relating to USOs' networks were operationalized. The first variable in Table 30 relates to the percentage of previous USOs from the same university of origin which successfully attract VC investment which measures available indirect ties to VC investors. The second variable relates to whether USOs have inter-firm networks of strategic alliances or not.

3.5.2.4 Independent Variables Measuring Intellectual Capital

Three variables relating to USOs' intellectual capital were operationalized. The first variable in Table 31 relates to whether a USO had patented IP or not. The second variable relates to whether the IP is owned by the firm or not. The third variable relates to the radicalness of innovation in USOs' business models. The radicalness of innovation was measured with reference to the themes suggested by Marvel and Lumpkin (2007). The business model and marketing activities of each USO was ascertained with reference to material stored on the Library House database.

The following seven statements were considered with reference to the information relating to each USO: large group of customers already use a very similar product / service; product / service represents an entirely new type of product / service; product / service may be described as a new technology; product / service is a gradual progression upon the last generation; product / service is a product line extension; product / service satisfies a need not met by competitors; and product / service is a new twist on an old theme. With reference to each statement, this researcher allocated a score of 1 (strongly disagree) to 5 (strongly agree). A PCA model was computed with reference to the seven statements. To satisfy the assumptions of PCA three statements had to be removed. Table 29 shows that a single valid component was identified. The latter scale had a Cronbach's alpha of 0.65. Component scores relating to this innovation radicalness component were included in the presented regression models.

3.5.2.5 Independent Variables Measuring Financial Resources

Two variables relating to USOs' networks were operationalized. The variable in Table 33 relates to financial resources of the USO. It is measured whether USOs have received public backed equity investment prior to attracting first VC investment or not.

3.5.2.6 Independent Variables Measuring VC Investment used to Explore USO Performance

The second research questions relates to USO performance. In addition to the previously introduced independent variables characterising the initial resources of USOs, USOs' ability to attract first VC investment is now also included as an independent variable to explore the second research question. This approach has been discussed in Section 2.6.2 leading to the theoretical framework in Figure 14.

Three independent variables relating to whether USOs have obtained first VC investment by 2008 were operationalized. The first variable in Table 34 is the former binary dependent variable introduced in Section 3.5.1.2 relating to whether USOs have obtained first VC investment or not by 2008.

Table 30: Independent Variables Measuring Networks

Independent Variables	Source of Data	Description	Question (if primary data)	Response Categories and Coding	Used before in
VCNetwork	Secondary Data: Library House	Percentage of previous USOs from university of origin which received VC funding		1 = 0-15%, 2 = 15- 30%, 3 = 30-45%, 4 = 45-60%, 5 = 60-75%, 6 = 75-100%	
Strategic Alliances	Secondary Data: Library House	Inter-firm networks of USO.		Yes = 1, No = 0	Baum and Silverman (2004)

Table 31: Independent Variables Measuring Intellectual Capital

Independent Variables	Source of Data	Description	Question (if primary data)	Response Categories and Coding	Used before in
PatentedIP	Primary Data	Number patents present in the USO before the first VC investment.	How many patents were held by your company before receiving funding from an outside equity investor?	Continuous recoded into 0 = no patents; 1 = one or more patents	Shane and Stuart (2002); Hsu (2007)
FirmOwnsIP	Primary Data	Measures whether the ownership of IP is assigned to the USO before the first VC investment.	Who owns the intellectual property (IP) in your company?	1 = Founders; 2 = Company, 3 = University; 4 = Other (please specify) Recoded into dummy variable 1 = IP ownership owned by USO; 0 = IP ownership not owned by USO	

Table 31 (Continued)**:** Independent Variables Measuring Intellectual Capital

Independent Variables	**Source of Data**	**Description**	**Question (if primary data)**	**Response Categories and Coding**	**Used before in**
Innovation Radicalness	Secondary Data: Library House	Multi-tem scale measuring the degree of radical innovation of USOs' business models	• Large group of customers already use a very similar product / service • Product / service represents an entirely new type of product / service • Product / service may be described as a new technology • Product / service is a gradual progression upon the last generation • Product / service is a product line extension • Product / service satisfies a need not met by competitors • Product / service is a new twist on an old theme	1 = Strongly Disagree; 2 = Disagree; 3= Agree; 4 = Strongly Agree	Marvel and Lumpkin (2007)

Table 32: PCA Model Relating to Innovation Radicalness

Items	**Component**	**Communality (h2)**
	1	
Large group of customers already use a very similar product / service	0.760	0.577
Product / service represents an entirely new type of product / service	0.765	0.585
Product / service satisfies a need not met by competitors	0.428	0.183
Product / service is a new twist on an old theme	0.814	0.663
Sums of squares of the component loadings	2.008	1.148
Percent of variance	50.199	
Cumulative percent of variance	50.199	
Diagnostics for sufficient correlations:		
Bartlett test of sphericity (Chi^2)	80.76***	
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0.67 (Mediocre)	
Robustness:		
Cronbach's Alpha Based on Standardized Items	0.65	

Table 33: Independent Variables Measuring Financial Resources

Independent Variables	**Source of Data**	**Description**	**Question (if primary data)**	**Response Categories and Coding**	**Used before in**
PublicBackedEquity	Primary Data; Secondary Data: Library House	Previous investments by public backed equity in USO.	Please provide the distribution of equity ownership in your company Time 1: Immediately after your company first received outside equity investment.	Ownership percentage of Public Backed Equity (0-100%) Recoded into two categories: 1 = Yes, 0 = No	

Table 34: Independent Variables Measuring First VC Investment for Models on USO Firm Performance

Independent Variables	**Source of Data**	**Description**	**Question (if primary data)**	**Response Categories and Coding**	**Used before in**
First VC investment (yes or no)	Primary Data; Secondary Data: Library House	Whether a USO attracted a first round of VC investment until 2008.	Please provide the distribution of equity ownership in your company Time 1: Immediately after your company first received outside equity investment.	Ownership percentage of first VC investment (0-100%) Recoded into two categories for the event of first VC Investment: 1 = Yes, if ownership percentage of first VC investment 1% or greater; 0 = No, if ownership percentage of first VC investment is 0%	Shane and Stuart (2002)
Generalist VC	Secondary Data: BVCA	First investment attracted from a generalist VC with a portfolio of investees of which less than half relate to a single sector or industry.		1 = Yes; 0 = No	Lockett *et al*, 2002
Specialist VC	Secondary Data: BVCA	First investment attracted from a specialist VC with a portfolio of investees of which more than half relate to a single sector or industry.		1 = Yes; 0 = No	Lockett *et al*, 2002

Table 35: Control Variables

Control Variables	**Source of Data**	**Description**	**Question (if Primary Data)**	**Response Categories and Coding**	**Used before in**
FirmAge	Secondary Data: Library House, FAME, Companies House	USO's age in 2008 since founding year (as early as 1990).		Continuous	Becchetti and Trovato (2002) Lopez-Gracia and Sogorb-Mira (2008)
IndependentFirm	Primary Data and Secondary Data: Library House, FAME, Companies House	Company status of USO in 2008 is an independent private firm.	What is the status of your company?	Response categories in questionnaire: 1 = It is still in business; 2= It was merged or acquired; 3 = It is out of business Elimination of USOs out of business from sampling frame and recoding to 1 = Independent Firm 0 = IPO, Merged or Acquired	Shane and Stuart, (2002) Busenitz *et al*. (2005)
PharmaBiotecSector	Secondary Data: Library House, FAME, Companies House	USO is active in Pharma and Biotech sector		1 = Yes; 0 = No	Stuart and Sorenson (2000); Baum Silverman (2004); Maurer and Ebers (2006)

Table 35 (Continued)**:** Control Variables

Control Variables	**Source of Data**	**Description**	**Question (if Primary Data)**	**Response Categories and Coding**	**Used before in**
OxCamLonRegion	Secondary Data: Library House, FAME, Companies House	USO originates from the Oxford, London and Cambridge cluster		1 = Yes; 0 = No	Florida and Smith (1993); Mason and Harrison (2002); Gompers and Lerner (2006)
RelativeMarketSize	Secondary Data: FAME	Relative market size measures the average turnover in USOs' sector divided by the number of competitors in the sector. Data was used based on the four digit SIC code of the USO's primary sector. If VC investment was attracted, the measure of relative market-size was computed for the year when this investment was obtained. If no VC investment was attracted, the most recent relative market size in 2008 was used.		Continuous	Shane and Cable (2002)

The remaining two independent variables in Table 34 relate to the type of VC investor. They are operationalized as two dummy variables representing three categories (Hair *et al.*, 2006). Two binary variables indicate whether USOs have received their first VC investment from a generalist or a specialist. As defined before in Section 3.5.1.2, generalist VC investors have less than half of their portfolio composed of investees from a single industry or sector. Specialist VC investors have a portfolio of which more than half of their investees relate to a single industry or sector. The group of USOs which did not obtain VC investment is omitted being the reference category.

3.5.3 Control Variables

Five variables relating to control variables for the forthcoming analysis were operationalized. The control variables in Table 35 relate to firm age, company status, sector, region and relative market size.

3.6 Multivariate Regression Analysis

3.6.1 Regression Techniques

Regression analysis explores the links between selected independent variables and a dependent variable (binary, ordinal, categorical or continuous) (Hair *et al.*, 2006). A regression model should be significant at least at the 0.1 level of analysis. The direction and strength of a relationship between an individual independent variable and the dependent variable can be summarized in a beta coefficient. The significance of each individual relationship can be tested with reference to a 't' test.

Logistic regression analysis can be used to explore a binary dependent variable. Dependent variables relating to first VC investment by 2008 (yes or no) and product launch (yes or no). A logarithm is used to derive the beta coefficients relating to independent and control variables. To facilitate interpretation, the beta coefficients are transformed using the constant e, which is the base of the natural logarithm, by the power of the coefficient (i.e.

Exp(B)). This transformation leads to log odds. For example, If the Exp(B) of an independent variable equals 1.5 an increase in this variable by one unit increases the positive likelihood of the dependent variable by 1.5 to occur. Conversely, Exp(B) coefficients which are smaller than zero indicate a negative likelihood of the dependent variable event.

Tobit regression analysis can be used to explore an ordinal dependent variable. Three continuous dependent variables relating to number of first VC offers, number of first VC investment and amount of first VC investment by 2008 were explored using tobit regression analysis. Respondents that reported zero responses can be included in tobit regression models.

Multinomial regression analysis can be used to explore categorical dependent variables with three or more categories. Total number of VC rounds by 2008 (i.e., 'no offers', one offer' and two or more offers') and total amount of VC funding by 2008 (i.e., 'no investment', 'one investment' and 'two or more investments') dependent variables were both transformed into three categories. Multinomial regression analysis was also used to explore the dependent variable relating to the type of first VC investment (no first VC finance obtained = 0, first VC investment from a generalist = 1, first VC investment from a specialist = 2) and amount of first VC investment (none = 0, 1 = £1 to £500,000, 2 = >£500,000).

Ordinary least squares (OLS) regression analysis can be used to explore continuous dependent variables that had not be transformed into categories. These include Total Number of External Investment Rounds Attracted Until 2008, Total Amount of External Investment (£'s) Attracted Until 2008Book Value of Total Assets (£'s) Until 2008, Number of Employees in the USOs in 2008, Absolute Employment Change between Founding Year and 2008 and a Composite Measure of Firm Performance. These variables were standardised in dividing them by the age of the firm as well as normalised using the natural logarithm.

Hierarchical regression analysis was conducted. Blocks of control and independent variables were considered with regression models. Finally, full models including all control and independent variables are presented. The statistical significance of each model is compared with reference to its level of statistical significance. Each models level of 'explanation' is also reported. Variations in 'explanation' between each model are monitored (i.e., change in R^2 between each model). The STATA 10.0 statistical software package was used to compute all the presented regression models in Chapters 4 and 5.

3.6.2 Assumptions of Statistical Techniques: Overview

The assumptions of regression analysis relating to the general linear model need to be tested and not violated (Hair *et al*., 2006). Assumptions relating to normality, homoscedasticity, linearity and multicollinearity are discussed, in turn, below.

3.6.2.1 Normality

It is assumed that each continuous variable has a normal distribution (Hair *et al*., 2006). Two normality tests were conducted. Skewness and a kurtosis tests (D'Agostino *et al*., 1990) as well as the non-parametric Kolmogorov-Smirnov 'Z' tests are shown in Table 36. Several variables were found not to have a normal distribution. Some variables were transformed. Variables indicated with the symbols ' # ' in Table 36 were included in the presented regression models.

3.6.2.2 Homoscedasticity and Heteroscedasticity

The homoscedasticity assumption is met when the variance of error terms is constant across the range of variables included in the regression analysis (Hair *et al*., 2006). A violation of this assumption is referred to as heteroscedacticity. Especially in cross-sectional samples and dependent variables which are capturing temporal effects heteroscedacticity is a common effect (Tabachnick and Fidell, 2007). To reduce the problem of temporal effects, continuous dependent variables relating to firm performance were divided by the age of the firm. The standardised dependent variables of total number of funding rounds, total amount of funding, book value of total assets, number of employees and employment Change were already summarized in Table 36 Computational tests for heteroscedacticity were conducted using STATA 10.0's 'hettest' (Breusch and Pagan, 1979; Cook and Weisberg, 1983). The significance of the tests for heteroscedasticity are reported in the presented OLS regression models. There is no strong evidence to suggest the regression models are distorted by heteroscedasticity

Table 36: Normality Tests for Continuous Variables: Skewness/Kurtosis and Kolmogorov-Smirnov 'Z' tests

Variable	Transformation	Skewness/Kurtosis Tests for Normality					Kolmogorov-Smirnov 'Z' Tests for Normality				
		n	Skewness	Kurtosis	Chi^2	p	Absolute	Positive	Negative	K-S Z	p
FirmAge#		125	0.04	0.96	4.29	0.12	0.12	0.12	-0.06	1.28	0.07
RelativeMarketize		125	0.00	0.00	.	0.00	0.42	0.42	-0.39	4.61	0.00
LogRelativeMarketize#	Natural Logarithm	125	0.00	0.36	10.15	0.01	0.12	0.12	-0.08	1.29	0.07
FounderAge#	Natural Logarithm	125	0.25	0.36	2.21	0.33	0.08	0.05	-0.08	0.90	0.39
FoundingTeamReputation#		125	0.61	0.99	0.26	0.88	0.10	0.10	-0.08	1.11	0.17
VCNetwork#		125	0.25	0.42	2.01	0.37	0.17	0.17	-0.16	1.95	0.00
InnovationRadicalness#		125	0.00	0.04	11.64	0.00	0.10	0.10	-0.07	1.16	0.14
Venture CapitalSum of Amount		125	0.00	0.00	.	0.00	0.38	0.37	-0.38	4.28	0.00
LogVentureCapitalSumofAmount#	Natural Logarithm	125	0.09	0.84	3.14	0.21	0.18	0.18	-0.08	1.38	0.04
NumberFundingRounds		125	0.00	0.00	.	0.00	0.26	0.26	-0.26	2.89	0.00
WeighNumberFundingRounds	Divided by FirmAge	125	0.00	0.00	.	0.00	0.25	0.25	-0.25	2.81	0.00
Log WeighNumberFundingRounds#	Natural Logarithm	125	0.09	0.47	3.50	0.17	0.08	0.08	-0.05	0.85	0.47
TotalAmountFunding		125	0.00	0.00	.	0.00	0.40	0.40	-0.39	4.50	0.00
WeighTotalAmountFunding	Divided by FirmAge	125	0.00	0.00	.	0.00	0.39	0.38	-0.39	4.39	0.00
LogWeighTotalAmountFunding	Natural Logarithm	125	0.02	0.49	5.93	0.05	0.09	0.09	-0.05	0.97	0.30
TotalAssets		125	0.00	0.00	.	0.00	0.35	0.35	-0.35	3.93	0.00
WeighTotalAssets	Divided by FirmAge	125	0.00	0.00	.	0.00	0.34	0.33	-0.34	3.82	0.00
LogWeighTotalAssets#	Natural Logarithm	125	0.00	0.02	11.71	0.00	0.06	0.03	-0.06	0.65	0.80
NumberEmployees2008		125	0.00	0.00	.	0.00	0.31	0.31	-0.29	3.50	0.00
WeighEmployees2008	Divided by FirmAge	125	0.00	0.00	68.20	0.00	0.25	0.25	-0.24	2.81	0.00
Log WeighEmployees2008#	Natural Logarithm	125	0.42	0.60	0.95	0.62	0.05	0.05	-0.04	0.61	0.86
EmploymentChange		125	0.00	0.00	.	0.00	0.33	0.33	-0.30	3.70	0.00
WeighEmploymentChange	Divided by FirmAge	125	0.00	0.00	.	0.00	0.26	0.26	-0.25	2.91	0.00
AtanWeighEmploymentChange#	Radian value of arctangent	125	0.00	0.96	10.83	0.00	0.13	0.13	-0.09	1.49	0.02

Variables marked with '#' were included in the regression models.

3.6.2.3 Linearity

The relationship between the dependent variable and each independent variable is required to be linear. Following Hair *et al*., (2006), residuals from the respective OLS regression models were plotted. These residual vs. predicted values plot and added variable plots (Hamilton, 2006) are shown in Section 2 of the Appendix. There is no evidence to suggest that the linearity assumption has been violated.

3.6.2.4 Multicollinearity

Multicollinearity implies that two or more independent variables are measuring the same phenomenon. A correlation matrix relating to all independent and control variables needs to be presented to test for multicollinearity. High correlations between paired independent variables suggest potential multicollinearity. Bivariate correlation coefficients below 0.7 suggest that multicollinerity is not a major problem (Tabachnick and Fidell, 2007). In addition, each variable's Variance Inflation Factor (VIF) is reported. According to Hair *et al*. (2006), the traditional rule of thumb is that no VIF score should exceed 10. They suggest that the value should be lower with regard to smaller samples (see also Cohen *et al*. (2003)).

Control and independent variables used in regression models to explore the dependent variables relating to the first VC investment by 2008 are summarized in Table 37. Variables included in regression models relating to USO firm performance are summarized in Tables 38 and 39.

No signs of multicollinearity were detected as no correlation coefficient exceeded 0.50. Further, none of the reported VIF scores was higher than 2.00. Therefore, all control and independent variables can be included in the regression models.

Table 37: Correlation Matrix Relating to Control and Independent Variables Included in Regression Models Focusing Upon First VC Investment by 2008

	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FirmAge	1.24	1							
Independent Firm	1.22	-0.18*	1						
PharmaBiotecSector	1.09	0.05	-0.01	1					
OxCamLonRegion	1.43	0.04	0.01	0.13	1				
RelativeMarketSize	1.14	0.01	-0.26**	0.05	0.04	1			
AgeFounder	1.28	-0.03	0.00	0.15†	0.23**	0.12	1		
FounderProfessor	1.40	0.17†	-0.26**	0.09	0.24**	0.11	0.34***	1	
FounderHabitualEntrepreneur	1.28	0.02	0.04	-0.11	0.12	0.01	0.05	0.03	1
FoundingTeamReputation	1.44	-0.12	-0.11	-0.11	-0.05	0.16†	0.04	-0.09	0.36***
VCNetwork	1.48	-0.09	-0.04	0.10	0.40***	0.15†	0.09	0.15†	0.17†
StrategicAlliances	1.04	0.04	0.00	0.06	-0.06	0.05	0.01	-0.05	0.00
PatentedIP	1.22	0.00	-0.03	0.09	0.24**	0.07	-0.01	0.21†	-0.08
FirmOwnsIP	1.24	0.26**	-0.02	0.01	0.03	-0.02	-0.01	0.07	0.16†
InnovationRadicalness	1.19	-0.07	0.10	-0.01	0.07	0.00	0.10	-0.01	0.11
PublicBackedEquity	1.13	-0.22*	0.02	0.00	-0.05	0.05	0.04	-0.02	-0.15†
Mean VIF	1.25								

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 37 (Continued)**:** Correlation Matrix Relating to Control and Independent Variables Included in Regression Models Focusing Upon First VC Investment by 2008

	VIF	(9)	(10)	(11)	(12)	(13)	(14)	(15)
FirmAge	1.24							
Independent Firm	1.22							
PharmaBiotecSector	1.09							
OxCamLonRegion	1.43							
RelativeMarketSize	1.14							
AgeFounder	1.28							
FounderProfessor	1.40							
FounderHabitualEntrepreneur	1.28							
FoundingTeamReputation	1.44	1						
VCNetwork	1.48	0.26**	1					
StrategicAlliances	1.04	0.02	0.06	1				
PatentedIP	1.22	-0.15†	0.04	-0.06	1			
FirmOwnsIP	1.24	-0.05	0.06	-0.02	-0.17†	1		
InnovationRadicalness	1.19	-0.09	0.18*	0.09	0.02	0.22*	1	
PublicBackedEquity	1.13	-0.02	0.09	0.07	0.09	-0.04	-0.05	1
Mean VIF	1.25							

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 38: Correlation Matrix Relating to Control and Independent Variables Included in Regression Models Focusing Upon USO Firm Performance

	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FirmAge	1.25	1							
Independent Firm	1.23	-0.18*	1						
PharmaBiotecSector	1.10	0.05	-0.01	1					
OxCamLonRegion	1.43	0.04	0.01	0.13	1				
RelativeMarketSize	1.14	0.01	-0.26**	0.05	0.04	1			
AgeFounder	1.28	-0.03	0.00	0.15†	0.23**	0.12	1		
FounderProfessor	1.44	0.17†	-0.26**	0.09	0.24**	0.11	0.34***	1	
FounderHabitualEntrepreneur	1.28	0.02	0.04	-0.11	0.12	0.01	0.05	0.03	1
FoundingTeamReputation	1.52	-0.12	-0.11	-0.11	-0.05	0.16†	0.04	-0.09	0.36***
VCNetwork	1.57	-0.09	-0.04	0.10	0.40***	0.15†	0.09	0.15†	0.17†
StrategicAlliances	1.07	0.04	0.00	0.06	-0.06	0.05	0.01	-0.05	0.00
PatentedIP	1.26	0.00	-0.03	0.09	0.24**	0.07	-0.01	0.21†	-0.08
FirmOwnsIP	1.28	0.26**	-0.02	0.01	0.03	-0.02	-0.01	0.07	0.16†
InnovationRadicalness	1.20	-0.07	0.10	-0.01	0.07	0.00	0.10	-0.01	0.11
PublicBackedEquity	1.17	-0.22*	0.02	0.00	-0.05	0.05	0.04	-0.02	-0.15†
First VC investment	1.47	-0.08	-0.16†	-0.07	0.13	0.12	0.05	0.22*	0.11
Mean VIF	1.29								

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 38 (Continued): Correlation Matrix Relating to Control and Independent Variables Included in Regression Models Focusing Upon USO Firm Performance

	VIF	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
FirmAge	1.25								
Independent Firm	1.23								
PharmaBiotecSector	1.10								
OxCamLonRegion	1.43								
RelativeMarketSize	1.14								
AgeFounder	1.28								
FounderProfessor	1.44								
FounderHabitualEntrepreneur	1.28								
FoundingTeamReputation	1.52	1							
VCNetwork	1.57	0.26**	1						
StrategicAlliances	1.07	0.02	0.06	1					
PatentedIP	1.26	-0.15†	0.04	-0.06	1				
FirmOwnsIP	1.28	-0.05	0.06	-0.02	-0.17†	1			
InnovationRadicalness	1.20	-0.09	0.18*	0.09	0.02	0.22*	1		
PublicBackedEquity	1.17	-0.02	0.09	0.07	0.09	-0.04	-0.05	1	
First VC investment	1.47	0.28**	0.37***	0.12	0.16†	0.11	0.00	0.21*	1
Mean VIF	1.29								

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 39: Correlation Matrix Relating to Control and Independent Variables Included in Regression Models Focusing Upon Type of First VC Investment (No Investment, Generalist or Specialist)

	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FirmAge	1.25	1							
Independent Firm	1.23	-0.18*	1						
PharmaBiotecSector	1.13	0.05	-0.01	1					
OxCamLonRegion	1.48	0.04	0.01	0.13	1				
RelativeMarketSize	1.15	0.01	-0.26**	0.05	0.04	1			
AgeFounder	1.28	-0.03	0.00	0.15†	0.23**	0.12	1		
FounderProfessor	1.46	0.17†	-0.26**	0.09	0.24**	0.11	0.34***	1	
FounderHabitualEntrepreneur	1.28	0.02	0.04	-0.11	0.12	0.01	0.05	0.03	1
FoundingTeamReputation	1.52	-0.12	-0.11	-0.11	-0.05	0.16†	0.04	-0.09	0.36***
VCNetwork	1.65	-0.09	-0.04	0.10	0.40***	0.15†	0.09	0.15†	0.17†
StrategicAlliances	1.07	0.04	0.00	0.06	-0.06	0.05	0.01	-0.05	0.00
PatentedIP	1.29	0.00	-0.03	0.09	0.24**	0.07	-0.01	0.21†	-0.08
FirmOwnsIP	1.28	0.26**	-0.02	0.01	0.03	-0.02	-0.01	0.07	0.16†
InnovationRadicalness	1.23	-0.07	0.10	-0.01	0.07	0.00	0.10	-0.01	0.11
PublicBackedEquity	1.17	-0.22*	0.02	0.00	-0.05	0.05	0.04	-0.02	-0.15†
Generalist VC	1.78	-0.07	-0.04	-0.15†	-0.04	-0.02	-0.03	0.01	0.03
Specialist VC	1.67	-0.02	-0.13	0.07	0.17†	0.14	0.07	0.21*	0.09
Mean VIF	1.35								

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 39 (Continued)**:** Correlation Matrix Relating to Control and Independent Variables Included in Regression Models Focusing Upon Type of First VC Investment (No Investment, Generalist or Specialist)

	VIF	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
FirmAge	1.25									
Independent Firm	1.23									
PharmaBiotecSector	1.13									
OxCamLonRegion	1.48									
RelativeMarketSize	1.15									
AgeFounder	1.28									
FounderProfessor	1.46									
FounderHabitualEntrepreneur	1.28									
FoundingTeamReputation	1.52	1								
VCNetwork	1.65	0.26**	1							
StrategicAlliances	1.07	0.02	0.06	1						
PatentedIP	1.29	-0.15†	0.04	-0.06	1					
FirmOwnsIP	1.28	-0.05	0.06	-0.02	-0.17†	1				
InnovationRadicalness	1.23	-0.09	0.18*	0.09	0.02	0.22*	1			
PublicBackedEquity	1.17	-0.02	0.09	0.07	0.09	-0.04	-0.05	1		
Generalist VC	1.78	0.14	0.24**	0.08	0.13	0.02	-0.11	0.13	1	
Specialist VC	1.67	0.15†	0.15†	0.05	0.05	0.09	0.09	0.09	-0.45***	1
Mean VIF	1.35									

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

3.7 Overview of Hypotheses and Independent Variables

The independent variables linked to the hypotheses relating to first VC investment by 2008 and USO firm performance discussed in Chapter 2 are summarized in Tables 40 and 41, respectively. Hypotheses relating to first VC investment by 2008 are tested in Chapter 4, whilst hypotheses relating to USO firm performance are tested in Chapter 5.

Table 40: Summary of Hypotheses and Independent Variables on Attraction of First VC Investment

Themes of Internal Resources	**Independent Variables:**	**Hypotheses:**
General Human Capital	Age Founder	**Hypothesis 1:** Older USO founders are more likely to attract first VC investment.
	Founder Professor	**Hypothesis 2:** USO founders with higher levels of academic reputation are more likely to attract first VC investment.
Specific Human Capital	Founder Habitual Entrepreneur	**Hypothesis 3:** USO founders who are experienced entrepreneurs are more likely to attract first VC investment.
	Founding Team Reputation	**Hypothesis 4:** USOs with an experienced founding team are more likely to attract first VC investment.
Networks	VC Network	**Hypothesis 5:** USOs from universities that have a strong network of previously VC funded USOs are more likely to attract first VC investment.
	Strategic Alliances	**Hypothesis 6:** USOs with alliance partners are more likely to attract first VC investment.
Intellectual Capital	Patented IP	**Hypothesis 7:** USOs with patented IP are more likely to attract first VC investment.
	FirmOwnsIP	**Hypothesis 8:** USOs with IP ownership are more likely to attract first VC investment.
	Innovation Radicalness	**Hypothesis 9:** USOs whose main product or service is associated with radical innovation are less likely to attract first VC investment.
Finance	Public Backed Equity	**Hypothesis 10:** USOs that have obtained publicly-backed equity funds are more likely to attract first VC investment.

Table 41: Summary of Hypotheses and Independent Variables on Firm Performance

Themes of Internal Resources	**Independent Variables:**	**Hypotheses:**
General Human Capital	AgeFounder	**Hypothesis 11:** USOs with older founders will report superior firm performance.
	Founder Professor	**Hypothesis 12:** USOs with founders with higher levels of academic reputation will report superior firm performance.
Specific Human Capital	Founder Habitual Entrepreneur	**Hypothesis 13:** USOs with experienced entrepreneurs will report superior firm performance.
	Founding Team Reputation	**Hypothesis 14:** USOs with an experienced founding team will report superior firm performance.
Networks	VCNetwork	**Hypothesis 15:** USOs from universities that have a strong network of previously VC funded USOs will report superior firm performance.
	Strategic Alliances	**Hypothesis 16:** USOs with alliance partners report superior firm performance.
Intellectual Capital	PatentedIP	**Hypothesis 17:** USOs with patented IP will report superior firm performance.
	FirmOwnsIP	**Hypothesis 18:** USOs that own their IP will report superior firm performance.
	Innovation Radicalness	**Hypothesis 19:** USOs whose main product or service is associated with radical innovation will report weaker firm performance.
Finance	Public Backed Equity	**Hypothesis 20:** USOs that have obtained publicly-backed equity funds will report superior firm performance.
VC Investment	FirstVC	**Hypothesis 21:** USOs with VC investment will report superior firm performance.
	GeneralistVC	**Hypothesis 22:** USOs with generalist VC investment will report superior firm performance.
	SpecialistVC	**Hypothesis 23:** USOs with specialist VC investment will report superior firm performance.

Chapter 4: Ability to attract First Venture Capital (VC) Investment

4.1 Introduction

This chapter tests hypotheses derived in Chapter 2 related to research question 1: Which resources of university spin-outs (USOs) are signals of quality and attract first venture capital (VC) investment? The array of dependent variables introduced in Section 3.5.1.1 is used for sensitivity analysis.

4.2 Hypotheses Testing

4.2.1 Likelihood of Attracting First VC Investment: Logistic Regression Analysis

This section tests hypotheses relating to whether USOs received a first round of VC investment or not. Respondents reporting first VC investment were allocated a value of '1', whilst those not reporting a VC investment were allocated a value of '0'. Seventy-eight (i.e. 62%) reported a first VC investment. Logistic Regression analysis was conducted. The reported beta coefficients are transformed to be interpreted as log-odds. A negative relationship between an independent variable and the dependent variable is indicated by a coefficient for Exp(B) < 1. A positive likelihood for the event of first VC investment to occur is indicated by Exp(B) > 1.

The base model 1-1 in Table 42 relates to the control variables. This model is significant at the 0.10 level and has a pseudo R^2 of 0.06. Independent firms (IndependentFirm) were significant less likely to have obtained first VC finance at the 0.10 level. Firms located in the Oxford, Cambridge or London cluster (OxCamLonRegion) were significant more likely to have obtained first VC investment at the 0.10 level.

Sets of variables were then added to the base model. Each of the models (Models 1-2 to 1-5) was significant at the 0.05 level or lower. The full model is presented in Model 1-6. This model has a pseudo R^2 of 0.29 and is significant at the 0.001 level. The change in R^2 is compared to the base model (Model 1-1) is 0.23, and this change is significant at the 0.01 level.

Six variables are significant in Model 1-6. Firms with more network links to VC investors (VCNetwork) were more likely to have obtained first VC finance at the 0.01 level. Founding team with more experience and reputation (FoundingTeamReputation) as well as firms with patented IP (PatentedIP) and owning their IP (FirmOwnsIP) were more likely to have obtained first VC investment at the 0.05 level. Further, firms with professors as founders (FounderProfessor) as well as those which had obtained previous public backed equity finance (PublicBackedEquity) were more likely to have obtained first VC investment at the 0.10 level. In consequence, Model 1-6 supports Hypotheses 2, 4, 5, 7, 8 and 10.

4.2.2 Number of First VC Offers: Tobit Regression Analysis

This section tests hypotheses relating to the number of first VC investment offers which were received by USOs. Thirty-six firms (29%) did not receive a single offer. The mean and median number of offers were 1.8 and 1, respectively. The number of offers ranged from 0 to 10 offers. Tobit regression analysis was conducted.

The base model 2-1 in Table 43 relates to the control variables. This model is not significant and has a pseudo R^2 of 0.02. Sets of independent variables were then added to the base model. The full model is presented in Model 2-6. This model has a pseudo R^2 of 0.09 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.07 and this change is significant at the 0.001 level.

Six variables are significant in Model 2-6. Firms with founding teams of higher experience and reputation (FoundingTeamReputation) as well as those with strategic alliance partners (StrategicAlliances) received more first VC offers at the 0.01 level. Further, firms with professors as founders (FounderProfessor) received more first VC offers at the 0.05 level. Firms with more network links to VC investors (VCNetwork), patented IP (PatentedIP) and IP ownership (FirmOwnsIP) received more VC offers at the 0.10 level. Accordingly, Hypotheses 2, 4, 5, 6, 7 and 8 are supported.

Table 42: Likelihood of Attracting First VC Investment: Logistic Regression Analysis

	Model:	**1-1**		**1-2**		**1-3**		**1-4**		**1-5**		**1-6**	
		Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.
Control Variables	FirmAge	0.91	0.06	0.91	0.07	0.93	0.07	0.88†	0.07	0.94	0.07	0.92	0.08
	Independent Firm	0.29†	0.20	0.48	0.37	0.28†	0.20	0.29†	0.20	0.28†	0.20	0.50	0.40
	PharmaBiotecSector	0.64	0.27	0.70	0.33	0.53	0.24	0.59	0.26	0.62	0.27	0.47	0.26
	OxCamLonRegion	2.00†	0.83	1.86	0.86	1.17	0.56	1.71	0.74	2.14†	0.91	0.93	0.54
	RelativeMarketSize	1.10	0.11	1.05	0.12	1.04	0.12	1.10	0.12	1.09	0.11	1.01	0.13
General Human Capital	AgeFounder			0.52	0.54							1.10	1.36
	FounderProfessor			3.28*	1.59							2.84†	1.62
Specific Human Capital	FounderHabitual Entrepreneur			0.96	0.43							1.01	0.52
	FoundingTeamReputation			1.92**	0.45							2.01*	0.56
Networks	VCNetwork					1.88***	0.35					1.86**	0.41
	StrategicAlliances					1.67	0.73					1.91	0.96
Intellectual Capital	PatentedIP							2.21†	0.97			3.86*	2.20
	FirmOwnsIP							2.35*	1.03			3.08*	1.64
	InnovationRadicalness							0.89	0.19			0.77	0.21
Finance	PublicBackedEquity									2.59*	1.08	2.28†	1.13
	n	125		125		125		125		125		125	
	pseudo R^2	0.06		0.14		0.16		0.09		0.09		0.29	
	Change in R^2	/		0.08*		0.10**		0.03		0.03*		0.23**	
	LR Chi^2	9.54†		23.29**		25.93***		15.70*		15.02*		47.96***	
	Log likelihood	-77.99		-71.11		-69.79		-74.91		-75.25		-58.78	
	Cases correctly classified	65.60%		72.00%		68.80%		66.40%		71.20%		76.00%	

Significance levels: †p < .10; *p <.05; **p < .01; ***p < .001

The beta coefficients are log odds. A negative likelihood of the event in the dependent variable to occur is Exp(B) < 1; a positive likelihood is Exp(B) > 1.

Table 43: Number of First VC Offers: Tobit Regression Analysis

	Model:	**2-1**		**2-2**		**2-3**		**2-4**		**2-5**		**2-6**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.07	0.08	-0.05	0.08	-0.05	0.08	-0.11	0.09	-0.04	0.09	-0.06	0.08
	Independent Firm	-1.19	0.72	-0.44	0.72	-1.15†	0.68	-1.23†	0.72	-1.20†	0.72	-0.57	0.67
	PharmaBiotecSector	-0.43	0.55	-0.34	0.53	-0.59	0.52	-0.50	0.54	-0.44	0.55	-0.58	0.51
	OxCamLonRegion	0.76	0.50	0.69	0.51	0.16	0.52	0.55	0.51	0.80	0.51	0.23	0.54
	RelativeMarketSize	0.17	0.13	0.13	0.12	0.11	0.12	0.16	0.12	0.17	0.13	0.07	0.11
General Human Capital	AgeFounder			-1.52	1.18							-1.34	1.13
	FounderProfessor			1.43**	0.53							1.20*	0.51
Specific Human Capital	FounderHabitualEntrepreneur			-0.42	0.51							-0.54	0.49
	FoundingTeamReputation			0.81**	0.27							0.75**	0.27
Networks	VCNetwork					0.58**	0.18					0.36†	0.18
	StrategicAlliances					1.16*	0.48					1.29**	0.46
Intellectual Capital	PatentedIP							0.94†	0.54			0.97†	0.51
	FirmOwnsIP							0.94†	0.53			0.94†	0.49
	InnovationRadicalness							0.08	0.25			0.07	0.24
Finance	PublicBackedEquity									0.67	0.50	0.47	0.46
	Constant	2.66**	0.97	7.14	4.37	0.42	1.09	1.89†	1.02	2.19	1.03	3.99	4.27
	Sigma	2.58	0.21	2.44	0.19	2.42	0.19	2.53	0.20	2.58	0.20	2.27	0.18
	n	125		125		125		125		125		125	
	Left-Censored	36		36		36		36		36		36	
	Uncensored	89		89		89		89		89		89	
	pseudo R^2	0.02		0.05		0.05		0.03		0.02		0.09	
	Change in R^2	/		0.03**		0.03***		0.01		0.00		0.07***	
	LR Chi^2	8.83		23.43**		25.7***		14.55†		10.62†		44.74***	
	Log likelihood	-241.40		-234.10		-232.96		-238.54		-240.50		-223.45	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

4.2.3 Number of First VC Investment Offers: Multinominal Logit Regression Analysis

A robustness test was computed relating to the number of first VC investment offers. The first VC investment offer variable was transformed into three categories. Firms with no VC investment offer were allocated a value of '0', those with one offer were allocated a value of '1', and those with two or more offers were allocated a value of '2'. Thirty-six firms (29%) did not receive an offer, 24 firms (24%) received one offer and 59 firms (47%) received two or more offers. Multinominal logit regression analysis was conducted.

The base model 3-1 in Table 44 relates to the control variables. This model is not significant and has a pseudo R^2 of 0.05. Sets of independent variables were then added to the base model. The full model is presented in Model 3-6. This Model has a pseudo R^2 of 0.26 and is significant at the 0.001 level. The change in R^2 compared with the base model is 0.21, and this change is significant at the 0.001 level.

In Model 3-6 three variables are significant with one first VC offer. Firms with patents (PatentedIP) were more likely to attract one offer at the 0.01 level. Founding teams of higher reputation and experience (FoundingTeamReputation) as well as with alliance partners (StrategicAlliances) were more likely to attract one offer at the 0.05 level. In consequence, Hypotheses 4, 6 and 7 are supported for firms which received one first VC investment offer.

In Model 3-6 seven variables are significant with two or more first VC offers. Firms with founding teams of higher reputation and experience (FoundingTeamReputation) as well as with alliances partners (StrategicAlliances) were more likely to attract two or more offers at the 0.01 level. Firms having founders with the status of a professor (FounderProfessor), more network links with VC investors (VCNetwork), patented IP (PatentedIP) as well as IP ownership (FirmOwnsIP) were more likely to attract two or more offers at the 0.05 level. Further, firms which attracted public backed equity (PublicBackedEquity) were more likely to attract two or more offers at the 0.10 level. Therefore, Hypotheses 2, 4, 5, 6, 7, 8 and 10 are supported for firms which received two or more first VC investment offers.

Table 44: Number of First VC Investment Offers (0, 1 and 2 or more): Multinominal Logit Regression Analysis

	Model:	**3-1**				**3-2**				**3-3**			
	Categories:	One offer		Two or more offers		One offer		Two or more offers		One offer		Two or more offers	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.15	0.09	-0.08	0.08	-0.13	0.10	-0.08	0.09	-0.16	0.10	-0.06	0.09
	Independent Firm	-1.69†	0.91	-1.16	0.85	-1.49	0.98	-0.33	0.92	-1.69†	0.94	-1.17	0.88
	PharmaBiotecSector	-0.84	0.60	-0.37	0.48	-0.61	0.63	-0.19	0.54	-1.08†	0.63	-0.65	0.52
	OxCamLonRegion	0.87	0.56	0.80†	0.48	0.96	0.61	0.88	0.55	0.93	0.62	0.37	0.55
	RelativeMarketSize	0.05	0.14	0.09	0.12	0.00	0.15	0.04	0.13	0.01	0.15	0.03	0.13
General Human Capital	AgeFounder					-0.52	1.35	-2.29†	1.23				
	FounderProfessor					0.09	0.66	1.64**	0.57				
Specific Human Capital	FounderHabitualEntrepreneur					0.04	0.58	-0.43	0.52				
	FoundingTeamReputation					0.55†	0.31	0.82**	0.27				
Networks	VCNetwork									0.18	0.23	0.57**	0.20
	StrategicAlliances									1.53*	0.62	1.37*	0.56
Intellectual Capital	PatentedIP												
	FirmOwnsIP												
	InnovationRadicalness												
Finance	PublicBackedEquity												
	Constant	2.30*	1.17	1.96†	1.07	3.84	4.94	9.25	4.51	1.39	1.38	-0.16	1.31
	n[#]	30		59		30		59		30		59	
	pseudo R^2	0.05				0.13				0.12			
	Change in R^2	/				0.08*				0.07**			
	LR Chi^2	11.75				33.62*				31.85**			
	Log likelihood	-126.05				-115.11				-116.00			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001 [#] = Base outcome: 'no VC offers' (n = 36)

Table 44 (Continued)**:** Number of First VC Investment Offers (0, 1 and 2 or more): Multinominal Logit Regression Analysis

	Model:	**3-4**				**3-5**				**3-6**			
	Categories:	One offer		Two or more offers		One offer		Two or more offers		One offer		Two or more offers	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.18†	0.10	-0.13	0.09	-0.12	0.09	-0.04	0.08	-0.16	0.12	-0.11	0.11
	Independent Firm	-1.74†	0.92	-1.18	0.85	-1.77†	0.93	-1.24	0.86	-1.36	1.05	-0.22	0.98
	PharmaBiotecSector	-0.97	0.62	-0.48	0.50	-0.89	0.61	-0.43	0.49	-1.23†	0.74	-0.85	0.67
	OxCamLonRegion	0.61	0.59	0.60	0.51	0.96†	0.57	0.90†	0.50	0.85	0.76	0.45	0.72
	RelativeMarketSize	0.04	0.14	0.10	0.12	0.06	0.14	0.10	0.12	-0.08	0.17	-0.03	0.15
General Human Capital	AgeFounder									-0.19	1.65	-1.95	1.56
	FounderProfessor									0.15	0.77	1.66*	0.70
Specific Human Capital	FounderHabitualEntrepreneur									0.06	0.66	-0.51	0.63
	FoundingTeamReputation									0.95*	0.38	1.09**	0.35
Networks	VCNetwork									0.16	0.27	0.50*	0.26
	StrategicAlliances									1.89*	0.75	1.94**	0.71
Intellectual Capital	PatentedIP	1.18†	0.61	0.91†	0.49					2.08**	0.79	1.55*	0.70
	FirmOwnsIP	0.57	0.58	1.04*	0.50					1.13	0.71	1.56*	0.66
	InnovationRadicalness	0.06	0.28	0.04	0.24					0.14	0.35	0.12	0.32
Finance	PublicBackedEquity					1.13*	0.56	1.22*	0.49	0.95	0.64	1.02†	0.61
	Constant	1.59	1.23	1.26	1.12	1.70	1.21	1.28	1.12	-0.38	6.19	4.19	5.84
	n#	30		59		30		59		30		59	
	pseudo R^2	0.08				0.07				0.26			
	Change in R^2	0.03				0.02				0.21***			
	LR Chi^2	20.74				18.90†				69.51***			
	Log likelihood	-121.55				-122.47				-97.17			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001 # = Base outcome: 'no VC offers' (n = 36)

4.2.4 Number of First VC Investments: Tobit Regression Analysis

This section tests hypotheses relating to the number of first VC investment which were received by USOs. Forty-seven firms (38%) did not receive a VC investment. The mean and median number of VC investments was 1.4 and 1, respectively. The number of VC investments ranged from 0 to 10 investments. Tobit regression analysis was conducted.

The base model 4-1 in Table 45 relates to the control variables. This model is significant at the 0.05 level and has a pseudo R^2 of 0.03. Independent firms (Independent Firm) were less likely to attract more first VC investments at the 0.05 level. Firms located in the Oxford, Cambridge or London cluster (OxCamLonRegion) were more likely to have obtained more first VC investments at the 0.10 level. Sets of independent variables were then added to the base model. The full model is presented in Model 4-6. This model has a pseudo R^2 of 0.12 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.09 and this change is significant at the 0.001 level.

Four variables are significant in Model 4-6. Firms with founders with the status of a professor (FounderProfessor), more founding team's experience and reputation (FoundingTeamReputation) as well as more network links to VC investors (VCNetworks) obtained more first VC investments at the 0.01 level. Further, firms with owning their IP (FirmOwnsIP) reported more first VC investments weakly at the 0.10 level. Consequently, Hypotheses 2, 4, 5 and 8 are supported in Model 4-6.

4.2.5 Number of First VC Investments: Multinominal Logit Regression Analysis

A robustness test was computed relating to the number of first VC investments. The variable of number of first VC investments was transformed into three categories. Firms with no VC investment offer were allocated a value of '0', those with one VC investment were allocated a value of '1', and those with two or more VC investments were allocated a value of '2'.

Table 45: Number of First VC Investments: Tobit Regression Analysis

	Model:	**4-1**		**4-2**		**4-3**		**4-4**		**4-5**		**4-6**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.07	0.08	-0.06	0.07	-0.04	0.07	-0.11	0.08	-0.05	0.08	-0.06	0.07
	Independent Firm	-1.56*	0.64	-0.84	0.61	-1.50*	0.60	-1.55*	0.64	-1.57*	0.64	-0.93	0.58
	PharmaBiotecSector	-0.09	0.49	0.03	0.46	-0.18	0.46	-0.16	0.49	-0.10	0.49	-0.15	0.44
	OxCamLonRegion	0.92*	0.45	0.81*	0.43	0.17	0.46	0.83†	0.45	0.95*	0.45	0.26	0.47
	RelativeMarketSize	0.18	0.11	0.13	0.10	0.11	0.11	0.17	0.11	0.17	0.11	0.08	0.10
General Human Capital	AgeFounder			-1.42	1.02							-1.09	0.99
	FounderProfessor			1.46**	0.46							1.21**	0.45
Specific Human Capital	FounderHabitualEntrepreneur			-0.23	0.44							-0.27	0.43
	FoundingTeamReputation			0.83***	0.23							0.67**	0.24
Networks	VCNetwork					0.65***	0.16					0.45**	0.16
	StrategicAlliances					0.32	0.42					0.46	0.40
Intellectual Capital	PatentedIP							0.58	0.49			0.55	0.45
	FirmOwnsIP							0.94*	0.47			0.79†	0.43
	InnovationRadicalness							-0.11	0.23			-0.13	0.21
Finance	PublicBackedEquity									0.49	0.45	0.39	0.41
	Constant	2.26**	0.86	6.39†	3.79	0.05	0.97	1.65†	0.92	1.91*	0.92	2.96	3.78
	Sigma	2.26	0.20	2.06	0.18	2.10	0.18	2.22	0.19	2.26	0.20	1.95	0.17
	n	125		125		125		125		125		125	
	Left-Censored	47		47		47		47		47		47	
	Uncensored	78		78		78		78		78		78	
	pseudo R^2	0.03		0.08		0.07		0.04		0.04		0.12	
	Change in R^2	/		0.05***		0.04***		0.01		0.01		0.09***	
	LR Chi^2	14.90*		35.16***		32.02***		19.49*		16.09*		51.21***	
	Log likelihood	-210.89		-200.76		-202.33		-208.60		-210.30		-192.74	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Forty-seven firms (38%) did not receive a VC investment, 37 firms (30%) received one VC investment and 41 firms (32%) received two or more VC investments. Multinominal logit regression analysis was conducted.

The base model 5-1 in Table 46 relates to the control variables. This model is significant at the 0.05 level and has a pseudo R^2 of 0.07. Independent firms (Independent Firm) and firms operating in the Pharma and Biotech Sector (PharmaBiotecSector) were weakly significant less likely to have more first VC investments at the 0.10 level.

Sets of independent variables were then added to the base model. The full model is presented in Model 5-6. It has a pseudo R^2 of 0.26 and is significant at the 0.001 level. The change in R^2 compared with the base model is 0.19. This change is significant at the 0.001 level.

In Model 5-6 five variables are significant with obtaining one first VC investment. Firms with patents (PatentedIP) were more likely to attract one first VC investment at the 0.01 level. Founding teams with more experience and reputation (FoundingTeamReputation), firm with more network links to VC investors (VCNetwork), firms owning their IP (FirmOwnsIP) and previously attracted public backed equity (PublicBackedEquity) were more likely to attract one first VC investments at the 0.01 level. Hypotheses 4, 5, 7, 8 and 10 are supported for firms which attracted one first VC investment.

In Model 5-6 four variables are significant with obtaining two or more first VC investments. More network links to VC investors (VCNetwork) were more likely to attract two or more first VC investments at the 0.001 level. Further, founders with the status of a professor (FounderProfessor), founding teams with more experience and reputation (FoundingTeamReputation) as well as firms owning their IP (FirmOwnsIP) were more likely to attract two or more first VC investments at the 0.05 level. Hypotheses 2, 4, 5 and 8 are supported for firms which attracted two or more first VC investments.

Table 46: Number of First VC Investments (0, 1 and 2 or more): Multinominal Logit Regression Analysis

	Model:	**5-1**				**5-2**				**5-3**			
	Categories:	One investment		Two or more investments		One investment		Two or more investments		One investment		Two or more investments	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.12	0.08	-0.06	0.08	-0.12	0.09	-0.06	0.09	-0.11	0.09	-0.04	0.09
	Independent Firm	-1.44†	0.80	-1.09	0.76	-1.20	0.88	-0.41	0.84	-1.45†	0.81	-1.18	0.81
	PharmaBiotecSector	-1.00†	0.57	-0.04	0.48	-0.87	0.59	0.07	0.55	-1.13*	0.58	-0.21	0.52
	OxCamLonRegion	0.66	0.49	0.75	0.47	0.54	0.53	0.78	0.54	0.38	0.55	-0.05	0.56
	RelativeMarketSize	-0.08	0.13	0.22†	0.12	-0.13	0.14	0.18	0.13	-0.11	0.14	0.16	0.13
General Human Capital	AgeFounder					0.35	1.19	-1.78	1.29				
	FounderProfessor					0.64	0.56	1.71**	0.58				
Specific Human Capital	FounderHabitualEntrepreneur					0.23	0.51	-0.34	0.53				
	FoundingTeamReputation					0.41	0.27	0.91**	0.31				
Networks	VCNetwork									0.42*	0.21	0.85***	0.22
	StrategicAlliances									0.58	0.50	0.46	0.51
Intellectual Capital	PatentedIP												
	FirmOwnsIP												
	InnovationRadicalness												
Finance	PublicBackedEquity												
	Constant	1.85†	1.02	0.96	1.01	0.01	4.35	6.37	4.70	0.46	1.18	-1.75	1.27
	$n^{\#}$	37		41		37		41		37		41	
	pseudo R^2	0.07				0.14				0.15			
	Change in R^2	/				0.07**				0.08***			
	LR Chi^2	19.34*				39.22**				39.71***			
	Log likelihood	-127.05				-117.11				-116.87			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

= Base outcome: 'no VC investment' (n = 47)

Table 46 (Continued)**:** Number of First VC Investments (0, 1 and 2 or more): Multinominal Logit Regression Analysis

	Model:	**5-4**				**5-5**				**5-6**			
	Categories:	One investment		Two or more investments		One investment		Two or more investments		One investment		Two or more investments	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.17†	0.09	-0.11	0.09	-0.09	0.08	-0.03	0.08	-0.12	0.10	-0.07	0.11
	Independent Firm	-1.58†	0.82	-1.08	0.77	-1.50†	0.81	-1.13	0.78	-1.34	0.93	-0.41	0.86
	PharmaBiotecSector	-1.21*	0.59	-0.10	0.49	-1.04†	0.57	-0.07	0.49	-1.41*	0.66	-0.23	0.63
	OxCamLonRegion	0.41	0.51	0.68	0.50	0.74	0.50	0.81†	0.48	-0.05	0.65	-0.06	0.69
	RelativeMarketSize	-0.12	0.14	0.23†	0.12	-0.09	0.13	0.22†	0.12	-0.22	0.16	0.18	0.14
General Human Capital	AgeFounder									1.29	1.40	-1.19	1.48
	FounderProfessor									0.45	0.65	1.70*	0.68
Specific Human Capital	FounderHabitualEntrepreneur									0.45	0.60	-0.26	0.62
	FoundingTeamReputation									0.53†	0.31	0.86*	0.35
Networks	VCNetwork									0.45†	0.24	0.87***	0.27
	StrategicAlliances									0.62	0.57	0.69	0.58
Intellectual Capital	PatentedIP	1.35*	0.57	0.43	0.50					2.08**	0.70	0.75	0.65
	FirmOwnsIP	0.82	0.52	0.97†	0.51					1.15†	0.60	1.26*	0.63
	InnovationRadicalness	-0.06	0.24	-0.17	0.25					-0.22	0.30	-0.34	0.32
Finance	PublicBackedEquity					0.97*	0.49	0.97*	0.48	0.92†	0.56	0.82	0.59
	Constant	1.01	1.09	0.50	1.06	1.29	1.06	0.37	1.07	-7.00	5.33	0.03	5.56
	n[#]	37		41		37		41		37		41	
	pseudo R^2	0.11				0.09				0.26			
	Change in R^2	0.04*				0.02*				0.19***			
	LR Chi^2	28.97*				24.99*				72.36***			
	Log likelihood	-122.24				-124.23				-100.54			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

[#] = Base outcome: 'no VC investment' (n = 47)

4.2.6 First VC Investment Amount (£'s): Tobit Regression Analysis

This section tests hypotheses relating to the first VC investment amount attracted by USOs. Forty-seven firms (38%) did not receive first VC investment. . The mean and median first VC investments were £622,430 and £502,494 respectively. The first investment ranged from £0 to £37,240,050. Tobit regression analysis was conducted.

The base model 6-1 in Table 47 relates to the control variables. This model is significant at the 0.005 level and has a pseudo R^2 of 0.02. Independent firms (Independent Firm) attracted significant less first VC investment amount at the 0.05 level. Firms located in the Oxford, Cambridge or London cluster (OxCamLonRegion) were significant more likely to have obtained more first VC investment at the 0.10 level.

Sets of independent variables were then added to the base model. The full model is presented in Model 6-6. This model has a pseudo R^2 of 0.09 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.07 and this change is significant at the 0.001 level.

Seven variables are significant in Model 6-6. Firms with more network links to VC investors (VCNetwork) attracted more first VC investment amount at the 0.01 level. Founding teams with more experience and reputation (FoundingTeamReputation) as well as firms with strategic alliances (StrategicAlliances), patented IP (PatentedIP) and firms owning their IP (FirmOwnsIP) attracted more first VC investment amount at the 0.05 level. Further, founders with the status of a professor and firms which attracted public backed equity attracted more first VC investment amount at the 0.10 level. Consequently, Hypotheses 2, 4, 5, 6, 7, 8 and 10 are supported in Model 6-6.

Table 47: First VC Investment Amount (£'s): Tobit Regression Analysis

	Model:	**6-1**		**6-2**		**6-3**		**6-4**		**6-5**		**6-6**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.12	0.16	-0.11	0.15	-0.07	0.15	-0.22	0.16	-0.06	0.16	-0.10	0.15
	Independent Firm	-3.14*	1.36	-1.99	1.32	-3.02*	1.25	-3.08*	1.32	-3.14*	1.34	-2.17†	1.18
	PharmaBiotecSector	-0.92	1.03	-0.61	0.99	-1.14	0.95	-1.13	1.00	-0.94	1.02	-1.11	0.89
	OxCamLonRegion	1.81†	0.95	1.53	0.93	0.35	0.95	1.41	0.94	1.91*	0.94	0.30	0.94
	RelativeMarketSize	0.20	0.24	0.10	0.23	0.06	0.22	0.17	0.23	0.17	0.23	-0.04	0.20
General Human Capital	AgeFounder			-2.11	2.19							-1.26	2.00
	FounderProfessor			2.37*	0.98							1.66†	0.90
Specific Human Capital	FounderHabitualEntrepreneur			0.29	0.93							0.29	0.86
	FoundingTeamReputation			1.45**	0.50							1.17*	0.47
Networks	VCNetwork					1.30***	0.33					0.92**	0.33
	StrategicAlliances					1.45†	0.87					1.70*	0.81
Intellectual Capital	PatentedIP							2.14*	1.00			2.25*	0.91
	FirmOwnsIP							2.19*	0.97			1.92*	0.86
	InnovationRadicalness							-0.21	0.46			-0.33	0.42
Finance	PublicBackedEquity									1.76†	0.93	1.43†	0.82
	Constant	6.02**	1.81	11.68	8.12	1.36	2.00	4.13*	1.89	4.76*	1.91	2.62	7.59
	Sigma	4.79	0.43	4.48	0.40	4.38	0.39	4.61	0.41	4.73	0.42	3.97	0.35
	n	125		125		125		125		125		125	
	Left-Censored	47		47		47		47		47		47	
	Uncensored	78		78		78		78		78		78	
	pseudo R^2	0.02		0.05		0.05		0.03		0.03		0.09	
	Change in R^2	/		0.03**		0.03***		0.01*		0.01†		0.07***	
	LR Chi^2	11.35*		26.26**		29.94***		19.28*		14.94*		52.38***	
	Log likelihood	-274.38		-266.92		-265.08		-270.41		-272.58		-253.86	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

4.2.7 First VC Investment Amount (£'s): Multinominal Logit Regression Analysis

A robustness test was computed relating to the amount of first VC investment. The variable of first VC investment amount was transformed into three categories. Firms with no first VC investment were allocated a value of '0', those with a first VC investments between £1 and £500,000 were allocated a value of '1', and those with investments greater than £500,000 were allocated a value of '2'. Forty-seven firms (38%) had no first VC investment, 39 firms (31%) attracted between £1 and £500,000 and 39 firms (31%) attracted more than £500,000. Multinominal logit regression analysis was conducted.

The base model 7-1 in Table 48 relates to the control variables. This model is not significant and has a pseudo R^2 of 0.05. Sets of independent variables were then added to the base model. The full model is presented in Model 7-6. It has a pseudo R^2 of 0.24 and is significant at the 0.001 level. The change in R^2 compared with the base model is 0.19 and this change is significant at the 0.001 level.

In Model 7-6 four variables are significant with firms attracting up to £500,000 of first VC investment. Firms with more network links to VC investors (VCNetwork) were more likely attracting up to £500,000 of first VC investment at the 0.01 level. Founders with the status of a professor (FounderProfessor) and firms with public backed equity investments (PublicBackedEquity) were more likely attracting up to £500,000 of first VC investment at the 0.05 level. Founding teams with more experience and reputation (FoundingTeamReputation) were more likely attracting up to £500,000 of first VC investment at the 0.10 level. Consequently, Hypotheses 2, 4, 5 and 10 are supported for the group of firms attracting up to £500,000 of first VC investment.

In Model 7-6 four variables are significant with firms attracting more than £500,000 of first VC investment. Firms with patents (PatentedIP) were more likely attracting more than £500,000 of first VC investment at the 0.001 level. Founding teams with more experience and reputation (FoundingTeamReputation) as well as firms owning the IP (FirmOwnsIP) were more likely attracting more than £500,000 of first VC investment at the 0.01 level. Further, firms with more network links to VC investors (VCNetwork) were more likely attracting more than £500,000 of first VC investment at the 0.05 level. Consequently, Hypotheses 4, 5, 7 and 8 are supported for the group of firms which attracted more than £500,000 of first VC investment.

Table 48: First VC Investment Amount (None = 0, £1 to £500,000 = 1 and > £500,000 = 2): Multinominal Logit Regression Analysis

	Model:	**7-1**				**7-2**				**7-3**			
	Categories:	£1 to £500,000		> £500,000		£1 to £500,000		> £500,000		£1 to £500,000		> £500,000	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.14†	0.08	-0.04	0.08	-0.14	0.09	-0.04	0.09	-0.12	0.09	-0.03	0.09
	Independent Firm	-1.04	0.80	-1.33†	0.75	-0.47	0.88	-0.90	0.80	-1.10	0.83	-1.40†	0.77
	PharmaBiotecSector	-0.54	0.51	-0.33	0.50	-0.50	0.55	-0.20	0.55	-0.72	0.54	-0.53	0.52
	OxCamLonRegion	0.72	0.48	0.67	0.48	0.60	0.52	0.68	0.53	0.13	0.55	0.18	0.55
	RelativeMarketSize	-0.01	0.12	0.18	0.12	-0.06	0.13	0.14	0.13	-0.05	0.13	0.13	0.13
General Human Capital	AgeFounder					-0.10	1.20	-1.20	1.23				
	FounderProfessor					1.30*	0.55	1.05†	0.57				
Specific Human Capital	FounderHabitualEntrepreneur					-0.17	0.51	0.09	0.51				
	FoundingTeamReputation					0.58*	0.27	0.76*	0.30				
Networks	VCNetwork									0.67***	0.21	0.58*	0.21
	StrategicAlliances									0.47	0.51	0.54	0.50
Intellectual Capital	PatentedIP												
	FirmOwnsIP												
	InnovationRadicalness												
Finance	PublicBackedEquity												
	Constant	1.60	1.01	1.10	0.99	1.09	4.42	4.67	4.46	-0.54	1.22	-0.71	1.18
	n[#]	39		39		39		39		39		39	
	pseudo R^2	0.05				0.11				0.11			
	Change in R^2	/				0.06†				0.06†			
	LR Chi^2	14.92				31.04*				31.29**			
	Log likelihood	-129.36				-121.31				-121.18			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

[#] = Base outcome: 'no VC investment' (n = 47)

Table 48 (Continued)**:** First VC Investment Amount (None = 0, £1 to £500,000 = 1 and > £500,000 = 2): Multinominal Logit Regression Analysis

	Model:	**7-4**				**7-5**				**7-6**			
	Categories:	£1 to £500,000		> £500,000		£1 to £500,000		> £500,000		£1 to £500,000		> £500,000	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.15†	0.09	-0.10	0.09	-0.11	0.08	-0.01	0.08	-0.11	0.11	-0.04	0.11
	Independent Firm	-1.07	0.80	-1.37†	0.79	-1.12	0.82	-1.37†	0.76	-0.41	0.90	-0.92	0.87
	PharmaBiotecSector	-0.56	0.52	-0.50	0.53	-0.59	0.52	-0.36	0.50	-0.75	0.62	-0.66	0.64
	OxCamLonRegion	0.66	0.50	0.49	0.51	0.82†	0.49	0.72	0.49	-0.07	0.65	0.03	0.70
	RelativeMarketSize	0.00	0.12	0.19	0.13	-0.02	0.13	0.18	0.12	-0.08	0.14	0.12	0.14
General Human Capital	AgeFounder									0.61	1.36	-0.61	1.46
	FounderProfessor									1.33*	0.63	0.68	0.67
Specific Human Capital	FounderHabitualEntrepreneur									-0.04	0.58	0.07	0.60
	FoundingTeamReputation									0.59†	0.31	0.93**	0.34
Networks	VCNetwork									0.68**	0.24	0.58*	0.25
	StrategicAlliances									0.55	0.56	0.82	0.58
Intellectual Capital	PatentedIP	0.27	0.50	1.48*	0.57					0.64	0.63	2.35***	0.72
	FirmOwnsIP	0.41	0.50	1.37*	0.54					0.62	0.59	1.86**	0.65
	InnovationRadicalness	0.05	0.23	-0.33	0.26					-0.04	0.30	-0.50	0.32
Finance	PublicBackedEquity					1.13*	0.48	0.78	0.48	1.08*	0.56	0.61	0.58
	Constant	1.36	1.05	-0.21	1.11	0.93	1.06	0.66	1.04	-5.10	5.25	-1.98	5.43
	n[#]	39		39		39		39		39		39	
	pseudo R^2	0.10				0.08				0.24			
	Change in R^2	0.05				0.03				0.19			
	LR Chi^2	28.35*				21.01†				66.79***			
	Log likelihood	-122.65				-126.32				-103.43			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001 [#] = Base outcome: 'no VC investment' (n = 47)

4.2.8 Investor Types Relating to First VC Investment: Multinominal Logit Regression Analysis

This section tests hypotheses relating to investor types of first VC investments attracted by USOs. The dependent variable of investor types relating to first VC investment has three categories. Firms with no VC investment were allocated a value of '0', those with a Generalist VC investor were allocated a value of '1', and those with a Specialist VC investor were allocated a value of '2'. Forty-seven firms (38%) did not receive a VC investment, 31 firms (25%) received generalist VC investment and 47 firms (37%) received Specialist VC investment.

The base model 8-1 in Table 49 relates to the control variables. This model is not significant and has a pseudo R^2 of 0.05.

Sets of independent variables were then added to the base model. The full model is presented in Model 8-6. This Model has a pseudo R^2 of 0.23 and is significant at the 0.001 level. The change in R^2 compared with the base model is 0.18. It is significant at the 0.001 level.

In Model 8-6 five variables are significant for firms attracting Generalist VC investors. Firms with more network links to VC investors (VCNetwork) were more likely attracting Generalist VC investors at the 0.001 level. Firms with patents (PatentedIP) were more likely attracting Generalist VC investors at the 0.01 level. Firms owning their IP (FirmOwnsIP) were more likely attracting Generalist VC investors at the 0.05 level. Further, founding teams with more experience and reputation (FoundingTeamReputation) as well as firms with less radical innovation (InnovationRadicalness) were more likely attracting Generalist VC investors at the 0.10 level. Thus, Hypotheses 4, 5, 7, 8 and 9 are supported for firms which first attracted Generalist VC investment.

In Model 8-6 five variables are significant for firms which first attracted Specialist VC investors. Founders with the status of a professor (FounderProfessor), founding teams with more experience and reputation (FoundingTeamReputation) as well as more network links to VC investors (VCNetwork) were more likely attracting Specialist VC investors at the 0.05 level. Further, firms with patents (PatentedIP) and firms owning their IP (FirmOwnsIP) were more likely attracting Specialist VC investors at the 0.10 level. In consequence, Hypotheses 2, 4, 5, 7 and 8 are supported for firms which first attracted Specialist VC investment.

Table 49: Investor Types Relating to First VC Investment (None = 0, Generalist = 1, Specialist = 2): Multinominal Logit Regression Analysis

	Model:	**8-1**				**8-2**				**8-3**			
		Generalist		Specialist		Generalist		Specialist		Generalist		Specialist	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.10	0.08	-0.08	0.08	-0.09	0.09	-0.09	0.08	-0.08	0.10	-0.07	0.08
	Independent Firm	-1.21	0.82	-1.25†	0.74	-0.76	0.88	-0.75	0.81	-1.29	0.87	-1.29†	0.76
	PharmaBiotecSector	-0.95	0.59	-0.16	0.47	-0.87	0.63	-0.07	0.51	-1.20†	0.63	-0.35	0.49
	OxCamLonRegion	0.37	0.52	0.89*	0.45	0.34	0.56	0.80	0.50	-0.50	0.63	0.48	0.51
	RelativeMarketSize	0.03	0.13	0.13	0.12	-0.01	0.14	0.09	0.12	-0.03	0.14	0.09	0.12
General Human Capital	AgeFounder					-0.47	1.24	-0.75	1.18				
	FounderProfessor					1.00†	0.59	1.31*	0.54				
Specific Human Capital	FounderHabitualEntrepreneur					-0.15	0.53	0.04	0.49				
	FoundingTeamReputation					0.70*	0.31	0.61*	0.26				
Networks	VCNetwork									0.87***	0.24	0.49*	0.20
	StrategicAlliances									0.58	0.54	0.45	0.48
Intellectual Capital	PatentedIP												
	FirmOwnsIP												
	InnovationRadicalness												
Finance	PublicBackedEquity												
	Constant	1.47	1.04	1.39	0.97	2.43	4.53	3.28	4.30	-1.36	1.32	-0.12	1.12
	n[#]	31		47		31		47		31		47	
	pseudo R^2	0.05				0.10				0.13			
	Change in R^2	/				0.05†				0.08**			
	LR Chi^2	14.09				28.25†				34.04**			
	Log likelihood	-128.13				-121.05				-118.15			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001 [#] = Base outcome: 'no VC investment' (n = 47)

Table 49 (Continued)**:** Investor Types Relating to First VC Investment (None = 0, Generalist = 1, Specialist = 2): Multinominal Logit Regression Analysis

	Model:	**8-4**				**8-5**				**8-6**			
		Generalist		Specialist		Generalist		Specialist		Generalist		Specialist	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.15†	0.09	-0.12	0.08	-0.07	0.09	-0.05	0.08	-0.09	0.11	-0.08	0.10
	Independent Firm	-1.22	0.84	-1.29†	0.75	-1.27	0.84	-1.30†	0.75	-0.84	0.96	-0.67	0.82
	PharmaBiotecSector	-1.16†	0.62	-0.21	0.48	-1.00†	0.60	-0.19	0.47	-1.61*	0.73	-0.43	0.58
	OxCamLonRegion	0.17	0.54	0.76	0.47	0.45	0.53	0.95*	0.46	-0.90	0.75	0.29	0.62
	RelativeMarketSize	0.01	0.13	0.14	0.12	0.03	0.13	0.13	0.12	-0.10	0.16	0.07	0.13
General Human Capital	AgeFounder									0.51	1.50	-0.11	1.34
	FounderProfessor									0.55	0.71	1.24*	0.60
Specific Human Capital	FounderHabitualEntrepreneur									-0.02	0.66	0.08	0.55
	FoundingTeamReputation									0.62†	0.34	0.74*	0.30
Networks	VCNetwork									0.99***	0.28	0.45*	0.23
	StrategicAlliances									0.77	0.62	0.58	0.53
Intellectual Capital	PatentedIP	1.28*	0.58	0.51	0.49					2.14**	0.75	0.99†	0.61
	FirmOwnsIP	0.99†	0.55	0.78†	0.49					1.38*	0.66	1.01†	0.57
	InnovationRadicalness	-0.31	0.26	0.02	0.23					-0.63†	0.34	-0.07	0.29
Finance	PublicBackedEquity					1.07*	0.51	0.87†	0.46	0.73	0.62	0.83	0.53
	Constant	0.51	1.13	0.96	1.02	0.83	1.11	0.89	1.01	-6.45	5.73	-1.97	5.07
	n[#]	31		47		31		47		31		47	
	pseudo R^2	0.09				0.07				0.23			
	Change in R^2	0.04†				0.02†				0.18***			
	LR Chi^2	23.74†				19.74†				63.36***			
	Log likelihood	-123.30				-125.30				-103.49			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001 [#] = Base outcome: 'no VC investment' (n = 47)

4.3 Summary of Findings for USOs' Attraction of First VC Investment

Table 50 summarises which hypotheses related to USOs' ability to attract first VC investment are supported among.

Hypothesis 1 on the general human capital of founders' age (AgeFounder) was not supported in any presented models. Conversely, Hypothesis 2 on the general human capital of founders with the status of a professor (FounderProfessor) was supported in all eight models. Founders with the status of a professor were more likely to attract first VC investment (Model 1-6), received more first VC offers (Model 2-6), received two or more VC offers (Model 3-6), received more first VC investments (Model 4-6) and received two or more first VC investments (Model 5-6). They attracted more first VC investment (Model 6-6), however, only up to £500,000 (Model 7-6). Further, founders with the status of a professor were more likely to attract Specialist VC investors (Model 8-6).

Hypothesis 3 on the specific human capital of founders' entrepreneurial experience (FounderHabitualEntrepreneur) was not supported in any presented models. In contrast, Hypothesis 4 on the specific human capital of founding teams' experience and reputation (FoundingTeamReputation) was supported in all eight models.

Founding teams with more experience and reputation were more likely to attract first VC investment (Model 1-6), received more first VC offers (Model 2-6), received one, two or more VC offers (Model 3-6), received more first VC investments (Model 4-6) and also received one, two or more first VC investments (Model 5-6). They attracted more first VC investment (Model 6-6) as well as up to and more than £500,000 (Model 7-6). Further, they were more likely to attract Generalist and Specialist VC investors (Model 8-6).

Hypothesis 5 on the network resource of links to VC investors (VCNetwork) is supported in all eight models. USOs with more network links to VC investors were more likely to attract first VC investment (Model 1-6), received more first VC offers (Model 2-6), received two or more VC offers (Model 3-6), received more first VC investments (Model 4-6) and also received one, two or more first VC investments (Model 5-6). They attracted more first VC investment (Model 6-6) as well as up to and more than £500,000 (Model 7-6). Further, they were more likely to attract Generalist and Specialist VC investors (Model 8-6). Hypothesis 6 of the inter-firm network resource of strategic alliances (StrategicAlliances)

was only partially supported in three out of eight models. USOs with strategic alliances received more first VC investment offers (Model 2-6) as well as one, two or more first VC investment offers (Model 3-6). Further, they received a greater amount of first VC investment (Model 6-6).

Hypothesis 7 on the intellectual capital of patents (PatentedIP) was supported in seven out of eight models. USOs with patents were more likely to attract first VC investment (Model 1-6), received more first VC offers (Model 2-6), received two or more VC offers (Model 3-6) and received one first VC investment (Model 5-6). They attracted more first VC investment (Model 6-6) as well as more than £500,000 (Model 7-6). Further, they were more likely to attract Generalist and Specialist VC investors (Model 8-6). Hypothesis 8 on the intellectual capital of USOs owning their IP (FirmOwnsIP) was supported in all eight models. USOs which own their IP were more likely to attract first VC investment (Model 1-6), received more first VC offers (Model 2-6), received two or more VC offers (Model 3-6), received more first VC investments (Model 4-6) and also received one, two or more first VC investments (Model 5-6). They attract more first VC investment (Model 6-6) as well as more than £500,000 (Model 7-6). Further, firms owning their IP were more likely to attract Generalist and Specialist VC investors (Model 8-6). Hypothesis 9 on the Intellectual Capital of USOs' innovation radicalness (InnovationRadicalness) was only supported in one out of eight models. USOs with lower radicalness of innovation were more likely to attract Generalist VC investors (Model 8-6).

Hypothesis 10 on the financial resource of public backed equity (PublicBackedEquity) was supported in five out of eight models. USOs which attracted previous investments of public backed equity were more likely to attract first VC investment (Model 1-6), received two or more first VC investment offers (Model 3-6) and received one first VC investment (Model 5-6). Further, they attracted a larger amount of first VC investment (Model 6-6), however only up to £500,000 (Model 7-6).

Therefore, Hypotheses 4, 5, 7 and 8 were most consistently supported, followed by Hypotheses 2 and 10.

Table 50: Summary of Findings for First VC Investment

		Model:	**1-6**	**2-6**	**3-6**		**4-6**
		Regression Technique:	Logistic	Tobit	Multinom		Tobit
		Dependent variable:	First VC Investment (Yes, No)	Number of Offers	Number of Offers		Number of Investments
					One	Two and more	
General Human Capital	Age Founder	**Hypothesis 1:** Older USO founders are more likely to attract first VC investment.					
	Founder Professor	**Hypothesis 2:** USO founders with higher levels of academic reputation are more likely to attract first VC investment.	+†	+*		+*	+**
Specific Human Capital	Founder Habitual Entrepreneur	**Hypothesis 3:** USO founders who are experienced entrepreneurs are more likely to attract first VC investment.					
	Founding Team Reputation	**Hypothesis 4:** USOs with an experienced founding team are more likely to attract first VC investment.	+*	+**	+*	+**	+**

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 50 (Continued)**:** Summary of Findings for First VC Investment

		Model:	**1-6**	**2-6**	**3-6**		**4-6**
		Regression Technique:	Logistic	Tobit	Multinom		Tobit
		Dependent variable:	First VC Investment (Yes, No)	Number of First VC Investment Offers	Number of First VC Investment Offers		Number of First VC Investments
					One	Two and more	
Networks	VC Network	**Hypothesis 5:** USOs from universities that have a strong network of previously VC funded USOs are more likely to attract first VC investment.	+**	+†		+*	+**
	Strategic Alliances	**Hypothesis 6:** USOs with alliance partners are more likely to attract first VC investment.		+**	+*	+**	
Intellectual Capital	Patented IP	**Hypothesis 7:** USOs with patented IP are more likely to attract first VC investment.	+*	+†	+**	+*	
	FirmOwns IP	**Hypothesis 8:** USOs with IP ownership are more likely to attract first VC investment.	+*	+†		+*	+†
	Innovation Radicalness	**Hypothesis 9:** USOs whose main product or service is associated with radical innovation are less likely to attract first VC investment.					

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 50 (Continued)**:** Summary of Findings for First VC Investment

		Model:	**1-6**	**2-6**	**3-6**		**4-6**
		Regression Technique:	Logistic	Tobit	Multinom		Tobit
		Dependent variable:	First VC Investment (Yes, No)	Number of First VC Investment Offers	Number of First VC Investment Offers		Number of First VC Investments
					One	Two and more	
Finance	Public Backed Equity	**Hypothesis 10:** USOs that have obtained publicly-backed equity funds are more likely to attract first VC investment.	+†			+†	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 50 (Continued)**:** Summary of Findings for First VC Investment

		Model:	**5-6**		**6-6**	**7-6**		**8-6**	
		Regression Technique:	Multinom		Tobit	Multinom		Multinom	
		Dependent variable:	Number of First VC Investments		Amount of First VC Investment	Amount of First VC Investment		Generalist VC	Specialist VC
			One	Two and more		£1 to £500,000	> £500,000		
General Human Capital	Age Founder	**Hypothesis 1:** Older USO founders are more likely to attract first VC investment.							
	Founder Professor	**Hypothesis 2:** USO founders with higher levels of academic reputation are more likely to attract first VC investment.		+*	+†	+*			+*
Specific Human Capital	Founder Habitual Entre-preneur	**Hypothesis 3:** USO founders who are experienced entrepreneurs are more likely to attract first VC investment.							
	Founding Team Reput-ation	**Hypothesis 4:** USOs with an experienced founding team are more likely to attract first VC investment.	+†	+*	+*	+†	+**	+†	+*

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 50 (Continued)**:** Summary of Findings for First VC Investment

		Model:	**5-6**		**6-6**	**7-6**		**8-6**	
		Regression Technique:	Multinom		Tobit	Multinom		Multinom	
		Dependent variable:	Number of First VC Investments		Amount of First VC Investment	Amount of First VC Investment		Generalist VC	Specialist VC
			One	Two and more		£1 to £500,000	> £500,000		
Net-works	VC Network	**Hypothesis 5:** USOs from universities that have a strong network of previously VC funded USOs are more likely to attract first VC investment.	+†	+***	+**	+**	+*	+***	+*
	Strategic Alliances	**Hypothesis 6:** USOs with alliance partners are more likely to attract first VC investment.			+*				
Intel-lectual Capital	Patented IP	**Hypothesis 7:** USOs with patented IP are more likely to attract first VC investment.	+**		+*		+***	+**	+†
	FirmOwns IP	**Hypothesis 8:** USOs with IP ownership are more likely to attract first VC investment.	+†	+*	+*		+**	+*	+†
	Innovat-ion Radical-ness	**Hypothesis 9:** USOs whose main product or service is associated with radical innovation are less likely to attract first VC investment.						-†	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 50 (Continued)**:** Summary of Findings for First VC Investment

		Model:	**5-6**		**6-6**	**7-6**		**8-6**	
		Regression Technique:	Multinom		Tobit	Multinom		Multinom	
		Dependent variable:	Number of First VC Investments		Amount of First VC Investment	Amount of First VC Investment		Generalist VC	Specialist VC
			One	Two and more		£1 to £500,000	> £ 500,000		
Finance	Public Backed Equity	**Hypothesis 10:** USOs that have obtained publicly-backed equity funds are more likely to attract first VC investment.	+†		+*	+*			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Chapter 5: USO Firm Performance

5.1 Introduction

This chapter tests hypotheses derived in Chapter 2 related to research question 2: Do VC funded USOs report superior firm performance? Firm performance is monitored with a selection of well-respected firm performance indicators introduced in Section 3.5.1.2. In addition to USOs' internal resources, their ability to attract first VC investment is regarded as an independent variable that could shape firm performance.

Like in the previous chapter, variables are entered blockwise to build up the full model. In order to assess the influence of first VC investment on superior firm performance, three models are discussed to identify which hypotheses are supported for USOs' firm performance. The first model contains the base model and all initial resource endowments. The second model contains the base model, all initial resource endowments as well as the independent variable of the first VC investment. The final model contains the base model, the initial resource endowments and two independent variables identifying whether the first round of VC investment was attracted from a Generalist or Specialist VC investor.

5.2 Hypotheses Testing

5.2.1 Total Number of External Investment Rounds Attracted Until 2008: OLS Regression Analysis

Hypotheses were tested with regard to the total number of external investment rounds until 2008. This measure includes all rounds of investments which firms received from external sources such as VC investment, public backed equity or business angels. The mean and median of total number of external investment rounds was 5.82 and 3 respectively. The total number of external investment rounds ranged from 1 to 50. The measure is weighted by firm age and transformed with the natural logarithm to ensure the normality assumption. OLS regression analysis was conducted to test the hypotheses.

The base model 9-1 in Table 51 relates to the control variables. This model is significant at the 0.001 level and has an adjusted R^2 of 0.22. Older firms (FirmAge) are related to significant less investment rounds at the 0.001 level. Further, independent firms (IndependentFirm) are related to significant less investment rounds at the 0.05 level.

Sets of independent variables were then added to the base model. The full model excluding VC investment variables is presented in Model 9-6. This model has an adjusted R^2 of 0.46 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.24 and this change is significant at the 0.001 level. The full model including first VC investment is presented in Model 9-8. This model has an adjusted R^2 of 0.54 and is significant at the 0.001 level. The change in R^2 compared with the base model is 0.32 and this change is significant at the 0.001 level. The full model including the distinction of VC investor types is presented in Model 9-10. This model has an adjusted R^2 of 0.54 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.31 and this change is significant at the 0.001 level.

Four variables are significant in Model 9-6. Firms with strategic alliances (StrategicAlliances) attracted more total investment rounds at the 0.001 level. Founders with the status of a professor (FounderProfessor) and firms with previous public backed equity investments (PublicBackedEquity) attracted more total investment rounds at the 0.05 level. Rejecting the hypothesised relationship, older founders (AgeFounder) attracted less total investment rounds at the 0.01 level. In consequence, Hypotheses 12, 16 and 20 are supported, while Hypothesis 11 is rejected in Model 9-6.

Five variables are significant in Model 9-8. Firms with strategic alliances (StrategicAlliances) and first VC investment (FirstVC) attracted more total investment rounds at the 0.001 level. Rejecting the hypothesised relationship, older founders (AgeFounder) attracted less total investment rounds at the 0.01 level. Founders with the status of a professor (FounderProfessor) and firms with previous public backed equity investments (PublicBackedEquity) attracted more total investment rounds at the 0.05 level. Thus, Hypotheses 12, 16, 20 and 21 are supported, while Hypothesis 11 is rejected in Model 9-8.

Table 51: Total Number of External Investment Rounds Attracted Until 2008: OLS Regression Analysis

	Model:	**9-1**		**9-2**		**9-3**		**9-4**		**9-5**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.17***	0.03	-0.18***	0.03	-0.17***	0.03	-0.18***	0.03	-0.15***	0.03
	Independent Firm	-0.63*	0.26	-0.40	0.26	-0.64**	0.23	-0.63*	0.26	-0.63**	0.25
	PharmaBiotecSector	0.04	0.19	0.09	0.19	-0.04	0.17	0.02	0.19	0.03	0.18
	OxCamLonRegion	0.25	0.18	0.24	0.18	0.14	0.17	0.20	0.18	0.28	0.17
	RelativeMarketSize	0.04	0.04	0.04	0.04	0.02	0.04	0.04	0.04	0.03	0.04
General Human Capital	AgeFounder			-1.02*	0.42						
	FounderProfessor			0.52**	0.19						
Specific Human Capital	FounderHabitualEntrepreneur			-0.05	0.18						
	FoundingTeamReputation			0.14	0.09						
Networks	VCNetwork					0.15*	0.06				
	StrategicAlliances					0.76***	0.16				
Intellectual Capital	PatentedIP							0.25	0.19		
	FirmOwnsIP							0.27	0.18		
	InnovationRadicalness							-0.02	0.09		
Finance	PublicBackedEquity									0.50**	0.17
	FirstVC										
	GeneralistVC										
	SpecialistVC										
	Constant	1.06**	0.34	4.48**	1.55	0.34	0.37	0.84*	0.36	0.70*	0.35
	N	125		125		125		125		125	
	adjusted R^2	0.22		0.26		0.37		0.22		0.26	
	Change in adjusted R^2	/		0.04†		0.15***		0.00		0.04**	
	F-statistic and significance level	7.84***		5.95***		11.48***		5.33***		8.41***	
	Test for Heteroscedasticity	0.02		0.35		1.52		0.13		0.23	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 51 (Continued)**:** Total Number of External Investment Rounds Attracted Until 2008: OLS Regression Analysis

	Model:	**9-6**		**9-7**		**9-8**		**9-9**		**9-10**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.17***	0.03	-0.15***	0.03	-0.16***	0.02	-0.15***	0.03	-0.16***	0.02
	Independent Firm	-0.42†	0.22	-0.40†	0.22	-0.33	0.21	-0.40†	0.22	-0.33	0.21
	PharmaBiotecSector	0.00	0.16	0.13	0.16	0.08	0.15	0.14	0.16	0.09	0.15
	OxCamLonRegion	0.17	0.17	0.10	0.15	0.17	0.16	0.12	0.15	0.19	0.16
	RelativeMarketSize	0.01	0.04	0.02	0.04	0.02	0.03	0.02	0.04	0.02	0.04
General Human Capital	AgeFounder	-0.98**	0.37			-0.94**	0.34			-0.95**	0.34
	FounderProfessor	0.49**	0.17			0.36*	0.16			0.37*	0.16
Specific Human Capital	FounderHabitualEntrepreneur	-0.03	0.16			-0.03	0.15			-0.03	0.15
	FoundingTeamReputation	0.11	0.08			0.03	0.08			0.03	0.08
Networks	VCNetwork	0.10	0.06			0.03	0.06			0.03	0.06
	StrategicAlliances	0.78***	0.15			0.69***	0.14			0.69***	0.14
Intellectual Capital	PatentedIP	0.18	0.16			0.05	0.15			0.04	0.16
	FirmOwnsIP	0.24	0.16			0.12	0.15			0.12	0.15
	InnovationRadicalness	-0.03	0.08			-0.01	0.07			-0.01	0.07
Finance	PublicBackedEquity	0.41**	0.15			0.30*	0.14			0.30*	0.14
	FirstVC			1.01***	0.15	0.71***	0.16				
	GeneralistVC							1.09***	0.19	0.78***	0.20
	SpecialistVC							0.95***	0.17	0.68***	0.17
	Constant	3.36*	1.41	0.13	0.33	3.08	1.30	0.12	0.33	3.15*	1.31
	N	125		125		125		125		125	
	adjusted R^2	0.46		0.42		0.54		0.42		0.53	
	Change in adjusted R^2	0.24***		0.20***		0.32***		0.20***		0.31***	
	F-statistic and significance level	7.95***		15.90***		9.96***		13.65***		9.33***	
	Test for Heteroscedasticity	3.38†		4.04*		3.01†		4.47*		2.97†	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Six variables are significant in Model 9-10. Firms with strategic alliances (StrategicAlliances) as well as with Generalist VC (GeneralistVC) or Specialist VC investors (SpecialistVC) investment attracted more total investment rounds at the 0.001 level. Rejecting the hypothesised relationship, older founders (AgeFounder) attracted less total investment rounds at the 0.01 level. Founders with the status of a professor (FounderProfessor) and firms with previous public backed equity investments (PublicBackedEquity) attracted more total investment rounds at the 0.05 level. In consequence, Hypotheses 12, 16, 20, 22 and 23 are supported, while Hypothesis 11 is rejected in Model 9-10.

5.2.2 Total Amount of External Investment (£'s) Attracted Until 2008: OLS Regression Analysis

Hypotheses were tested with regard to the total amount of external investment attracted until 2008. This measure includes all rounds of investments which firms received from external sources such as VC investment, public backed equity, business angels, grants or awards. The mean and median of the total amount of external investment was £19,753,730 and £1,136,000, respectively. The total amount of external investment ranged from £39,000 to £103,000,000. OLS regression analysis was conducted. The measure is weighted by firm age and transformed with the natural logarithm to ensure the normality assumption. OLS regression analysis was conducted to test the presented hypotheses.

The base model 10-1 in Table 52 relates to the control variables. This model is significant at the 0.001 level and has an adjusted R^2 of 0.21. Independent firms (IndependentFirm) are related to significant less investment rounds at the 0.001 level. Firms in the Oxford, Cambridge or London region attracted weakly significant more total amount of investment on the 0.10.

Sets of independent variables were then added to the base model. The full model excluding VC investment variables is presented in Model 10-6. This model has an adjusted R^2 of 0.41 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.20 and this change is significant at the 0.001 level. The full model including first VC investment is presented in Model 10-8. This model has an adjusted R^2 of 0.55 and is

significant at the 0.001 level. The change in R^2 compared with the base model is 0.34 and this change is significant at the 0.001 level. The full model including the distinction of VC investor types is presented in Model 10-10. This model has an adjusted R^2 of 0.55 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.34 and this change is significant at the 0.001 level.

Seven variables are significant in Model 10-6. Firms with strategic alliances (StrategicAlliances) attracted more total investment amount at the 0.001 level. Founding teams with more experience and reputation (FoundingTeamReputation) and more network links to VC investors (VCNetwork) attracted more total investment amount at the 0.01 level. Rejecting the hypothesised relationship, older founders (AgeFounder) attracted significant less total investment rounds at the 0.05 level. Founders with the status of a professor (FounderProfessor), firms with patents (PatentedIP) and firms owning their IP (FirmOwnsIP) attracted more total investment amount at the 0.10 level. In consequence, Hypotheses 12, 14, 15, 16, 17 and 18 are supported, while Hypothesis 20 is rejected in Model 10-6.

Five variables are significant in Model 10-8. Firms with first VC investment (FirstVC) attracted significant more total investment amount at the 0.001 level. Firms with strategic alliances (StrategicAlliances) attracted more total investment amount at the 0.01 level. Firms with more network links to VC investors attracted more total investment amount at the 0.05 level. Rejecting the hypothesised relationship, older founders (AgeFounder) attracted less total investment rounds at the 0.05 level. Founding teams with more experience and reputation (FoundingTeamReputation) attracted more total investment amount at the 0.10 level. Thus, Hypotheses 14, 15, 16 and 21 are supported, while Hypothesis 11 is rejected in Model 10-8.

Six variables are significant in Model 10-10. Firms with Generalist VC (GeneralistVC) or Specialist VC (SpecialistVC) investment attracted more total investment amount at the 0.001 level. Firms with strategic alliances (StrategicAlliances) attracted more total investment amount at the 0.01 level. Firms with more network links to VC investors attracted more total investment amount at the 0.05 level. Rejecting the hypothesised relationship, older founders (AgeFounder) attracted less total investment rounds at the 0.05 level. Founding teams with more experience and reputation (FoundingTeamReputation) attracted more total investment amount at the 0.10 level. In consequence, Hypotheses 14, 15, 16, 22 and 23 are supported, while Hypothesis 11 is rejected in Model 10-10.

Table 52: Total Amount of External Investment (£'s) Attracted Until 2008: OLS Regression Analysis

	Model:	**10-1**		**10-2**		**10-3**		**10-4**		**10-5**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.11	0.06	-0.10†	0.06	-0.09†	0.05	-0.14*	0.06	-0.10	0.06
	Independent Firm	-2.56***	0.53	-2.07***	0.52	-2.52***	0.48	-2.54***	0.53	-2.56***	0.53
	PharmaBiotecSector	0.29	0.39	0.47	0.37	0.13	0.35	0.25	0.39	0.28	0.39
	OxCamLonRegion	0.70†	0.36	0.77*	0.36	0.20	0.36	0.60	0.37	0.72*	0.36
	RelativeMarketSize	0.13	0.09	0.10	0.09	0.07	0.08	0.13	0.09	0.13	0.09
General Human Capital	AgeFounder			-1.87*	0.84						
	FounderProfessor			0.81*	0.38						
Specific Human Capital	FounderHabitualEntrepreneur			-0.22	0.36						
	FoundingTeamReputation			0.63***	0.18						
Networks	VCNetwork					0.51***	0.12				
	StrategicAlliances					1.04**	0.33				
Intellectual Capital	PatentedIP							0.46	0.39		
	FirmOwnsIP							0.57	0.38		
	InnovationRadicalness							-0.08	0.18		
Finance	PublicBackedEquity									0.34	0.36
	FirstVC										
	GeneralistVC										
	SpecialistVC										
	Constant	8.07***	0.70	14.25***	3.11	6.06***	0.75	7.65***	0.75	7.83***	0.74
	n	125		125		125		125		125	
	adjusted R^2	0.21		0.29		0.36		0.21		0.21	
	Change in adjusted R^2	/		0.08**		0.15***		0.00		0.00	
	F-statistic and significance level	7.43		6.53***		10.8***		5.04***		6.34***	
	Test for Heteroscedasticity	0.28		0.06		0.81		0.21		0.32	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 52 (Continued)**:** Total Amount of External Investment (£'s) Attracted until 2008: OLS Regression Analysis

	Model:	**10-6**		**10-7**		**10-8**		**10-9**		**10-10**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.11*	0.06	-0.07	0.05	-0.08†	0.05	-0.07	0.05	-0.08†	0.05
	Independent Firm	-2.12***	0.48	-1.98***	0.42	-1.88***	0.42	-1.99***	0.43	-1.88***	0.42
	PharmaBiotecSector	0.23	0.34	0.52†	0.31	0.45	0.30	0.53†	0.31	0.44	0.31
	OxCamLonRegion	0.29	0.37	0.34	0.29	0.29	0.32	0.34	0.29	0.28	0.33
	RelativeMarketSize	0.06	0.08	0.09	0.07	0.06	0.07	0.09	0.07	0.06	0.07
General Human Capital	AgeFounder	-1.50†	0.78			-1.39*	0.68			-1.38*	0.68
	FounderProfessor	0.61†	0.35			0.28	0.31			0.27	0.31
Specific Human Capital	FounderHabitualEntrepreneur	-0.29	0.34			-0.29	0.29			-0.29	0.29
	FoundingTeamReputation	0.50**	0.18			0.28†	0.16			0.28†	0.16
Networks	VCNetwork	0.40**	0.13			0.23*	0.12			0.24*	0.12
	StrategicAlliances	1.14***	0.32			0.88**	0.28			0.89**	0.28
Intellectual Capital	PatentedIP	0.58†	0.35			0.22	0.31			0.23	0.31
	FirmOwnsIP	0.58†	0.33			0.26	0.29			0.26	0.30
	InnovationRadicalness	-0.13	0.16			-0.06	0.14			-0.07	0.14
Finance	PublicBackedEquity	0.11	0.32			-0.19	0.28			-0.19	0.28
	FirstVC			2.46***	0.29	1.94***	0.32				
	GeneralistVC							2.52***	0.36	1.88***	0.40
	SpecialistVC							2.42***	0.33	1.97***	0.35
	Constant	10.86***	3.00	5.80	0.62	10.10***	2.61	5.79***	0.62	10.04***	2.63
	n	125		125		125		125		125	
	adjusted R^2	0.41		0.50		0.55		0.52		0.55	
	Change in adjusted R^2	0.20***		0.29***		0.34***		0.31***		0.34***	
	F-statistic and significance level	6.69***		21.68***		10.58***		18.54***		9.88***	
	Test for Heteroscedasticity	0.52		9.52**		3.32†		9.91**		3.10†	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

5.2.3 Likelihood of Product Launch to the Market Until 2008: Logistic Regression Analysis

Hypotheses were tested with regard to the ability of firms to launch a product to the market until 2008. Respondents reporting a product launch were allocated a value of '1', whilst those not reporting a product launch were allocated a value of '0'. Fifty-six USOs (45%) launched a product, whilst 69 (55%) did not launch a product. Logistic Regression analysis was conducted to test the presented hypotheses. The reported beta coefficients are transformed to be interpreted as log-odds. A negative relationship between an independent variable and the dependent variable is indicated by a coefficient for Exp(B) < 1. A positive likelihood for the event of first VC investment to occur is indicated by Exp(B) > 1.

The base model 11-1 in Table 53 relates to the control variables. This model is significant at the 0.001 level and has a pseudo R^2 of 0.23. Older firms (FirmAge) were more likely to launch a product at the 0.001 level. Firms operating in the Pharma and Biotech sector (PharmaBiotechSector) and those located in the Oxford, Cambridge or London region (OxCamLonRegion) were less likely to launch a product at the 0.01 level.

Sets of independent variables were then added to the base model. The full model excluding VC investment variables is presented in Model 11-6. This model has a pseudo R^2 of 0.39 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.16 and this change is significant at the 0.10 level. The full model with first VC investment is presented in Model 11-8. This model has a pseudo R^2 of 0.39 and is significant at the 0.001 level. The change in R^2 compared with the base model is 0.16 and this change is significant at the 0.10 level. The full model including the distinction of VC investor types is presented in Model 11-10. This model has a pseudo R^2 of 0.40 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.17 which is significant at the 0.10 level.

Four variables are significant in Model 11-6. Rejecting the hypothesised relationship, firms with patents (PatentedIP) were less likely to launch a product at the 0.01 level. Conversely, firms with strategic alliances (StrategicAlliances) were more likely to launch a product launch at the 0.05 level. Also rejecting the hypothesised relationship, firms owning their IP (FirmOwnsIP) were less likely to launch a product at the 0.05 level.

Table 53: Likelihood of Product Launch to the Market Until 2008: Logistic Regression Analysis

	Model:	**11-1**		**11-2**		**11-3**		**11-4**		**11-5**	
		Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.
Control Variables	FirmAge	1.47***	0.14	1.50***	0.15	1.48***	0.14	1.60***	0.17	1.46***	0.14
	Independent Firm	0.90	0.58	1.00	0.66	0.88	0.58	0.93	0.64	0.87	0.56
	PharmaBiotecSector	0.20**	0.10	0.18**	0.10	0.18**	0.10	0.18**	0.10	0.18***	0.10
	OxCamLonRegion	0.26**	0.13	0.25**	0.13	0.33*	0.17	0.34	0.18	0.22***	0.11
	RelativeMarketSize	1.01	0.11	1.00	0.11	1.01	0.11	1.03	0.12	1.01	0.11
General Human Capital	AgeFounder			1.51	1.60						
	FounderProfessor			1.08	0.54						
Specific Human Capital	FounderHabitualEntrepreneur			0.58	0.28						
	FoundingTeamReputation			1.14	0.29						
Networks	VCNetwork					0.80	0.15				
	StrategicAlliances					2.41*	1.10				
Intellectual Capital	PatentedIP							0.20**	0.10		
	FirmOwnsIP							0.25*	0.14		
	InnovationRadicalness							0.76	0.20		
Finance	PublicBackedEquity									0.42*	0.19
	FirstVC										
	GeneralistVC										
	SpecialistVC										
	n	125		125		125		125		125	
	pseudo R^2	0.23		0.24		0.26		0.33		0.25	
	Change in R^2	/		0.01		0.03†		0.10**		0.02†	
	LR Chi^2	39.53***		40.95		44.34***		56.99***		43.30***	
	Log likelihood	-66.20		-65.49		-63.80		-57.47		-64.32	
	Cases correctly classified	68.80%		69.60%		69.60%		75.20%		71.20%	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 53 (Continued)**:** Likelihood of Product Launch to the Market Until 2008: Logistic Regression Analysis

	Model:	**11-6**		**11-7**		**11-8**		**11-9**		**11-10**	
		Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.	Exp(B)	S.E.
Control Variables	FirmAge	1.59***	0.19	1.46***	0.14	1.60***	0.19	1.46***	0.14	1.58***	0.19
	Independent Firm	0.98	0.73	0.83	0.54	1.01	0.75	0.83	0.54	1.02	0.76
	PharmaBiotecSector	0.10***	0.07	0.20**	0.10	0.10***	0.07	0.18***	0.09	0.09**	0.06
	OxCamLonRegion	0.30†	0.22	0.27**	0.13	0.30†	0.21	0.26**	0.13	0.28†	0.20
	RelativeMarketSize	1.07	0.13	1.01	0.11	1.07	0.13	1.00	0.11	1.06	0.13
General Human Capital	AgeFounder	1.36	1.73			1.37	1.73			1.67	2.18
	FounderProfessor	1.54	0.96			1.49	0.95			1.35	0.88
Specific Human Capital	FounderHabitualEntrepreneur	0.59	0.35			0.58	0.34			0.56	0.33
	FoundingTeamReputation	0.88	0.26			0.86	0.26			0.87	0.26
Networks	VCNetwork	0.80	0.19			0.79	0.19			0.84	0.21
	StrategicAlliances	3.55*	1.96			3.44*	1.92			3.67*	2.11
Intellectual Capital	PatentedIP	0.15**	0.09			0.15**	0.09			0.16**	0.10
	FirmOwnsIP	0.30*	0.17			0.29*	0.17			0.30*	0.17
	InnovationRadicalness	0.66	0.20			0.66	0.20			0.62	0.19
Finance	PublicBackedEquity	0.35†	0.19			0.34†	0.19			0.33†	0.19
	FirstVC			0.71	0.32	1.20	0.73				
	GeneralistVC							0.45	0.26	0.75	0.56
	SpecialistVC							0.97	0.49	1.59	1.05
	n	125		125		125		125		125	
	pseudo R^2	0.39		0.23		0.39		0.24		0.40	
	Change in R^2	0.16†		0.00		0.16†		0.01		0.17†	
	LR Chi^2	67.57***		40.12***		67.66***		41.97***		68.91***	
	Log likelihood	-52.18		-65.90		-52.14		-64.98		-51.41	
	Cases correctly classified	80.00%		69.60%		80%		71.20%		80.00%	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Further, USO which attracted public backed equity (PublicBackedEquity) were weakly less likely to launch a product at the 0.10 level. In consequence, Hypothesis 16 is supported, but Hypotheses 17, 18 and 20 are rejected in Model 11-6.

The variables in Models 11-8 and 11-10 have the same direction and significance levels as reported in Model 11-6. Therefore, these two models also support Hypothesis 16 and reject Hypotheses 17, 18 and 20, irrespective of adding VC investment variables to the models.

5.2.4 Book Value of Total Assets (£'s) Until 2008: OLS Regression Analysis

Hypotheses were tested with regard to the book value of each firm's total assets until 2008. The mean and median book value of assets was £2,000,000 and £249,855, respectively. The book value of assets ranged from £6,000 to £34,826,000. The measure is weighted by firm age and transformed with the natural logarithm to ensure the normality assumption. OLS regression analysis was conducted to test the presented hypotheses.

The base model 12-1 in Table 54 relates to the control variables. This model is significant at the 0.01 level and has an adjusted R^2 of 0.10. Independent firms (IndependentFirm) had significant lower book value of total assets at the 0.01 level. Firms in the Oxford, Cambridge or London region (OxCamLonRegion) had significant higher book value of total assets at the 0.05 level.

Sets of independent variables were then added to the base model. The full model excluding VC investment variables is presented in Model 12-6. This model has an adjusted R^2 of 0.23 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.13 and this change is significant at the 0.01 level. The full model including first VC investment is presented in Model 12-8. This model has an adjusted R^2 of 0.27 and is significant at the 0.001 level. The change in R^2 compared with the base model is 0.17 and this change is significant at the 0.001 level. The full model including the distinction of VC investor types is presented in Model 12-10. This model has an adjusted R^2 of 0.26 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.16 and this change is significant at the 0.001 level.

Table 54: Book Value of Total Assets (£'s) Until 2008: OLS Regression Analysis

	Model:	**12-1**		**12-2**		**12-3**		**12-4**		**12-5**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.02	0.07	0.00	0.07	-0.01	0.06	-0.02	0.07	-0.03	0.07
	Independent Firm	-1.68**	0.60	-1.21*	0.60	-1.68*	0.56	-1.68**	0.61	-1.68**	0.60
	PharmaBiotecSector	0.15	0.44	0.16	0.43	0.01	0.41	0.15	0.44	0.15	0.44
	OxCamLonRegion	0.92*	0.41	0.99*	0.42	0.72†	0.42	0.91*	0.43	0.92*	0.41
	RelativeMarketSize	0.15	0.10	0.12	0.10	0.11	0.10	0.15	0.10	0.16	0.10
General Human Capital	AgeFounder			-0.64	0.97						
	FounderProfessor			0.70	0.43						
Specific Human Capital	FounderHabitualEntrepreneur			-0.96*	0.41						
	FoundingTeamReputation			0.60*	0.21						
Networks	VCNetwork					0.27†	0.15				
	StrategicAlliances					1.32***	0.39				
Intellectual Capital	PatentedIP							0.04	0.44		
	FirmOwnsIP							0.03	0.43		
	InnovationRadicalness							0.01	0.21		
Finance	PublicBackedEquity									-0.15	0.40
	FirstVC										
	GeneralistVC										
	SpecialistVC										
	Constant	4.94***	0.79	6.92*	3.58	3.66***	0.89	4.91***	0.86	5.05***	0.84
	n	125		125		125		125		125	
	adjusted R^2	0.10		0.16		0.20		0.08		0.1	
	Change in adjusted R^2	/		0.06*		0.10***		-0.02		0.00	
	F-statistic and significance level	3.86**		3.53***		5.41***		2.35*		3.21**	
	Test for Heteroscedasticity	0.01		2.73†		4.24*		0.01		0.00	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 54 (Continued)**:** Book Value of Total Assets (£'s) Until 2008: OLS Regression Analysis

	Model:	**12-6**		**12-7**		**12-8**		**12-9**		**12-10**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.03	0.07	0.01	0.07	-0.01	0.07	0.01	0.07	-0.01	0.07
	Independent Firm	-1.25*	0.58	-1.34*	0.57	-1.10*	0.57	-1.34*	0.58	-1.10†	0.57
	PharmaBiotecSector	-0.02	0.42	0.29	0.42	0.11	0.41	0.29	0.42	0.09	0.42
	OxCamLonRegion	0.81†	0.45	0.70†	0.39	0.81†	0.44	0.70†	0.40	0.79†	0.45
	RelativeMarketSize	0.09	0.10	0.13	0.10	0.10	0.10	0.13	0.10	0.09	0.10
General Human Capital	AgeFounder	-0.52	0.95			-0.46	0.92			-0.44	0.93
	FounderProfessor	0.67	0.43			0.48	0.42			0.47	0.43
Specific Human Capital	FounderHabitualEntrepreneur	-1.07**	0.41			-1.07**	0.40			-1.07**	0.40
	FoundingTeamReputation	0.52*	0.22			0.39*	0.22			0.39†	0.22
Networks	VCNetwork	0.21	0.16			0.11	0.16			0.12	0.16
	StrategicAlliances	1.41***	0.38			1.26***	0.38			1.26***	0.38
Intellectual Capital	PatentedIP	0.17	0.42			-0.04	0.42			-0.02	0.43
	FirmOwnsIP	0.24	0.40			0.06	0.40			0.06	0.40
	InnovationRadicalness	-0.03	0.20			0.00	0.19			0.00	0.20
Finance	PublicBackedEquity	-0.43	0.39			-0.60	0.38			-0.60	0.38
	FirstVC			1.45***	0.39	1.13**	0.44				
	GeneralistVC							1.44**	0.49	1.05†	0.54
	SpecialistVC							1.46***	0.44	1.17*	0.47
	Constant	5.62	3.63	3.59***	0.83	5.18	3.54	3.59***	0.84	5.10	3.57
	n	125		125		125		125		125	
	adjusted R^2	0.23		0.19		0.27		0.23		0.26	
	Change in adjusted R^2	0.13**		0.09***		0.17***		0.13***		0.16**	
	F-statistic and significance level	3.43***		5.83***		3.80***		4.95***		3.55***	
	Test for Heteroscedasticity	7.97*		4.12*		11.27**		4.17*		11.53**	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Three variables are significant in Model 12-6. Firms with strategic alliances (StrategicAlliances) had a higher book value of total assets at the 0.001 level. Rejecting the hypothesised relationship, founders who are experienced entrepreneurs (FounderHabitualEntrepreneur) had a lower book value of total assets at the 0.01 level. Founding teams with more experience and reputation (FoundingTeamReputation) had a higher book value of total assets at the 0.05 level. In consequence, Hypotheses 14 and 16 are supported, while Hypothesis 13 is rejected in Model 12-6.

Four variables are significant in Model 12-8. Firms with strategic alliances (StrategicAlliances) had a higher book value of total assets at the 0.001 level. Firms with first VC investment (FirstVC) had a higher book value of total assets at the 0.01 level. Rejecting the hypothesised relationship, founders who are experienced entrepreneurs (FounderHabitualEntrepreneur) had a lower book value of total assets at the 0.01 level. Founding teams with more experience and reputation (FoundingTeamReputation) had a higher book value of total assets at the 0.05 level. Thus, Hypotheses 14, 16 and 21 are supported, while Hypothesis 13 is rejected in Model 12-8.

Five variables are significant in Model 12-10. Firms with strategic alliances (StrategicAlliances) had a higher book value of total assets at the 0.001 level. Rejecting the hypothesised relationship, founders who are experienced entrepreneurs (FounderHabitualEntrepreneur) had a lower book value of total assets at the 0.01 level. Firms with Specialist VC investment (SpecialistVC) had a higher book value of total assets at the 0.05 level. Founding teams with more experience and reputation (FoundingTeamReputation) as well as firms with Generalist VC investors (GeneralistVC) had weakly a higher book value of total assets at the 0.10 level. In consequence, Hypotheses 14, 16, 22 and 23 are supported, while Hypothesis 13 is rejected in Model 12-10.

5.2.5 Number of Employees in the USOs in 2008: OLS Regression Analysis

Hypotheses were tested with regard to each firm's number of employees until 2008. The mean and median number of employees was 16.23 and 7, respectively. The number of employees ranged from 1 to 160. The measure is weighted by firm age and transformed

with the natural logarithm to ensure the normality assumption. OLS regression analysis was conducted to test the presented hypotheses.

The base model 13-1 in Table 55 relates to the control variables. This model is significant at the 0.05 level and has an adjusted R^2 of 0.07. Independent firms (IndependentFirm) had significant lower number of employees at the 0.01 level.

Sets of independent variables were then added to the base model. The full model excluding VC investment variables is presented in Model 13-6. This model has an adjusted R^2 of 0.14 and is significant on the 0.01 level. The change in R^2 compared with the base model is 0.07 and this change is significant at the 0.05 level. The full model with first VC investment is presented in Model 13-8. This model has an adjusted R^2 of 0.16 and is significant at the 0.01 level. The change in R^2 compared with the base model is 0.09 and this change is significant at the 0.05 level. The full model with the distinction of VC investor types is presented in Model 13-10. This model has an adjusted R^2 of 0.17 and is significant on the 0.01 level. The change in R^2 compared with the base model is 0.10 and this change is significant at the 0.10 level.

Two variables are significant in Model 13-6. Firms with strategic alliances (StrategicAlliances) had a higher number of employees at the 0.01 level. Founding teams with more experience and reputation (FoundingTeamReputation) had a higher number of employees at the 0.10 level. In consequence, Hypotheses 14 and 16 are supported in Model 13-6.

Two variables are significant in Model 13-8. Firms with strategic alliances (StrategicAlliances) and firms with first VC investment (FirstVC) had a higher number of employees at the 0.05 level. Thus, Hypotheses 16 and 21 are supported, while Hypothesis 14 is no longer significantly supported in Model 13-8.

Two variables are significant in Model 13-10. Firms with strategic alliances (StrategicAlliances) and firms with Generalist VC investment (GeneralistVC) had a higher number of employees at the 0.05 level. Thus, Hypotheses 16 and 22 are supported, while Hypothesis 14 is no longer significantly supported in Model 13-10.

Table 55: Number of Employees in the USOs in 2008: OLS Regression Analysis

	Model:	**13-1**		**13-2**		**13-3**		**13-4**		**13-5**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.05	0.03	-0.04	0.03	-0.04	0.03	-0.04	0.04	-0.05	0.03
	Independent Firm	-1.03**	0.30	-0.84**	0.31	-1.02**	0.29	-1.03***	0.30	-1.03***	0.30
	PharmaBiotecSector	-0.08	0.22	-0.01	0.22	-0.14	0.21	-0.08	0.22	-0.08	0.22
	OxCamLonRegion	0.23	0.20	0.25	0.21	0.10	0.21	0.22	0.21	0.23	0.20
	RelativeMarketSize	0.00	0.05	-0.01	0.05	-0.01	0.05	0.00	0.05	0.01	0.05
General Human Capital	AgeFounder			-0.66	0.49						
	FounderProfessor			0.31	0.22						
Specific Human Capital	FounderHabitualEntrepreneur			-0.09	0.21						
	FoundingTeamReputation			0.26*	0.11						
Networks	VCNetwork					0.15*	0.07				
	StrategicAlliances					0.53**	0.20				
Intellectual Capital	PatentedIP							0.02	0.22		
	FirmOwnsIP							-0.11	0.22		
	InnovationRadicalness							0.03	0.10		
Finance	PublicBackedEquity									-0.15	0.20
	FirstVC										
	GeneralistVC										
	SpecialistVC										
	Constant	1.35**	0.39	3.50	1.82	0.70	0.45	1.37**	0.43	1.46***	0.42
	n	125		125		125		125		125	
	adjusted R^2	0.07		0.1		0.15		0.05		0.07	
	Change in adjusted R^2	/		0.03†		0.08**		-0.02		0.00	
	F-statistic and significance level	2.95*		2.56*		4.04***		1.84†		2.54*	
	Test for Heteroscedasticity	0.25		0.04		0.21		0.23		0.14	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 55 (Continued)**:** Number of Employees in the USOs in 2008: OLS Regression Analysis

	Model:	**13-6**		**13-7**		**13-8**		**13-9**		**13-10**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.05	0.04	-0.04	0.03	-0.04	0.04	-0.04	0.03	-0.04	0.04
	Independent Firm	-0.86**	0.30	-0.88**	0.29	-0.80**	0.30	-0.89**	0.29	-0.80**	0.30
	PharmaBiotecSector	-0.08	0.22	-0.02	0.21	-0.03	0.22	0.01	0.21	0.01	0.22
	OxCamLonRegion	0.14	0.23	0.14	0.20	0.14	0.23	0.17	0.20	0.19	0.23
	RelativeMarketSize	-0.02	0.05	-0.01	0.05	-0.02	0.05	0.00	0.05	-0.01	0.05
General Human Capital	AgeFounder	-0.61	0.49			-0.58	0.49			-0.62	0.49
	FounderProfessor	0.29	0.22			0.21	0.22			0.24	0.22
Specific Human Capital	FounderHabitualEntrepreneur	-0.12	0.21			-0.12	0.21			-0.12	0.21
	FoundingTeamReputation	0.21†	0.11			0.16	0.11			0.17	0.11
Networks	VCNetwork	0.11	0.08			0.07	0.08			0.05	0.08
	StrategicAlliances	0.56**	0.20			0.50*	0.20			0.49*	0.20
Intellectual Capital	PatentedIP	0.09	0.22			0.01	0.22			-0.04	0.22
	FirmOwnsIP	-0.08	0.21			-0.15	0.21			-0.16	0.21
	InnovationRadicalness	0.01	0.10			0.03	0.10			0.05	0.10
Finance	PublicBackedEquity	-0.21	0.20			-0.28	0.20			-0.28	0.20
	FirstVC			0.61**	0.20	0.45*	0.23				
	GeneralistVC							0.81***	0.25	0.67*	0.28
	SpecialistVC							0.47*	0.22	0.34	0.24
	Constant	2.95	1.89	0.78†	0.42	0.00	0.00	0.77†	0.42	2.98	1.87
	n	125		125		125		125		125	
	adjusted R^2	0.14		0.13		0.16		0.14		0.17	
	Change in adjusted R^2	0.07*		0.06**		0.09*		0.07**		0.10*	
	F-statistic and significance level	2.36**		4.16***		2.51**		3.86***		2.47**	
	Test for Heteroscedasticity	0.01		0.38		0.19		0.60		0.18	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

5.2.6 Absolute Employment Change between Founding Year and 2008: OLS Regression Analysis

Hypotheses were tested with regard to each firm's absolute employment change between the founding year and 2008. The mean and median of absolute employment change was 5.4 and 1.5, respectively. Absolute employment change ranged from -0.83 to 72.00. The measure is weighted by firm age and transformed with the natural logarithm to ensure the normality assumption. OLS regression analysis was conducted to test the presented hypotheses.

The base model 14-1 in Table 56 relates to the control variables. This model is significant at the 0.01 level and has an adjusted R^2 of 0.09. Independent firms (IndependentFirm) had a significant lower employment change rate at the 0.01 level.

Sets of independent variables were then added to the base model. The full model excluding VC investment variables is presented in Model 14-6. This model has an adjusted R^2 of 0.21 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.12 and this change is significant at the 0.01 level. The full model including first VC investment is presented in Model 14-8. This model has an adjusted R^2 of 0.33 and is significant at the 0.001 level. The change in R^2 compared with the base model is 0.24 and this change is significant at the 0.01 level. The full model with the distinction of VC investor types is presented in Model 12-10. This model has an adjusted R^2 of 0.34 and is significant on the 0.01 level. The change in R^2 compared with the base model is 0.25 and this change is significant at the 0.01 level.

Three variables are significant in Model 14-6. Firms with strategic alliances (StrategicAlliances) reported more absolute employment growth at the 0.01 level. Founders with the status of a professor (FounderProfessor) and firms with more network links to VC investors (VCNetwork) reported more absolute employment growth at the 0.05 level. In consequence, Hypotheses 12, 15 and 16 are supported in Model 14-6.

Five variables are significant in Model 14-8. Firms with strategic alliances (StrategicAlliances) reported more absolute employment growth at the 0.001 level.

Table 56: Absolute Employment Change in USOs Between Founding Year and 2008: OLS Regression Analysis

	Model:	**14-1**		**14-2**		**14-3**		**14-4**		**14-5**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01
	Independent Firm	-0.39**	0.11	-0.33**	0.12	-0.39***	0.11	-0.39**	0.11	-0.39***	0.11
	PharmaBiotecSector	0.06	0.08	0.06	0.08	0.04	0.08	0.06	0.08	0.06	0.08
	OxCamLonRegion	0.07	0.08	0.06	0.08	0.04	0.08	0.06	0.08	0.07	0.08
	RelativeMarketSize	-0.02	0.02	-0.02	0.02	-0.03	0.02	-0.02	0.02	-0.02	0.02
General Human Capital	AgeFounder			-0.34†	0.18						
	FounderProfessor			0.19*	0.08						
Specific Human Capital	FounderHabitualEntrepreneur			0.00	0.08						
	FoundingTeamReputation			-0.04	0.04						
Networks	VCNetwork					0.05†	0.03				
	StrategicAlliances					0.23**	0.07				
Intellectual Capital	PatentedIP							0.07	0.08		
	FirmOwnsIP							0.00	0.08		
	InnovationRadicalness							0.01	0.04		
Finance	PublicBackedEquity									-0.05	0.08
	FirstVC										
	GeneralistVC										
	SpecialistVC										
	Constant	0.55***	0.15	1.75*	0.69	0.33†	0.17	0.51**	0.16	0.59***	0.16
	n	125		125		125		125		125	
	adjusted R^2	0.09		0.13		0.22		0.13		0.13	
	Change in adjusted R^2	/		0.04†		0.13**		0.04		0.04	
	F-statistic and significance level	3.52**		3.00**		4.60***		2.25*		3.00**	
	Test for Heteroscedasticity	0.10		0.00		0.03		1.16		1.15	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 56 (Continued)**:** Absolute Employment Change in USOs Between Founding Year and 2008

	Model:	**14-6**		**14-7**		**14-8**		**14-9**		**14-10**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01
	Independent Firm	-0.34**	0.11	-0.35**	0.11	-0.32**	0.11	-0.35**	0.11	-0.32**	0.11
	PharmaBiotecSector	0.02	0.08	0.08	0.08	0.04	0.08	0.10	0.08	0.06	0.08
	OxCamLonRegion	-0.01	0.09	0.04	0.08	-0.01	0.08	0.05	0.08	0.01	0.09
	RelativeMarketSize	-0.02	0.02	-0.02	0.02	-0.02	0.02	-0.02	0.02	-0.02	0.02
General Human Capital	AgeFounder	-0.30	0.18			-0.29	0.18			-0.30	0.18
	FounderProfessor	0.18*	0.08			0.15†	0.08			0.16†	0.08
Specific Human Capital	FounderHabitualEntrepreneur	-0.01	0.08			-0.01	0.08			-0.01	0.08
	FoundingTeamReputation	-0.07	0.04			-0.08*	0.04			-0.08†	0.04
Networks	VCNetwork	0.06*	0.03			0.05	0.03			0.04	0.03
	StrategicAlliances	0.25**	0.07			0.23***	0.07			0.22**	0.07
Intellectual Capital	PatentedIP	0.04	0.08			0.01	0.08			0.00	0.08
	FirmOwnsIP	0.00	0.08			-0.03	0.08			-0.04	0.08
	InnovationRadicalness	-0.02	0.04			-0.01	0.04			0.00	0.04
Finance	PublicBackedEquity	-0.10	0.07			-0.13†	0.07			-0.13†	0.07
	FirstVC			0.20*	0.08	0.17*	0.08				
	GeneralistVC							0.28**	0.09	0.26*	0.10
	SpecialistVC							0.14†	0.09	0.13	0.09
	Constant	1.37*	0.69	0.37	0.16	1.31†	0.68	0.36	0.16	1.39	0.68
	n	125		125		125		125		125	
	adjusted R^2	0.21		0.13		0.33		0.14		0.34	
	Change in adjusted R^2	0.12**		0.04*		0.24**		0.05*		0.25**	
	F-statistic and significance level	3.17***		4.18***		3.32***		3.94***		3.26***	
	Test for Heteroscedasticity	1.02		0.62		4.19*		0.56		4.87*	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Firms with first VC investment (FirstVC) reported more absolute employment growth at the 0.05 level. Rejecting the hypothesised relationship, founding teams with more experience and reputation (FoundingTeamReputation) reported less absolute employment growth at the 0.05 level. Similarly, firms with public backed equity investments (PublicBackedEquity) reported less absolute employment growth at the 0.10 level. Founders with the status of a professor (FounderProfessor) reported more absolute employment growth at the 0.10 level. Thus, Hypotheses 12, 16 and 21 are supported, while Hypothesis 14 and 20 are rejected in Model 14-8.

Five variables are significant in Model 12-10. Firms with strategic alliances (StrategicAlliances) reported more absolute employment growth at the 0.01 level. Firms with Generalist VC investment (GeneralistVC) reported more absolute employment growth at the 0.05 level. Rejecting the hypothesised relationship, founding teams with more experience and reputation (FoundingTeamReputation) reported less absolute employment growth at the 0.05 level. Similarly, firms with public backed equity investments (PublicBackedEquity) reported less absolute employment growth at the 0.10 level. Founders with the status of a professor (FounderProfessor) reported more absolute employment growth at the 0.10 level. Thus, Hypotheses 12, 16 and 23 are supported, while Hypothesis 14 and 20 are rejected in Model 14-10.

5.2.7 Composite Measure of Firm Performance: OLS Regression Analysis

Hypotheses were tested with regard to a composite measure of firm performance discussed in Section 3.5.1.2. Component scores relating to a single component generated by the PCA (i.e. total number of external investment rounds, total amount of external investment, book value of total assets, number of employees and absolute employment change) were considered as a dependent variable. Issues relating the construction as well as the validity and reliability of the composite measure of firm performance are discussed in Section 3.5.1.2. The mean and median of the composite measure of firm performance was 0.00 and -0.20, respectively. The composite measure of firm performance ranged from -1.96 to 2.70. OLS regression analysis was conducted to test the presented hypotheses.

The base model 15-1 in Table 57 relates to the control variables. This model is significant at the 0.001 level and has an adjusted R^2 of 0.15. Independent firms (IndependentFirm) had a significant lower performance score at the 0.001 level. Firms in the Oxford, Cambridge or London region (OxCamLonRegion) had higher performance scores at the 0.05 level.

Sets of independent variables were then added to the base model. The full model excluding VC investment variables is presented in Model 15-6. This model has an adjusted R^2 of 0.33 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.18 and this change is significant at the 0.001 level. The full model including first VC investment is presented in Model 15-8. This model has an adjusted R^2 of 0.42 and is significant at the 0.001 level. The change in R^2 compared with the base model is 0.27 and this change is significant at the 0.001 level. The full model including the distinction of VC investor types is presented in Model 15-10. This model has an adjusted R^2 of 0.42 and is significant on the 0.001 level. The change in R^2 compared with the base model is 0.27 and this change is significant at the 0.001 level.

Five variables are significant in Model 15-6. Firms with strategic alliances (StrategicAlliances) had higher performance scores at the 0.001 level. Founders with the status of a professor (FounderProfessor) and firms with more network links to VC investors (VCNetwork) had higher performance scores at the 0.05 level. Founding teams with more experience and reputation (FoundingTeamReputation) had higher performance scores at the 0.10 level. Rejecting the hypothesised relationship, older founders (AgeFounder) had lower performance scores at the 0.10 level. In consequence, Hypotheses 12, 14, 15 and 16 are supported, while Hypothesis 11 is rejected in Model 15-6.

Four variables are significant in Model 15-8. Firms with strategic alliances (StrategicAlliances) and firms with first VC investment (FirstVC) had higher performance scores at the 0.001 level. Founders with the status of a professor (FounderProfessor) had higher performance scores at the 0.10 level. However, more network links to VC investors (VCNetwork) and founding teams with more experience and reputation (FoundingTeamReputation) were no longer significant compared to the previous model. Rejecting the hypothesised relationship, older founders (AgeFounder) had lower performance scores at the 0.10 level. Thus, Hypotheses 12, 16 and 21 are supported, whereas Hypothesis 11 is rejected in Model 15-8

Table 57: Composite Measure of Firm Performance: OLS Regression Analysis

	Model:	**15-1**		**15-2**		**15-3**		**15-4**		**15-5**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.05†	0.03	-0.05†	0.03	-0.04	0.03	-0.05†	0.03	-0.05	0.03
	Independent Firm	-1.09***	0.25	-0.86***	0.26	-1.08***	0.23	-1.09***	0.26	-1.09***	0.26
	PharmaBiotecSector	0.08	0.19	0.13	0.18	0.00	0.17	0.07	0.19	0.08	0.19
	OxCamLonRegion	0.33†	0.17	0.34†	0.18	0.17	0.17	0.29	0.18	0.33†	0.17
	RelativeMarketSize	0.03	0.04	0.02	0.04	0.00	0.04	0.03	0.04	0.03	0.04
General Human Capital	AgeFounder			-0.84*	0.41						
	FounderProfessor			0.46*	0.19						
Specific Human Capital	FounderHabitualEntrepreneur			-0.16	0.18						
	FoundingTeamReputation			0.21*	0.09						
Networks	VCNetwork					0.18**	0.06				
	StrategicAlliances					0.67***	0.16				
Intellectual Capital	PatentedIP							0.15	0.19		
	FirmOwnsIP							0.10	0.18		
	InnovationRadicalness							0.00	0.09		
Finance	PublicBackedEquity									0.05	0.17
	FirstVC										
	GeneralistVC										
	SpecialistVC										
	Constant	1.13***	0.34	3.94*	1.53	0.33	0.36	1.02**	0.36	1.10**	0.36
	n	125		125		125		125		125	
	adjusted R^2	0.15		0.20		0.31		0.13		0.18	
	Change in adjusted R^2	/		0.05*		0.16***		-0.02		0.03	
	F-statistic and significance level	5.27***		4.41***		8.90***		3.34**		4.37***	
	Test for Heteroscedasticity	0.00		0.01		0.44		0.00		0.00	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 57 (Continued)**:** Composite Measure of Firm Performance: OLS Regression Analysis

	Model:	**15-6**		**15-7**		**15-8**		**15-9**		**15-10**	
		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variables	FirmAge	-0.06†	0.03	-0.03	0.03	-0.04†	0.03	-0.03	0.03	-0.04†	0.03
	Independent Firm	-0.88***	0.24	-0.88***	0.23	-0.79***	0.22	-0.88***	0.23	-0.79***	0.22
	PharmaBiotecSector	0.02	0.17	0.16	0.17	0.10	0.16	0.18	0.17	0.12	0.16
	OxCamLonRegion	0.18	0.18	0.19	0.16	0.18	0.17	0.21	0.16	0.21	0.17
	RelativeMarketSize	0.00	0.04	0.01	0.04	0.00	0.04	0.02	0.04	0.01	0.04
General Human Capital	AgeFounder	-0.74†	0.39			-0.70†	0.36			-0.72*	0.36
	FounderProfessor	0.41*	0.17			0.29†	0.17			0.30†	0.17
Specific Human Capital	FounderHabitualEntrepreneur	-0.19	0.17			-0.19	0.16			-0.19	0.16
	FoundingTeamReputation	0.15†	0.09			0.07	0.08			0.08	0.08
Networks	VCNetwork	0.15*	0.06			0.09	0.06			0.08	0.06
	StrategicAlliances	0.71***	0.16			0.62***	0.15			0.61***	0.15
Intellectual Capital	PatentedIP	0.17	0.17			0.04	0.16			0.02	0.17
	FirmOwnsIP	0.12	0.16			0.00	0.16			0.00	0.16
	InnovationRadicalness	-0.03	0.08			-0.01	0.08			0.00	0.08
Finance	PublicBackedEquity	-0.07	0.16			-0.18	0.15			-0.18	0.15
	FirstVC			0.90***	0.16	0.70***	0.17				
	GeneralistVC							1.02***	0.19	0.80***	0.21
	SpecialistVC							0.82***	0.18	0.65***	0.18
	Constant	2.83†	1.48	0.29	0.33	2.55†	1.38	0.28	0.33	2.65†	1.39
	n	125		125		125		125		125	
	adjusted R^2	0.33		0.32		0.42		0.33		0.42	
	Change in adjusted R^2	0.18***		0.17***		0.27***		0.18***		0.27***	
	F-statistic and significance level	5.12***		11.10***		6.54***		9.67***		6.17***	
	Test for Heteroscedasticity	0.19		2.56		0.88		3.35†		1.20	

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Five variables are significant in Model 15-10. Firms with strategic alliances (StrategicAlliances) as well as firms with investment by Generalist VC investors (GeneralistVC) or Specialist VC investors (SpecialistVC) had higher performance scores at the 0.001 level. Founders with the status of a professor (FounderProfessor) had higher performance scores at the 0.10 level. However, more network links to VC investors (VCNetwork) and founding teams with more experience and reputation (FoundingTeamReputation) were no longer significant compared to the previous model. Rejecting the hypothesised relationship, older founders (AgeFounder) had lower performance scores at the 0.10 level. In consequence, Hypotheses 12, 16, 22 and 23 are supported, while Hypothesis 11 is rejected in Model 12-10.

5.3 Summary of Findings for USOs' Firm Performance

Table 58 summarises the hypotheses relating to firm performance discussed in Chapter 2 that were empirically supported. Support for each hypothesis is discussed, in turn below.

Hypothesis 11 on the general human capital of founders' age (AgeFounder) is never supported for USO firm performance. However, it is rejected in the following models. Older founders were attracting less number of total external investment rounds (Models 9-6, 9-8 and 9-10), less total amount of external funding (Models 10-6, 10-8 and 10-10) as well as lower scores for the composite firm performance measure (15-6, 15-8 and 15-10). Conversely, Hypothesis 12 on the general human capital of founders with the status of a professor (FounderProfessor) was partially supported in four out of seven models. Founders with the status of a professor attracted more total external investment rounds (Models 9-6, 9-8 and 9-10) and total amount of funding, but only if VC investments are not included to the model (Model 10-6). Further, they are related to higher absolute employment change (Models, 14-6, 14-8 and 14-10) as well as higher scores for the composite firm performance measure (15-6, 15-8 and 15-10).

Hypothesis 13 on the specific human capital of experienced entrepreneurs (FounderHabitualEntrepreneur) is never supported. However, it is rejected for the book value of total assets (Models 12-6, 12-8 and 12-10). Hypothesis 14 on the specific human

capital of the experience and reputation of founding teams (FoundingTeamReputation) is partially supported for three out of seven models. Founding teams with more experience and reputation attracted more total amount of external investment (Models 10-6, 10-8 and 10-10) and higher book value of total assets (Models 12-6, 12-8 and 12-10). Further, they are related to a higher number of employees before the VC variables are introduced to the model (Model 13-6). Conversely, Hypothesis 14 is rejected for employment change once VC variables are introduced to the models. Here, more founding team's experience and reputation relates to less absolute employment change (Models 14-8 and 14-10). Hypothesis 14 is supported for the dependent variable of composite firm performance measure, however, only for the model excluding the VC variables (Model 15-6).

Hypothesis 15 on the network resource of network links to VC investors (VCNetwork) is only partially supported for three out of seven models. More network links to VC investors lead to a higher total amount of external investment (Models 10-6, 10-8 and 10-10). They also relate to more absolute employment change and higher scores for the composite firm performance measure, however, only for the respective models excluding the VC variables (Models 14-6 and 15-6 respectively). Hypothesis 16 on the network resource of strategic alliances (StrategicAlliances) is consistently supported in all seven models. Strategic alliances attracted more total number of external investment rounds (Models 9-6, 9-8, 9-10), more total amount of external investment (Models 10-6, 10-8, 10-10) and had a higher likelihood for product launch (Models 11-6, 11-8, 11-10). Further, they were related to a higher book value of total assets (Models 12-6, 12-8, 12-10), higher number of employees (Models 13-6, 13-8, 13-10), higher absolute employment change (Models 14-6, 14-8, 14-10) as well as higher scores of the composite firm performance measure (Models 15-6, 15-8, 15-10).

Hypothesis 17 on the intellectual capital of patents (PatentedIP) is only supported in one out of seven models. However, patents were only related to a higher total amount of external investment when VC variables were not included in the models (Model 10-6). Conversely, Hypothesis 17 is rejected for the positive likelihood of a product launch (Models 11-6, 11-8, 11-10). Like patents, Hypothesis 18 on the intellectual capital of IP ownership owned by the firm is only supported in one model. However, IP ownership was only related to a higher total amount of funding when VC variables were not included in the model (Model 10-6). Conversely, Hypothesis 18 is rejected for the positive likelihood of a product launch (Models 11-6, 11-8, 11-10). Hypothesis 19 on the Intellectual Capital of innovation radicalness (InnovationRadicalness) is never supported or rejected.

Hypothesis 20 on the financial resource of public backed equity (PublicBackedEquity) is only supported in one out of seven models. Public backed equity investments attracted a higher total number of external investment rounds. However, Hypothesis 20 is rejected for the positive likelihood of a product launch (Models 11-6, 11-8 and 11-10). Further, it is rejected for absolute employment change once VC variables are introduced. Here public backed equity relates to a lower employment change rate (Models 14-8 and 14-10).

Hypothesis 21 on the resource of first VC investment (FirstVC) is consistently supported in six out of seven models. First VC investment attracted more total number of external investment rounds (Models 9-6, 9-8, 9-10), more total amount of external investment (Models 10-6, 10-8, 10-10) and were related to a higher book value of total assets (Models 12-6, 12-8, 12-10). Further, it was related to higher number of employees (Models 13-6, 13-8, 13-10), higher absolute employment change (Models 14-6, 14-8, 14-10) as well as higher scores of the composite firm performance measure (Models 15-6, 15-8, 15-10). Hypothesis 22 on the resource of Generalist VC investment (GeneralistVC) is also consistently supported for six out of seven models. Generalist VC investment attracted more total number of funding rounds (Models 9-6, 9-8, 9-10), more total amount of external investment (Models 10-6, 10-8, 10-10) and were related to a higher book value of total assets (Models 12-6, 12-8, 12-10). Further, it was related to higher number of employees (Models 13-6, 13-8, 13-10), higher absolute employment change (Models 14-6, 14-8, 14-10) as well as higher scores of the composite firm performance measure (Models 15-6, 15-8, 15-10). Finally, Hypothesis 23 on the resource of Specialist VC investment (SpecialistVC) was supported for four out of seven models. Specialist VC investment attracted more total number of external investment rounds (Models 9-6, 9-8, 9-10), more total amount of external investment (Models 10-6, 10-8, 10-10) and were related to a higher book value of total assets (Models 12-6, 12-8, 12-10). Further, it was related to higher scores of the composite firm performance measure (Models 15-6, 15-8, 15-10).

Therefore, Hypotheses 16 was the only hypotheses supported in all models. Hypotheses 21 and 22 were supported in all models except product launch. Hypotheses 23, 12 and 14 were also frequently supported.

Table 58: Summary of Findings for Firm Performance

		Dependent Variable:	**Total Number of External Investment Rounds**			**Total Amount of External Investment Attracted**			**Likelihood of Product Launch**		
		Regression Technique:	**OLS**			**OLS**			**Logistic**		
		Model:	**9-6**	**9-8**	**9-10**	**10-6**	**10-8**	**10-10**	**11-6**	**11-8**	**11-10**
			Excl.VC	VC	Type VC	Excl.VC	VC	Type VC	Excl.VC	VC	Type VC
General Human Capital	Age Founder	**Hypothesis 11:** USOs with older founders will report superior firm performance.	-**	-**	-**	-†	-*	-*			
	Founder Professor	**Hypothesis 12:** USOs with founders with higher levels of academic reputation will report superior firm performance.	+**	+*	+*	+†					
Specific Human Capital	Founder Habitual Entre-preneur	**Hypothesis 13:** USOs with experienced entrepreneurs will report superior firm performance.									
	Founding Team Reputation	**Hypothesis 14:** USOs with an experienced founding team will report superior firm performance.				+**	+†	+†			
Networks	VC Network	**Hypothesis 15:** USOs from universities that have a strong network of previously VC funded USOs will report superior firm performance.				+**	+*	+*			
	Strategic Alliances	**Hypothesis 16:** USOs with alliance partners report superior firm performance.	+***	+***	+***	+***	+**	+**	+*	+*	+*

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 58 (Continued)**:** Summary of Findings for Firm Performance

		Dependent Variable:	**Total Number of External Investment Rounds**			**Total Amount of External Investment Attracted**			**Likelihood of Product Launch**		
		Regression Technique:	**OLS**			**OLS**			**Logistic**		
		Model:	**9-6**	**9-8**	**9-10**	**10-6**	**10-8**	**10-10**	**11-6**	**11-8**	**11-10**
			Excl.VC	VC	Type VC	Excl.VC	VC	Type VC	Excl.VC	VC	Type VC
Intellectual Capital	Patented IP	**Hypothesis 17:** USOs with patented IP will report superior firm performance.				+†			-**	-**	-**
	FirmOwnsIP	**Hypothesis 18:** USOs that own their IP will report superior firm performance.				+†			-*	-*	-*
	Innovation Radicalness	**Hypothesis 19:** USOs whose main product or service is associated with radical innovation will report weaker firm performance.									
Finance	Public Backed Equity	**Hypothesis 20:** USOs that have obtained publicly-backed equity funds will report superior firm performance.	+**	+*	+*				-†	-†	-†
VC Investment	FirstVC	**Hypothesis 21:** USOs with VC investment will report superior firm performance.		+***			+***				
	GeneralistVC	**Hypothesis 22:** USOs with generalist VC investment will report superior firm performance.			+***			+***			
	Specialist VC	**Hypothesis 23:** USOs with specialist VC investment will report superior firm performance.			+***			+***			

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 58 (Continued)**:** Summary of Findings for Firm Performance

		Dependent Variable:	**Book Value of Total Assets**			**Number of Employees**			**Absolute Employment Change**		
		Regression Technique:	**OLS**			**OLS**			**OLS**		
		Model:	**12-6**	**12-8**	**12-10**	**13-6**	**13-8**	**13-10**	**14-6**	**14-8**	**14-10**
			Excl.VC	VC	Type VC	Excl.VC	VC	Type VC	Excl.VC	VC	Type VC
General Human Capital	Age Founder	**Hypothesis 11:** USOs with older founders will report superior firm performance.									
	Founder Professor	**Hypothesis 12:** USOs with founders with higher levels of academic reputation will report superior firm performance.							+*	+†	+†
Specific Human Capital	Founder Habitual Entre-preneur	**Hypothesis 13:** USOs with experienced entrepreneurs will report superior firm performance.	-**	-**	-**						
	Founding Team Reputation	**Hypothesis 14:** USOs with an experienced founding team will report superior firm performance.	+*	+*	+†	+†				-*	-†
Networks	VC Network	**Hypothesis 15:** USOs from universities that have a strong network of previously VC funded USOs will report superior firm performance.							+*		
	Strategic Alliances	**Hypothesis 16:** USOs with alliance partners report superior firm performance.	+***	+***	+***	+**	+*	+*	+**	+***	+**

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 58 (Continued)**:** Summary of Findings for Firm Performance

		Dependent Variable:	**Book Value of Total Assets**			**Number of Employees**			**Absolute Employment Change**		
		Regression Technique:	**OLS**			**OLS**			**OLS**		
		Model:	**12-6**	**12-8**	**12-10**	**13-6**	**13-8**	**13-10**	**14-6**	**14-8**	**14-10**
			Excl.VC	VC	Type VC	Excl.VC	VC	Type VC	Excl.VC	VC	Type VC
Intellectual Capital	PatentedIP	**Hypothesis 17:** USOs with patented IP will report superior firm performance.									
	FirmOwnsIP	**Hypothesis 18:** USOs that own their IP will report superior firm performance.									
	Innovation Radicalness	**Hypothesis 19:** USOs whose main product or service is associated with radical innovation will report weaker firm performance.									
Finance	Public Backed Equity	**Hypothesis 20:** USOs that have obtained publicly-backed equity funds will report superior firm performance.								-†	-†
VC Investment	FirstVC	**Hypothesis 21:** USOs with VC investment will report superior firm performance.		+***			+*			+*	
	GeneralistVC	**Hypothesis 22:** USOs with generalist VC investment will report superior firm performance.			+†			+*			+*
	SpecialistVC	**Hypothesis 23:** USOs with specialist VC investment will report superior firm performance.			+*						

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 58 (Continued)**:** Summary of Findings for Firm Performance

		Dependent Variable:	**Composite Measure of Firm Performance**		
		Regression Technique:	**OLS**		
		Model:	**15-6**	**15-8**	**15-10**
			Excl.VC	VC	Type VC
General Human Capital	AgeFounder	**Hypothesis 11:** USOs with older founders will report superior firm performance.	-†	-†	-†
	Founder Professor	**Hypothesis 12:** USOs with founders with higher levels of academic reputation will report superior firm performance.	+*	+†	+†
Specific Human Capital	Founder Habitual Entrepreneur	**Hypothesis 13:** USOs with experienced entrepreneurs will report superior firm performance.			
	Founding Team Reputation	**Hypothesis 14:** USOs with an experienced founding team will report superior firm performance.	+†		
Networks	VCNetwork	**Hypothesis 15:** USOs from universities that have a strong network of previously VC funded USOs will report superior firm performance.	+*		
	Strategic Alliances	**Hypothesis 16:** USOs with alliance partners report superior firm performance.	+***	+***	+***

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Table 58 (Continued)**:** Summary of Findings for Firm Performance

		Dependent Variable:	**Composite Measure of Firm Performance**		
		Regression Technique	**OLS**		
		Model:	**15-6**	**15-8**	**15-10**
			Excl.VC	VC	Type VC
Intellectual Capital	PatentedIP	**Hypothesis 17:** USOs with patented IP will report superior firm performance.			
	FirmOwnsIP	**Hypothesis 18:** USOs that own their IP will report superior firm performance.			
	Innovation Radicalness	**Hypothesis 19:** USOs whose main product or service is associated with radical innovation will report weaker firm performance.			
Finance	Public Backed Equity	**Hypothesis 20:** USOs that have obtained publicly-backed equity funds will report superior firm performance.			
VC Investment	FirstVC	**Hypothesis 21:** USOs with VC investment will report superior firm performance.		+***	
	GeneralistVC	**Hypothesis 22:** USOs with generalist VC investment will report superior firm performance.			+***
	SpecialistVC	**Hypothesis 23:** USOs with specialist VC investment will report superior firm performance.			+***

Significance levels: †p < .1; *p <.05; **p < .01; ***p < .001

Chapter 6: Conclusions

6.1 Introduction

This study explored the factors associated with USOs that were able to attract first VC investment. In addition, this study explored the factors associated with superior firm performance of USOs. The link between first VC investment or not and superior USO performance was monitored. The purpose of this study was to address several gaps in the knowledge base in these areas of research.

Gaps in the knowledge base relating to what factors affect USOs' ability to attract first VC investment were identified and discussed in Section 2.2. Previous studies did rarely replicate, integrate and extend theoretical insights in order to derive hypotheses to explore the co-ordination between demand and supply of VC investment. There is also a lack of studies which empirically tested hypotheses on factors leading to first VC investment using representative cross-sectional samples and multivariate statistical analyses. Further, gaps in the knowledge base relating to what factors including the attraction of first VC investment can lead USOs to superior firm performance were identified and discussed in Section 2.5. Previous studies missed out on integrating themes of initial resource endowments into a theoretical framework which can be used to derive hypotheses. Only few studies are available which use representative cross-sectional samples and multivariate statistical analyses to test these hypotheses related to USO firm performance in the light of VC investment.

This chapter discusses how this study and its findings reduced the identified gaps in the knowledge base. It points out what contributions to theory were made and reports key findings related to two research questions. Further, implications are derived for several groups of practitioners. These include academic entrepreneurs, universities and their TTOs, VC investors as well as public policy makers. Finally, limitations and areas of future research are discussed.

6.2 Theoretical Contribution

Several new contributions to theory were made. They include theory development based on replicating previous theoretical insights as well as extending them to apply them to the context and research questions of this study. Moreover, contributions relate to a quantitative methodology for empirically testing hypotheses which were derived from the developed theoretical insights using a novel and representative data set.

In order to explore factors related to the attraction of first VC investment the theoretical framework of the RBV of the firm was replicated in Section 2.3 for identifying themes of resources which characterize the demand side perspective of USOs seeking first VC investment. The resource themes of general and specific human capital of founders as well as firms' networks, intellectual capital and financing were integrated by the RBV of the firm. This framework was then extended with signalling theory to argue why the identified resource themes are also meaningful from a supply side perspective. Signalling theory implies that VC investors can interpret initial resources of USOs as credible signals of quality in order to make an investment decision in spite of constraints from uncertainty and asymmetric information. In considering demand and supply side perspectives, the resource themes identified by the novel joint framework of the RBV of the firm and signalling theory are thus attributed with the ability to co-ordinate demand and supply on the VC financing market for USOs. This new contribution to theory is further applicable in studies on entrepreneurial finance and the co-ordination of markets in the presence of uncertainty and asymmetric information.

The joint framework of the RBV of the firm and signalling theory also contributed to theory in deriving hypotheses related to the attraction of first VC investment in Section 2.4. Hypotheses on general human capital (age and academic status of founders), specific human capital (entrepreneurial experience of founders as well as experience and reputation of founding team), intellectual capital (patented IP) were replicated and extended to be applicable in the context of USOs. Further, novel hypotheses were derived relating to intellectual capital (IP owned by the firm, radicalness of innovation) and financing (public backed equity).

The role of initial resources of USOs and their founders as well as their ability to attract VC investment was also related to firm performance. This contribution to theory relates to the debate on to what extent firm performance is determined by firms' internal factors. This study replicated the RBV of the firm in Section 2.6 in order to suggest that new firms' performance relates to their initial resources of general and specific human capital of founders as well as firms' networks, intellectual capital and financing. Moreover, in attracting additional resources in the form of financing and business expertise from VC investors, new firms may successfully adapt to their environment in achieving superior performance. Insights from this framework are applicable to studies in entrepreneurship investigating how the resources of new firms shape their performance prospects and to what extent they enable successful adaptation to their environment. With the help of this theoretical framework it was also possible to explore whether resources which attracted first VC investment as signals of quality also related to superior firm performance.

The framework on firm performance also contributed to theory in deriving hypotheses related to superior firm performance in Section 2.7. Hypotheses on general human capital (age and academic status of founders), specific human capital (entrepreneurial experience of founders as well as experience and reputation of founding team), intellectual capital (patented IP) and financing (VC investment) were replicated and extended to be applicable in the context of USOs. Further, novel hypotheses were derived relating to intellectual capital (IP owned by the firm, radicalness of innovation) and financing (public backed equity, generalist VC and specialist VC).

In addition to contributions of theory development, all the derived hypotheses were also tested empirically using a unique and novel sample of 125 British USOs which is representative for the population of USOs which were founded between 1990 and 2007, and still active in 2008. Information was gathered from founders and key decision-makers and a 25% response rate was reported with reference to the cross-sectional survey. Notably, no significant differences were detected between the valid respondents and the valid non-respondents to the survey. Results from the survey can, therefore, be generalized to the population of USOs. In addition, complimentary information was gathered from reputable secondary data sources relating to company status, financing and performance. This study was the first academic research project to obtain firm level information on British USOs from the private VC database Library House. No evidence of a common methods bias was detected.

Further, multivariate statistical techniques were used for testing hypotheses. These included logistic and multinominal regression analyses for categorical dependent variables as well as tobit and OLS regressions for continuous dependent variables. Multivariate statistical analysis has the advantage that the relative importance of a group of independent variables can be observed relating to a dependent variable. To further strengthen the contribution of this study an array of dependent variables (introduced in Section 3.5.1) were used in order to conduct a sensitivity analysis. The dependent variable of Likelihood to attract First VC Investment (yes, no) was used for the first time in a cross-sectional study on British USOs. Further novel dependent variables included Number of First VC Offers (number; none, one, two or more), Number of First VC Investments (number; none, one, two or more), First VC Investment Amount (amount (£'); none, £1 to £500,000, > £500,000) and Investor Types Relating to First VC Investment (no VC, Generalist VC, Specialist VC).

Similarly, several dependent variables were used to measure firm performance until 2008 in order to conduct a sensitivity analysis. They included Total Number of External Investment Rounds Attracted Until 2008, Total Amount of External Investment (£'s) Attracted Until 2008, Likelihood of Product Launch to the Market Until 2008; Book Value of Total Assets (£'s) Until 2008, Number of Employees in the USOs in 2008, Absolute Employment Change between Founding Year and 2008 as well as a Composite Measure of Firm Performance. These dependent variables were mostly replicated from previous entrepreneurship studies. However, they were applied for the first time in a cross-sectional study on firm performance of USOs in the UK. The array of dependent variables contributes in generating more robust results as well as providing in deeper insights. The resulting key findings from testing hypotheses derived from the theoretical framework of this study are reported in the following sections.

6.3 Key Findings

6.3.1 Overview

Table 59 summarizes how frequently hypotheses were significantly supported in the models in presented in Chapters 4 and 5 exploring both research questions. Key findings are extracted from this table and discussed in the sections relating to each research question.

Table 59: Overview of Supported Hypotheses for both Research Questions

Resource Theme:	**Measure:**	**Hypotheses relating to Research Question 1:**	**Hypothesis supported in Models:**	**Number of times hypo-thesis was supported:**	**Hypotheses relating to Research Question 2:**	**Hypothesis supported in Models:**	**Number of times hypothesis was supported:**		
							Excl.VC	VC	Type VC
General Human Capital	Age Founder	**H 1:** Older USO founders are more likely to attract first VC investment.		0/12	**H 11:** USOs with older founders will report superior firm performance.		0/7	0/7	0/7
	Founder Professor	**H 2:** USO founders with higher levels of academic reputation are more likely to attract first VC investment.	First VC Investment (Yes, No) Number of First VC Investment Offers Two and more First VC Investment Offers Number of First VC Investments Two and more First VC Investments Amount of First VC Investment £1 to £500,000 of First VC Investment Specialist VC Investment	8/12	**H 12:** USOs with founders with higher levels of academic reputation will report superior firm performance.	Total Number of External Investment Rounds (Excl. VC, VC, Type VC) Total Amount of External Investment Attracted (Excl. VC) Absolute Employment Change (Excl. VC, VC, Type VC) Composite Measure of Firm Performance (Excl. VC, VC, Type VC)	4/7	3/7	3/7
Specific Human Capital	Founder Habitual Entrepreneur	**H 3:** USO founders who are experienced entrepreneurs are more likely to attract first VC investment.		0/12	**H 13:** USOs with experienced entrepreneurs will report superior firm performance.		0/7	0/7	0/7
	Founding Team Experience	**H 4:** USOs with an experienced founding team are more likely to attract first VC investment.	First VC Investment (Yes, No) Number of First VC Investment Offers One First VC Investment Offer Two and more First Investment Offers Number of First VC Investments One First VC Investment Two and more First VC Investments Amount of First VC Investment £1 to £500,000 of First VC Investment More than £500,000 of First VC Investment Generalist VC Investment Specialist VC Investment	12/12	**H 14:** USOs with an experienced founding team will report superior firm performance.	Total Amount of External Investment Attracted (Excl. VC, VC, Type VC) Book Value of Total Assets (Excl. VC, VC, Type VC) Number of Employees (Excl.VC) Composite Measure of Firm Performance (Excl. VC)	4/7	2/7	2/7

Table 59 (Continued)**:** Overview of Supported Hypotheses for both Research Questions

Resource Theme:	**Measure:**	**Hypotheses relating to Research Question 1:**	**Hypothesis supported in Models:**	**Number of times hypo-thesis was supported:**	**Hypotheses relating to Research Question 2:**	**Hypothesis supported in Models:**	**Number of times hypothesis was supported:**		
							Excl.VC	VC	Type VC
Networks	VC Network	**H 5:** USOs from universities that have a strong network of previously VC funded USOs are more likely to attract first VC investment.	First VC Investment (Yes, No) Number of First VC Investment Offers Two and more First Investment Offers Number of First VC Investments One First VC Investment Two and more First VC Investments Amount of First VC Investment £1 to £500,000 of First VC Investment More than £500,000 of First VC Investment Generalist VC Investment Specialist VC Investment	11/12	**H 15:** USOs from universities that have a strong network of previously VC funded USOs will report superior firm performance.	Total Amount of External Investment Attracted (Excl. VC, VC, Type VC) Absolute Employment Change (Excl.VC) Composite Measure of Firm Performance (Excl. VC)	3/7	1/7	1/7
	Strategic Alliances	**H 6:** USOs with alliance partners are more likely to attract first VC investment.	Number of First VC Investment Offers One First VC Investment Offer Two and more First Investment Offers Amount of First VC Investment	4/12	**H 16:** USOs with alliance partners report superior firm performance.	Total Number of External Investment Rounds (Excl. VC, VC, Type VC) Total Amount of External Investment Attracted (Excl. VC, VC, Type VC) Likelihood of Product Launch (Excl. VC, VC, Type VC) Book Value of Total Assets (Excl. VC, VC, Type VC) Number of Employees (Excl. VC, VC, Type VC) Absolute Employment Change (Excl. VC, VC, Type VC) Composite Measure of Firm Performance (Excl. VC, VC, Type VC)	7/7	7/7	7/7

Table 59 (Continued)**:** Overview of Supported Hypotheses for both Research Questions

Resource Theme:	**Measure:**	**Hypotheses relating to Research Question 1:**	**Hypothesis supported in Models:**	**Number of times hypo-thesis was supported:**	**Hypotheses relating to Research Question 1:**	**Hypothesis supported in Models:**	**Number of times hypothesis was supported:**		
							Excl.VC	Excl.VC	Excl.VC
Intellectual Capital	PatentedIP	**H 7:** USOs with patented IP are more likely to attract first VC investment.	First VC Investment (Yes, No) Number of First VC Investment Offers One First VC Investment Offer Two and more First Investment Offers One First VC Investment Amount of First VC Investment More than £500,000 of First VC Investment Generalist VC Investment Specialist VC Investment	9/12	**H 17:** USOs with patented IP will report superior firm performance.	Total Amount of External Investment Attracted (Excl. VC)	1/7	0/7	0/7
	FirmOwnsIP	**H 8:** USOs with IP ownership are more likely to attract first VC investment.	First VC Investment (Yes, No) Number of First VC Investment Offers Two and more First Investment Offers Number of First VC Investments One First VC Investment Two and more First VC Investments Amount of First VC Investment More than £500,000 of First VC Investment Generalist VC Investment Specialist VC Investment	10/12	**H 18:** USOs that own their IP will report superior firm performance.	Total Amount of External Investment Attracted (Excl. VC)	1/7	0/7	0/7
	Innovation Radicalness	**H 9:** USOs whose main product or service is associated with radical innovation are less likely to attract first VC investment.	Generalist VC Investment	1/12	**H 19:** USOs whose main product or service is associated with radical innovation will report weaker firm performance.		0/7	0/7	0/7

Table 59 (Continued)**:** Overview of Supported Hypotheses for both Research Questions

Resource Theme:	**Measure:**	**Hypotheses for Research Question 1:**	**Hypothesis supported in Models:**	**Number of times hypo-thesis was supported:**	**Hypotheses for Research Question 2:**	**Hypothesis supported in Models:**	**Number of times hypothesis was supported:**		
							Excl.VC	Excl.VC	Excl.VC
Finance	Public Backed Equity	**H 10:** USOs that have obtained publicly-backed equity funds are more likely to attract first VC investment.	First VC Investment (Yes, No) Two and more First Investment Offers One First VC Investment Amount of First VC Investment £1 to £500,000 of First VC Investment	5/12	**H 20:** USOs that have obtained publicly-backed equity funds will report superior firm performance.	Total Number of External Investment Rounds (Excl. VC, VC, Type VC)	1/7	1/7	1/7
VC Investment	FirstVC Investment				**H 21:** USOs with VC investment will report superior firm performance.	Total Number of External Investment Rounds (VC) Total Amount of External Investment Attracted (VC) Book Value of Total Assets (VC) Number of Employees (VC) Absolute Employment Change (VC) Composite Measure of Firm Performance (VC)		6/7	
	Generalist VC				**H 22:** USOs with generalist VC investment will report superior firm performance.	Total Number of External Investment Rounds (Type VC) Total Amount of External Investment Attracted (Type VC) Book Value of Total Assets (Type VC) Number of Employees (Type VC) Absolute Employment Change (Type VC) Composite Measure of Firm Performance (Type VC)			6/7
	Specialist VC				**H 23:** USOs with specialist VC investment will report superior firm performance.	Total Number of External Investment Rounds (Type VC) Total Amount of External Investment Attracted (Type VC) Book Value of Total Assets (Type VC) Composite Measure of Firm Performance (Type VC)			4/7

6.3.2 Key Findings Relating to the Ability to Attract First VC Investment

The following key findings relate to the first research question: Which resources of USOs are signals of quality and attract first VC investment? Hypotheses for exploring this research question were derived from the joint theoretical framework of the RBV of the firm and signalling theory. Key findings relate to the hypotheses tested in Chapter 4 and their overview in Table 59. They are summarized in Table 60 and discussed below.

Table 60: Key Findings on the Ability to Attract First VC Investment (Research Question 1)

Key Findings relating to:	**Key Findings** (* = new finding, # = replicated finding)**:**
Internal factors of USOs as signals of quality to attract first VC investment:	• New evidence confirmed the implications of the novel theoretical framework of the RBV of the firm and signalling theory that initial resource endowments of USOs can be signals of quality which attract VC investment.* • At least one hypothesis relating to each resource themes of USOs' general and specific human capital, networks, intellectual capital and finance was supported in attracting first VC investment.*
Relative importance of signals of quality to attract first VC investment:	• Initial resource endowments of USOs differed in their strength of being signals of quality to attract first VC investment.* • The strongest signals of quality related to: 1. Experienced and reputable team (specific human capital)# 2. Network links to VC investors (networks)# 3. Firm owns IP (intellectual capital)* 4. Patented IP (intellectual capital)# 5. Founder Professor (general human capital)# 6. Public backed equity (finance)* • Public backed equity reduced an 'equity gap' for USOs seeking less than £500,000 of first VC investment.* • Strategic alliances (networks) were only weak signals of quality which did not increase the likelihood of attracting first VC investment.* • USOs with radical innovation (intellectual capital) were unlikely to receive investment from a generalist VC firm.* • Older founders (general human capital) or founders with previous entrepreneurial experience (specific human capital) were not more likely to attract first VC investment.*

Table 60 (Continued)**:** Key Findings on the Ability to Attract First VC Investment (Research Question 1)	
Key Findings relating to:	**Key Findings** (* = new finding, # = replicated finding)**:**
Other factors related to attract first VC investment	• Control variables of firm age, region, relative market size and industry showed overall no significant influence on the take-up of first VC investment.

The first key finding is that at least one hypothesis of each resource theme related to the attraction of first VC investment was supported. There is overall strong evidence that initial resource endowments of USOs can serve as signals of quality which attract first VC investment. Accordingly, the novel joint framework of the RBV of the firm and signalling theory is an appropriate perspective to explore the factors coordinating demand and supply on the VC financing market for USOs.

The second key finding is that signals of quality differ in their importance to attract first VC investment. Using the array of dependent variables related to first VC investment for a sensitivity analysis reveals a hierarchy of importance among signals of quality which is reported below with reference to whether findings are novel or replicated.

The strongest signal of quality was the experience and reputation of USOs' founding teams (specific human capital). This finding confirms earlier studies which highlight that VC investors strongly associate the quality of the founding team with the prospects of investment opportunities (MacMillan *et al*., 1985; Zacharakis and Meyer, 1998). USOs with highly experienced and reputable founding teams were more likely to attract VC investment and generally attracted more first VC investment offers, more investments, higher investment amounts as well as received investment from all types of VC investors.

The second strongest signal of quality was if USOs had strong network links to VC investors (networks). This finding also confirms earlier studies that VC investors rely on the social capital of networks to identify credible investment opportunities (Shane and Stuart, 2002). USOs from universities with a strong network of previously VC financed USOs were also more likely to attract VC investment and generally attracted more first VC investment offers, more investments, higher investment amounts as well as received investment from both types of VC investors.

The third strongest signal of quality was if USOs owned the IP (intellectual capital). This is a new finding and shows that VC investors have a strong preference for keeping the valuable resource of IP in control of the firm they invest in. USOs which owned the IP were also more likely to attract VC investment and generally attracted more first VC investment offers and more investments. However, this signal of quality relates particularly for USOs which attracted more than £500,000 of first VC investment. USOs which owned their IP attracted investment from both types of VC investors.

The fourth strongest signal of quality was if USOs had patented IP (intellectual capital). This finding confirms earlier studies that firms with patented IP are more preferred by VC investors (Shane, 2001; Hsu, 2007). USOs with patented IP were more likely to attract first VC investment and received more first VC investment offers. However, this signal of quality related only to attracting one first VC investment while then attracting more than £500,000. USOs with patented IP attracted investment from both types of VC investors.

The fifth strongest signal of quality was if USOs' founders had the status of a professor (general human capital). This finding confirms earlier studies that VC investors infer from the education and qualification of founders to the performance prospect of investment opportunities (Shane and Stuart, 2002; Levie and Gimmon, 2008). USOs with founders being professors were more likely to attract first VC investment and received more first VC investment offers as well as actual investments. They were more likely to attract up to £500,000 of first VC investment. However, they were only more likely to attract first VC investment from specialist VC firms.

The sixth strongest signal of quality was if USOs had previously attracted public backed equity investment (finance). This new finding using evidence of a cross-sectional study of USOs shows for the first time that public policy schemes to support USOs in attracting VC can have a positive effect. USOs with public backed equity investment were more likely to attract first VC investment, two or more offers as well as one investment. They were also more likely to attract first VC investment up to £500,000. This finding reflects that public backed equity schemes can fulfil their assigned role in helping USOs to bridge an 'equity gap' of attracting equity investment of less than £500,000 (Wright *et al*., 2006).

Strategic alliances were only a weak signal of quality (network)[11]. Only three models in this study confirmed previous findings that this resource helped USOs to attract VC investment (Baum and Silverman, 2004). USOs with strategic were not more likely to attract first VC investment although they received more first VC investment offers.

USOs with radical innovation (intellectual capital) were only significantly less likely to attract investment from generalist VC investors. This novel finding adds to anecdotal evidence that generalist VC investors tend to be risk averse and thus avoid investing in firms with radical innovation (Lockett *et al.*, 2002). However, there was no significant evidence in this study that USOs with radical innovation would generally struggle nor have an advantage in attracting first VC investment.

There was no evidence that USOs with more mature founders (general human capital) and previous entrepreneurial experience (specific human capital) could use these resources as signals of quality to attract first VC investment.

The array of control variables was overall not significant. Hence, the findings can be interpreted in being independent of external factors like relative market size, industry and region. Company status and firm age also showed overall no significant influence.

In summary, the presented replicated and new key findings contribute to closing the identified gaps in the knowledge base identified in Section 2.2. The novel joint framework of the RBV of the firm and signalling theory offers a theoretical insight in exploring demand and supply side issues of VC financing of USOs. A comparable theory driven approach has been missing in previous studies. Moreover, the quantitative methodology and the representative cross-sectional sample ensured generalisable findings which complement the predominantly anecdotal evidence and qualitative character of earlier studies on barriers USOs face when attracting fist VC investment. Consequently, the developed theoretical insights, derived hypotheses and applied quantitative methodology can be replicated and extended in future studies.

[11] This issue was recently discussed with a VC investor. The concern was raised that strategic alliances prior to first VC investment might spoil attractive exit options for future mergers and acquisitions. This new insight is an interesting lead into future research on the importance and impact of strategic alliances on the development on young firms and their need to secure external financing.

6.3.3 Key Findings Relating to USO Firm Performance and the Role of First VC Investment

The following key findings relate to the second research question: Do VC funded USOs report superior firm performance? Hypotheses for exploring this research question were derived from the RBV of the firm in order to determine to what extent firm performance is subject to firms' internal factors as well as their ability to attract first VC investment help them to adapt to their environment. Key findings relate to the hypotheses tested in Chapter 5 and their overview in Table 59. They are summarized in Table 61 and discussed below.

Table 61: Key Findings Relating to USO Firm Performance and the Role of First VC Investment (Research Question 2)

Key Findings relating to:	**Key Findings** (* = new finding, # = replicated finding)**:**
Influence of internal factors on superior firm performance:	• This study provided new evidence that internal factors relate to superior firm performance as implied by the RBV of the firm.#
Relative importance of internal factors related to superior firm performance:	• The importance of internal factors being related to superior firm performance varies. The most important were: 1. Strategic alliances (networks)# 2. First VC investment / First VC investment from Generalist VC Firms* 3. Founder Professor (general human capital); This influence was reduced in the presence of First VC Investment# 4. First VC Investment from Specialist VC Firms* 5. Experienced and Reputable Founding Teams (specific human capital); This influence was reduced in the presence of First VC Investment# • Patented IP, Firm owns IP and radical innovation (intellectual capital) as well as public backed equity (finance) were weakly or not related to superior firm performance.* • Older founders (general human capital) and founders with previous entrepreneurial experience (specific human capital) were not related to superior firm performance.*

Table 61 (Continued)**:** Key Findings Relating to USO Firm Performance and the Role of First VC Investment (Research Question 2)	
Key Findings relating to:	**Key Findings** (* = new finding, # = replicated finding)**:**
The attraction of first VC investment and its influence on superior firm performance:	• USOs which attracted first VC investment were always reporting superior firm performance with the exception of launching a product to the market place.* • USOs which received investment from Generalist VC investors performed better than those which received it from Specialist VC investors.* • Presence of first VC investment reduced the importance of general human capital in the form of founders being professors and specific human capital in the form of experienced and reputable founding teams being related to superior firm performance.#
Comparison whether resources which attracted first VC investment as signals of quality also related to superior firm performance:	• Among the six strongest signals of quality to attract first VC investment only experienced and reputable team (specific human capital) and USOs with founder being professors (general human capital) were related to superior firm performance. However, their influence was further reduced in the presence of first VC investment.*
Other factors related to USO firm performance:	• Older USOs were strongly related to superior firm performance. # • No strong evidence was found that region, sector or relative market size determined superior firm performance.*

The first key finding is that several hypotheses on USOs' internal factors of resource themes as well as the attraction of first VC investment were supported in being related to superior firm performance. Accordingly, there is new evidence that USOs' internal initial resource endowments and their ability to attract first VC investment were related to superior firm performance as implied by the RBV of the firm.

The next key finding is that USOs' initial resources differ in their importance of being related to superior firm performance. Moreover, the attraction of first VC investment also influenced the importance of initial resources leading to superior firm performance. An array of dependent variables measuring superior firm performance was used for a sensitivity analysis. Starting with the most important, the resources of USOs which are related with

superior firm performance are reported below as well as with reference to whether findings are new or confirm earlier studies.

Strategic alliances were the most prominent initial resource endowment in this study which related to superior firm performance. Whereas strategic alliances were only weakly related to attract first VC investment, they were always related to superior firm performance. They attracted more total rounds and larger amounts of external investment, reported a higher book value of total assets, more employees, a greater absolute change in employment as well as higher scores of the composite measure of firm performance. The resource of strategic alliances was also the only internal factor in this study which had a higher likelihood of launching a product to the market place. Moreover, this finding is independent of whether USOs were able to attract investment from first VC investors or not. This finding relates to previous studies on the importance of new firms to build inter-firm networks to generate a competitive advantage related to superior firm performance (Stuart, 2000; Baum and Silverman, 2004).

USOs which attracted first VC investment were second most related to superior firm performance. While USOs with first VC investment were not more likely to launch a product to the market, they attracted more total rounds and larger amounts of external investment, reported a higher book value of total assets, more employees, a greater absolute change in employment as well as higher scores of the composite measure of firm performance. Apart from being directly related to superior firm performance, the presence of first VC investment also influenced the relationship between other internal firm resources and firm performance. Notably, the presence of first VC investment weakened the direct influence of the founding team's specific human capital related to superior firm performance. This finding is consistent with earlier studies which argue that VC investors make use of their managerial control in influencing and optimising the quality and performance of their investees' management teams (Hellmann and Puri, 2002).

Distinguishing between types of VC investors revealed novel differences in their influence on their investees' firm performance. USOs which obtained investment from generalist VC investors were more often related to superior performance in the models of this study than USOs with investments from specialist VC investors. USOs with generalist VC investment attracted more total rounds and larger amounts of external investment,

reported a higher book value of total assets, more employees, a greater absolute change in employment as well as higher scores of the composite measure of firm performance.

USOs whose founders had the status of a professor also reported superior firm performance. They attracted more total rounds and larger amounts of external investment, reported a higher book value of total assets, more employees, a greater absolute change in employment as well as higher scores of the composite measure of firm performance. However, once first VC investment was included in the models, the direct influence of this resource on superior firm performance was reduced in significance (Total Number of External Investment Rounds, Absolute Employment Change, Composite Measure of Firm Performance) or no longer significant (Total Amount of External Investment Attracted).

USOs with experienced founding teams partially reported superior firm performance. They attracted larger amounts of external investment and reported a higher book value of total assets, more employees and higher scores of the composite measure of firm performance. However, once first VC investment was included in the models, the direct influence of this resource on superior firm performance was reduced related to number of employees and the composite measure of firm performance.

Networks of USOs in the form of links to VC investors were one of the most important signals of quality leading to the attraction of first VC investment. However, new evidence on the importance of this resource related to superior firm performance is weak. With the exception of attracting larger amounts of external investment, all other dimensions of firm performance were not influenced by network links to VC investors. In particular, once first VC investment was attracted.

Finance of USOs in the form of public backed equity was only related to superior firm performance in securing more rounds of external investment. Conversely, it reduced the likelihood of a product launch. There was also evidence that public backed equity in the presence of VC investment reduced absolute employment growth. This evidence suggests that public backed equity may attract VC investors to invest in USOs which still require extensive time to get to the marketplace and face moderate growth due to their early stage and new technologies (Wright *et al*., 2006). However, the finding of poor performance of USOs with public backed equity investments contributes to the debate that public policy schemes still need to better address issues of investment and market readiness (Mason and Harrison, 2001, 2004).

Intellectual capital of USOs in the form of patents and IP ownership of the firm did hardly relate to superior firm performance, in particular, not in the presence of VC investment. It also reduced the likelihood of a product launch. This new evidence reflects that these resources were only necessary as signals of quality to attract VC investors. This finding is consistent with studies which argue that patented IP leading to superior firm performance cannot be generalised. There was also no evidence of radical innovation being significantly related to firm performance. However, it is notable that radical innovation always had a negative relationship with performance in all tested models in Chapter 5. Radical innovation could thus be an important indicator of the risk of new firms.

General human capital of USOs in the form founders' age was never related to superior firm performance. There was no evidence that more mature academic entrepreneurs are more successful. Similarly, specific human capital of USOs in the form founders' previous entrepreneurial experience did not relate to superior firm performance.

A further important key finding is that those resources which were strong signals of quality to attract first VC investment were not necessarily strongly related to superior firm performance, too. Table 59 shows that hypotheses related to the same resource themes were more frequently supported for the attraction of first VC investment rather than being related to first VC investment. This is the case for founders' academic status, experienced founding teams, VC network, patented IP, IP owned by the firm and public backed equity investments. Accordingly, USOs with a strong initial resource base alone are less likely to report superior firm performance than those firms which attracted first VC investment.

Another important key finding is in spite of the presented evidence that internal resource characteristics along with first VC investment were significantly related to superior firm performance, other factors should be considered, too. It is notable in all presented models in Chapter 5 that the control variable of firm age was throughout significantly related to superior firm performance. Older USOs were thus more likely to be related to superior firm performance. In particular, they were more likely to launch a product. This finding indicates that new firms have to prove and establish themselves constantly on the market place to achieve superior firm performance. Whereas USOs' initial internal resources as well as their attraction of first VC investment can contribute significantly the ability to adapt to external factors affecting firm performance, adaptation is subject to an ongoing

process. However, there was no strong evidence in this study that other external factors such as region, industry or relative market size would relate to superior firm performance.

In summary, the presented replicated and new key findings contribute to closing the identified gaps in the knowledge base identified in Section 2.5 as summarized in Table 61. The replicated framework of the RBV of the firm offers a theoretical insight in exploring what factors including USOs' internal initial resources and their ability to attract first VC investment relate to superior firm performance. A comparable theory driven perspective has been missing in previous studies. Moreover, the quantitative methodology and the unique cross-sectional sample enables this study to be the first to explore the firm performance of British USOs using firm and founder level data as units of analysis. The presented generalisable findings complement to previous studies which relate to predominantly anecdotal evidence from qualitative research and those studies which explore USO formation and development on an aggregated national level measuring the quantitative output of new USOs per university. Consequently, the developed theoretical insights, derived hypotheses and applied quantitative methodology can be replicated and extended in future studies.

6.4 Implications for Practitioners

6.4.1 Groups of Practitioners in the Context of USOs

The findings of this study have important implications for several groups of practitioners which are concerned about barriers USOs face in attracting first VC investment and achieving superior firm performance. Recommendations, best practices and related changes to behaviour are discussed for each of the following practitioner groups in the next sections.

The first group of practitioners are academic entrepreneurs. Relating to their role as firm founders and owners recommendations are made how they can increase their likelihood of attracting first VC investment as well as what resources their firms require for successfully adapting to their environment and achieve superior firm performance.

The second group of practitioners are universities and their TTOs. Their role is to administer and encourage academic entrepreneurship in order to generate financial returns from commercialising IP generated at their research departments. Findings in this study are used to recommend how universities and their TTOs can help USOs to attract first VC investment as well as to build a resource base which is leading them to superior firm performance.

The third group of practitioners are VC investors. Their role is to identify and invest in USOs with high performance prospects in order to generate substantial returns. Findings in this study are used to help VC investors to review and revise their investment strategies in USOs regarding what signals of quality were also related to superior firm performance. Moreover, implications are made to what extent VC investment and the type of VC investor influence USOs firm performance.

Finally, public policy makers are addressed in their role of providing incentives on a national and regional scale to encourage the formation of knowledge based businesses in order to generate economic growth and employment. Findings in this study can help public policy makers to develop best practices on how they can influence the VC market for USOs from a demand side (i.e. USOs, founders, universities and their TTOs) as well as the supply side (i.e. VC firms) in order to ensure that sufficient financing is available while promoting USOs with superior firm performance.

6.4.2 Academic Entrepreneurs

Best practices for academic entrepreneurs to attract first VC investment and lead their USOs to superior firm performance are summarized in Table 62. They are discussed below.

Table 62: Implications for Academic Entrepreneurs

Best practices for academic entrepreneurs in order to attract first VC investment:	• Building an experienced and reputable founding team. • Make best use of network links to VC investors which have been built up by previous USOs from the same university of origin.

Table 62 (Continued)**:** Implications for Academic Entrepreneurs	
Best practices for academic entrepreneurs in order to attract first VC investment (Continued)**:**	• Costs and benefits analysis with university and TTO regarding patenting IP and assigning IP ownership to the firm in order to increase the likelihood of attracting first VC investment. • Professors had an advantage in attracting first VC investment. • Public backed equity is effective as early stage financing in order to continue to attract first VC investment. • Attracting public backed equity reduces the 'equity gap' and helps to attract first VC investment of less than £500,000. • Generalist VC firm were less likely to invest in USOs with radical innovation.
Best practices for academic entrepreneurs in order to lead their firms to superior performance:	• The attraction of first VC investment related to superior firm performance with the exception of a higher likelihood for launching a product to the market place. • Patenting IP and assigning IP ownership to the firm showed no direct influence on superior firm performance. They only lead to superior firm performance in attracting first VC investment. • VC investors make strong use of their control rights and influence managerial decision making despite experienced and reputable founding teams or founders of high academic status. • Generalist VC investors were more likely to lead USOs to superior firm performance than sector and industry specialist VC firms. • Building strategic alliances was commonly associated with superior firm performance irrespective of attracting first VC investment.

Academic entrepreneurs who are concerned about barriers to attract first VC investment can learn from the identified signals of quality in this study in order to increase their likelihood for the take-up of VC. The most important signal of quality which academic entrepreneurs can directly influence is building an experienced and reputable founding team. Academic entrepreneurs should also make best use of network links to VC investors which have been built up by previous USOs from the same university of origin. According to this study, such networks can even help to attract first VC investment in regions in the UK with a weaker presence of VC firms. Academic entrepreneurs need to discuss with their university, department and TTO the costs and benefits of patenting IP and assigning IP ownership to the firm in order to increase the likelihood of attracting first VC investment.

Academic entrepreneurs should also make best use of their academic status, as VC investors infer from this signal of quality to the capabilities and potential of their investment opportunities. Academic entrepreneurs who are not professors can compensate this in attracting an academic of higher status to become a member of the founding team. Finally, academic entrepreneurs should search for public backed equity schemes which can help their USOs to attract early stage financing. Moreover, according to this study they avoid an 'equity gap' and can attract first VC investment of less than £500,000 if they previously attracted public backed equity investment.

In addition to the presented recommendations for attracting first VC investment, academic entrepreneurs need to carefully consider internal factors leading to superior firm performance. Although the attraction of first VC investment generally relates to superior firm performance, potential costs and benefits need to be assessed. VC investment is costly, as academic entrepreneurs, their universities and TTOs need to patent their IP, as well as sign the control rights of the IP over to the firm. It thus needs to be carefully considered whether these costs are justified giving the expected future benefits and returns from commercialising IP. Moreover, academic entrepreneurs need to be prepared that VC investors will have strong control over the management decisions in the firm. Despite experienced and reputable founding teams and academic status of their investees, VC investors will impose their own objectives on the firm. To avoid a conflict of interest, academic entrepreneurs need to carefully assess whether the expertise and track-record of VC investors meet their requirements. This study showed that generalist VC investors were more likely to lead USOs to superior firm performance than sector and industry specialist VC firms. Moreover, there was no evidence that VC investors were likely to help USOs launching their product to the market place.

Academic entrepreneurs are strongly advised to build strategic alliances which were commonly associated with superior firm performance. Academic entrepreneurs should also consider radicalness of innovation as an important measure of risk of their business model. They should seek advice from their TTO and related agencies which can help to assess the feasibility of new business ideas in order to achieve investment and market readiness.

6.4.3 Universities and their TTOs

Best practices for universities and their TTOs in order to help their USOs attracting first VC investment and leading them to superior firm performance are summarized in Table 63. They are discussed below.

Table 63: Implications for Universities and their TTOs

Best practices in order to help USOs to overcome barriers to attract first VC investment:	• All founders should be supported in building reputable and experienced founding teams to increase the likelihood of attracting first VC investment. • Universities and their TTOs need to build and maintain network links to VC investors who have already invested in previous USOs. Such networks are to the benefit of future USOs seeking first VC investment. • Need to educate academic entrepreneurs about the costs, benefits and conflicts of patenting IP and assigning IP ownership to firms in order to attract first VC investment. • Regional disadvantages in access to VC investment can be compensated by network to VC investors. • USOs with radical innovation may need additional support in attracting external financing. • USOs seeking less than £500,000 of external equity investment should be linked up with public backed equity funds before considering first VC investment.
Best practices in order to help USOs in order to develop and achieve superior firm performance:	• Academics irrespective of their age or previous entrepreneurial experience should be encouraged to start USOs. • VC investment generally related to superior firm performance. • TTOs need to build up expertise whether and what type of VC investor is likely to best serve the interest of their USOs. • Support USOs in attracting strategic alliance partner. • TTOs need to assess whether the expertise and due diligence offered by public backed equity schemes meet the requirements of USOs to become investment and market ready.

Universities and their TTOs need to be aware that academic entrepreneurs of higher academic status also have a higher likelihood to attract VC investment. Founders who lack higher academic status should particularly be supported in building reputable and experienced founding teams to increase the likelihood of attracting first VC investment. To

effectively reduce barriers to VC investment, Universities and their TTOs need to build and maintain network links to VC investors who have already invested in previous USOs. Such networks are to the benefit of future USOs seeking first VC investment. Moreover, regional disadvantages in access to VC investment can be compensated in building active networks and clusters between universities, TTOs, USOs as well as present and future academic entrepreneurs. Further, universities and their TTOs can play a vital role in assisting their USOs to find attractive alliance partners which are likely to lead firms to superior performance. Universities and their TTOs should encourage USOs which seek less than £500,000 of external equity investment to consider public backed equity funds. However, the providers and due diligence schemes of these funds also prepare USOs to become investment ready leading them to first VC investment as well as to become market ready in order to achieve superior firm performance.

Universities and their TTOs should consider that VC investment is often related to superior firm performance. However, universities and their TTOs need to educate academic entrepreneurs about the costs, benefits and conflicts of patenting IP and assigning IP ownership to firms in order to attract first VC investment. Because these issues of managing IP were more likely to affect the attraction of VC than directly lead to superior firm performance a thoughtful decision is required whether attracting VC investments is an important strategic objective. Moreover, universities and their TTOs should seek the dialogue with VC investors, academic entrepreneurs and public policy makers to discuss best practices of IP management and avoid conflicts. Further, TTOs need to build up expertise whether and what type of VC investor is likely to best serve the interest of their USOs. Universities and their TTOs should encourage academics irrespective of age or previous entrepreneurial experience to start USOs.

6.4.4 VC Investors

Best practices for VC investors to review their investment strategies of choosing USOs and leading them to superior firm performance are summarized in Table 64. They are discussed below.

Table 64: Implications for VC Investors

Best practices in order to help VC investors to screen for signals of quality among investment opportunities:	• Initial resources of USOs can be signals of quality which reduce risk and uncertainty in order to separate 'good' from 'bad' investment opportunities. • The most commonly observed signals of quality were reputable and experienced founding teams, strong network links to VC investors, firms with patented IP, IP owned by the firm, founders being professors and the previous attraction of public backed equity investment. • Radicalness of innovation in USOs is a major risk factor which may require specialist VC expertise to be assessed.
Best practices in order to help VC investors to lead their investees to superior firm performance:	• Initial resources used as signals of quality do not necessarily directly relate to superior firm performance. • VC investors need to frequently review and update their beliefs what initial resources of USOs are related with superior firm performance. • Failure to update beliefs on what resources qualify as signals of quality can lead to biases in decision making and inferior outcomes. • The requirements that investees patent IP and assign IP ownership to the firm in order to attract first VC investment can lead to conflicts if VC investors fail to deliver superior firm performance. • The promotion of VC investors' interest can require reducing the influence of founding teams and founders on managerial decision making. • VC investors should promote and help USOs to build strategic alliances. • VC investors need to thoroughly assess whether their expertise and funding scope meet the needs of their investees and their own goals to generate substantial returns. • Specialist VC investors may need to consider to build up more expertise bringing their investees to the market place and turning them into mature firms.

This study offers VC investors new insights on interpreting initial resources of USOs as signals of quality in order to reduce risk and uncertainty when seeking to separate 'good' from 'bad' investment opportunities. Prominent initial resources of USOs which attracted VC investors were reputable and experienced founding teams, strong network links to VC investors, with patented IP as well as the firm owning the IP. Further important signals of quality included USOs with founders being professors and the previous attraction of public backed equity investment.

However, this study showed that initial resources used as signals of quality do not necessarily directly relate to superior firm performance. It is rather the presence of the VC

investor which made a difference in influencing investees' development after the investment was made. For instance, resources of patented IP and IP owned by the firm were not directly related with firm performance. VC investors thus need to be aware that their demands for patented IP and IP owned by the firm may lead to conflicts with academic entrepreneurs, their universities and TTOs. In particular, if VC-funded USOs fail to deliver superior firm performance. Moreover, general and specific human capital of founders and founding teams was only partially and weakly related with superior firm performance. In contrast, VC investors appeared not to have a preference for USOs with strategic alliance partners, although this resource showed the strongest relationship with superior firm performance. Therefore, VC investors need to update their beliefs about which signals of quality are likely to lead to superior firm performance. Otherwise they risk making judgment errors in the form of an availability bias if they restrict themselves to follow the same investment criteria (Levie and Gimmon, 2008).

Overall, VC investors were a crucial factor in leading USOs to superior firm performance. There was also evidence that heterogeneity of VC firm types can make a difference. USOs which attracted generalist VC investors generally outperformed those firms which attracted specialist VC investors. However, recent developments show that generalist VC investors are increasingly pulling out of investing in USOs, other new high technology firms and those ventures with radical innovation. This reflects that the risks associated with commercialising academic research are a severe challenge for private investors (Lockett *et al*., 2002; Connell, 2007). This challenge is likely to increase in times of economic turmoil and recession. In particular, VC investors which are not solely financed with equity from institutional investors, but also rely on debt, will withdraw from investing in high risk ventures such as USOs. Specialist VC investors which rely on their sector and industry expertise enabling them to identify successful investment opportunities are also forced away from investing in USOs if they fail to convince their own institutional investors regarding their abilities to generate substantial returns from new high risk ventures. Further, a successful performance record is also required to keep up support schemes by public policy schemes which aim to reduce the risk of VC investors.

6.4.5 Public Policy Makers

Best practices for universities and their TTOs in order to help their USOs attracting first VC investment and leading them to superior firm performance are summarized in Table 65. They are discussed below.

Table 65: Implications for Public Policy Makers

Best practices in order to facilitate USOs' access to VC investment:	• The availability of sufficient VC investment to USOs is a matter of incentivising as well as supporting supply and demand.
	• Supply-side:
	  ○ Public backed equity schemes can reduce an equity gap on the financing market for USOs seeking less than £500,000 of first VC investment.
	  ○ USOs with radical innovation are likely to need public support schemes as generalist VC investors increasingly pull out of this market.
	• Demand-side:
	  ○ Public backed equity schemes need to be reviewed in order to improve the investment readiness of USOs.
	  ○ Support in helping to build networks between academic entrepreneurs, universities TTOs and VC investors.
	  ○ Educate about the costs and benefits of VC investment.
	  ○ Development of national best practices for managing IP including issues of patenting and ownership.

Best practices for reducing barriers of development in order to help USOs to achieve superior firm performance:	• VC investment should be continued to be regarded as a crucial resource which can lead USOs to superior firm performance and therefore promote the growth of a knowledge based economy. • Public backed equity schemes need to be reviewed in order to improve the market readiness of USOs. • Adopt a resource-based perspective in order to develop benchmarking and diagnostic tools for conducting firm level analyses on USO firm performance and the role of VC investment. • More firm and founder level data needs to be collected and systematically analysed to trace the formation, development and performance of USOs.

The evidence in this study generally recommends public policy makers that VC investment remains a crucial resource which can lead USOs to superior firm performance and therefore promote the growth of a knowledge based economy. However, public policy makers need to be aware that the availability of sufficient VC investment to USOs should take into account demand and supply side issues.

From a VC supply side perspective, public policy makers should continue to implement public backed equity schemes in order to avoid an equity gap on the financing market. USOs which attracted public backed equity investment were more likely to continue to take-up first VC investment of less than £500,000. However, in spite of the public backed equity schemes USOs with radical innovation were less likely to attract VC investment from general VC firms. This finding shows policy makers that USOs at the forefront of innovation depend on the supply of specialised VC investment or public backed funding schemes to satisfy their financial needs. Moreover, public policy makers are strongly advised to review not only whether public backed equity schemes increase the supply of first VC investment for USOs, but also whether these funding schemes relate to superior firm performance. Findings in this study show that USOs which received public backed equity investment performed poorly related to launching products to the market place and absolute employment change. Moreover, this poor performance was also observed for USOs which attracted first VC investment. Consequently, public policy makers are recommended to review due diligence processes and business expertise provided by public backed equity investors in order to improve the investment and market readiness of USOs.

The criticism that public backed equity funds can fail to lead USOs towards superior firm performance leads to recommendations on how public policy makers can address the demand side perspective on VC investment (i.e. academic entrepreneurs, universities and their TTOs). The presented evidence in this study on what resources USO require to send signals of quality to VC investors can be used to review national and regional public policy schemes promoting the start and development of USOs and leading them towards investment readiness. Public policy makers can also have an important role helping to build networks between academic entrepreneurs, universities TTOs and VC investors. This study showed that once such links were established and maintained the attraction of VC investment is less likely to be influenced by region or clusters. Notably, this network effect is even effective for USOs from universities which are not based in regions with a strong presence of VC investment such as London and the South East. Further, USOs should be educated be prepared for the levels of equity demanded by VC investors or the extent to which they execute their managerial control in order to avoid conflicts of interest which can harm firm performance. Public policy makers should also take on the role of developing best practices for managing IP including patenting and ownership for reducing conflicts between all interest groups.

Finally, the resource-based perspective of this study offers an important step towards developing benchmarking and diagnostic tools to study the development of USOs, their ability to attract first VC investment and their performance in light of this investment. Accordingly, public policy makers are strongly recommended to adopt a firm level perspective on assessing the performance of USOs rather than relying on studies only reporting the quantity of USOs launched from UK universities (Sainsbury, 2007). Further, they should facilitate access to firm level information on USOs for academic researchers to generate further valuable insights. Accordingly, efforts to improve data sources collecting firm and founder level data along with accurately identifying the population of USOs are urgently required.

6.5 Limitations and Future Research

This study has used a quantitative methodology to explore what internal factors of USOs were related to attracting first VC investment as well as superior firm performance in light of this investment. Although this approach was able to reduce gaps in the knowledge base and produce novel findings, possible limitations are discussed in this section. Furthermore, recommendations are made for fruitful areas of future research.

In choosing a quantitative approach, established theories were replicated, integrated and extended in order to derive and test hypotheses. Accordingly, phenomena which lie outside the identified theoretical lenses cannot be captured. However, in reviewing available qualitative studies on VC financing and firm performance of USOs this study ensured that the replicated and extended theoretical perspectives were best suited to capture the phenomena of interest.

Limitations due to measurement errors and biases relate to the collection of secondary and primary data. Data on USOs' initial resource endowments were solely collected from the demand-side. However, the supply-side perspective in incorporating an array of studies identifying prominent criteria in VC decision-making. Because the VC investors themselves who invested in the USOs in the sample were not individually identifiable, more specific investment criteria were not possible to explore. However, this study was able to ensure the accuracy and relevance of the collected primary data with the

obtained secondary data from Library House which was the most reputable data base at the time providing information on USOs specifically to VC investors.

Secondary data obtained from Library House was used to identify the population of USOs which were founded between 1990 and 2007, and still active in 2008. This data could only be accessed due to an individually negotiated agreement. Public sources were not available to provide firm level information. Interestingly, all public sources exclusively cited the obtained data from Library House as the most reliable source to identify firm level information on British USOs (Sainsbury, 2007). Obtaining this data has been the central obstacle for this research. In overcoming this obstacle, it was possible to conduct the first quantitative and cross-sectional study on British USOs using firm as well as founder specific data.

Given the relatively small population of 505 British USOs which were founded between 1990 and 2007 as well as still active in 2008, the sample size of 125 is modest. The response rate of 25% is in line with comparable studies. Extensive response bias tests ensure sufficient representativeness in order to generalise the presented findings as reported in Section 3.3.3.1. Nevertheless, future studies on British USOs should aim for larger sample sizes as the overall population of USOs further increases.

The accuracy of the collected primary data highly depends on the recollection ability of the identified and successfully contacted key informant. Only founding academic entrepreneurs of USOs were contacted to participate on in the questionnaire in this study in order to minimise measurement errors and response biases. However, information on founding teams was inferred from the key informant rather than other members of the founding team. Where possible, information from primary data was compared with available secondary data to reduce measurement errors and minimise a common methods bias.

The design of the questionnaire was instrumental in reducing possible limitations from selective recall-biases, measurement errors and to facilitate straight forward responses by the key informants to achieve a high response rate. Previous pilot interviews and pilot study ensured content and face validity as reported in Section 3.3.3. Further, questions were limited and mostly asked in closed format. As a result most of the collected data was operationalised using categorical variables. Because this study was the first of its kind to test hypotheses using cross-sectional data on a firm and founder level, categorical variables

facilitate the interpretation of novel findings. This limitation was also taken into account in order to use measures which can be easier replicated and extended in future research. In addition, multi-item scales were used for measuring the specific human capital of the founding team as well as for determining radicalness of innovation. Both scales were replicated and applied for the first time in the context of USOs and should be further developed.

The findings, implications and limitations of this study also raise potentially interesting avenues for future research. The novel theoretical framework of the RBV of the firm and signalling theory and its derived hypotheses should be replicated in future studies. Replication is crucial for theory development as it requires a feedback loop in order to verify earlier findings (Whetten, 1989). Apart from its application in the context of USOs, this framework can be generally applied and extended to others markets of entrepreneurial finance and types of firms.

Because this study on VC financing and firm performance of British USOs is the first to use a quantitative approach, measures operationalised for independent, dependent and control variables should be further replicated, extended and refined in future studies to improve their validity. In particular novel multi-item scales like the nature and extent of radical innovation should be further developed. For instance, more research is required to analyse the relationship between radical innovation of new firms, their ability to attract external investment such as VC finance and subsequent performance. Future studies on innovation should also take closer into account R&D input and output measures. Two examples of related research questions are does radical innovation influence the take-up of VC finance and firm performance of high-technology start-ups and USOs?, and does R&D input increase firm performance?

Future studies can also add further dependent variables measuring productivity of new firms in order to complement the firm performance measures used in this study. Furthermore, firm performance measures should also be monitored over time. Longitudinal studies ensure that adaptation processes of new firms can be better monitored and related to performance outputs. Longitudinal studies are also helpful to establish causal links rather than on associations between initial resources of new firms, their ability to attract VC investment and relationship with superior firm performance. For instance, the firms in the dataset for this study should be continued to be monitored over the next years to generate

the first panel data study on USO firm performance in the UK. Moreover, studies on the likelihood of survival, IPOs and M&As can be added to the insights of the present study and reduce a survivor bias. This panel data would also be ideal to consider longitudinal impacts from external factors such as the credit crunch and the recent recession and their influence on USO firm performance. Future studies can also strengthen the causality of observed relationships in using control groups (e.g. USOs and other high-technology ventures). Accordingly, research question like do USOs and other high-technology start-ups suffer from a liability of newness?, and does VC financing reduce liability of newness for USOs and other high-technology start-ups?, could be explored.

In addition, qualitative studies can also be important to further explore new insights on USOs, their VC financing and performance. For instance, case studies should be conducted to explore the paths of development which the few USOs and their founders undertook that successfully achieved IPOs. Further, exploratory studies could relate to the experience of founding teams of USOs and their experience of working with VC investors. Qualitative research should be also undertaken to explore heterogeneity of VC investors. For instance, comparative case studies on generalist and specialist VC firms could provide further insights how their decision making is structured and what factors determine their portfolio of investees. Related examples of research questions are what does it take to float an USO on the stock market?, what differences between generalist and specialist VC decision making?, or how to founding teams cope with the presence of VC investors?, could be explored.

The evidence provided in this study can also encourage theory development in areas of behavioural economics and psychology. The finding that resources of new ventures which VC investors often frame as important investment criteria and signals of quality fail to deliver superior firm performance demands for further research. Related studies could utilise an array of methods including experimental, field-studies, focus groups or interviews in order to investigate reasons for this mismatch in VC decision making. Accordingly, research questions such as are VC investors overconfident? or do VC investors have an availability bias in their decision making?, could be explored.

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Appendix

Appendix 1: Online Survey

Durham University Nationwide Survey of Academic Entrepreneurs

Instructions

This survey addresses you as the founder of the company identified in your invitation. This company is herein referred to as 'your company'.

We hope to obtain a comprehensive picture of the activities of UK academic entrepreneurs. We ask you, therefore, to try to answer all the questions. Please do so even if you are no longer involved in the company, regardless of the reason.

All information that you provide will be treated **anonymously** and only reported in the aggregate.

Thank you for your participation.

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Durham University Nationwide Survey of Academic Entrepreneurs

Information about yourself, the founding entrepreneur

What was your highest academic degree at the time of founding your company?

◯ Bachelor ◯ Masters ◯ PhD

Other (please specify)

Your year of birth:

Your nationality:

Had you managed a research group in a university before founding your company?

◯ Yes ◯ No

How many refereed publications did you have before founding your company?

	Yes, full-time	Yes, part-time	No
Had you worked in business before founding your company?	◯	◯	◯
Did you continue working as an academic after founding your company?	◯	◯	◯
Are you working as an academic today?	◯	◯	◯
Are you working for your company today?	◯	◯	◯

Did you found your company alone or did you have co-founders?

◯ Alone ◯ Co-founders

17% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Information about your company's co-founders

How many people founded your company including yourself?

	Yes	No
Did any of your co-founders have previous business experience?	◯	◯
Had any of them previously founded a company?	◯	◯

Please indicate how much you agree with the following statements concerning your founding team.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
At least one member of the team had founded a successful company before.	◯	◯	◯	◯	◯
We expected our team would be credible to potential investors.	◯	◯	◯	◯	◯
A trusted third party believed our team could successfully start a company.	◯	◯	◯	◯	◯
We thought that our team's experience would be attractive to potential investors.	◯	◯	◯	◯	◯

25% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Skip logic other companies

How many other companies have you founded (including this one)?

Did you found other companies before this one?

◯ Yes ◯ No

30% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Entrepreneurial Decision Making

Indicate how much you agree with the following phrases that complete this sentence:

As an entrepreneur, I ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... enjoy making my own decisions.	◯	◯	◯	◯	◯
... would rather be a leader than a follower.	◯	◯	◯	◯	◯
... prefer to run my own business, even if this means I have to accept more risk.	◯	◯	◯	◯	◯
... would rather receive orders than give them.	◯	◯	◯	◯	◯
... try to avoid situations where someone else tells me what to do.	◯	◯	◯	◯	◯

45% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Status of your company

What is the status of your company?

- ◯ It is still in business
- ◯ It was merged or acquired
- ◯ It is out of business because it was not viable
- ◯ It is out of business because of other reasons

55% completed

Durham University Nationwide Survey of Academic Entrepreneurs

In business - Did you ever apply for an equity investment?

Please indicate how much you agree with the following statements concerning your experience as an entrepreneur.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The high failure rate of new companies made me hesitate before starting my own.	◯	◯	◯	◯	◯
My academic career could insure me against the failure of my company.	◯	◯	◯	◯	◯
Being an entrepreneur could put my academic career at risk.	◯	◯	◯	◯	◯
Being an entrepreneur could impose high personal financial risks on me.	◯	◯	◯	◯	◯
I would face greater risks than a manager employed by a company.	◯	◯	◯	◯	◯
As an entrepreneur I have found that focusing on day to day business activities is necessary to keep my company going.	◯	◯	◯	◯	◯

Have you ever had contact with an outside equity investor, such as a business angel, a venture capitalist or a public equity fund, regarding an investment in your company?

◯ Yes ◯ No

65% completed

Durham University Nationwide Survey of Academic Entrepreneurs

In business - Do you have an equity investor?

Based on your experience as an entrepreneur, please complete the following phrases on the influences of an outside equity investor in a company:

If I had to share ownership with an outside equity investor, I would...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... reduce the risk of running my business.	◯	◯	◯	◯	◯
... prefer to share control rather than taking all the risk myself.	◯	◯	◯	◯	◯
... receive help to run my company.	◯	◯	◯	◯	◯
... rather give orders than receive them from the investor.	◯	◯	◯	◯	◯
... find it difficult to share ownership and control.	◯	◯	◯	◯	◯
... take greater risks.	◯	◯	◯	◯	◯
... improve my company's competitive advantage.	◯	◯	◯	◯	◯
... improve the long-term viability of my company.	◯	◯	◯	◯	◯

Has your company ever received funding from an outside equity investor such as a business angel, a venture capitalist or a public equity fund?

◯ Yes ◯ No

75% completed

Durham University Nationwide Survey of Academic Entrepreneurs

In business - with equity investor

How many grants and awards did your company obtain before receiving funding from an outside equity investor?

How many patents were held by your company before receiving funding from an outside equity investor?

How many members are on your company's board of directors?

How many of them were appointed by your investors?

How many of them were appointed by your university?

Are you, or have you been the CEO of your company?

◯ Yes ◯ No

Yes, but I stopped being the CEO in (please insert year):

Are you currently on the board of directors of your company?

◯ Yes ◯ No

How many venture capitalists made a formal offer to invest in your company?

How many venture capitalists have invested in your company?

Which of the following helped you in attracting outside equity investors?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
My university's reputation	◯	◯	◯	◯	◯
My company's business idea	◯	◯	◯	◯	◯
My personal academic reputation	◯	◯	◯	◯	◯
My personal contacts and networks	◯	◯	◯	◯	◯
My company's industry	◯	◯	◯	◯	◯

85% completed

Durham University Nationwide Survey of Academic Entrepreneurs

with equity - Part 2

Who owns the intellectual property (IP) in your company? (check all that apply)

☐ Founders ☐ Company ☐ University

Other (please specify)

Please provide the distribution of equity ownership in your company at two different times.

Time 1: Immediately after your company first received outside equity investment.

Time 2: The current distribution.

Please indicate the distribution of equity ownership by rounding up to the nearest 1%:

	Time 1	Time 2
Your share:		
Management:		
University:		
Other companies:		
Venture capitalists:		
Business angels:		
Public funds:		
Hybrid public and private equity funds:		
IPO (public shares):		
Other:		

In case you chose "other" ownership, please specify:

95% completed

Durham University Nationwide Survey of Academic Entrepreneurs

In business - no equity investor

How many grants and awards has your company obtained until today?

How many patents are currently held by your company?

How many members are on your company's board of directors?

How many of them were appointed by your university?

Are you, or have you been the CEO of your company?

◯ Yes ◯ No

Yes, but I stopped being the CEO in (please insert year):

Are you currently on the board of directors of your company?

◯ Yes ◯ No

How many venture capitalists made a formal offer to invest in your company?

Who owns the intellectual property (IP) in your company (check all that apply)?

☐ Founders ☐ Company ☐ University

Other (please specify)

Please provide the current distribution of equity ownership in your company.

Please indicate the distribution of equity ownership by rounding up to the nearest 1%:

Your share:	
Management:	
University:	
Other:	

In case you chose "other" ownership, please specify:

Durham University Nationwide Survey of Academic Entrepreneurs

Merged or acquired - Did you ever apply for an equity investment?

Please indicate how much you agree with the following statements concerning your experience as an entrepreneur.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The high failure rate of new companies made me hesitate before starting my own.	◯	◯	◯	◯	◯
My academic career insured me against the failure of my company.	◯	◯	◯	◯	◯
Being an entrepreneur put my academic career at risk.	◯	◯	◯	◯	◯
Being an entrepreneur imposed high personal financial risks on me.	◯	◯	◯	◯	◯
I faced greater risks than a manager employed by a company.	◯	◯	◯	◯	◯
As an entrepreneur I found that focusing on day to day business activities is necessary to keep my company going.	◯	◯	◯	◯	◯

Before your company was merged or acquired, did you have contact with a business angel, a venture capitalist or a public equity fund regarding an investment in your company?

◯ Yes ◯ No

65% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Merged or acquired - Did you have an equity investor?

Based on your experience as an entrepreneur, please complete the following phrases on the influences of an outside equity investor in a company:

If I had to share ownership with an outside equity investor, I would...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... reduce the risk of running my business.	◯	◯	◯	◯	◯
... prefer to share control rather than taking all the risk myself.	◯	◯	◯	◯	◯
... receive help to run my company.	◯	◯	◯	◯	◯
... rather give orders than receive them from the investor.	◯	◯	◯	◯	◯
... find it difficult to share ownership and control.	◯	◯	◯	◯	◯
... take greater risks.	◯	◯	◯	◯	◯
... improve my company's competitive advantage.	◯	◯	◯	◯	◯
... improve the long-term viability of my company.	◯	◯	◯	◯	◯

Before your company was merged or acquired, did it ever receive funding from an outside equity investor, such as a business angel, a venture capitalist or a public equity fund?

◯ Yes ◯ No

75% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Merged or acquired - with equity

How many grants and awards did your company obtain before the first round of funding from an outside equity investor?

How many patents were held by your company before the first round of funding from an outside equity investor?

How many members did your company's board of directors have when it was merged or acquired?

How many of them were appointed by your investors when it was merged or acquired?

How many of them were appointed by your university when it was merged or acquired?

Were you the CEO of your company when it was merged or acquired?

◯ Yes ◯ No

Yes, but I stopped being the CEO in (please insert year):

Were you a member of your company's board of directors when it was merged or acquired?

◯ Yes ◯ No

How many venture capitalists made a formal offer to invest in your company when it was merged or acquired?

How many venture capitalists have invested in your company when it was merged or acquired?

Which of the following helped you in attracting outside equity investors?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
My university's reputation	◯	◯	◯	◯	◯
My company's business idea	◯	◯	◯	◯	◯
My personal academic reputation	◯	◯	◯	◯	◯
My personal contacts and networks	◯	◯	◯	◯	◯
My company's industry	◯	◯	◯	◯	◯

85% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Merged or acquired - with equity Part 2

Who owned the intellectual property (IP) in your company when it was merged or acquired? (check all that apply)

☐ Founders ☐ Company ☐ University

Other (please specify)

Please provide the distribution of equity ownership in your company at two different times.

Time 1: Immediately after your company first received outside equity investment.

Time 2: The distribution when it was merged or acquired.

Please indicate the distribution of equity ownership by rounding up to the nearest 1%:

	Time 1	Time 2
Your share:		
Management:		
University:		
Other companies:		
Venture capitalists:		
Business angels:		
Public funds:		
Hybrid public and private equity funds:		
IPO (public shares):		
Other:		

In case you chose "other" ownership, please specify:

95% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Merged or acquired - no equity

Please answer the following questions concerning the point in time when your company was merged or acquired.

How many grants and awards had your company obtained?

How many patents were held by your company?

How many members did your company's board of directors have?

How many of them were appointed by your university?

Were you the CEO of your company?

◯ Yes ◯ No

Yes, but I stopped being the CEO in (please insert year):

Were you on the board of directors of your company?

◯ Yes ◯ No

How many venture capitalists made a formal offer to invest in your company?

Who owned the intellectual property (IP) in your company? (check all that apply)

☐ Founders ☐ Company ☐ University

Other (please specify)

Please provide the distribution of equity ownership in your company when it was merged or acquired.

Please indicate the distribution of equity ownership by rounding up to the nearest 1%:

Your share:	
Management:	
University:	
Other companies:	
Other:	

In case you chose "other" ownership, please specify:

95% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Out of business - Did you ever apply for an equity investment?

Please indicate how much you agree with the following statements concerning your experience as an entrepreneur.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The high failure rate of new companies made me hesitate before starting my own.	◯	◯	◯	◯	◯
My academic career insured me against the failure of my company.	◯	◯	◯	◯	◯
Being an entrepreneur put my academic career at risk.	◯	◯	◯	◯	◯
Being an entrepreneur imposed high personal financial risks on me.	◯	◯	◯	◯	◯
I faced greater risks than a manager employed by a company.	◯	◯	◯	◯	◯
As an entrepreneur I found that focusing on day to day business activities is necessary to keep my company going.	◯	◯	◯	◯	◯

Before your company went out of business, did you have contact with a business angel, a venture capitalist or a public equity fund regarding an investment in your company?

◯ Yes ◯ No

65% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Out of business - Did you have an equity investor?

Based on your experience as an entrepreneur, please complete the following phrases on the influences of an outside equity investor in a company:

If I had to share ownership with an outside equity investor, I would...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... reduce the risk of running my business.	◯	◯	◯	◯	◯
... prefer to share control rather than taking all the risk myself.	◯	◯	◯	◯	◯
... receive help to run my company.	◯	◯	◯	◯	◯
... rather give orders than receive them from the investor.	◯	◯	◯	◯	◯
... find it difficult to share ownership and control.	◯	◯	◯	◯	◯
... take greater risks.	◯	◯	◯	◯	◯
... improve my company's competitive advantage.	◯	◯	◯	◯	◯
... improve the long-term viability of my company.	◯	◯	◯	◯	◯

Before your company went out of business, did it ever receive funding from an outside equity investor, such as a business angel, a venture capitalist, or a public equity fund?

◯ Yes ◯ No

75% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Out of business - with equity

How many grants and awards did your company obtain before the first round of funding from an outside equity investor?

How many patents were held by your company before the first round of funding from an outside equity investor?

How many members did your company's board of directors have when it went out of business?

How many of them were appointed by your investors when it went out of business?

How many of them were appointed by your university when it went out of business?

Were you the CEO of your company when it went out of business?

◯ Yes ◯ No

Yes, but I stopped being the CEO in (please insert year):

Were you a member of your company's board of directors when it went out of business?

◯ Yes ◯ No

How many venture capitalists made a formal offer to invest in your company when it went out of business?

How many venture capitalists have invested in your company when it went out of business?

Which of the following helped you in attracting outside equity investors?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
My university's reputation	◯	◯	◯	◯	◯
My company's business idea	◯	◯	◯	◯	◯
My personal academic reputation	◯	◯	◯	◯	◯
My personal contacts and networks	◯	◯	◯	◯	◯
My company's industry	◯	◯	◯	◯	◯

85% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Out of business - with equity - Part 2

Who owned the intellectual property (IP) in your company when it went out of business?(check all that apply)

☐ Founders ☐ Company ☐ University

Other (please specify)

Please provide the distribution of equity ownership in your company at two different times.

Time 1: Immediately after your company first received outside equity investment.

Time 2: The distribution when it went out of business.

Please indicate the distribution of equity ownership by rounding up to the nearest 1%:

	Time 1	Time 2
Your share:		
Management:		
University:		
Other companies:		
Venture capitalists:		
Business angels:		
Public funds:		
Hybrid public and private equity funds:		
IPO (public shares):		
Other:		

In case you chose "other" ownership, please specify:

95% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Out of business - no equity

Please answer the following questions concerning the point in time when your company went out of business.

How many grants and awards had your company obtained?

How many patents were held by your company?

How many members did your company's board of directors have?

How many of them were appointed by your university?

Were you the CEO of your company?

○ Yes ○ No

Yes, but I stopped being the CEO in (please insert year):

Were you on the board of directors of your company?

○ Yes ○ No

How many venture capitalists made a formal offer to invest in your company?

Who owned the intellectual property (IP) in your company? (check all that apply)

☐ Founders ☐ Company ☐ University

Other (please specify)

Please provide the distribution of equity ownership in your company when it went out of business.

Please indicate the distribution of equity ownership by rounding up to the nearest 1%:

Your share:	
Management:	
University:	
Other companies:	
Other:	

In case you chose "other" ownership, please specify:

95% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Open question

These final questions are optional. We would however appreciate any additional views you would like to share.

Please continue to the next page to close and submit the survey.

In your opinion, what are the main challenges academic entrepreneurs face in attracting funding?

In your opinion, what would make it more attractive for academics to start business ventures based on their research?

100% completed

Durham University Nationwide Survey of Academic Entrepreneurs

Thank you for your participation!

You have now completed the survey.

Thank your very much for your participation. We will send you a copy of our final report as soon as it is completed.

Cornelius Mueller
Professor Daniel Read
Dr Frits Wijbenga

Contact us at:

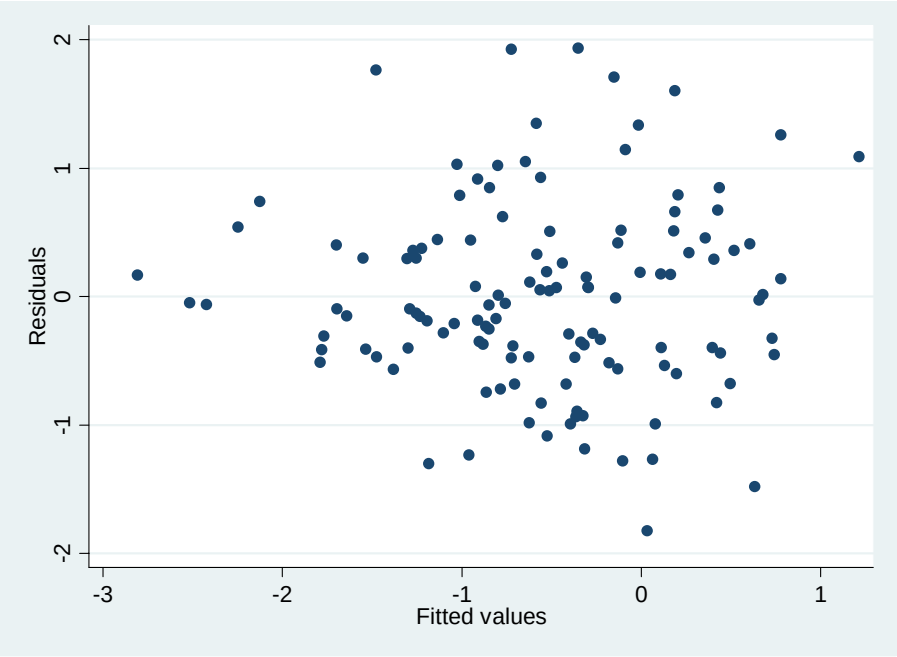
Email: c.m.f.mueller@durham.ac.uk
Phone: +44 (0)791 7152424

If you have any additional questions, comments or feedback please contact us directly or use the box below.

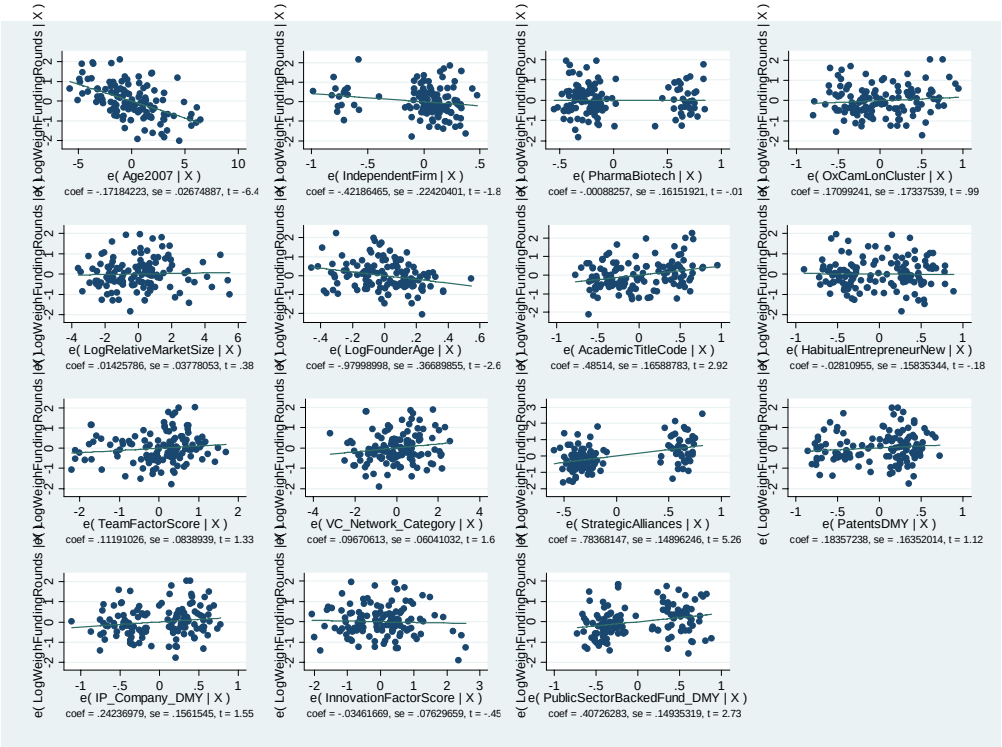
Appendix 2: Linearity Diagnostic Plots for OLS Analyses

2.1 Total Number of External Investment Rounds Attracted Until 2008

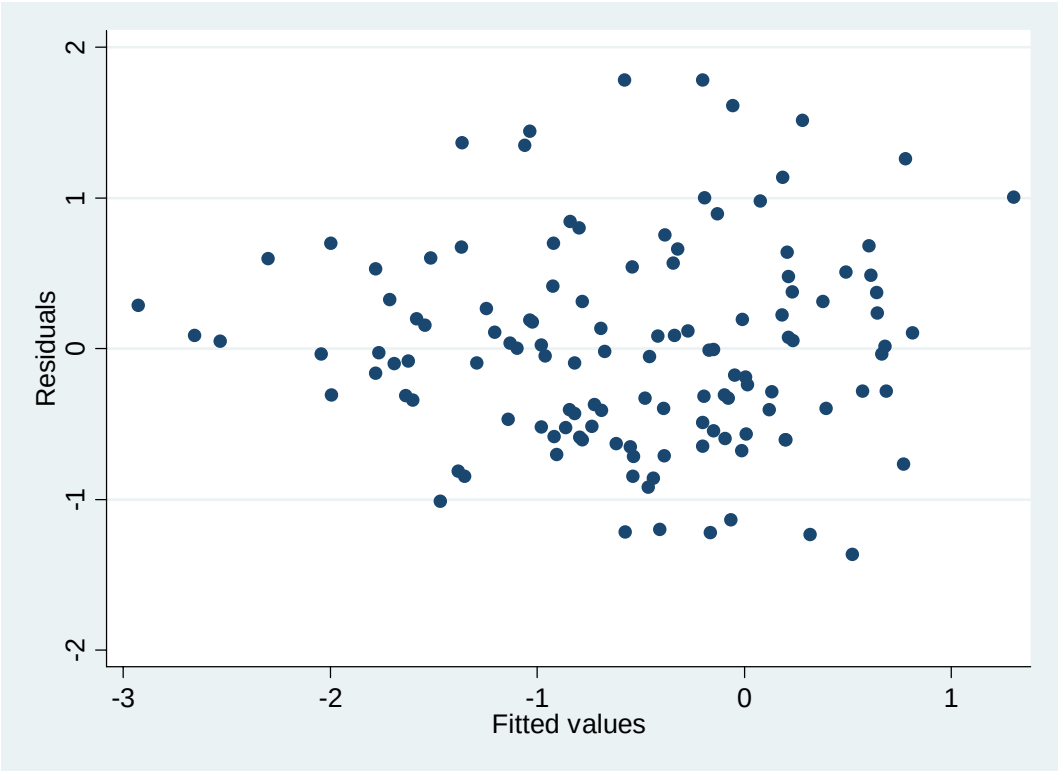
Graph 1: Residual vs. Predicted Values Plot for Model 9-6 (No VC)



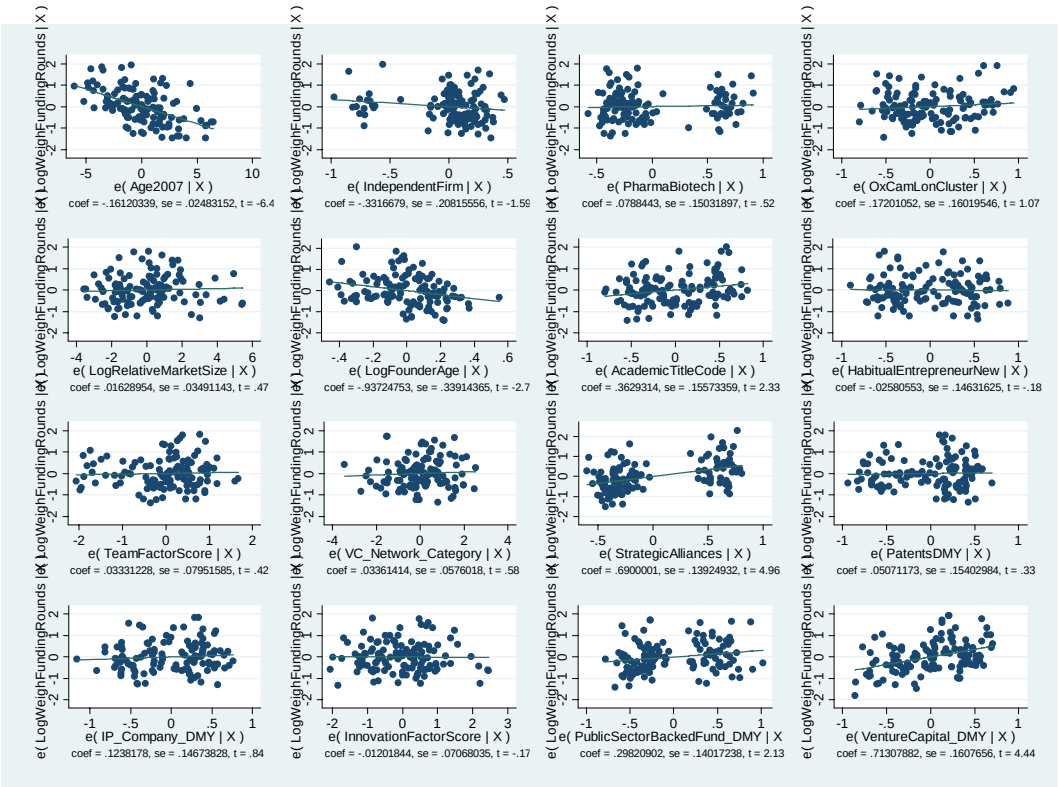
Graph 2: Added Variable Plots for Model 9-6 (No VC)



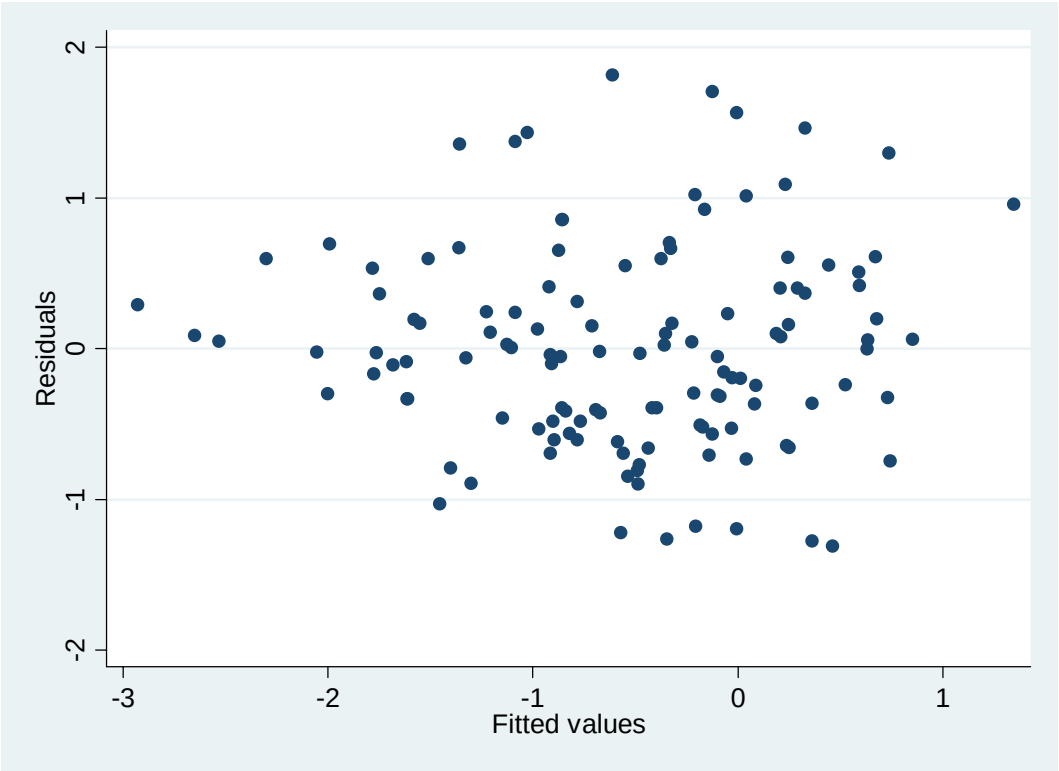
Graph 3: Residual vs. Predicted Values Plot for Model 9-8 (VC)



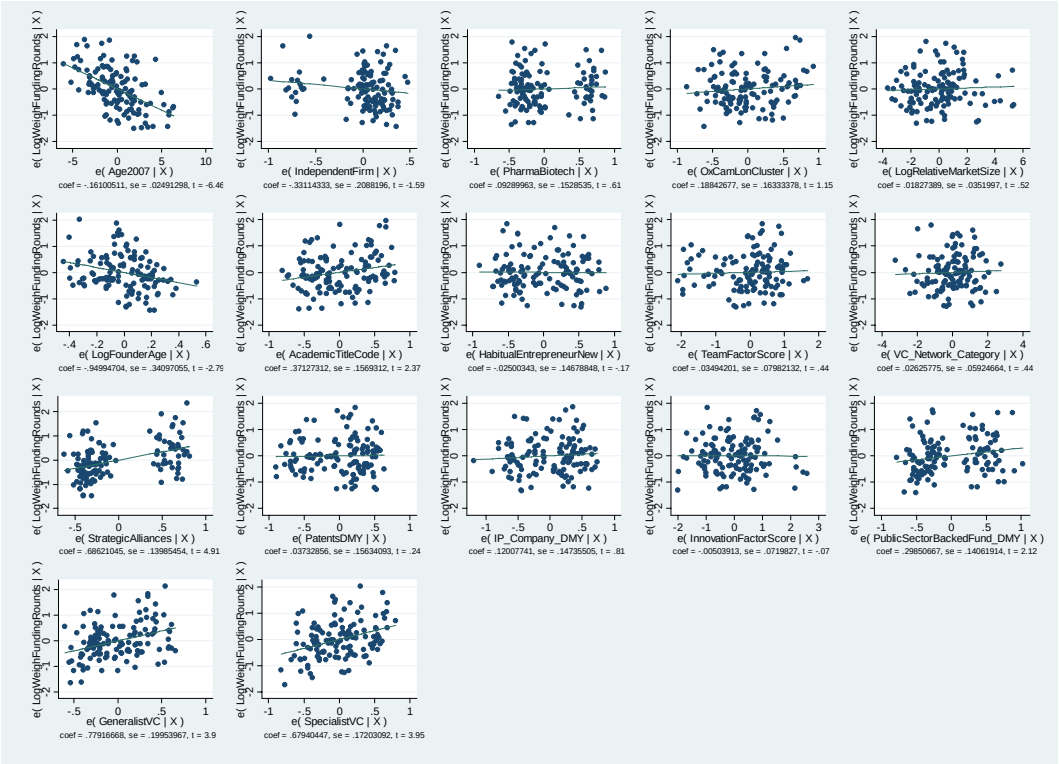
Graph 4: Added Variable Plots for Model 9-8 (VC)



Graph 5: Residual vs. Predicted Values Plot for Model 9-10 (Type VC)

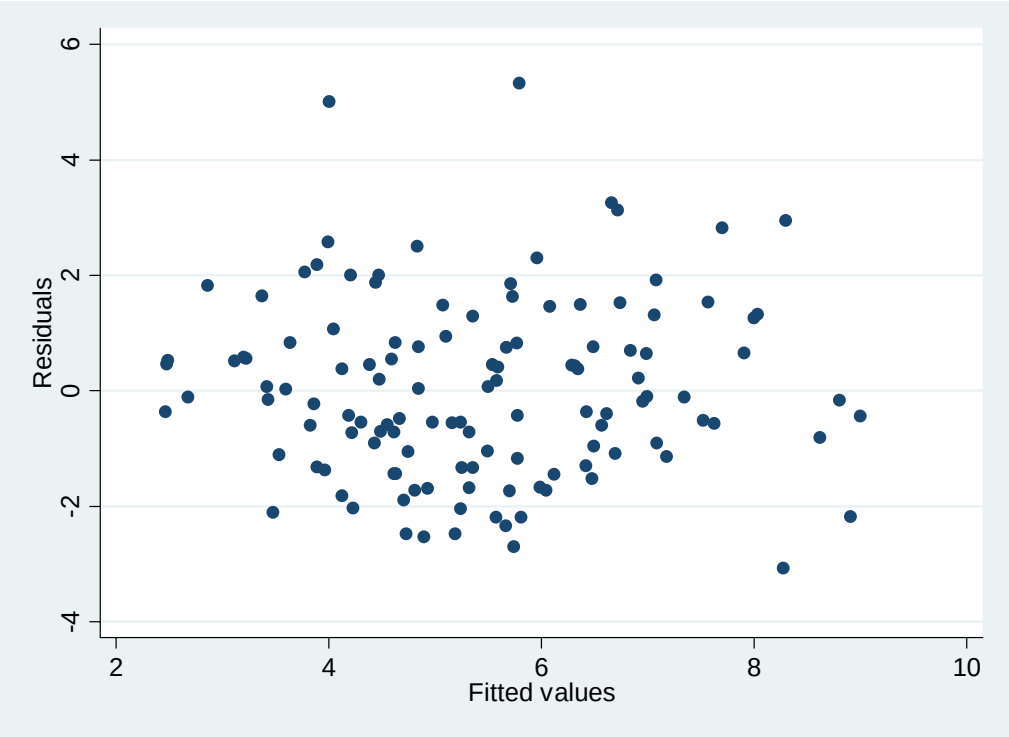


Graph 6: Added Variable Plots for Model 9-10 (Type VC)

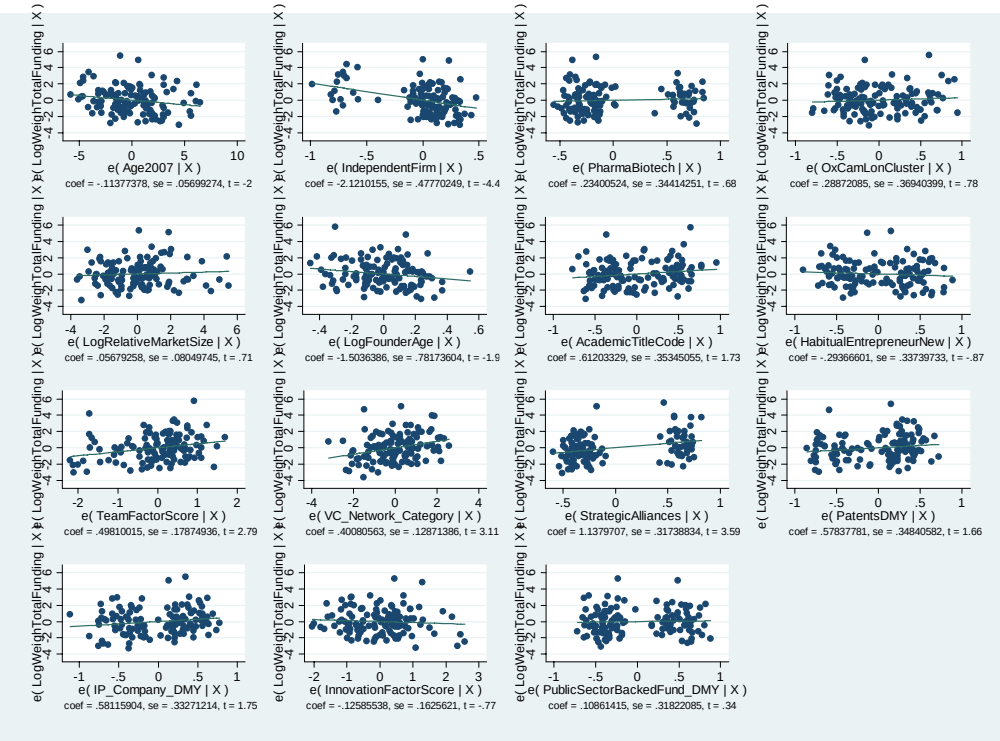


2.2 Total Amount of External Investment (£'s) Attracted Until 2008

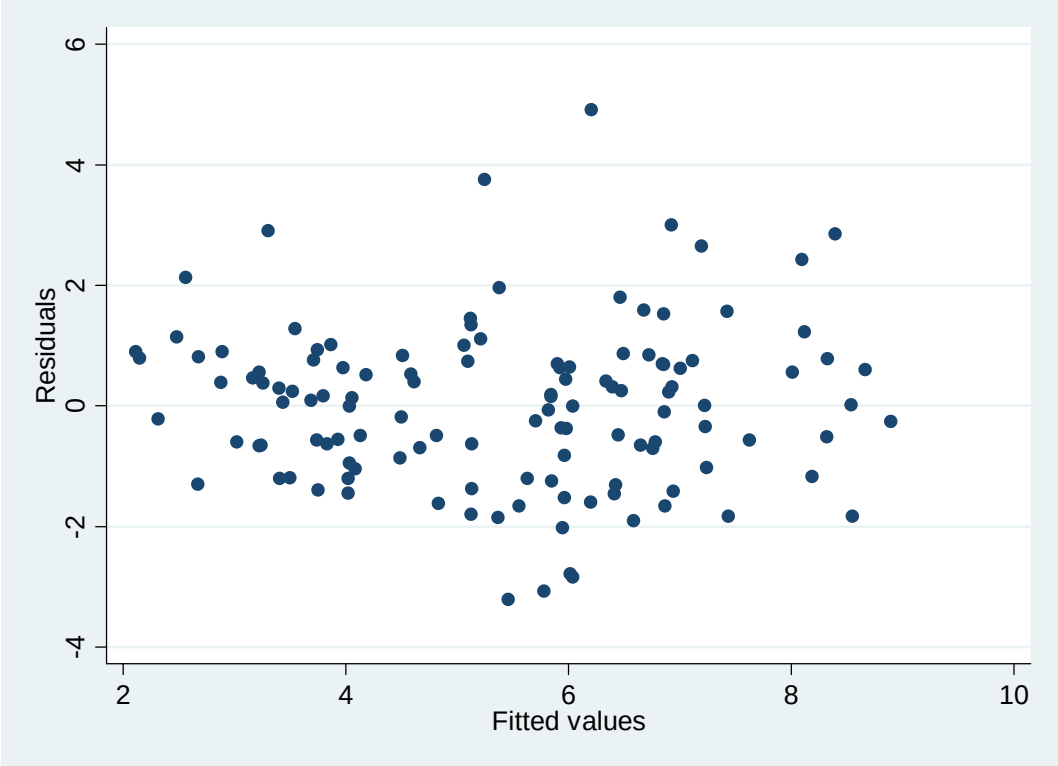
Graph 7: Residual vs. Predicted Values Plot for Model 10-6 (No VC)



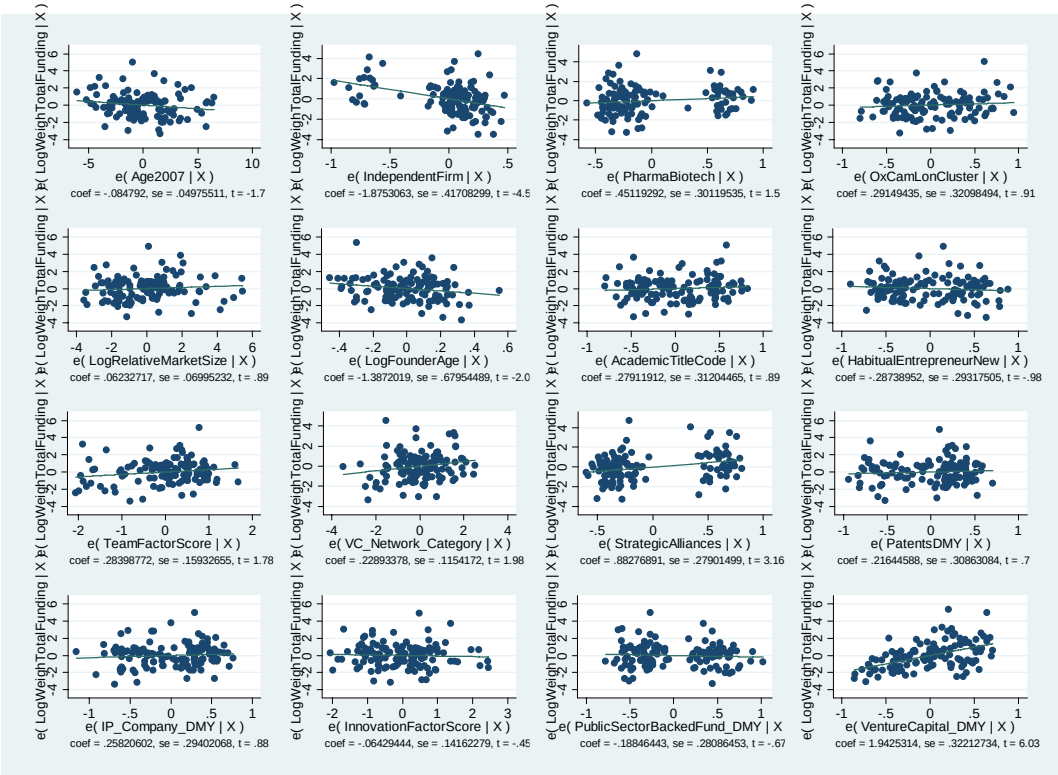
Graph 8: Added Variable Plots for Model 10-6 (No VC)



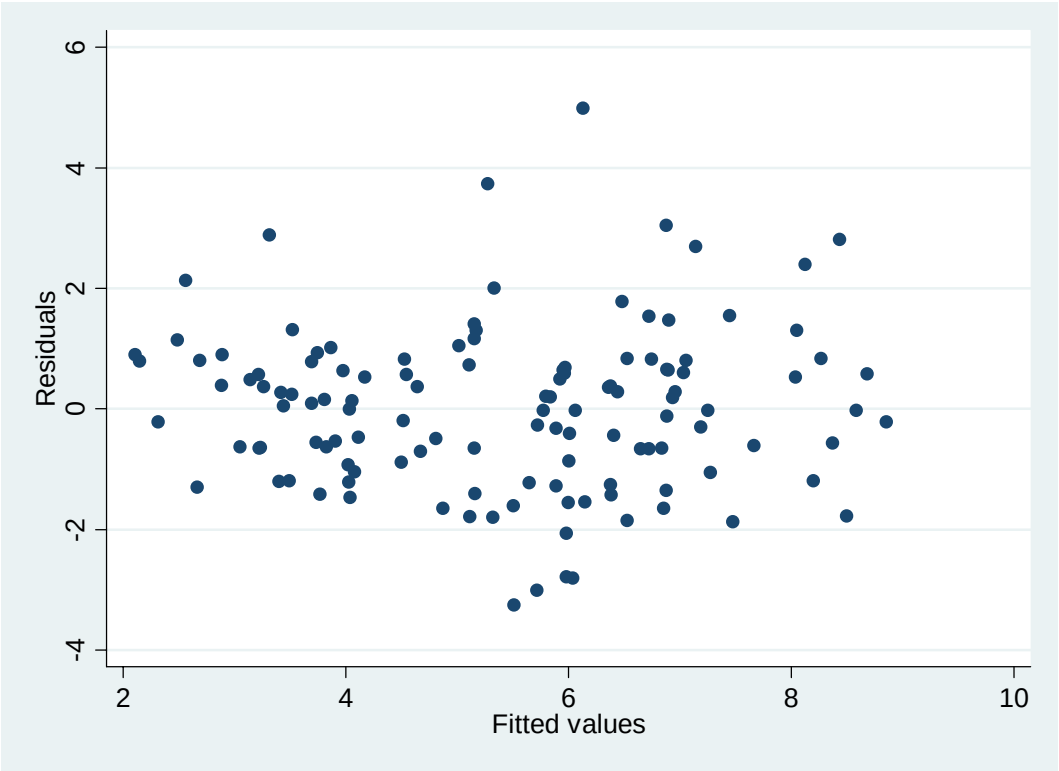
Graph 9: Residual vs. Predicted Values Plot for Model 10-8 (VC)



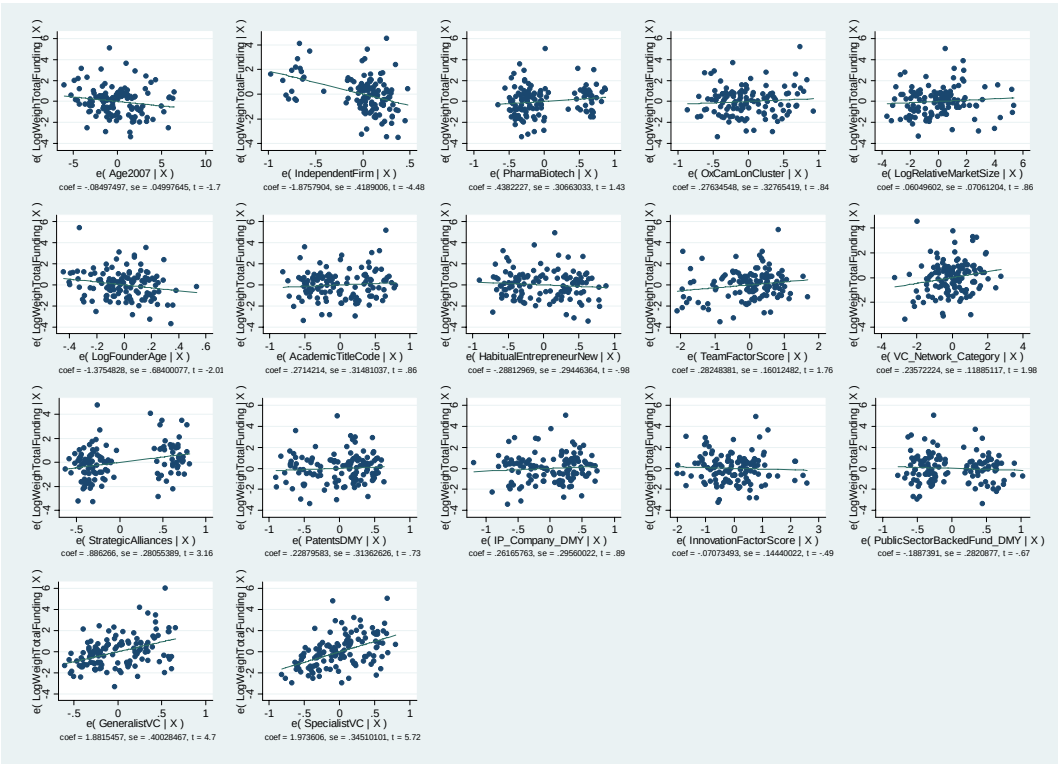
Graph 10: Added Variable Plots for Model 10-8 (VC)



Graph 11: Residual vs. Predicted Values Plot for Model 10-10 (Type VC)

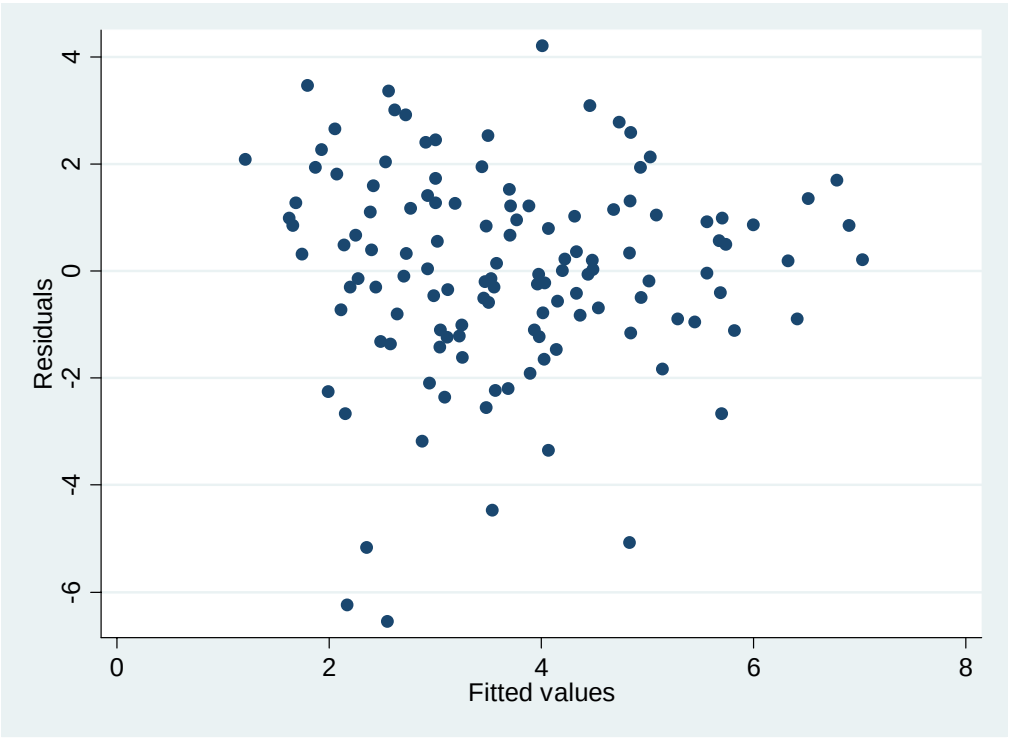


Graph 12: Added Variable Plots for Model 10-10 (Type VC)

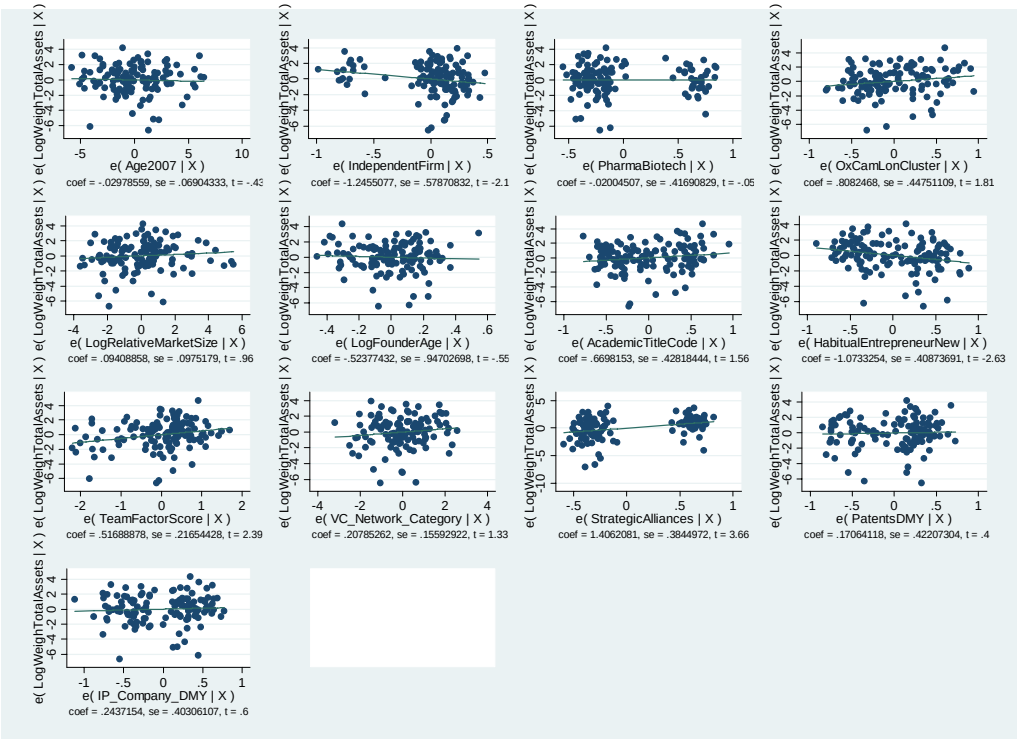


2.3 Book Value of Total Assets (£'s) Until 2008

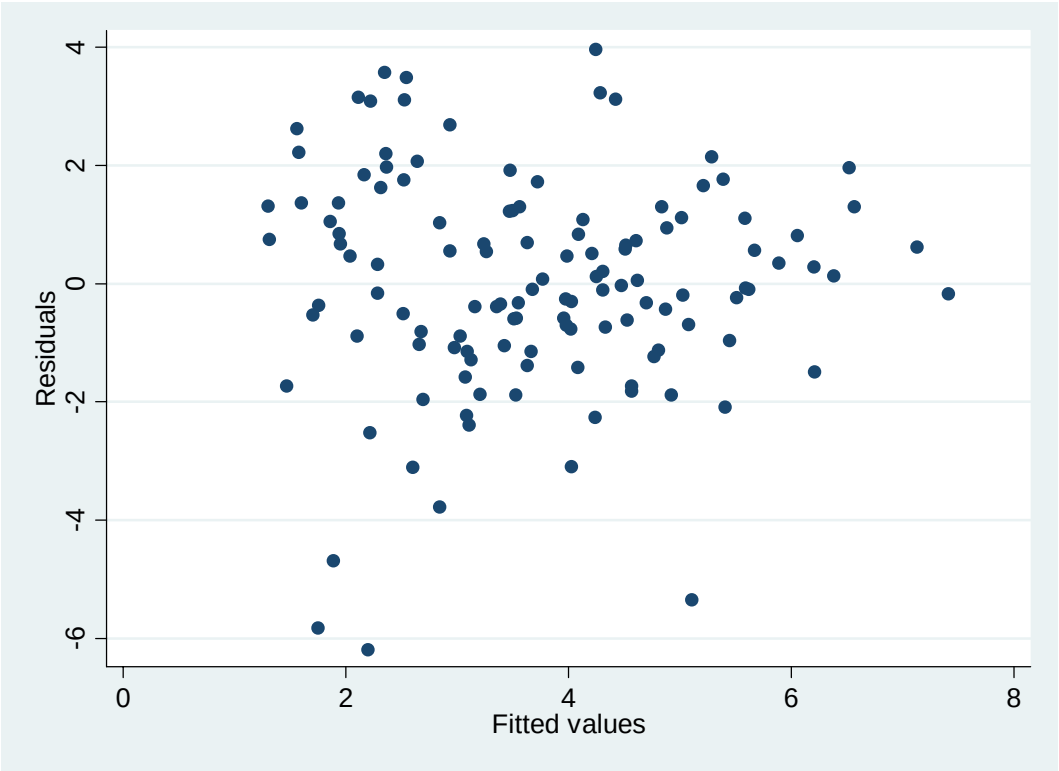
Graph 13: Residual vs. Predicted Values Plot for Model 12-6 (No VC)



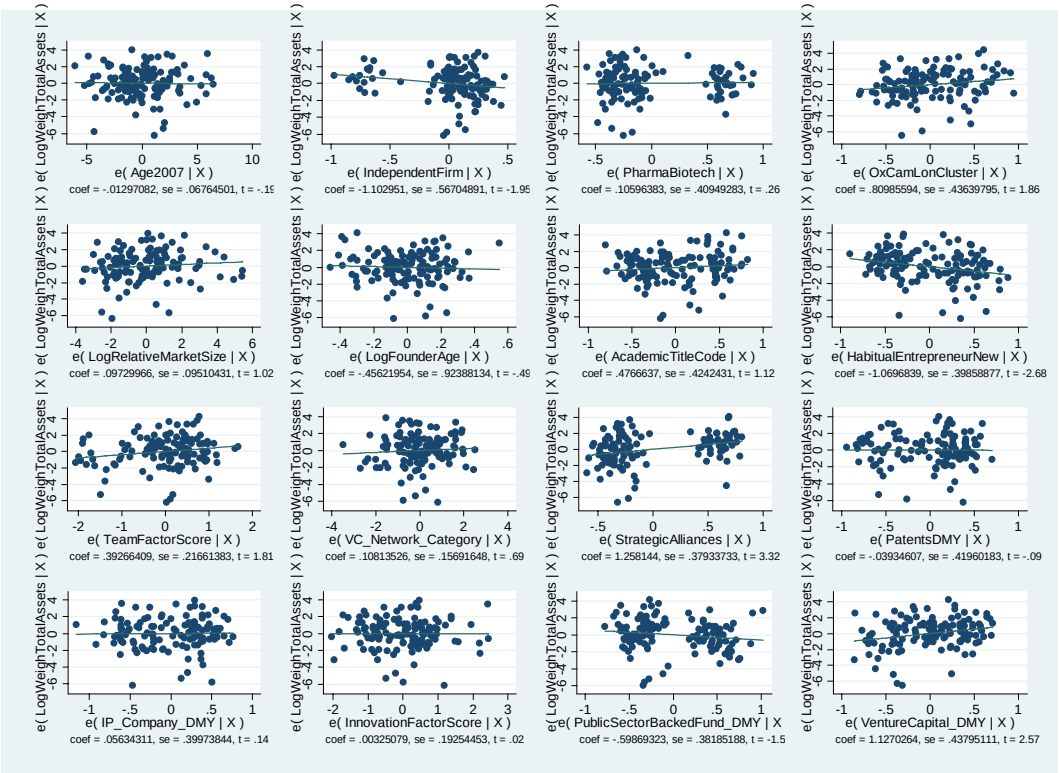
Graph 14: Added Variable Plots for Model 12-6 (No VC)



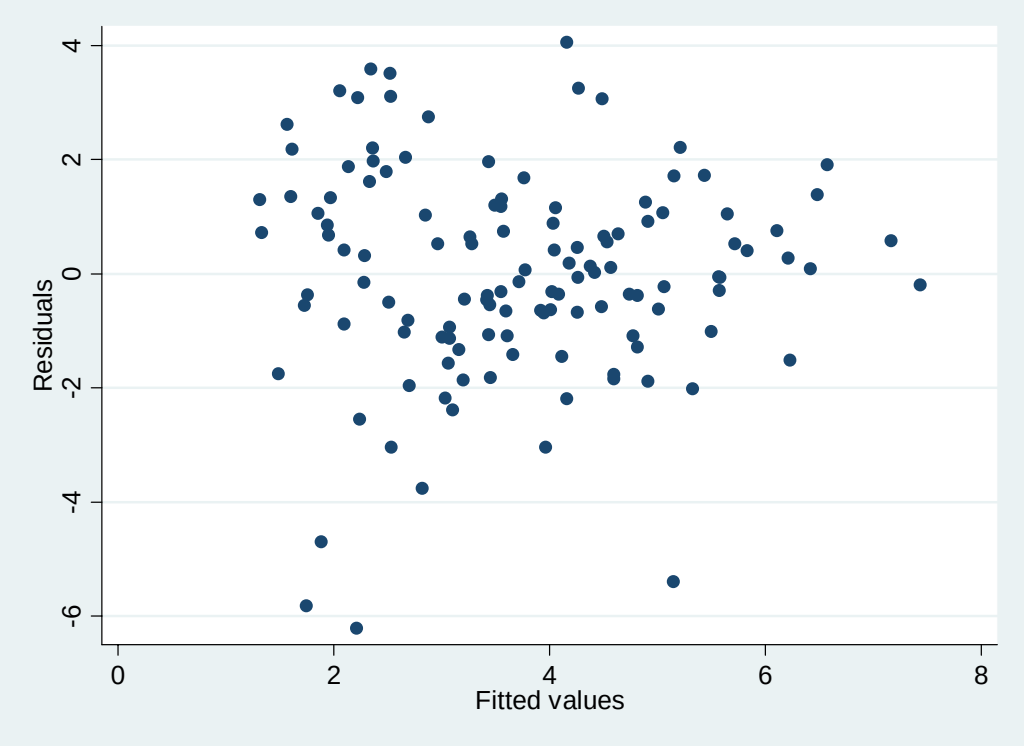
Graph 15: Residual vs. Predicted Values Plot for Model 12-8 (VC)



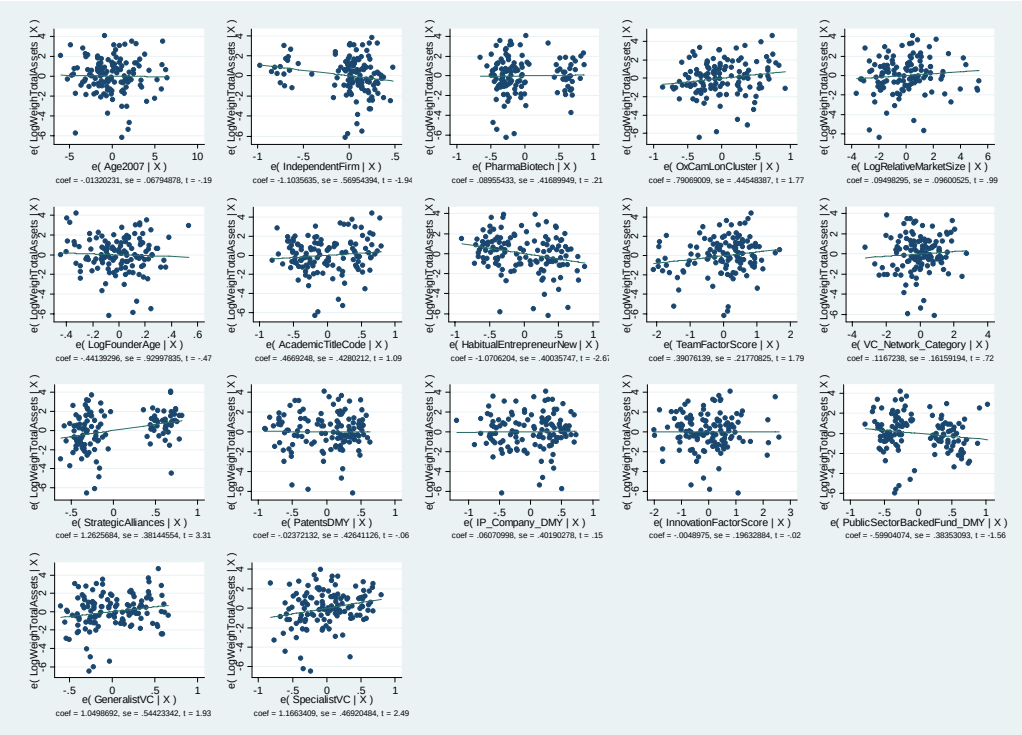
Graph 16: Added Variable Plots for Model 12-8 (VC)



Graph 17: Residual vs. Predicted Values Plot for Model 12-10 (Type VC)

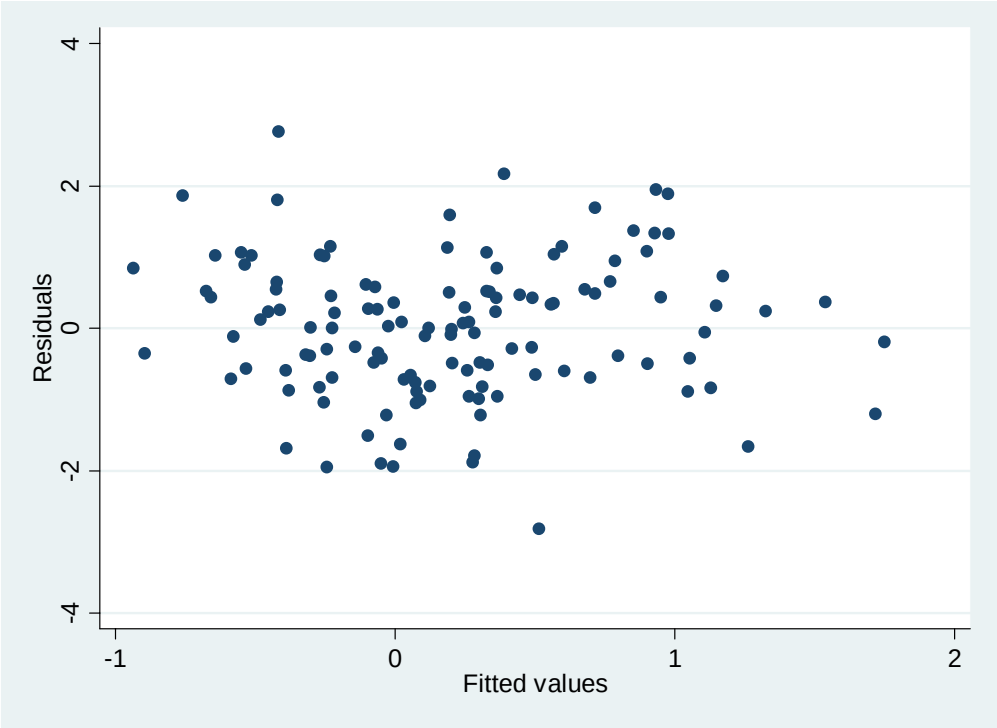


Graph 18: Added Variable Plots for Model 12-10 (Type VC)

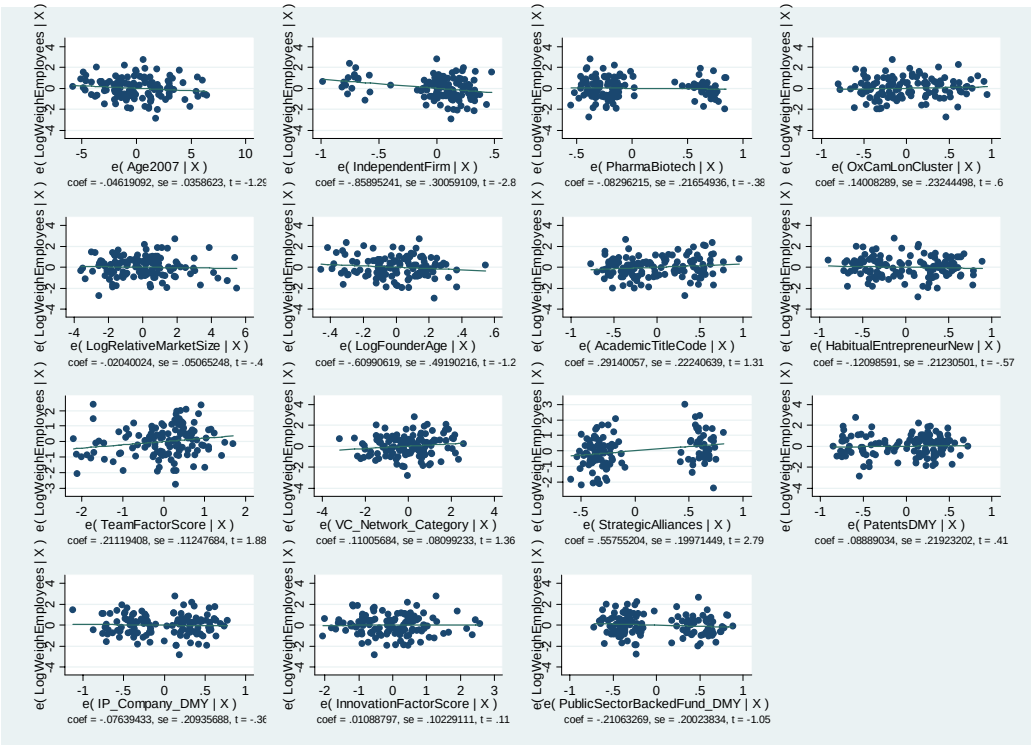


2.4 Number of Employees in the USOs in 2008

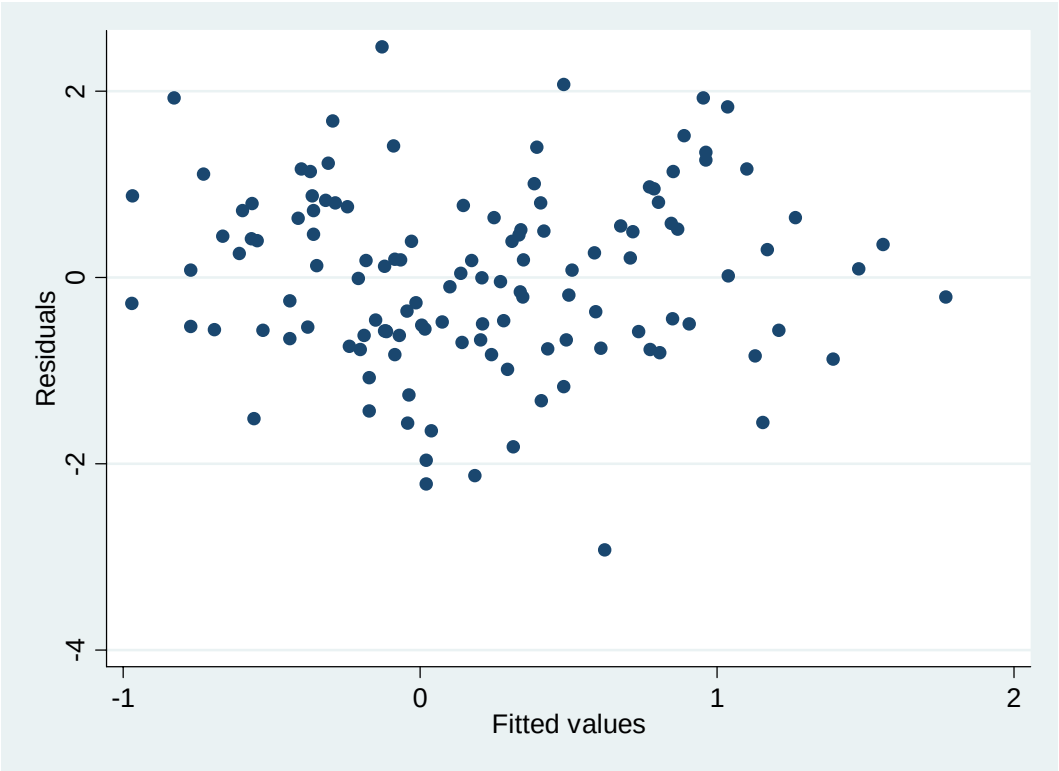
Graph 19: Residual vs. Predicted Values Plot for Model 13-6 (No VC)



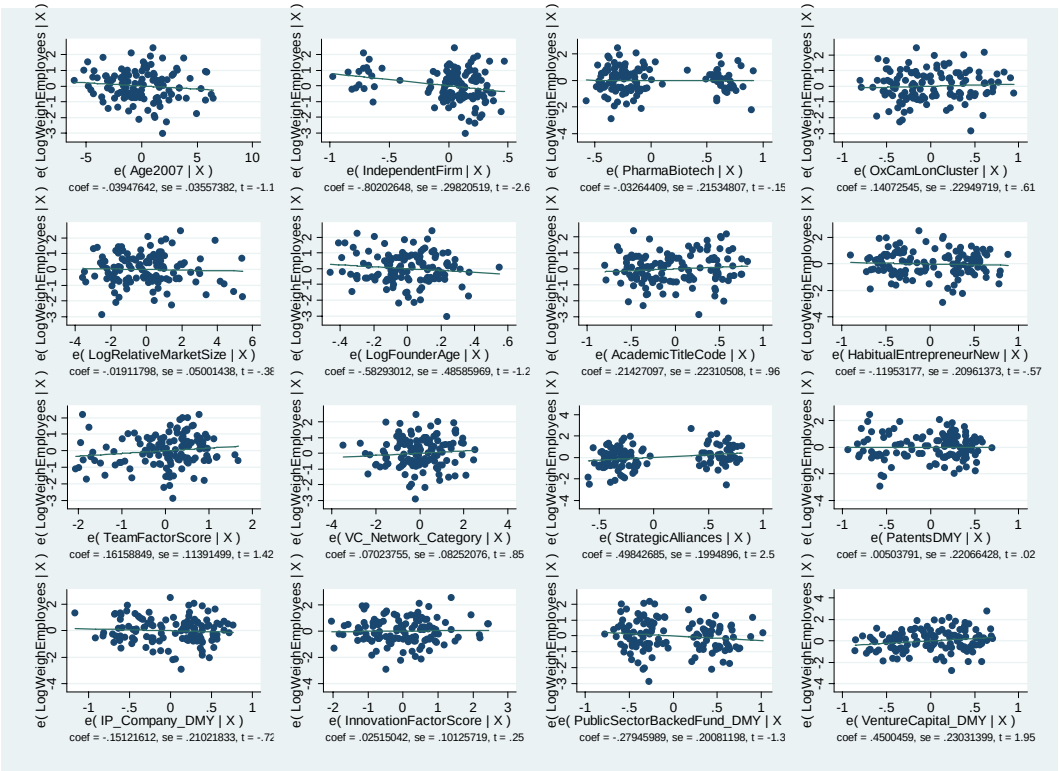
Graph 20: Added Variable Plots for Model 13-6 (No VC)



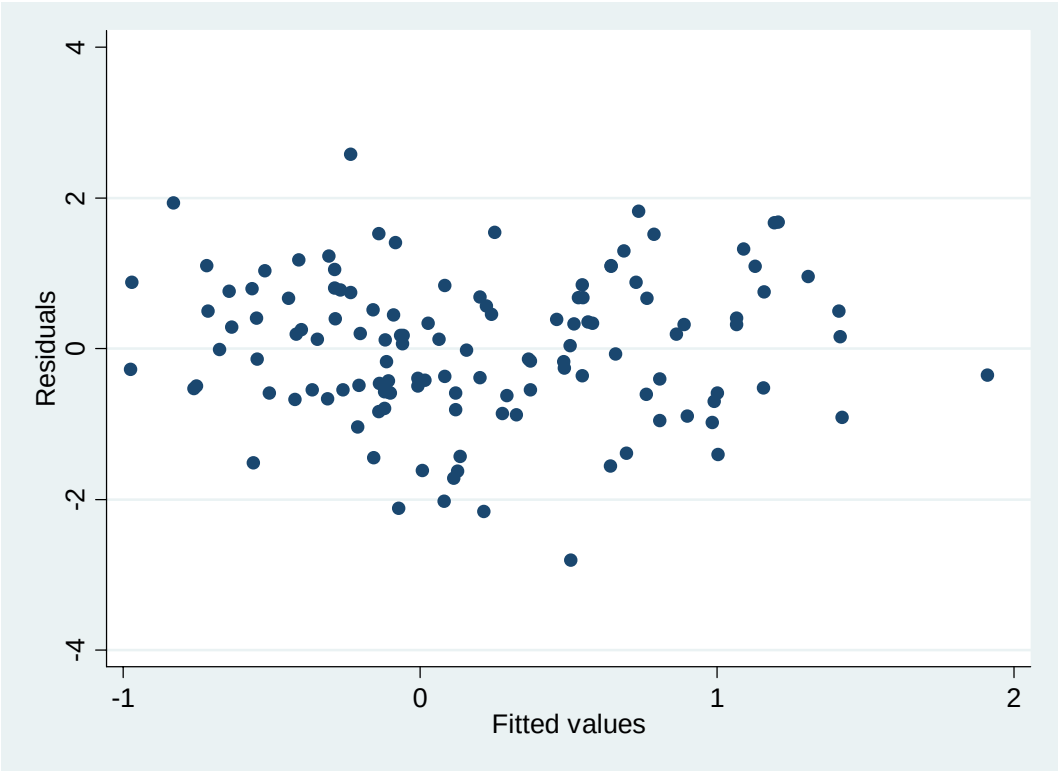
Graph 21: Residual vs. Predicted Values Plot for Model 13-8 (VC)



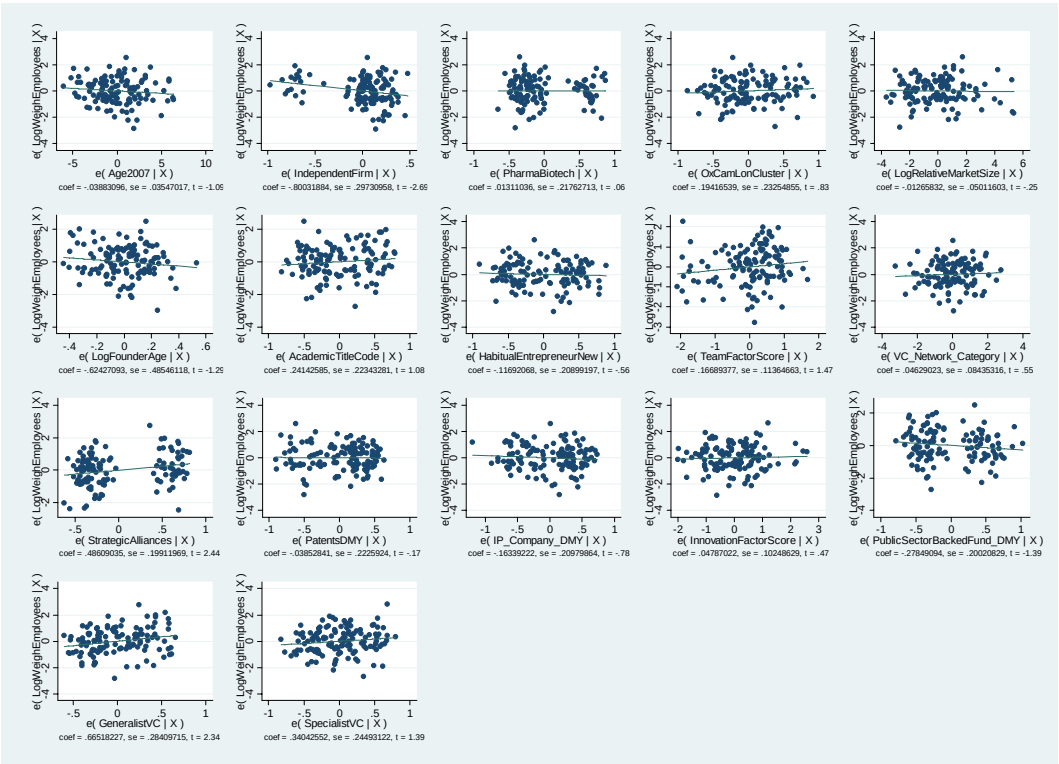
Graph 22: Added Variable Plots for Model for Model 13-8 (VC)



Graph 23: Residual vs. Predicted Values Plot for Model 13-10 (Type VC)

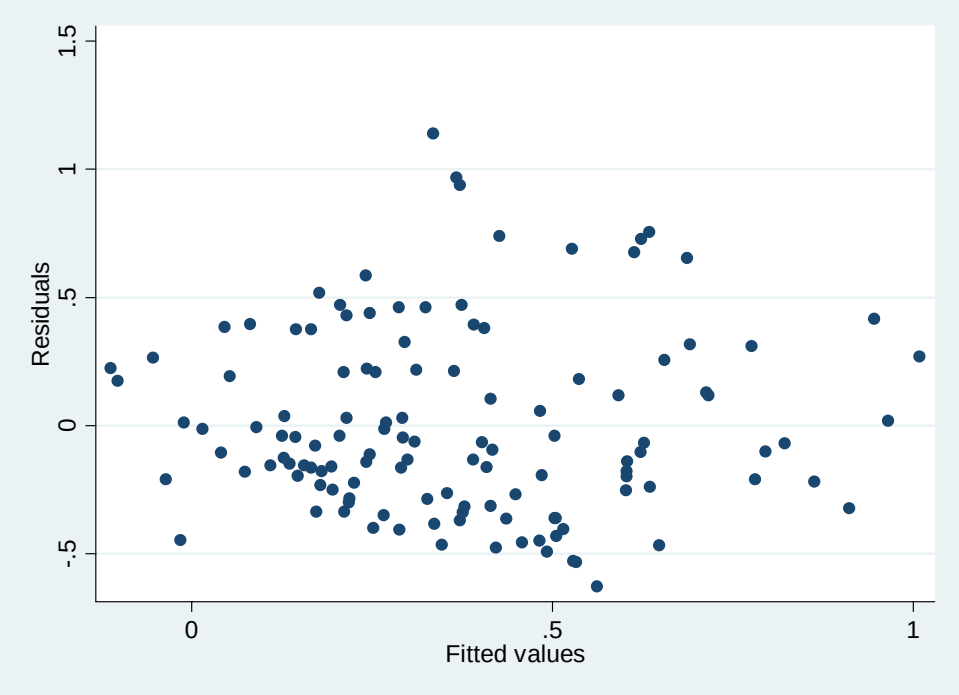


Graph 24: Added Variable Plots for Model for Model 13-10 (Type VC)

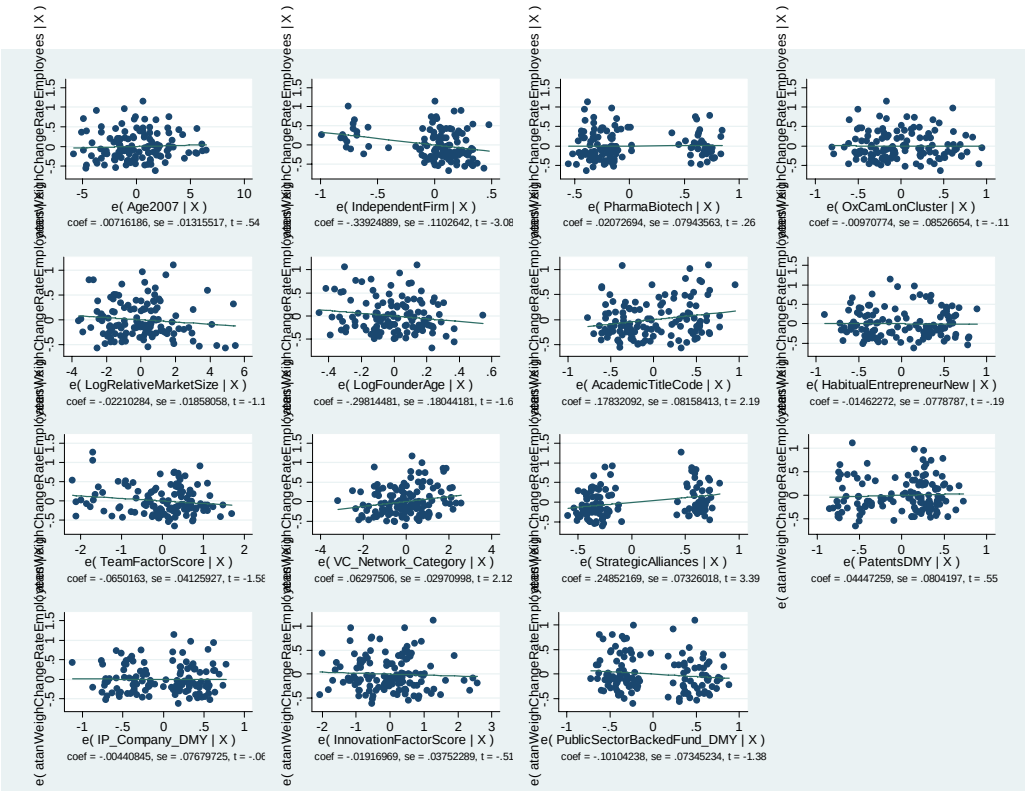


2.5 Absolute Employment Change between Founding Year and 2008

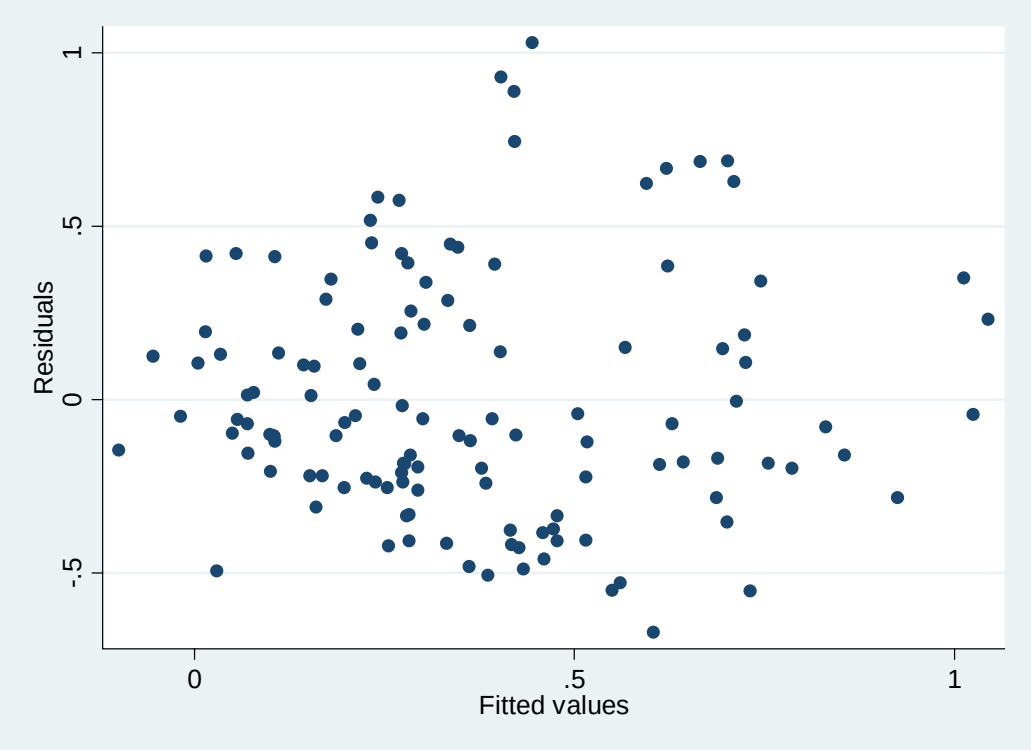
Graph 25: Residual vs. Predicted Values Plot for Model 14-6 (No VC)



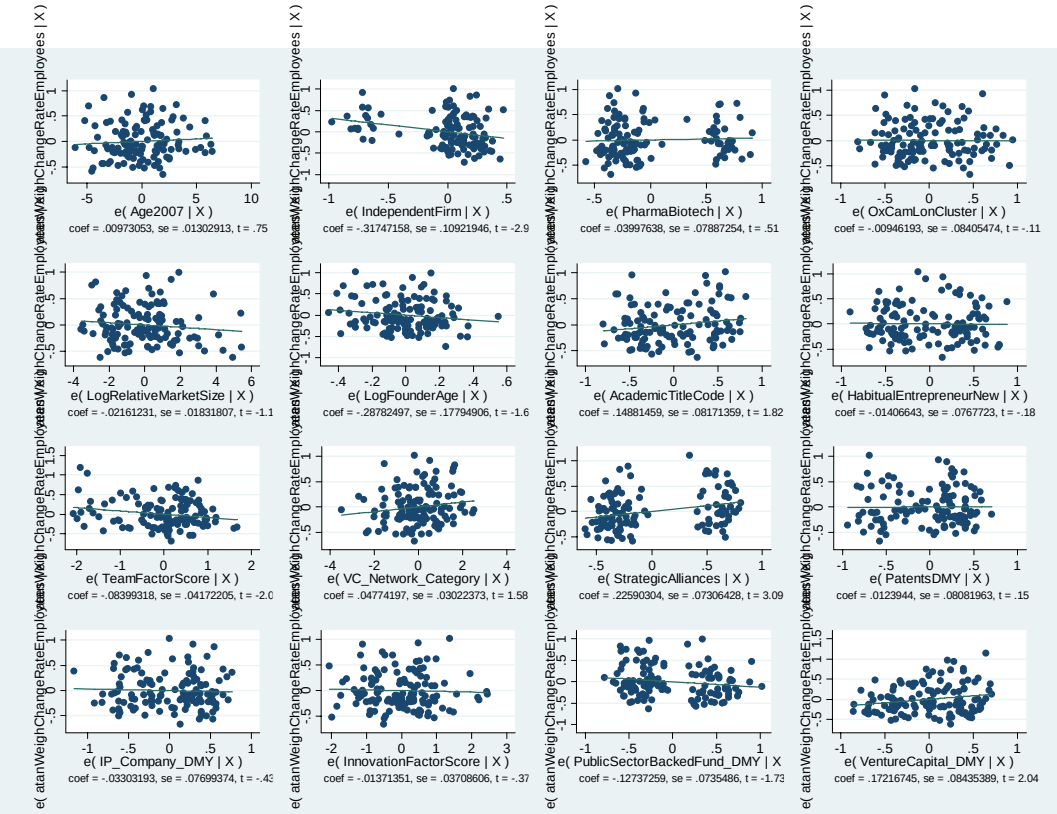
Graph 26: Added Variable Plots for Model for Model 14-6 (No VC)



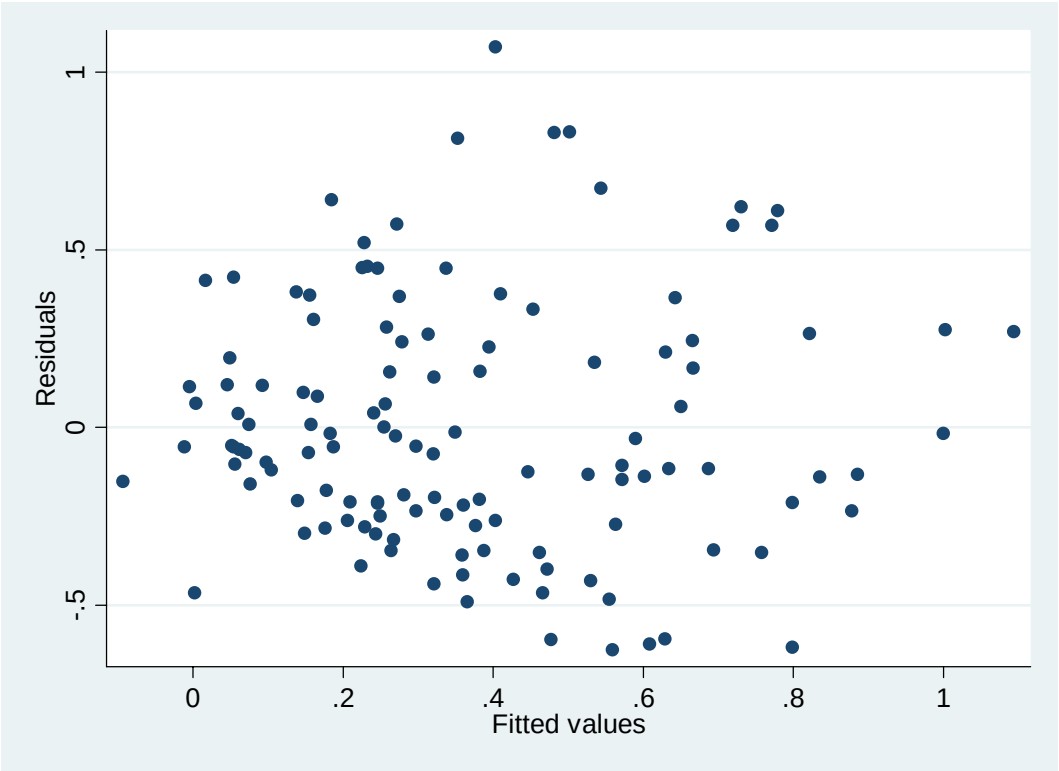
Graph 27: Residual vs. Predicted Values Plot for Model 14-8 (VC)



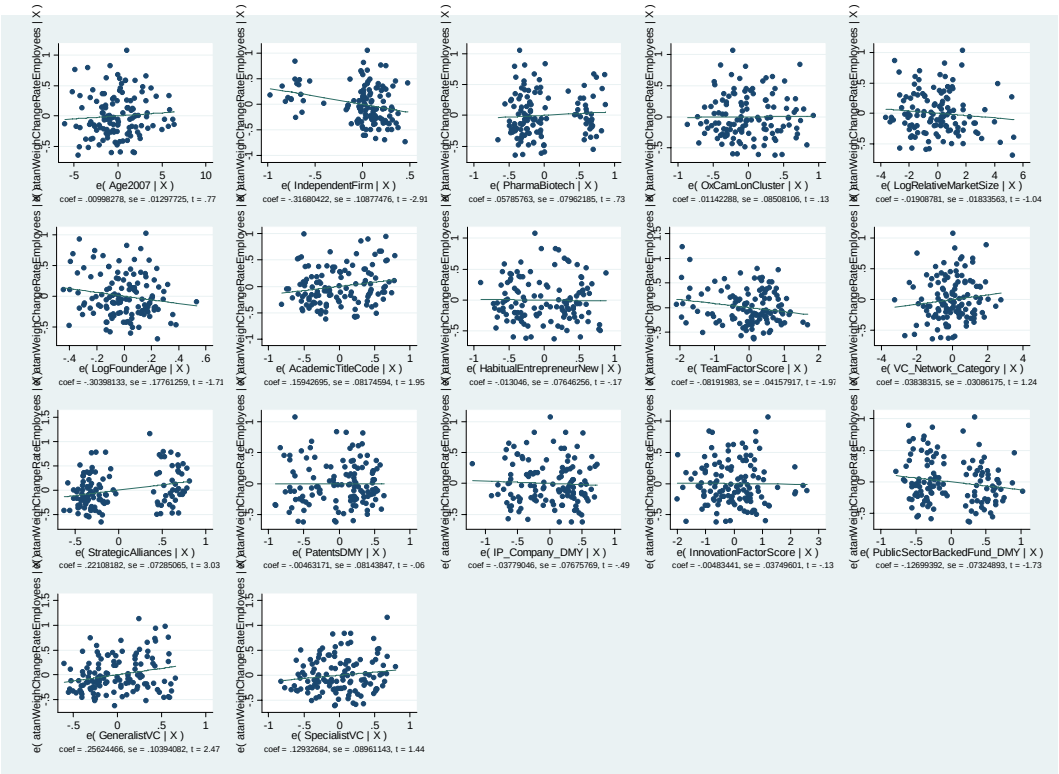
Graph 28: Added Variable Plots for Model for Model 14-8 (VC)



Graph 29: Residual vs. Predicted Values Plot for Model 14-10 (Type VC)

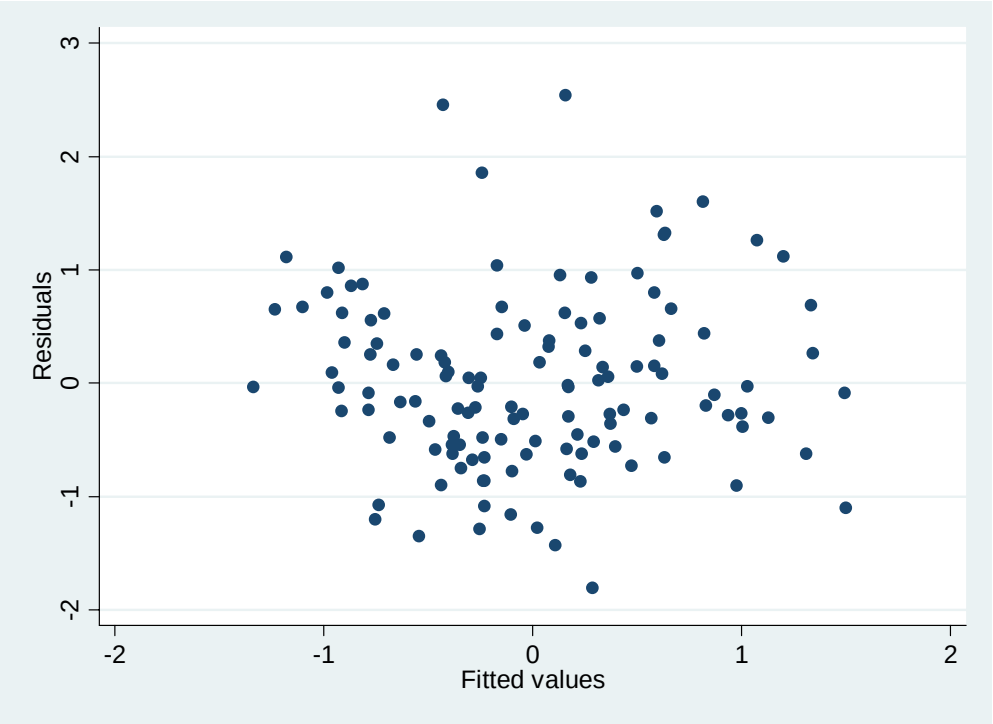


Graph 30: Added Variable Plots for Model for Model 14-10 (Type VC)

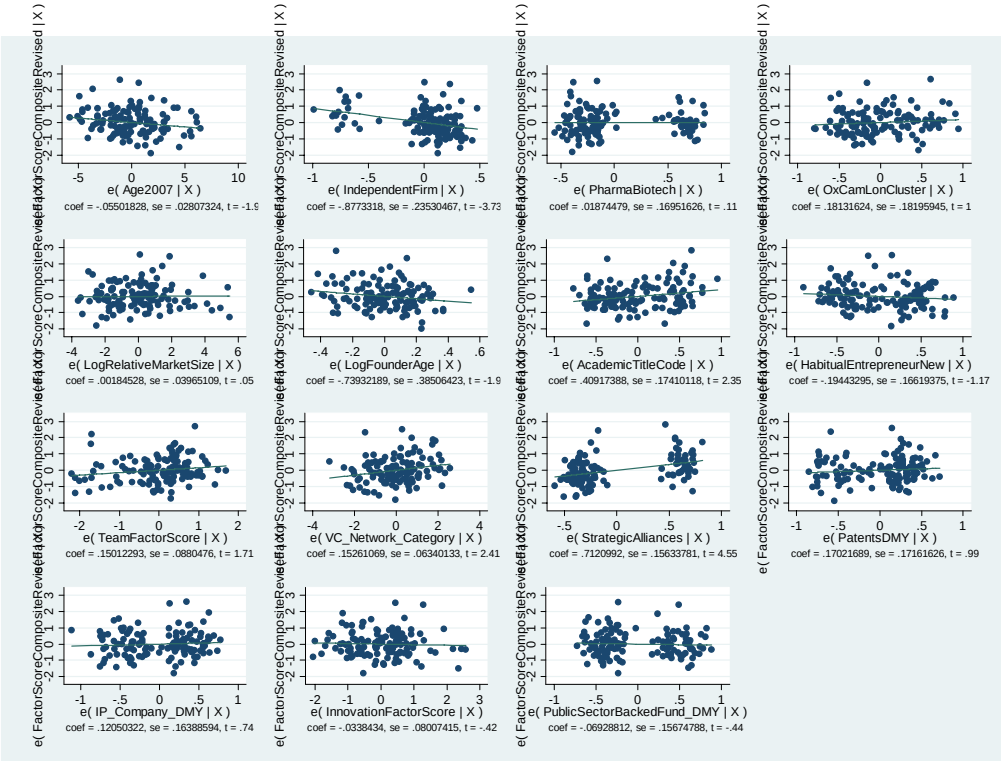


2.6 Composite Measure of Firm Performance

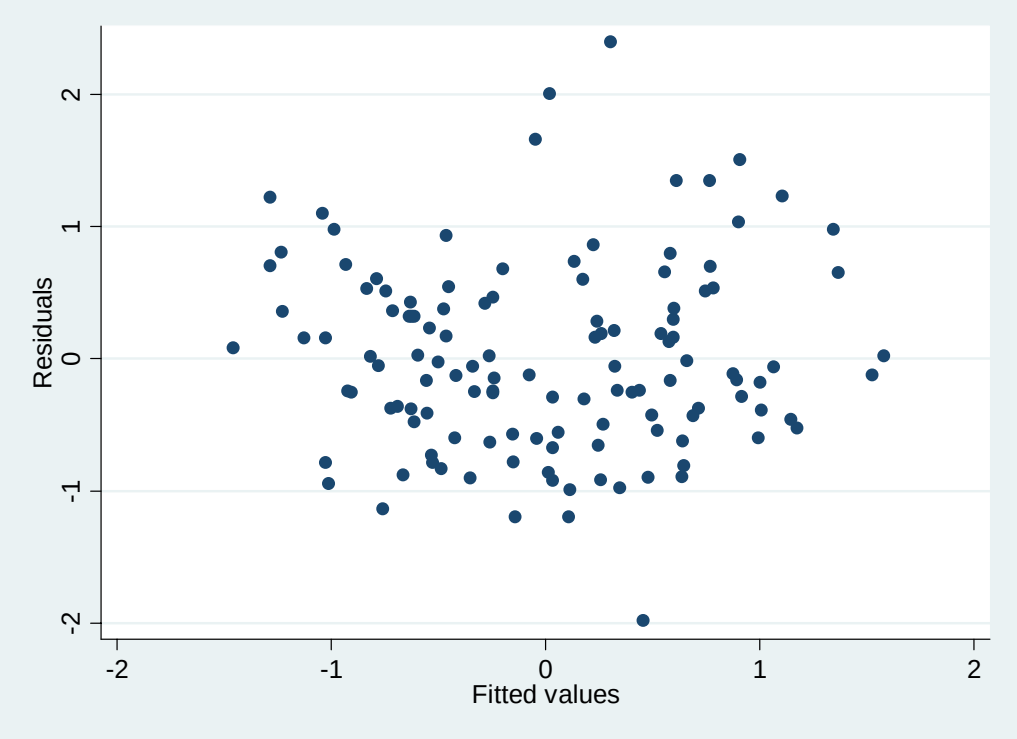
Graph 31: Residual vs. Predicted Values Plot for Model 15-6 (No VC)



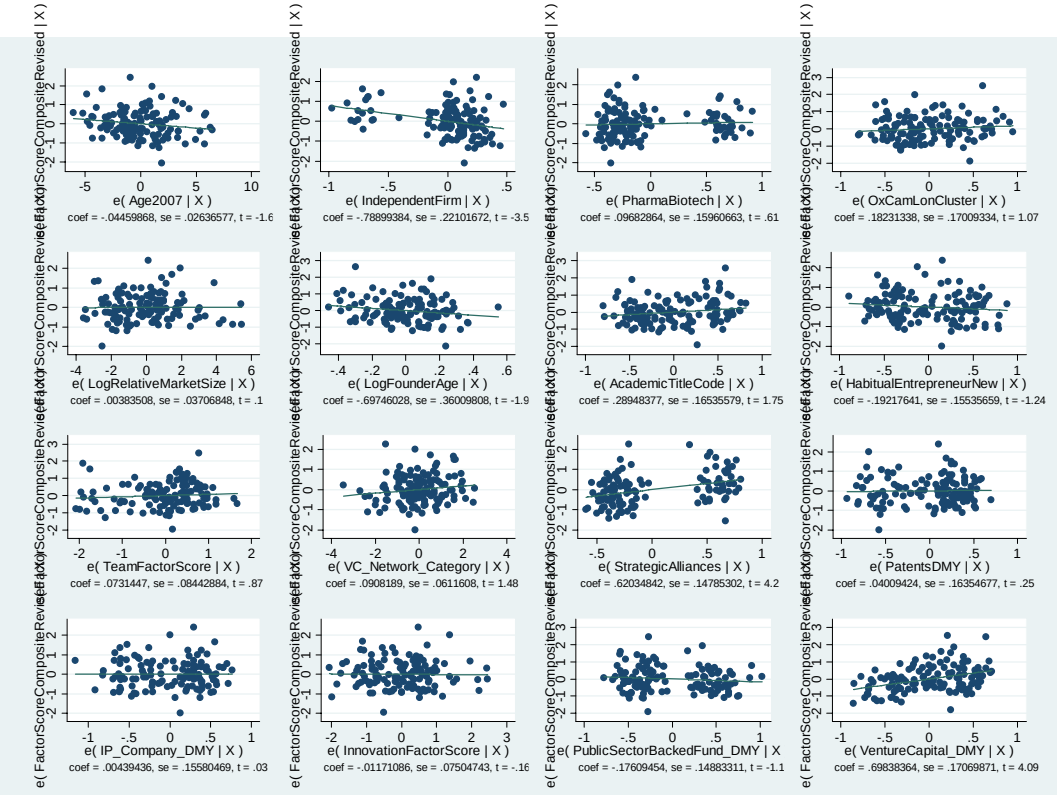
Graph 32: Added Variable Plots for Model for Model 15-6 (No VC)



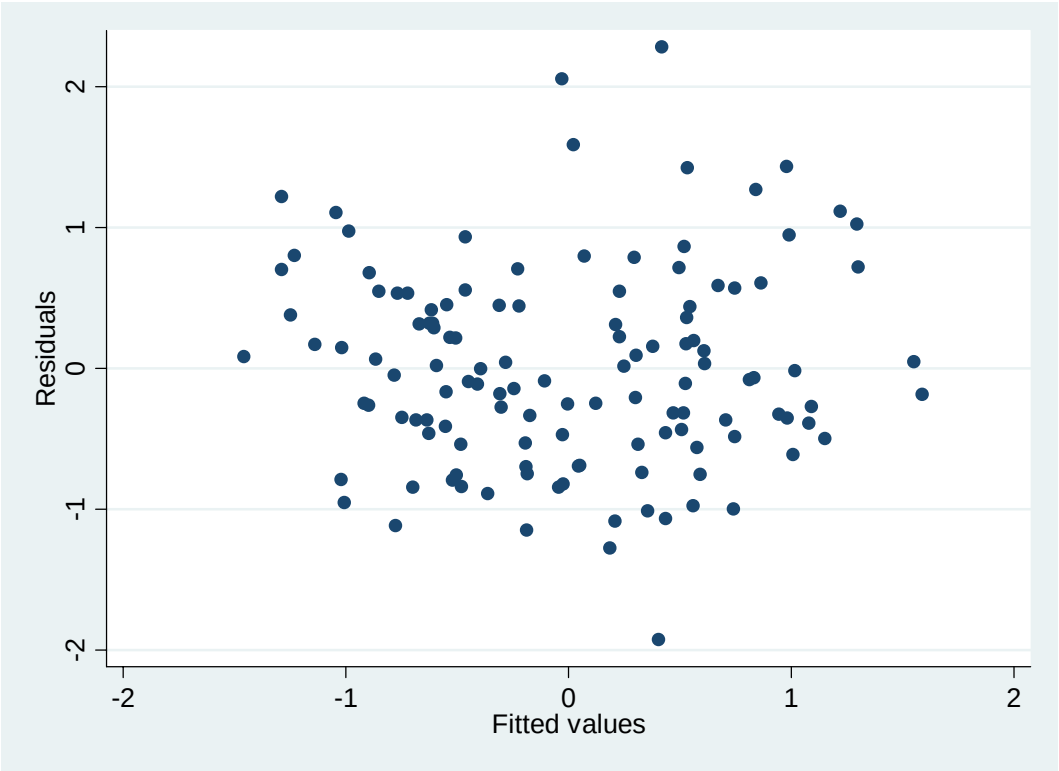
Graph 33: Residual vs. Predicted Values Plot for Model 15-8 (VC)



Graph 34: Added Variable Plots for Model for Model 15-8 (VC)



Graph 35: Residual vs. Predicted Values Plot for Model 15-10 (Type VC)



Graph 36: Added Variable Plots for Model for Model 15-10 (VC)