The Perception of Risks and Uncertainty in Innovation Finance

Thesis

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The Perception of Risks and Uncertainty in Innovation Finance

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Thesis submitted to The Open University in fulfilment of the requirements for the degree of Doctor of Philosophy

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Abstract

This thesis investigates how the perceptions of uncertainty by investors in early-stage ventures affect their investment decisions. Uncertainty is fundamental to entrepreneurship and innovation projects. It is the ability of entrepreneurs and investors to understand and respond to uncertainty in the business environment that brings forth innovative projects. However, very little has been done to understand the role of uncertainty in the decision-making of early-stage investors. The thesis thus addresses this gap in a two-part sequential mixed-methods study.

The first part is a qualitative study that seeks to understand how business angels think about uncertainty. Findings from the qualitative study suggest that in general, investors do not think about uncertainty in terms of probability of events occurring as pertains in the ambiguity aversion literature. Investors think about uncertainty in terms of missing or incomplete information. The second part employs a policy capturing experiment that addresses how investor characteristics affect perceptions of uncertainty and how these perceptions affect investor decisions. The design of the experiment is partly based on findings from the qualitative study. The findings from the second part suggest that while investing experience has a negative moderating effect on investor perceptions of uncertainty, entrepreneurial background and familiarity with venture industry have no effects. Additionally, investor perceptions of uncertainty mediate the relationship between business information cues and investor decisions. The thesis makes empirical, theoretical, and methodological contributions that have implications for practice. For example, inexperienced business angels can work closely with their more experienced counterparts to learn how they deal with uncertainty. Business angel networks can facilitate this through angel education programmes, networking events, and
mentorship programmes. Also, entrepreneurs may need to use a targeted approach in finding the right investors for funding.
Dedication

This thesis is dedicated to:

My lovely wife (Esinam Arthur-Annobil), parents, siblings,

and

My beloved children

Kweku, Ewuradjoa, and Nana Kojo

For their continuous support, love, encouragement, understanding, and prayers.
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Finally, I am deeply indebted to the role and support of my lovely wife, Mrs Esinam Arthur-Annobil for the decision to allow me to relocate from Ghana to the United Kingdom for this PhD study while performing parental duties in my absence. I would also like to thank Carolynne Wilson for the support and always being there for me during this PhD journey.
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Chapter 1 – Introduction

1.1 Research background and problem

This study investigates how the perceptions of risks and uncertainty by early-stage investors affect their investment decisions when they review innovative early-stage business opportunities. I seek to understand how early-stage investors form their perceptions of uncertainty when they review these business opportunities for investments and how these perceptions affect their decisions. Innovative entrepreneurial ventures at their early stages are typically associated with high uncertainties as the opportunities being explored are mostly untested and unproven (Mina et al., 2013). These ventures are easily scalable with high-growth potentials when successful but are associated with low survival rates as they are inherently uncertain.

One of the fundamental assumptions of entrepreneurship is the belief that entrepreneurs make decisions and implement them in the face of unknowable future outcomes (Shane and Eckhardt, 2003). Uncertainty is fundamental to entrepreneurship and innovation projects (McMullen and Shepherd, 2006). It is the ability of entrepreneurs to understand and respond to uncertainty in the business environment that brings forth innovative entrepreneurial ventures (McKelvie et al., 2011). These ventures face financial constraints largely because of the uncertainties associated with their future success (Mina et al., 2013). These investments are essentially bets on the unknown future success of these ventures and not based on any probability estimations (Knight, 1921). Investment decisions in these ventures are thus done in the face of uncertainty.

The uncertainty construct is central to entrepreneurship research and practice. It forms the basis for virtually every condition, context, and level of analysis (Townsend et al., 2018). The seminal work by Knight (1921) on risk, uncertainty and profit is one of the most cited works in entrepreneurial research with respect to discussions on risk and
uncertainty. Knight (1921) distinguishes risk from uncertainty; risky situations have quantifiable probabilities while uncertainty situations come with unquantifiable probabilities. Knight then argues that uncertainty is a prerequisite for explaining the nature of competition and profit. In essence, for entrepreneurs to make profits beyond normal returns it has to be done under conditions of uncertainty.

While uncertainty is at the centre of the exploitation of entrepreneurial opportunities (Townsend et al., 2018; Packard et al., 2017; McKelvie et al., 2011), not much research has been done to understand its effect on the investment decision process of early-stage investors. Investor decision-making has been studied extensively across the spectrum in the early-stage private equity space, from venture capital (Zacharakis and Shepherd, 2001; Zacharakis and Meyer, 1998) to informal venture capital investors such as business angels (Brush et al., 2012; Mitteness et al., 2012a; Maxwell et al., 2011; Mason and Harrison, 1996a). The concept of uncertainty and its effects on investor decision has however has not been studied thoroughly. Understanding the effects of uncertainty on early-stage investor decisions is vital to improving investment decisions as it has the potential to reduce behavioural biases in early-stage investment decisions such as overconfidence and uncertainty aversion.

This study focuses on business angels as they play a crucial role in the early-stage entrepreneurial ecosystem. Business angels, also referred to as angel investors, are mostly high net worth individuals who invest their own money directly in early-stage private ventures to which they have no family ties (Mason and Harrison, 2008). Uncertainties in early-stage ventures are at the highest at the pre-seed stage where business ideas and products are sometimes not even proven (Huang and Pearce, 2015). Business angels are among the first investors in an innovative venture and thus most exposed to uncertainty. As the venture matures, uncertainty about its prospects is reduced. Thus, if we want to
study the effect of uncertainty on decision making, then the effects are likely most pronounced at this early stage. This makes business angels the most appropriate focus of study.

Business angels provide four key economic contributions in the early-stage entrepreneurial ecosystem (Avdeitchikova and Landström, 2016). First, business angels serve as the main source of financial capital for early-stage startup businesses that struggle to raise funds from other sources such as formal venture capitals or traditional banks. Available data indicates that business angels on aggregate provide as much or even more funds to these firms than formal venture capitalists (Sohl, 2012; Mason and Harrison, 2000). In a recent report from EBAN (2021), business angels in aggregate are estimated to invest 2 times as much capital as venture capitalists in early-stage ventures.

Second, business angels contribute to making early-stage ventures more attractive to other larger investors in later rounds of investments. As business angels mainly provide equity financing, they provide patient capital compared to early-stage firms that are financed through, for example, bank loans. With equity financing, the venture is not required to pay off the funds as happens with debt financing. For very early-stage ventures this allows them to develop products and start operating without the added requirement of periodically meeting debt obligations. Additionally, angel investor backing sends a positive signal to later investors, specifically venture capitalists, of the quality of the business (Capizzi et al., 2022; Mason and Harrison, 2000). As Mason and Harrison (2000) report, venture capitalists believe the presence of business angels brings additional expertise that is absent from non-BA backed ventures. It also suggests that the entrepreneurs are willing to take on the views of outsiders (in this case equity investors) in the development of their ventures.
Third, because business angels typically provide additional value-adding activities, they play a unique role in developing not just the business but the entrepreneurs behind the business. They provide value-adding services to the business and the entrepreneurs through serving on boards, acting as advisors, mentoring, and coaching. These are services that entrepreneurs do not typically get from formal venture capitalists who are more profit-oriented and do not have the patience for entrepreneurs who may lack the requisite skills to run the business.

Finally, through their activities business angels contribute to the strengthening of the entrepreneurial ecosystems. As some angel investors are themselves former entrepreneurs, they serve as a connection between entrepreneurs seeking funding and the network of intermediaries that provide funding. Additionally, business angels serve as gatekeepers for other entrepreneurial finance sources as they are usually the first to invest outside of family and friends. They provide a screening service to the ecosystem, and if that is somehow flawed or suboptimal, then any follow-on investment that relies on BAs selecting the best start-ups will inherit the problem. Their activities thus contribute to firm growth in any region where there is active angel investing. To this extent, any meaningful intervention from policy makers for early-stage financing will best be achieved through business angels and hence it is important to understand their decision-making process better to improve it.

Considering the crucial role that angel investors play in the development of early-stage innovative firms, it is important to understand how the uncertainties in these businesses affect their investment decisions. Research on business angel investment decision-making has focused mainly on the investment process and its stages (Maxwell et al., 2011; Riding et al., 2007; Tyebjee and Bruno, 1984), decision-factors used by angel investors (Mason and Stark, 2004; Feeney et al., 1999; Mason and Harrison, 1996a), and
how these factors vary across different stages (Maxwell et al., 2011; van Osnabrugge, 2000). Not much has been done to explore or investigate how these decisions are done in the face of the uncertainties in the businesses and the role uncertainty plays in the decision-making. The few works that have studied uncertainty in angel investing decision-making focus on strategies used by investors to deal with uncertainty (Huang and Pearce, 2015; Wiltbank et al., 2009). This study addresses this gap in literature by explicitly measuring investor perceptions of uncertainty and how it affects investor decisions.

### 1.2 Research objectives and questions

The primary objective of this thesis is to investigate how angel investors perceive uncertainty in business opportunities and how their perceptions of uncertainty affect their investment decisions. The secondary objective is to understand how investor background and experiences affect their perceptions of uncertainty and their investment decisions relative to uncertain information. The secondary objective is in response to the call by Drover and colleagues (2017) that the nuances of investor backgrounds, motivations, and characteristics on investor decisions needs to be explicitly explored. Business angels are heterogenous in nature and are often influenced by individual personalities, motivations, background, experiences when they make investment decisions (Maxwell, 2016).

From the discussions in section 1, the broad research questions for this study are obtained as follows:

1. How do business angels form their perceptions of uncertainty in early-stage businesses?
2. How do the perceptions of uncertainty in early-stage businesses affect investor decisions?
3. How do investor background, experiences, and preferences affect their investment decisions in the face of uncertain information?

1.3 Overview of chapters

In this section, I provide the structure for the rest of the thesis in addition to an overview of the chapters for easy reading.

Chapter 2 Literature review

This chapter presents a review of the literature relevant to the study. It brings together the literature on angel investing and on uncertainty from the fields of economics, finance, and entrepreneurship. I start with a review of business angel investing research over the past four decades and the main themes from these works. There are three generations of research covering this period: the first generation covers business angel characteristics and the BA market; the second generation mainly focuses on the investment decision process, policy interventions in the BA market, and the application of other theories in BA studies; while the third generation research covers an array of research areas including investment decision making, further angel typology, applications and development of new theories in angel research, and some longitudinal studies of angel investments. I situate the thesis in the third-generation research as it applies the uncertainty construct in the angel investment decision making process.

I then discuss the key elements of the business angel investment decision process and review how angel characteristics affect investment decisions. I also review studies relating to risks and uncertainty in the finance and economics literature to understand the underlying theories and how they relate to angel investing. This is followed by a discussion of the risk and uncertainty constructs as used in entrepreneurial research and
action and how it relates to angel investing to put the study in context. Finally, I discuss
the limited application of risk and uncertainty in angel investing research and how the
current project contributes to angel investing research literature. I identify the gaps in the
literature relating to how risk and uncertainty affect angel investor decision making. This
thesis addresses the identified gaps in the literature.

Chapter 3 Research methodology, design, and data

This chapter focuses on the research methodology employed for the study as well as the
development of the research design and data collection activities. The chapter starts
with a discussion of the research paradigm and philosophy adopted for the study. I adopt
the philosophical or research paradigm stance of pragmatism which is a blend of both
subjectivism and objectivism stance. This translates into a sequential mixed-methods
approach where one study informs the follow-on study. I discuss the methodological
approaches used in research on angel investment decision making and uncertainty
aversion.

Based on the discussions and the epistemological stance, I designed and developed a sequential mixed-method approach whereby I conduct an initial qualitative
study whose findings inform the design of the main policy-capturing experimental study.
This was crucial as having an ecologically valid study is important for the thesis. The
uncertainty construct as applied in the angel investor context is limited, and this required
an initial study that assisted in operationalising the uncertainty construct as well as
developing scenarios for the quantitative part of the study. The rest of the chapter
discusses the details of the research design, the data collection activities, and ethical
considerations. I finally summarise the details of the data collected in terms of descriptive
statistics, correlation tables and what it means for the analysis in the later chapters.
Chapter 4 How angel investors think about uncertainty

This chapter focuses on the first phase of the study, which is qualitative study, and what it means for the second phase of the study. The main objective of this chapter is to explore how business angels think about uncertainty, as we do not know much about this from the literature. Knowing how early-stage investors think about uncertainty and what information cues they consider uncertain is important especially in the context of operationalising uncertainty for the main experimental study. It also provides rich insights into business angels’ thinking about uncertainty, which are hard to achieve through surveys or experiments.

The main method for this part of the study is semi-structured interviews with business angels in the UK. I take a thematic inductive approach to analyse the data collected. The main finding here is that business angels find Ellsberg-type modelled uncertainty unusual and unrealistic compared to what they encounter in their professional life. I conclude that uncertainty cannot be modelled as the Ellsberg type in an ecologically valid study of business angels. However, what creates uncertainty for business angels is the absence or presence of particular information cues. The study also finds that in relation to how investors think about uncertainty, business angels jointly think about the business opportunity and the team behind opportunity and assess how they fit together. I also find that some investor characteristics affect how investors perceive uncertainty as well as their investment decisions. Finally, I discuss the implications of the qualitative study for the design of the main study.
Chapter 5 Investor experience and uncertainty perception

In this chapter, I build on the preliminary findings from chapter 4 to examine how investor backgrounds and experiences influence their perceptions of uncertainty. This chapter answers two main questions. First, how does the professional background or entrepreneurial background of investors affect their perceptions of uncertainty? Second, how does past angel investment experiences affect their perceptions of uncertainty? This chapter forms part of the second phase of the study, which employs a policy capturing experiment to address these questions. The findings here are mixed. While angel investing experience moderates investor perceptions of uncertainty, investor backgrounds like entrepreneurial experience and familiarity of venture industry have no effects on perceptions of uncertainty.

Chapter 6 Uncertainty and angel investor decisions

This chapter examines the role of uncertainty in investor decisions. It focuses on how investor perceptions of uncertainty affect the decisions of business angels when they review early-stage business opportunities. I address this in three ways. First, what are the general attitudes of business angels towards uncertain information? Are they uncertainty-seeking, or do they avoid uncertainty like other decisions makers? Second, what is the role of uncertainty perceptions in observed investor decisions? Do perceptions of uncertainty play a mediating role between uncertain information cues and investor decisions? Finally, how do investor characteristics affect uncertain information cues and investor decisions? The findings in this chapter expand on existing works and provide an understanding of how investors make decisions relative to uncertainty. While uncertain information leads to a lower inclination to invest, this is mediated through investor perceptions of uncertainty.
Chapter 7 Discussion and conclusion

This chapter puts together the key findings of this thesis and links it to existing literature. In this chapter, I review the main contributions of this thesis as well as methodological, empirical, and theoretical contributions. I then highlight what these mean for business angels, business angel networks, and entrepreneurs at large. I also provide an overview of the limitations of this research and suggests opportunities for future research.

1.4 Contributions of the research

This study makes empirical, theoretical, and methodological contributions to the angel investing literature. The study contributes to knowledge by examining the role of uncertainty and its effects on early-stage investments decisions. The uncertainty construct has not been thoroughly studied in the early-stage financing literature although we know of its crucial role in the entrepreneurship literature. The few works that have studied uncertainty in early-stage investing focus on strategies investors use to deal with uncertainty in their decision-making process (Huang and Pearce, 2015; Wiltbank et al., 2009). This study explicitly measures perceptions of uncertainty and examines its effect on investor decisions.

The study makes four empirical contributions to the angel investing decision-making literature. First, the study shows how business angels think about uncertainty and what business angels consider as uncertain in their investing operations. Contrary to the dominant uncertainty measure in the finance and economics literature, what drives uncertainty in early-stage ventures for business angels is incomplete information. That is, the presence and absence of particular information cues creates uncertainty about the success of the venture. This is important in the design of the quantitative studies as it
shows which dimension of uncertainty is ecologically valid in the context of business angels.

The second empirical contribution relates to how investor background and experiences shape investor perceptions of uncertainty in early-stage ventures. The study shows how different backgrounds and experiences affect investor perceptions of uncertainty differently. For example, past angel investing experience negatively moderates investor perceptions of uncertainty. On the contrary, past entrepreneurial experience and familiarity with the industry in which the venture operates have no effects on investor perceptions of uncertainty. This extends the conversation on the heterogeneity of business angels and how their backgrounds and experiences shape their investments activities.

Third, the study establishes the role of perceptions of uncertainty in the investment decision process of business angels. This is a major contribution of the study. The study finds that investor perceptions of uncertainty mediate investor decisions in the face of uncertainty. The study extends past works by measuring investor perceptions of uncertainty and examining how they affect investor decisions. The study shows that perceptions of uncertainty serve as a mechanism through which investors make decisions at the initial stages of the decision-making process.

The fourth empirical contribution of the study provides evidence relating to the general attitudes of early-stage investors towards uncertainty. While there is evidence from past angel investing research that some business angels have uncertainty seeking tendencies, the current study shows the context in which this occurs. The study finds that in general business angels like other decision-makers are averse to uncertainty. In general, business angels are not necessarily uncertainty seeking but are willing to bear uncertainty in the pursuit of potentially strong profit opportunities.
The study also makes an important theoretical contribution by proposing a descriptive decision-making model for business angel investment decision-making in the face of uncertainty. The model is a moderated-mediation decision-making model that puts together the major empirical findings from the research. The model explains how business angels with different backgrounds and experiences make decisions through their perceptions of uncertainty.

Finally, the study also makes an important methodological contribution. I use an empirically derived approach to show how to operationalise uncertainty in the context of business angels. I use a qualitative study to empirically show how business angel think about uncertainty to inform the design of an experimental study. It contributes to the economics and finance literature by showing which uncertainty dimension is useful in the context of early-stage investors and how to operationalise uncertainty.
Chapter 2 – Literature Review

2.1 Introduction

This chapter provides a targeted review of the literature relevant to the study. Following the research objectives and questions in section 0, there are two streams of literature that are of interest to this study – the angel investing literature and the literature on risk and uncertainty. The aim of this chapter is to critically review these two streams of literature to understand what we know about angel investor decision-making processes and what role uncertainty plays in this process. The first part of the review from section 0 to section 2.5 covers the angel investing literature while the second part in sections 2.6 and 2.7 focuses on the risk and uncertainty literature. The last part in section 2.8 looks at the limited application of the risk and uncertainty in the angel investing literature.

I start the review in section 0 with a discussion of the definition of business angels to understand who they are. Clearly establishing business angels as the object of study allows for a proper development of the methodology, selection of sample, interpretation of the results and what they mean for practice and the wider entrepreneurial finance ecosystem. I then review the business angel investing research over the past four decades and the main themes coming from these works. Based on the initial work by Mason and Harrison (1999) and the follow-on by White and Dumay (2017), we can classify business angel research into four generations. I discuss the key themes emerging from the various generations of research works in section 2.3 and clearly establish where this study is situated.

Owing to the focus of this research on the role of uncertainty in the investment decision-making of angel investors, I review the key elements of the business angel investment decision process in section 2.4. This is to understand the various elements of the process and decision factors that business angels use at different stages of the
investment process and how they contribute to the uncertainties in early-stage ventures. In section 2.5, I focus on angel characteristics and their effects on investment decisions; what we know and what we do not know. In this section, I review how business angel backgrounds and experiences affect their decision-making and what it means for their perceptions of uncertainty in early-stage ventures.

From discussions in the preceding sections, what is evident is the neglect of the role of uncertainty in decision-making process of business angels. This leads to a review of studies relating to risks and uncertainty in finance and economics literature in section 2.6. To contextualise the uncertainty discussion in the entrepreneurial finance space, I review the discussions on the risk and uncertainty construct as used in entrepreneurial action research and how it relates to angel investing in section 2.7. Finally, I bring all the elements from the other sections together in section 2.8 and discuss the limited application of risk and uncertainty in angel investing research and how the current project contributes to angel investing research literature and the entrepreneurial finance literature as a whole.

2.2 Business angel – the object of study

Historically the main source of funding for early-stage ventures have been venture capital (VC) firms until the early 80s when institutional investors (largely pension funds) started to allocate funds to the industry (Gompers and Lerner, 1999). This led to a large inflow of capital into the venture capital industry as other institutional investors joined in. The huge growth in the sector coupled with the limited time frame for these funds also meant VC fund managers had to find ways of turning around funds quickly with the expected high-return requirements from institutional investors. This has driven up the minimum size of investment that VCs are willing to make at every stage of investment and led to more investment to late-stage ventures compared to early-stage ventures. Costs
associated with the operations of venture capital firms like due diligence and monitoring of investments are fixed which makes small investments for very early-stage businesses not commercially prudent (Mason, 2009).

The trend in the institutional venture capital industry towards investing in larger and later-stage deals, at the expense of smaller early-stage investments, has been well-documented in both the USA and Europe (Murray, 1999; Sohl, 1999; Wright and Robbie, 1998; Timmons and Bygrave, 1997; Bygrave and Timmons, 1992). This pattern of investment in the venture capital industry led to the role of the informal venture capital which started with what Wetzel (1981) termed ‘business angels’ or angel investors.

Business angels supply relatively smaller amounts of finance for firms at their seed, start-up, and early stages of growth (Mason and Harrison, 2000; van Osnabrugge and Robinson, 2000; Sohl, 1999). Indeed, business angel finance is increasingly recognized as occupying an important place in the spectrum of private equity finance available to growing entrepreneurial businesses (Brophy, 1997). As highlighted in the research background (section 1.1), BAs have been shown to be the largest external source of early-stage risk capital, substantially dwarfing investments made by professionally managed venture capital firms (Sohl, 2003; Mason and Harrison, 2000; Gaston, 1989; Wetzel, 1987). Since they do not incur the transaction costs of venture capital firms, they are able to make smaller seed and start-up stage investments, well below the minimum deal sizes and stages considered by venture capital fund managers (Mason and Harrison, 1997).

The first major work in the business angel field is from Wetzel in 1981 where he sought to throw light on an invisible entrepreneurial finance market whose operation was somewhat hidden. In that study, (Wetzel, 1981) defined business angels as “financially sophisticated individuals of means, often with previous investment or management
experience with entrepreneurial ventures” Over the years, however, the definition of business angels has evolved or simply been broadened to cater for the different nuances of the market over four decades that have passed since Wetzel’s work. There are three principal ways the definition has evolved.

First, angel investors are heterogenous in nature and in behaviour, some of which do not meet or simply deviate from the original definitions (Lahti, 2011; Avdeitchikova, et al. 2008; Sørheim and Landström, 2001). The market now has seen some relatively younger individuals who may or may not have entrepreneurial backgrounds. They may also not be wealthy in the classical sense but seek to create wealth through angel investing. Second, the operations of business angel networks and investing through syndicates means the traditional definition is somewhat limited. Many investors are investing through their networks and alongside other investors in the networks or through syndicates (Antretter et al., 2020; Wood et al., 2020; Bonnet et al., 2019).

Third, business angels also need to be distinct from other informal sources of finance for early-stage businesses such as family and friends. Typically, funds from family and friends are the first source of financing for entrepreneurs who have access to this network. These sources are typically not commercially oriented as family and friends do not necessarily expect to make a financial return when they fund entrepreneurs that they are related to (Bygrave and Hunt, 2005). Business angel investing is primarily for a commercial purpose, with investors typically hoping to make large returns if the businesses are successful. Albeit there are some investors who say they see angel investing as a hobby and obtain ‘psychic income’ by helping entrepreneurs raise the needed funding (Shane, 2008).

According to Mason (2016), there are four characteristics of angel investors that make them distinct from other forms of early-stage investments. First, angel investors
invest their own money. Unlike formal venture capitalists who invest funds on behalf of other investors, business angels invest their own funds directly in early-stage ventures. Second, angel investors invest in private unquoted businesses. This is to eliminate any confusion about individuals’ investments in publicly traded stocks. Third, business angels make direct investments and do not invest through some intermediary. A decision to invest or not in a venture is made directly by them even if they invest through a syndicate. A syndicate here means a group of business angels investing together in ventures that are of interest to the members. It typically includes an experienced business angel who takes the lead in most engagements with the entrepreneurs and may have an influence on the decisions of members. Even in a syndicated angel investment, every member takes their own decisions whether to invest in a particular venture or not. This means if one describes him- or herself as a business angel but invests in, say, a venture capital vehicle that invests in early-stage businesses, these will not count as part of their angel investing activities. If investing through say VC funds is mainly the vehicle through which the individual gets exposure to early-stage startup businesses, then the individual cannot be described as a business angel. Finally, angel investors typically invest with financial motives. This is important as it makes angel investors distinct from other sources of entrepreneurial finance such as family and friends who typically do not invest primarily for financial motives (Mason, 2016).

I adopt the following definition from Mason and Harrison (2008) which covers the core elements discussed in this section. They define an angel investor as, “high net worth individuals, acting alone or in a formal or informal syndicate, who invests his or her own money directly in an unquoted business in which there is no family connection and who, after making the investing, generally takes an active involvement in the business, for example, as an advisor or member of the board of directors” (Mason and Harrison, 2008, p. 309).
There are, however, a few concerns about this definition. The first point of concern is whether business angels take an active role in their investee companies or not. There is evidence that some investors take a passive role in their investee companies (Mason, 2016). The question is whether this will exclude these investors from the angel investor market or not. I argue that it should not be so. There is evidence to show that some investors take an active part in some investee companies and not in others (Mason, 2016). One reason for not being active in an investee company will be that it was a through a syndicate with a lead investor being the active investor in the company. This could be that their skills and experiences may not be useful in the context of that particular business and prefer to take on a passive role. These investors however may be active in other ventures where they believe their background and experiences are more useful.

Another point of conflict lies in the operations of business angel networks (BANs). The operations of some BANs have an impact on the definition of business angels. For example, BANs that operate on a ‘core-periphery’ basis could be problematic for the definition of business angel. Typically, in these networks, there is a core group of active investors who identify, screen, and evaluate deals for potential investments. Less experienced and passive investors are then invited to co-invest in these businesses (Gregson et al., 2013). This has the potential to dilute the definition of business angels as these passive investors are only reduced to a yes or no function with very little in analysing deals for potential investments. Issues of herding could also arise in these arrangements as passive investors may just follow the lead of these core active investors. However, even in these circumstances, the ultimate decision to invest in any particular venture still lies with the individual who decides whether or not to invest.

There have been other developments in the informal venture capital space as entrepreneurs seeking seed and early-stage capital are finding innovative ways of raising
funds and other stakeholders creating avenues to better help grow these businesses. These new ways can be mainly seen in the use of crowd-investing, incubators, and accelerators. With crowd-investing, the entrepreneur raises external financing from a large audience, referred to as ‘the Crowd’ on a designated website or platform, instead of soliciting a small group of well-informed investors like BAs (Hornuf and Schwienbacher, 2016; Ahlers et al., 2015; Bradford, 2012). There is however evidence that some angel investors also invest via crowdfunding platforms (Mason and Botelho, 2014). This development, however, is more of a complementary nature than a typical case. Angel investors may come in to compliment the funds raised from crowdfunding platforms at later rounds although many investors are concerned about these arrangements.

Incubators on the other hand shelter vulnerable nascent businesses, allowing them to become stronger before going independent while introducing them to potential financiers, connections to legal, technology transfer, and accounting consultants (Cohen, 2013). Accelerators like incubators also help ventures define and build their initial products, identify promising customer segments, and secure resources, including capital and employees. However, accelerator programs are programmes of limited duration, usually lasting about three months compared to incubators that could last between 3 to 5 years. They usually provide a small amount of seed capital, plus working space (Cohen, 2013). Typically, at the exit stage of these ventures from these programs, angel investors are the main source of equity finance for these businesses.

Despite concerns raised by some researchers on the definition of business angels, the definition adopted from Mason and Harrison (2008) is not materially affected. This definition will thus guide the rest of the thesis especially for the development of the methodology and the selection of participants for the study.
2.3 The evolution of business angel investing research

2.3.1 First generation of angel research

Angel investment research is over four decades old. Wetzel (1981, 1983) is credited for the early works of angel investing which focused on the attitudes, behaviours, and characteristics of business angels. Prior to this, little was known about the role business angels play in financing early-stage ventures, especially tech-based and manufacturing businesses. Wetzel’s seminal work inspired what Mason and Harrison (1999) describe as the first generation of business angel research. These research works focused on two main themes. The first relates to the business angel market. Issues around the nature and size of the BA market are studied in this stream of research. The second relates to the characteristics and behaviour of business angels in the entrepreneurial finance space. This is what is often referred to as the ABC (attitudes, behaviours, and characteristics) studies of business angels (Wetzel, 1987).

In relation to the BA market theme, several scholars have attempted to estimate the size of BA markets across different geographical regions albeit with conceptual and methodological challenges (Mason and Harrison, 2017; Avdeitchikova and Landström, 2005; Sohl, 2003; Gaston, 1989; Wetzel, 1987). Gaston (1989) for example estimated that the US informal capital market space between 1982 and 1987 was around $33 billion. Recent estimate of angel investor activities in the US market is about $24 billion (Sohl, 2020). These estimates, however, do not include funds that are available, but investors cannot find the right opportunities (Mason and Harrison, 1994) or from ‘virgin investors’ who have funds and are willing to make their first investments (Freear et al., 1994; Mason and Harrison, 1993).

Business angel research is fraught with difficulties in accessing data sources as the BA market is a somewhat invisible one (Mason and Harrison, 2008). As Wetzel (1983,
p. 26) argues the size of the BA market is “unknown or probably unknowable”. BA market size estimations from these research works can thus be considered as crude estimates at best, and cross-country comparison has to be done with caution. However, one key conclusion of these research works is that BAs invest more than formal venture capital firms in ventures in their seed and early-stage growth stage (Freear and Wetzel, 1990). For example, in the United Kingdom, business angel activities were estimated to be about £500 million in about 3500 ventures which was 10 times as many investments and four times the amount invested by formal venture capital firms in {period of study} (Mason and Harrison, 1997).

The second theme in the first-generation research relates to the profile of business angels. Four main things come up under this theme. First, the business angel is typically a high-net-worth male in his 50s (middle-aged) who was typically once an entrepreneur. Second, they rely heavily on family, friends, and business associates to find potential opportunities to invest in. Thirdly, they are typically motivated to invest for financial returns although some may have non-financial motivations too. Finally, they prefer to be involved in their investee companies and bring their past experiences to bear as either advisors or board members (Wetzel, 1983, summarised in Landström and Mason, 2016). Similar studies in countries outside of the US find that business angels across other parts of the world have many similarities; Haines et al., 2003; Riding and Short, 1988 (Canada), Mason and Harrison, 1994 (The UK), Månsson and Landström, 2006; Landström, 1993; (Sweden), Hindle and Wenbam, 1999 (Australia), and Brettel, 2003; Stadler and Peters, 2003 (Germany). Although BA markets differ across regions, they have many similarities in their attitudes, behaviours, and characteristics (Kelly, 2007) and also consistent over time (Månsson and Landström, 2006).
2.3.2 Second generation of angel research

The first-generation research made the activities of business angels more visible which attracted a lot of scholars and led to the second generation of research. This generation focuses on three main issues. First, scholars inspired by what we knew about the operations of formal venture capitalists sought to understand the angel investor decision making process. Second, the increased visibility of the activities on business angels led to some policy interventions in the market. Researchers explored how these policy interventions had impacted the BA market mainly through angel networks and other introductory services. Finally, some researchers also studied the applicability of some known theories in other areas to explain the activities of business angels (Landström and Mason, 2016; Mason and Harrison, 1999).

Most research work done in the second generation focuses on understanding the investment decision-making process of business angels and the investment decision criteria used by BAs (Landström, 1998; Mason and Rogers, 1997; Riding et al., 1994). Indeed, most of business angel research across generations is in this thematic area (Tenca et al., 2018). Findings from these research works show that angels use a multi-stage decision process; sourcing the deal, screening applications, detailed evaluation, and due diligence; negotiating and contracting; and finally, post-investment activities. They also use a multitude of criteria to make their investment research (Maxwell et al., 2011).

Beyond the categorisation of the investment process and investments criteria used, later research work within this thematic area covers a broad range of topics including venture readiness for funding (Brush et al., 2012), the debate on which is more important, the business opportunity or the entrepreneur, also referred to as horse versus jockey conundrum (Mitteness et al., 2012a; Clark, 2008), trust and agency issues (Lahti 2011; Maxwell et al., 2011; Maxwell and Levesque, 2010; van Osnabrugge, 2000), contracting
and negotiating (Ibrahim, 2008; Kelly and Hay, 2003), and post-investment activities and exits (Mason and Harrison, 2017; Wiltbank, 2005).

The second stream of research in this era focuses on the impact of policy interventions on the business angel market. The studies in this thematic area focus on how policy interventions have increased participation in angel investing and how they have reduced the inefficiencies in the market by making it easier for entrepreneurs to find the right angels. Studies on the activities of business angel networks are dominant in this thematic area (Gregson et al., 2013; Collewaert et al., 2010; Paul and Whittam, 2010; Zu Knyphausen-Aufseß and Westphal, 2008; Aernoudt and Erikson, 2002; Aernoudt, 1999; Lerner, 1998). Business angel networks resulted from policy interventions to reduce BA market inefficiencies. One of the issues identified from first-generation research works was the difficulty for entrepreneurs to find business angels due to the private nature of their activities (Wetzel, 1983). Business angel networks therefore address this issue by acting as financial intermediaries in the BA market serving as a venue for business angels and entrepreneurs to find each other (Zu Knyphausen-Aufseß and Westphal, 2008). While generally there is evidence to show the importance of business angel networks to the activities of business angels, there are concerns about whether they add value to business angels that are members. For example, Zu Knyphausen-Aufseß and Westphal (2008) conclude that BAs do not substantially benefit from these networks.

The final stream of research in this era relates to the application of known theories in other fields in understanding the business angel market and how it operates. Works done include applications of decision theory (Feeney et al., 1999; Landström, 1995), stakeholder theory (Pollack and Bosse, 2014), agency theory (Kelly and Hay, 2003; van Osnabrugge, 2000; Fiet, 1995; Landström, 1992), social capital theory (Saetre, 2003;
Sorheim, 2003), trust models (Harrison et al., 1997), and signalling theory (Prasad et al., 2000) to business angel investment processes.

2.3.3 Third generation of angel research

A third-generation research stream emerged post 2000. Most of the studies in this generation are an extension of the primary works and focus of the first and second generations. In the third generation, there is still interest in understanding the investment decision-making of business angels but with a much narrower focus (Landström and Mason, 2016). A narrower focus provides an avenue for better understanding of what we already know about business angels. Other areas outside of the first and second generation include methodological and theoretical issues all in response to the research agenda set by Mason and Harrison (1999).

There have been research works extending the main themes from first-generation works on BA markets and the profile of business angels. There are more sophisticated estimates of the BA market (Harrison et al., 2010), works covering typologies of angel investors (Festel and De Cleyn, 2013; Paul et al., 2003; Sørheim and Landström, 2001), and organisation of the marketplace (Johnson and Sohl, 2012; Aernoudt, 2004; Harrison and Mason, 2000). There are other first generation-like works that have focused on specific investor characteristic issues such as women business angel participation (Harrison and Mason, 2007; Sohl and Hill, 2007), and entrepreneurial characteristics of business angels (Lindsay, 2004; Politis and Landstrom, 2002).

On the extension of investment decisions of BAs, the focus has been on how intangible factors about the entrepreneur affect investor decisions. For example, Parhankangas and Ehrlich (2014) explore how entrepreneurs can use impression management tools to woo angel investors. Other research work includes how the passion
of entrepreneurs affects the decision making of investors (Mitteness et al., 2012b) and the effects of available exit options on investor decisions at the initial screening stage of the investment process (Mason and Botelho, 2016). There is also evidence that angel investing continues to be largely localized; investors invest in businesses in close proximity to their locations (Harrison et al, 2010; Avdeitchikova, 2009). There are arguments that this is only present in investments in businesses at the very early stage. However, there is no evidence that this phenomenon is less likely to occur in investments into ventures at the latter stage (Harrison et al, 2010).

On methodological issues, the most prominent works are from Avdeitchikova et al. (2008) and Farrell et al. (2008). They raise issues on the definition of the population used for past research. They find an inconsistent use of definitions of informal investors, informal venture capital investors and business angels which makes comparison of works difficult. Another issue relates to the common use of samples of convenience in business angel research, and they propose ways of obtaining more representative samples in future. Mason and Harrison (2008) contribute to the literature in this area with a review of potential data sources in the UK for business angel research.

Research works with a focus on theoretical issues have still been limited to the use of existing theories (for example, stakeholder theories (Pollack and Bosse, 2014), institutional theory (De Clercq et al., 2012), trust models (Bammens and Collewaert, 2014), prospect theory (Florin et al., 2013) and game theory (Fairchild, 2011). For example, Fairchild (2011) uses game theory to determine how entrepreneurs make funders choice between business angels and venture capitalists. Bammens and Collewaert (2014) apply the construct of trust to determine how it affects business angels’ evaluation of venture performance as part of their investment decisions.
2.3.4 Fourth generation of angel research

Beyond the first three generations, a review of recent studies (post 2015) shows that there is an emerging fourth generation of business angel research. What distinguishes the fourth-generation research from the previous three is a shift in focus in methodology and data sources. The first- and second-generation research is dominated by exploratory methods like interviews and surveys to provide an initial understanding of the then understudied area of entrepreneurial finance research. The third-generation research is dominated by real-time methods like verbal protocol analysis, conjoint analysis, and observational studies to address the post-hoc concerns associated with the use of interviews and surveys.

The fourth-generation studies employ quantitative approaches aimed at establishing empirical causal relationships or effects. These studies improve on past research works by using secondary datasets or field experiments. The secondary datasets come from two main sources: published early-stage investment databases like CrunchBase or unpublished data from business angel networks. The shift in focus of methodology and data sources in the fourth generation is mainly driven by researchers’ interest in establishing some casual effects of business angel activities which can be achieved through natural experiments (secondary data sources) and field experiments.

One of the emerging themes from this generation relates to works around angel investments returns. In the past, works in this area has been limited due to the difficulty in accessing past angel investments data. Publicly available secondary datasets that cover angel investments have made it possible now for these studies to be conducted. For example, Capizzi (2015) study the effect of investor experience and investments holding period on the performance angel investments as measured by internal rate of return. Also, Antretter et al. (2020) investigate how portfolio diversification practices of business
angels affect their portfolio performance and the role of knowledge acquired through co-investment networks in this process.

Another emerging theme from this generation focuses on group decision making dynamics. For example, Block et al. (2019) use a combination of secondary data from CrunchBase and social media data of business angels to study how different investor personalities facilitate their participation in business angel syndication. Another paper from Wood et al., (2020) employ an experiment to look at how peer opinion of business angels in angel investor network pitch meetings affect the financial commitment decisions of member business angels. The emerging use of these quantitative approaches have made it possible for these studies to be conducted.

Other studies in the fourth generation focus on issues relating to the business angel marketplace. For example, Capizzi et al. (2022) study how business angel investment practices influence the chances of ventures securing follow-on investments from venture capital firms. Edelman et al. (2018) also look at how angel investors treat differently women-led entrepreneurial ventures from their counterparts that are led by males. Another paper in this category is from Cipollonea and Giordani (2019). They do a cross-country study that looks at how the differences in countries affect matching process between entrepreneurs and business angels.

This study is positioned in the third and fourth generations of research for two reasons. First, I extend earlier works in the angel investment decision making process but with a specific focus on how uncertainty in early-stage ventures affect investor decisions. The interest here is on how information provided by entrepreneurs shapes the perceptions of uncertainty of investors and how it affects their investment decisions. Second, to address the main research questions I employ a quantitative approach through the use of a field experiment to investigate how uncertain information affect investor perceptions.
and their resultant decisions. The need to establish a causal relationship between uncertainty and investor decisions calls for this methodological approach in line with what we have in the fourth-generation research.

2.4 The business angel investment decision making process

In this section, I focus on the investment decision making process of angel investors. This is important for the research for three reasons.

First, this study focuses on the role of uncertainty in the investment decisions of business angels and hence it is important to review works that have been done under this thematic area to identify any gaps in the literature.

Second, the research objectives as listed in section 0 require that we use an experimental design approach for the methodology. I explain this further in section 3.2 of the methodology chapter. An experiment requires the manipulation of factors of interest to examine how they affect decisions. This means I need a basis to hypothesise the critical decision factors that influence investor decisions to enable the development of the experiment.

Finally, some recent research works show that angel investor decision-making is dynamic. Business angels use different criteria at different stages of the investment process (White and Dumay, 2020; Maxwell et al., 2011) and also over time (Avdeitchikova, 2008). This means it is important to identify which stage of the decision-making process this research focuses on as it may influence which factors are most important for investors at that stage.

I start by broadly describing a generic model of business angel decision processes based on prior research. Different models have been developed to characterise the
different stages that business angels use in their investment decisions (Maxwell et al., 2011; Riding et al., 2007; Fried and Hisrich, 1994; Tyebjee and Bruno, 1984). These models show that BAs use a less formal approach in their investments compared to their venture capital (VC) colleagues. van Osnabrugge (2000) attributes this mainly to differences in how BAs manage potential agency risks compared to VCs. First, BAs invest their own funds and are not accountable to anyone as VCs are. Second, BAs seek to be part of the venture post-investment in more of a partnership approach than VCs who prefer to have an oversight approach in the relationship (Bruton et al., 2000).

Despite the difference in the proposed models, the business angel decision making process can be grouped into six generic stages as captured in Figure 2-1. The stages are deal origination, initial screening, selection/evaluation, due diligence, negotiating and contracting, and post-investment including exit/harvesting (Maxwell et al., 2011; Riding et al., 2007).

I start by discussing the key decision factors that business angels use in their decision-making process in section 2.4.1. Then I review the literature that covers the stages of the decision-making process as described in Figure 2-1. The details of the stages show which decision criteria or factors are emphasized by business angels at the different stages of the decision-making process. Finally, I put this research in the context of what we find in the literature and what it means for the current study.
2.4.1 Critical factors for investment decision-making

Business angels consider and use multiple factors in their investment decision-making process. Initial studies referred to these criteria as ‘investment decision criteria’ (Feeney et al., 1999; Landström, 1998) while more recent studies have focused on criteria used for rejection (Mason et al., 2017; Maxwell et al., 2011). Depending on how an investor views a criterion it could be described as an investment criterion or a rejection
criterion. That is, a favourable view is termed “investment criteria” or reasons why an investment is made, while a negative view is termed “rejection criteria” or reason why an investment is not made.

Based on Maxwell et al. (2011) and Maxwell (2016), I summarise the key research findings covering this line of research in Table 2.1. I group decision criteria into factors that relate to the following categories: the main product of the venture (Mason and Stark, 2004, Bachher and Guild, 1996; Mason and Harrison, 1996a), market related factors (Landström, 1998; Bachher and Guild, 1996), characteristics about the entrepreneur and the team (Sudek, 2006; Haines et al., 2003; Feeney et al., 1999), the financials of the venture (van Osnabrugge, 2000; Feeney et al., 1999), and the factors that relate to the investment deal (Paul et al., 2007; van Osnabrugge, 2000; Mason and Harrison, 1996a).

Among factors related to the product, key considerations for business angels are how the product is protected from competition (Sudek, 2006; Stedler and Peters, 2003; Landström, 1998), the uniqueness or how innovative the product is (Mason and Stark, 2004; van Osnabrugge, 2000) and how ready the product is for the market (Mason and Stark, 2004; Mason and Harrison, 2002, 1996a). Several issues are considered about the characteristics of the market as well. They include the size of the market (Sudek, 2006; Haines et al., 2003; Haar et al., 1988), the growth prospects of the market (Paul et al., 2007; Sudek, 2006; Mason and Stark, 2004) and the peculiar dynamics in the market (Mason and Harrison, 2003; Feeney et al., 1999; Bachher and Guild, 1996).

Factors relating to the entrepreneur and the management team behind the venture are considered to be the most important decision factors for business angels (Maxwell and Levesque, 2014; Maxwell et al., 2011). Two key factors about the entrepreneur that are dominant in the literature are the relevant industry experience of the entrepreneur (Haines et al., 2003; Mason and Harrison, 2003; Landström, 1998) and any track record
of the entrepreneur in past entrepreneurial ventures (Sudek, 2006; Mason and Stark, 2004; Feeney et al., 1999). Other less tangible factors, such as the entrepreneur’s passion and commitment (Warnick et al., 2018; Maxwell et al., 2011; Sudek, 2006; Feeney et al., 1999) and how trustworthy the entrepreneur is (Haines et al., 2003; van Osnabrugge, 2000), are also important for business angels. Beyond the entrepreneur, the characteristics of the management team can make a difference in the success of the venture (Paul et al., 2007; Sudek, 2006; Mason and Harrison, 1996a).

On the financials of the ventures, business angels are first interested in whether the profitability numbers presented by entrepreneurs are realistic (Sudek, 2006; Stedler and Peters, 2003). Other issues of concern include the size of the investment (van Osnabrugge, 2000; Feeney et al., 1999), return on investment and venture valuation (Sudek, 2006; Haines et al., 2003), and the cash flow and liquidity of the venture (Haines et al., 2003; van Osnabrugge, 2000; Feeney et al., 1999). Finally, the specifics of the investment deal that are also of concern to BAs include how the business fits with investor’s investment preferences (Paul et al., 2007; Sudek, 2006; Mason and Stark, 2004), available co-investment opportunities (van Osnabrugge, 2000; Landström, 1998), future exit options for the investor (Botelho et al., 2021a; Mitteness et al., 2012a; van Osnabrugge, 2000), and the post-investment role in the venture (van Osnabrugge, 2000; Feeney et al., 1999).

The decision factors are not all used in a single decision-making process by all investors (Zacharakis and Meyer, 1998). As discussed in the next sub-section, the business angel investment decision-making process is a multi-stage one (White and Dumay, 2020). How BAs use the factors differs from stage to stage (Mason and Harrison, 2003; van Osnabrugge, 2000). For example, Maxwell and colleagues (2011) show that different factors are used at different stages of the evaluation process. At the initial stages,
a fatal flaw in any critical factor is considered enough to reject an opportunity. However, at the final stage of the evaluation process, investors spend more time on the relatively few applications that make it there. Sudek (2006) also shows that investors only consider entrepreneur-related factors after they are satisfied with their assessment of key characteristics about the venture itself. Finally, Dumay and White (2020) show that Australian business angels apply different decision criteria at each-step of the decision-making process suggesting the complexities of the decision-making process.
Table 2-1: Investment decision factors used by business angels is past research (1/3)

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Notes: This tables shows investment decision criteria that business angels use during their investment decision making process. It shows the number of articles that report each decision factor and summarises them per decision criteria category. It also includes for each article the sample size, the geographical focus of the study, and the methodology employed.
2.4.2 Investment decision-making stages and decision factors

In this section, I review the literature that covers the stages of the decision-making process especially in relation to what decision criteria are most relevant in the stages.

2.4.2.1 Deal Origination

The first stage of the investment decision-making process is the deal origination stage. Deal origination, or deal sourcing, refers to processes used by business angels to identify investment opportunities in the market. The goal at this stage is to ensure a large volume of potential deals. Business angels faced with a lot of time constraints use their informal personal networks as a source of obtaining new investment opportunities (Kelly and Hay, 2003). Sourcing opportunities from personal networks and trusted sources also helps with finding the right business opportunity and eliminates those that do not fit with the personal investment preferences of the investor (Harrison and Mason, 1999; Harrison et al., 1997).

Business angel networks (BANs) and syndicated groups are a good source of potential deals as well. The primary function of a business angel network is that of a financial intermediary facilitating trading between business angels and entrepreneurs seeking funding (Zu Knyphausen-Aufseß and Westphal, 2008). They serve as a communication channel for entrepreneurs that enables access to potential angel investors and by so doing offering BAs a source of potential deals (Mason, 2009; Mason and Harrison, 1996b). Additionally, participating in these networks enables the use of other BAs in the network to serve as trusted sources for business opportunities. The BANs also serve as a good source of filtered business opportunities as the operators of the networks serve as gatekeepers for BAs. There is, however, a downside to this as some opportunities
that hitherto may be attractive to business angels will not reach them as they are filtered out by the administrators of the network.

Some business angels are also increasingly sourcing opportunities from social media platforms. This is a developing phenomenon as social media network platforms are becoming a common platform for professionals to meet and engage. Business angels with LinkedIn and Twitter accounts use them in their normal networking activities, but these platforms also serve as a place where potential opportunities come to them via their inboxes. For example, there are network platforms on LinkedIn for entrepreneurs and business angels. Business angels on these platforms find potential opportunities through their association with these platforms. In my qualitative study of BA decision-making (described in chapters in 3 and 4), business angels talked about the usefulness of social media platforms as a source of potential deals. Some indicate that they receive hundreds of applications for funding every month via these channels.

2.4.2.2 Initial screening

The next step in the decision-making process is the screening stage. Business angels review multiple opportunities to find those that have both good potential returns and affords them the opportunity to contribute to it its success (Warnick et al.,2018; Mason and Rogers, 1997). Due to the high volumes of potential opportunities that seek funding, BAs quickly review the executive summaries of business plans to determine if the opportunity fits well with their personal investment criteria (Mason, 2008). At this stage, they want to spend less time and effort to eliminate ventures that have less potential of success or do not fit with their personal preferences. As Brush et al. (2012) argue, BAs must rule out the ‘no hopers’ to focus time and efforts on proposals that have potential.
Screening criteria used by investors at this stage reflect a propensity to focus on areas that they are familiar with especially in terms of technology, products, and market scope of the business (Tyebjee and Bruno, 1984). Factors that are typically considered at this stage are location, sector or industry, and the BA’s ability to contribute to the success of the business (Mason and Rogers, 1997). Business angels typically prefer to invest in ventures that are within their geographical area (Harrison et al., 2010). This is mainly to ensure they are able to be part of the ventures post investments through face-to-face interactions acting as advisors and board members (Mason et al, 2021). There is however a significant minority of investments by business angels outside of their locality done mainly through syndication (Mason et al, 2021; Gvetadze et al., 2020; Harrison et al., 2010).

Additionally, they also have preference for specific sectors or industries. This is related to their ability to contribute to the venture post-investment. Business angels act as advisors or board members to their investee companies and hence prefer ventures in familiar industries. Other factors that are considered at this stage include concerns with the entrepreneur (Feeney et al., 1999), and issues with the venture itself (Bachher and Guild, 1996). Most of the applications received are rejected at the initial screening stage. Mason and Harrison (2015), in a study of UK angel investors, report that 70% of applications are rejected at the initial screening stage. Riding et al. (1994) also report a slightly higher number of 73% rejection at this stage. In an EBAN report for 2021, they report that for every 100 applications 77 do not make it to the next stage for deal evaluation.

I contend that the uncertainties in information provided in business proposals by entrepreneurs drive investors to desk-reject applications at this stage. Typically, business angels only depend on information provided by entrepreneurs to make decisions on
whether to proceed to the next stage of the investment process where they perform a thorough evaluation of the venture. The information provided forms the basis of investor perceptions of uncertainty in the venture and in effect their decisions. I therefore situate the current study at the screening stage of the decision-making process to further understand the high rejection numbers observed and the role perceptions of uncertainty play in this.

2.4.2.3 Selection/Evaluation

Ventures that are not rejected at the initial screening stage are fully assessed at the evaluation stage. The evaluation stage involves a more detailed analysis of the business proposals that make it past the initial screening stage. It may also be the first time that the investor interacts or engages with the entrepreneur. Typically, the investor seeks to know more about the business at this stage. The investor has the opportunity to ask any question resulting from their initial review of the business proposal. The selection and evaluation stage may involve a multi-stage process that continues until an offer is made by the investor or the proposal is rejected (Maxwell et al., 2011). One of the major research works that have focused on the complexities of this stage is from Maxwell et al. (2011). They identify four sub-stages that are mainly distinguished by different criteria that investors considered important for their decisions. As they argue, investors adopt a sequential elimination process that first rejects opportunities based on a single fatal flaw, then reject those that either have insufficient return or excessive venture risks, then reject those that they have concerns about the ability of the entrepreneur and finally those where they considered the relationship risks with the entrepreneur as high. I provide further details of the sub-stages in the following paragraphs.

At the first stage of the evaluation process, business angels use eight critical factors for their decisions. The factors are low market potential (Feeney et al., 1999),
limited evidence of product adoption (Bachher and Guild, 1996), lack of protectability (Landström, 1998; Mason and Harrison, 1996a), limited entrepreneur experience (Cassar, 2014), excessive time to market (Mason and Harrison, 2002; MacMillan et al, 1985), lack of viable route to market (Mason and Stark, 2004), limited customer engagement (Wiltbank et al., 2009; Mason and Harrison, 1996a;) and financial forecasts that indicate the venture will run out of funds (Collewaert, 2012; Mason and Stark, 2004). Any opportunity that has a ‘fatal flaw’ in any one of the eight critical factors identified by Maxwell et al. (2011) is typically rejected at this stage. The factors at this stage are not typically used in a compensatory manner. That is, a flaw in one is not reduced by a positive in another.

At the next stage of the evaluation process, investors combine the eight factors to form an assessment of potential investment return and risks of the opportunity. Opportunities are rejected at this stage for one of two reasons: potential return below a desired level or venture risk above a desired level (Jeffrey et al., 2016). In assessing the potential investment return and the venture’s risk, the factors are used in a compensatory manner. However, in deciding whether to reject the opportunity, a low venture risk does not compensate for a low potential return and vice versa. Investors have a desired minimum return they expect from their investment and a maximum venture risk they are willing to take as well and both conditions have to be met for an opportunity to progress to the next stage. At this stage, the entrepreneur’s characteristics are not considered much as this is only important to investors when they are satisfied with venture characteristics.

At the third stage of the evaluation process, opportunities are rejected for what investors consider as high managerial risk. Managerial risk is the risk that the entrepreneur will not be able to deliver the venture potential (Feeney et al., 1999). That is, the non-delivery of the venture potential due to factors within the manager. Therefore,
at this stage business angels focus on evaluating characteristics of the entrepreneur. Entrepreneur related factors that are assessed at this stage include: technical expertise (Sandberg et al., 1989), social skills (Baron and Markman, 2003), ability to discover new opportunities (Baron, 2007), management capability (Reuber and Fischer, 1994), risk management skills (Baron and Markman, 2003), leadership skills (Mitteness et al., 2010), industry knowledge (Cassar, 2014), educational background (Franke et al., 2008), past record as a founder (Gompers et al., 2006; Haines et al., 2003; Feeney et al., 1999), commitment and passion (Mitteness et al., 2012b; Sudek, 2006; Feeney et al., 1999), and confidence (Brush et al., 2012). How the entrepreneur presents essential information, responds to questions, responses to feedback and criticism all feed into the investor’s assessment of the ability of the entrepreneur to deliver on the potential of the venture.

The last stage involves the assessment of what is termed relationship risk. Relationship risk is the risk that the entrepreneur may take actions and decisions that are detrimental to the interest of the investor. This is somewhat related to agency risk. Relationship risk comes from either the lack of capacity (knowledge or experience) of the entrepreneur or the entrepreneur putting his interest above that of the investor (agency risk). This is assessed mainly based on trust behaviours exhibited by the entrepreneur during the interaction with the investor (Sudek, 2006).

What is evident at the evaluation stage is the different ways business angels use the information provided to evaluate potential opportunities at different sub-stages. While some factors are used in compensatory manner, others are not. The evaluation stage involves some interaction between investors and entrepreneurs which mean there is an opportunity for the provision of additional information beyond what is provided by the entrepreneur. Since investor perceptions of uncertainties are based on information, additional information has the potential to reduce these perceptions and in effect influence
investor decisions. This provision of additional information is typically absent at the screening stage and formation of uncertainty perceptions are entirely dependent on the information initially provided.

2.4.2.4 Due diligence, negotiations, and consummation

The next stage is the due diligence, negotiations, and consummation stage. When an investor is satisfied with the details of the business plan and the answers provided by the entrepreneur during their interactions at the evaluation stage the venture is selected for due diligence. This is the first step of this stage of the investment decision-process. Due diligence involves steps taken by the investor to validate the details of the business proposal in addition to the verbal claims made by the entrepreneur during conversations with the investor. Investors use a variety of informal approaches to conduct their due diligence activities (Haines et al., 2003). More experienced investors focus less on the financials of the venture and more on the characteristics of the entrepreneur as they seek to manage relationship risks (Harrison et al., 2015). Additionally, BAs perform less due diligence compared to VCs as they do not need to justify their decisions to third parties like VCs have to (van Osnabrugge and Robinson, 2000). This however does not mean that business angels are not thorough in their due diligence process. As Wiltbank (2005) reports, angels spend on average about 40 hours on due diligence. An interesting finding from Wiltbank (2005) is that, while more due diligence leads to more successful exits, it also leads to more failures. Perhaps, business angels who undertake more due diligence take bets on highly uncertain ventures who will either fail or become homeruns. Finally, at the due diligence stage, proposals are rejected based on the potential for profits (Croce et al., 2017)
In the next step of this stage, the business angel offers a monetary amount for an equity stake in the business when the due diligence process is satisfactory to the investor. Here the business angel negotiates with the entrepreneur for the price to pay for a part of the venture. There is also a shareholder agreement that has to be negotiated and agreed on before the relationship is consummated (Haines et al., 2003; Kelly and Hay, 2003). The assessment of the entrepreneur’s behaviour in the earlier stages of the process influences how the clauses in the agreements are structured (Kaplan and Stromberg, 2004). When the price for the shares of the venture and the clauses of the shareholder agreement are agreed on the relationship is consummated.

Opportunities that make it to this stage are mostly rejected for three major reasons. The first reason relates to when investors find material inaccuracies in their search to confirm information received through business plans and their interactions with the entrepreneur (Mason et al., 2015). The second major reason for deals not being consummated at this stage relates to disagreements over the valuation of the firm (Riding et al., 1994). The final reason relates to the terms of the shareholder agreement (Haines et al., 2003). However, valuation is the most cited reason for the deals breaking-up at this stage. Entrepreneurs overvalue the potential of the business while investors undervalue it. The expected contributions of the investor are often discounted by the entrepreneur in the valuation (Mason et al., 2015) and this is the major cause of the disagreement.

2.4.2.5 Post-investment activities

There are two main post-investment activities for business angels. The first involves working with the entrepreneurs to develop and grow the venture. Business angels, when compared to venture capitalists, are more involved in the venture after the investment. They often contribute to the success of the venture by acting as advisors or
board members. Venture capitalists typically are more interested in monitoring the performance of their investee companies. Business angels, however, see their active roles in the ventures as part of their entrepreneurial career. They pass on their knowledge and experiences to the less experienced entrepreneurs that they work with (Politis and Landström, 2002). It is instructive to note that the role business angels play post-investment is not accidental. Business angels place an emphasis on their role post-investment at the earliest stages of the decision-making process (White and Dumay, 2020).

The second activity involves how business angels exit their investee firms and what options are available to them. On exit options, strategic acquisitions through trade-sales are the main exit paths for business angels. Exits through initial public offerings (IPOs) and management buyouts are rare as the business will not have developed to that stage when the business angel needs to exit (Freear and Wetzel, 1990). The investor and the entrepreneur typically position the business to attract strategic investors (McKaskill, 2009), typically larger firms in the same industry or venture capitalists.

Failure should also be considered as an exit option. As Mason and colleagues (2015) find, businesses that have plans to rapidly test market demand and if unsuccessful fail early are more likely to obtain funding than those that have a prolonged failure time. For business angels, successful investing is not only about maximising the gains from successful investments but also about minimising the losses from those that fail. It is better for business angels to exit early investments that show a high likelihood to fail post-investment (Mason and Botelho, 2014). Failure may be necessitated by varying reasons including lower than expected product adoption rate, unfavourable market conditions, or unexpected catastrophic events.
It is important to note that most exits or liquidity events of business angels are planned and not opportunistic (Botelho et al., 2021a). Exit options are of great importance to business angels who consider it throughout the decision-making process even as early as deal origination. (White and Dumay, 2020).

2.5 Business angel characteristics and investment decisions

In the previous section I looked at the investment decision process of business angels and the factors they consider when they make decisions. In this section, I take this a step further by reviewing the literature on how investor characteristics affect their decision making. Business angels are heterogeneous in nature and are often influenced by their individual personalities, motivations, background, and experiences when they make investment decisions (Maxwell, 2016). I discuss how various characteristics of business angels affect their investment decisions in the following paragraphs.

First, the investing experience of a business angel affects their decision-making process. Investing experience is measured by either the number of years that the investor has been engaged in early-stage investing or the number of investments made. BAs with more investing experience have been shown to make faster investment decisions (Harrison et al., 2015). This is because they use fewer factors to evaluate business opportunities (Maxwell et al., 2011) and pay less attention to the financials of the opportunity (van Osnabrugge and Robinson, 2000). They also spend less time on due diligence as they believe they know how to mitigate potential relationship risks (Benjamin and Margulis, 1996). To that extent, they spend more time evaluating the entrepreneur’s previous venture partnership as a means of mitigating potential relationship risks (Madill et al., 2005; Sorheim, 2005). BA experience also influences how they use decision factors in their evaluation. For example, investors with more investing experience place greater
emphasis on the combination of product passion and entrepreneurs’ openness to feedback whereas those with more entrepreneurial experience emphasise the combination of entrepreneurial passion and entrepreneurs’ openness to feedback (Warnick et al., 2018).

Second, the cultural and professional background of a business angel also affects their investment decisions. BAs with relevant knowledge and experience in the industry or market of an opportunity feel more component to assess them (Mason and Stark, 2004). Indeed, when BAs share some commonalities (motivations, experience, and expectations) with the entrepreneur, it can favourably affect their investment decision (Maxwell and Levesque, 2014). The cultural background of an investor also influences how they invest. For example, Stedler and Peters (2003) find that German BAs are often more interested in high-growth technology ventures compared to their counterparts in the UK and USA. Ding et al. (2014) also find that compared to BAs in Denmark, those in China are more interested in prior entrepreneur relationships and use less objective assessment of risk. These are all influenced by their cultural backgrounds.

Third, motivations of investors shape their investment preferences which in turn affects their investment decisions. The primary motivation for most business angels in angel investments is for financial return (Wetzel, 1983). There are other non-financial motivations in the form of psychic income from helping entrepreneurs to achieve their goals (Maddill et al., 2005), contributing to the society (Benjamin and Margulis, 1996), and facilitating new venture creation and entrepreneurial activity (Freear et al., 1994). Mason (2008) also finds that business angels with common characteristics (motivations, experience, and expectations) make investments in a similar manner and can thus be grouped together.

There are also individual specific factors that affect the investments styles of business angels. For example, Block and co-authors (2019) find that the personality of
business angels influences their investment syndication choices. Investors that are extraverts are more likely to participate in business angels syndicating. On the contrary, conscientiousness reduces the likelihood of syndication among business angels. However, while business angel personality influences the composition of a syndicate it has no effect on venture success.

Finally, with the increasing role of business angel networks in the early-stage investment ecosystem, dynamics of group decisions have become important. Group decisions occur in pitch forums and business angel network events, and this has an influence on investment decisions (Mason et al., 2013). Less experienced angel investors are influenced by their relatively more experienced colleagues in the network. BA group structure also influences decision-making; more formal networks have more influence on decision making than less formal groups who only serve as deal sourcing points (Gregson et al., 2013).

From the literature discussed in the preceding paragraphs in this section, two things are evident. First, investors are heterogenous and come into angel investing with different backgrounds. The background of investors includes their past professional work experiences, their educational background, cultural background, and whether they have an entrepreneurial background or not. These experiences prior to their angel investing activities shape how they process information from entrepreneurs. Information from familiar sources may be looked on more favourably than from those that are less familiar to investors. In the context of investor perceptions of uncertainty, how do these backgrounds of investors affect their perceptions of uncertainty? Second, there is also evidence that investing experience affects how investors make their decisions. Again, how does the past investing experiences of business angels affect their perceptions of uncertainty? These are gaps in the current literature that are addressed by the current study.
in chapter 5. Further, how do the backgrounds and experiences of business angels affect their decision making in the face of uncertainty? This question is also addressed in chapter 6.

At the centre of the identified gaps highlighted in the previous paragraph is the uncertainty construct. To this I review the risk and uncertainty literature to understand what research works have been done and how it relates to the business angel decision making process. I review the definitions and dimensions of uncertainty in addition to how uncertainty is measured to help develop the research design for the study.

2.6 Risk and uncertainty – definitions and dimensions

2.6.1 Definitions and dimensions of uncertainty

Decision makers such as business angels must often make decisions now about events that may occur in the future. Expected utility (EU) theory prescribes how to choose rationally when one is not sure which outcome will result from current acts. von Neumann and Morgenstern (vNM) in 1947 showed that if preferences obeyed a set of axioms then those preferences could be represented by the expectation of some utility function. Rational decision makers therefore choose acts that maximizes their utility of possible outcomes or what is termed the expected utility. In expected utility theory, the probability of each outcome occurring is objectively known ex ante.

However, in most natural settings, probabilities of outcomes are not well known or agreed upon and choices are said to be made under “uncertainty”. Savage (1954), inspired by Ramsey (1931), developed the Subjective Expected Utility (SEU) based on the vNM EU approach with de Finetti’s (1937) calculus of subjective probabilities. In SEU, probabilities are not objectively known as assumed in EU but are based on the subjective beliefs of the decision maker. Savage proved that, if the decision-maker
adheres to axioms of rationality, believing an uncertain event has possible outcomes each with an assigned utility, then the person's choices can be explained as arising from this utility function combined with the subjective belief that there is a probability of each outcome. Which decision the person prefers depends on which subjective expected utility is higher. Different people may make different decisions under the same conditions because they may have different utility functions or different beliefs about the probabilities of the outcomes or both.

In both EU and SEU theories, decision makers are assumed to be rational and utility maximisers given the information available to them. However, decision-makers have been shown to be constrained in their decision-making process by three unavoidable factors in what Simon (1955) termed bounded rationality. First, information available regarding possible alternatives and their consequences is limited or incomplete and often unreliable. Secondly, the human mind has limited capacity to process and evaluate all available information to make the desired optimal decision predicted. Finally, during the process of decision making, decision-makers have only a limited amount of time to decide on acts available to them. Hence, even individuals who intend to make rational utility maximizing decisions are bound to make satisficing choices often based on heuristics and rules of thumb (Simon, 1955).

Experiments have also shown that many individuals do not behave in a manner consistent with Savage's axioms of SEU (Ellsberg, 1961; Allais, 1953). Most evidence that is critical of SEU focuses on precisely the distinction between whether the probability of outcome is known or unknown by the decision maker. Two of the most known distinctions made are risk versus uncertainty (Knight, 1921), and unambiguous versus ambiguous probability (Ellsberg, 1961). Knight formalised a distinction between risk and uncertainty in his 1921 book *Risk, Uncertainty, and Profit*. As Knight observed, an ever-
changing world brings new opportunities for businesses to make profits. However, an ever-changing world also implies that we have an imperfect knowledge of future events. Thus, ‘risk’ applies to situations where we do not know the precise outcome of a given situation but can accurately measure the likelihoods of potential outcomes. Conversely, ‘uncertainty’ applies to situations where we cannot know all the information required to accurately measure the likelihoods of outcomes before decisions are taken. Knight notes that there is a fundamental distinction between the reward for taking a known risk (i.e. ‘Risk’) and that for assuming an unknown risk (i.e. ‘Uncertainty’).

Ellsberg, in his 1961 seminal paper, used thought experiments to show that there exist cases where lack of information about relevant aspects of a problem might cause the decision maker to act in ways that are incompatible with probabilistic beliefs and hence the SEU. In the two-urn experiment, a decision maker is presented with two urns which contains say 100 balls each. Urn 1 contains 50 red balls and 50 black balls which can be verified by the decision maker. However, the composition of Urn 2 is unknown to the decision maker. Ellsberg postulates that in a choice situation, a decision maker would strictly prefer receiving a prize upon drawing a red ball from Urn 1 than receiving the same prize upon drawing a red ball from Urn 2, and similarly if one replaces red by black. This shows that in general people exhibit an aversion to what Ellsberg terms ‘ambiguous’ information, meaning they have an inherent preference for the known over the unknown. Ellsberg called this ambiguity aversion. In decision theory and economics, ambiguity aversion is a preference for ‘known risks’ (i.e., ‘Risk’) over ‘unknown risks’ (i.e., ‘Uncertainty’). An ambiguity-averse individual would rather choose an alternative where the probability distribution of the outcomes is known over one where the probabilities are unknown.
Beyond the distinctions of uncertainty made by Knight (1921) and Ellsberg (1961), there have been other distinctions in the finance and economics literature. Some scholars describe extreme uncertainty as unknowable risks (Kahneman, 2011; Diebold et al., 2010; Hastie and Dawes, 2009) which is distinct from Knight’s uncertainty or Ellsberg’s ambiguity. In both Knight’s and Ellsberg’s distinction, uncertainty refers to situations where the possible future outcomes are known, but what is missing is a probabilistic estimate of their chances of occurrence. Unknowable situations refer to cases where uncertainty is so extreme that both the outcomes and their probabilities are unknown. Therefore, in this distinction, we have known risk (where both outcomes and probabilities are known), uncertainty (where outcomes are known but probabilities are unknown), and unknowable risk (where both outcomes and probabilities are unknown). Huang and Pearce (2015) argue that angel investors are faced with cases of unknowable risks as they deal with ventures with ideas about markets and products that sometimes do not even exist.

Another seminal work on uncertainty is the work by Milliken that breaks down environmental uncertainty into different components. Unlike the other works described in the preceding paragraphs, Milliken (1987) unpacks uncertainty faced by decision-makers into three distinct types: state, effect, and response. State uncertainty refers to how the decision-maker is unable to predict how the components of the environment are changing. Effect uncertainty is the inability of the decision-maker to predict the effects of the changing environment on the firm. The last one, response uncertainty describes the inability of decision-makers to know the response options available to them for the changing environment in addition to the likely consequences of a response choice. The implication of Milliken’s distinction is that uncertainty is a function of the nature of the missing information represented by each type. This means each type of uncertainty may
have different implications for the decision-maker in terms of how to interpret and respond to it.

A more recent typology from Dequech (2011) distinguishes uncertainty from three dimensions. The first is substantive-procedural, which is borrowed from (Dosi and Egidi, 1991) and reflects Simon’s (1979) distinction of whether the uncertainty comes from a lack of information (substantive) or a lack of computational ability (procedural). The second relates to a weak – strong dimension, which is based on Knight’s (1921) distinction between probabilistic uncertainty (weak) and nonprobabilistic uncertainty (strong). The last dimension is the ambiguous-fundamental dimension which distinguishes uncertainties that have stable and finite outcomes that are just unknown (ambiguous) against fundamental uncertainty that relates to realities that depend on nonpredetermined structural changes from the creative abilities of individuals.

2.6.2 Measuring uncertainty aversion

Most empirical measurements of uncertainty aversion rely on the Ellsberg experiment model. In Ellsberg’s 2-colour urn experiment, decision-makers are presented with pairs of urns with different information on the composition of balls; one with known probability (risky urn) and the other with unknown probability (ambiguous urn). Choices made by decision-makers are used to measure how averse they are to uncertain or ambiguous information. In this case, a strict preference for the risky urn will be interpreted as ambiguity aversion. A strict preference for the ambiguous urn will be interpreted as ambiguity seeking while ambiguity neutrality will be when a decision maker is indifferent about the two urns. Since Ellsberg’s experiment in 1961, many researchers have conducted variations of the experiments under different conditions including respondents of different characteristics, varying uncertainty information, and
incentivized experiments. It has also been employed in real life cases in economics, insurance, and finance.

The two main early extensions of the Ellsberg’s experiments are variations in uncertainty levels and eliciting how much people are willing to pay to avoid uncertainty (Becker and Brownson, 1964). Unlike the original Ellsberg experiment, participants are presented with different pairs of urns (risky and ambiguous urns) with varying degrees of ambiguity in the ambiguous urns. Participants do not only make decisions on which urn to draw from but also indicate how much they are willing to pay to draw from the risky urn to avoid the ambiguous urn. This is used not only to measure ambiguity aversion but also what is termed the ambiguity premium paid to avoid ambiguous situations. Most works in this space have adopted this approach (Oechssler and Roomets, 2015; Trautmann and van de Kuilen, 2015; Borghans et al., 2009).

There are two main ways of measuring ambiguity premium paid by an ambiguity averse individual to avoid ambiguity. The first is measured as the ratio of the difference between the valuation of the risky option and the valuation of the ambiguous option to the expected value of the risky option (Trautmann and van de Kuilen, 2015). This is possible when the study measures both valuations of the risky and ambiguous options as well as the expected value of the risky option. The other measure is simply the ratio of the difference between the valuation of the risky and ambiguous option to the valuation of the risky option (Trautmann and van de Kuilen, 2015). In the second measure you do not need the measure the expected value of the risky option as done in studies that measure risk aversion.

In a paper to demonstrate gender differences in risk and ambiguity aversion, Borghans et al. (2009) conducted a variation of the Ellsberg 2-colour urn experiment to elicit strict ambiguity preferences. In the paper, participants are presented with four urns
of 2 colours, blue and yellow. Each urn contains a total of 10 balls with different compositions of blue and yellow balls. There is one risky urn with exactly 5 blue balls and 5 yellow balls. The other three ambiguous urns contain balls with varying degrees of ambiguity in the probability of the balls: 40-60%, 20-80%, and 0-100%. For each urn, participants are made to bet on a colour and to give the minimum price for which they will be willing to sell the bet. The difference between the price for the risky urn and the ambiguous urn is used as the measure of ambiguity aversion.

Studies in real markets have adopted similar approaches typically through the choice between two options, the certain option, and the uncertain option. Camerer and Kunreuther (1989) for example created a theoretical insurance market in which players could transfer potential losses to other players by paying a negotiated insurance premium. The probability of loss was presented as either known (e.g., 10%) or unknown (e.g., between 0 and 20%). In another study, Sarin and Weber (1993) tested the effects of ambiguity on prices in a market auction setting, auctioning off ambiguous and unambiguous lotteries using business students and bankers. The unambiguous lottery contained five winning and 5 losing balls while the ambiguous lottery contained balls with unknown composition. Muthukrishnan et al. (2009) also test ambiguity aversion in a marketing setting using brands of different products by indicating a perceived more or less ambiguous brand quality. Participants indicated their preferred brand and how much they are willing to pay for it.

In a more recent work, Dimmock et al. (2016) established that ambiguity aversion is negatively related to stock market participation. Using a large representative sample, they conduct an experiment to measure general ambiguity attitudes of participants by means of a tractable model of matching probabilities of ambiguous events. This is then used together with secondary data from a longitudinal internet study of the chosen sample
to establish a correlation of their attitudes towards ambiguity and their financial asset decisions. Other studies have used similar designs of measuring general ambiguity attitudes through experiments, then linking these attitudes to economic choices. For example, Engle-Warnick et al. (2007), in a study of effects of ambiguity aversion on farming choices, find that Peruvian farmers who avoid ambiguity in an experimental task are less likely to adopt new varieties of crop. In a similar study, Ross et al. (2012) also measure general ambiguity attitudes of farmers in Laos and then measure their use of the new variety of rice. They find that participants with high aversion to ambiguity are less likely to use the new variety of rice and even when they do, use it less intensively than the less ambiguity-averse farmers.

Other researchers have measured uncertainty aversion by decomposing secondary data into various parameters and analysing the effects uncertainty aversion on these parameters. For example, using secondary data, Li et al. (2016) study the role ambiguity aversion plays in the determination of mutual fund investors’ response to fund performance. Multiple performance-based signals of uncertain precision are used as proxies for uncertainty in the future performance of a fund and used to measure how investors respond to them. The data is decomposed into the various performance signals, and investor sensitivity to the worst performing signal in any period is used as a measure of ambiguity aversion.

2.7 Risk and uncertainty in entrepreneurial research and action

The concept of uncertainty is fundamental to entrepreneurship research (Townsend et al., 2018). It is the ability of the entrepreneur to interpret or perceive the uncertainty and respond to it that determines the success or failure of the business (McKelvie et al., 2011). One of the core assumptions of entrepreneurship is
entrepreneurs take entrepreneurial actions in the face of inherently uncertain and unknowable futures (Sarasvathy et al., 2003; Shane and Eckhardt, 2003; Knight, 1921). From the perspective of both firm founders and funders who make decisions on what future outcomes are feasible, which investments are prudent and whether to proceed with a venture or not; these entrepreneurial decisions are made in the face of uncertainty (Packard et al., 2017).

From the perspective of risk, there has been empirical research investigating risk preferences and associated cognitive biases within the entrepreneurial action or decision-making space. Miner and Raju (2004) conducted a review (meta-analysis) of prior research with the focus of comparing risk-taking propensities of entrepreneurs and non-entrepreneurs (managers). There was no evidence of any difference in their risk attitudes. They instead found that entrepreneurs perceive business ventures as less risky and more controllable than managers (Sarasvathy et al., 1998; Palich and Bagby, 1995). Entrepreneurs also have few regrets and do not consider counterfactual alternatives to past events (Baron, 1998). Using prior research, Wu and Knott (2006) proposed that entrepreneurs are risk averse with regards to uncertainty around customer demand but over-confident regarding their own skills and ability and hence are prone to risk-seeking behaviours.

Uncertainty, however, is dominant in entrepreneurial action research. As Folta (2007) puts it, in entrepreneurship uncertainty rules the day. “Though uncertainty is prevalent in business and other social situations, it is pervasive in entrepreneurial settings” (Sorenson and Stuart, 2008, p. 530). In entrepreneurship, uncertainty is not viewed with a negative undertone. Indeed, the presence of a-priori uncertainty associated with the viability of an opportunity is an essential pre-condition for the very existence of the opportunity (Sorenson and Stuart, 2008; McGrath et al., 2004). The willingness and
ability of an entrepreneur to take advantage of an opportunity while bearing the uncertainty that comes with it determines both the paths undertaken and the entrepreneurial profits or outcomes. In fact, one cannot have an opportunity without uncertainty (McMullen et al., 2007).

Another seminal work on uncertainty that has been explored in entrepreneurial action research is Milliken’s work that disaggregates uncertainty. In a single-level approach, McKelvie et al. (2011) use Milliken’s (1987) construct of uncertainty (state, effect, and response) to investigate the effect of uncertainty on entrepreneurial action. As explained in section 0, state uncertainty refers to the inability of the decision-maker to predict how the environment changes while effect uncertainty is the inability of the decision-maker to predict the effects of these changes on the firm. Response uncertainty describes the lack of knowledge of the response options available to decision-makers in the face of the changing environment and the likely consequences of a response choice. Mc Kelvie et al. (2011) focus on the decision making of the individual entrepreneur, in this case his or her willingness to exploit an entrepreneurial opportunity in the face of varying degrees of uncertainty and combinations of the different dimensions of uncertainty. In general, they find that entrepreneurs are averse to uncertainty – more uncertainty leads to decreased willingness to undertake an entrepreneurial action. However, the type of uncertainty experienced by the entrepreneur has different effects on the entrepreneur’s willingness to undertake an entrepreneurial action and require different ways of resolving. While state uncertainty (perceived environmental uncertainty) does not affect an entrepreneur’s willingness to undertake an entrepreneurial action, perceived effect uncertainty negatively affects the willingness of the entrepreneur to take an entrepreneurial action. For example, on the role of how the entrepreneur’s expertise moderates the relationship between uncertainty and entrepreneurial action, they find that
it is only in the case of perceived effect uncertainty (the predictability of future states) that there is any evidence.

Miller (2012) distinguishes Knightian uncertainty from other constructs of uncertainty such as perceived uncertainty (Milliken, 1987) or adopter-specific uncertainty (Rogers, 2003). Miller argues that perceived uncertainty is a quality of the individual (in this case the entrepreneur) while Knightian uncertainty relates to the environment – specifically about the potential outcomes and the probability distribution of the possible outcomes from actions. Knightian uncertainty is based on an ‘objectivist uncertainty’ while perceived uncertainty is based on a ‘subjectivist uncertainty’. Miller concludes that entrepreneurial outcomes depend both on the subjective perceptions (perceived uncertainty) of the entrepreneur and what Knight (1921) describes as ‘true’ uncertainty, which constitutes the objective conditions of the environment and how they react with perceived uncertainty and entrepreneurial actions.

Other scholars, however, have questioned whether in practice entrepreneurs are incentivized by uncertainty in their pursuit of entrepreneurial opportunities (Posen, et al., 2016; Klingebiel and Adner, 2015; Driouchi and Bennett, 2012). They argue that in practice individuals are either unable or unwilling to make a distinction between risk and uncertainty as Knight (1921) proposes (Taleb, 2007; Savage, 1972). They rather confront risk and uncertainty as though they are one and the same (Taleb, 2007). The effectuation literature, however, contends that entrepreneurs deal with uncertainty differently. Effectuation scholars argue that experienced entrepreneurs do not use predictive approaches (predict future outcomes) in their decision making but prefer effectual control measures to shape future outcomes even when they deem them potentially unfavourable (Dew et al., 2009; Sarasvathy, 2001).
However, uncertainty has been used to explain the environments in which entrepreneurial activities operate (Gaglio and Katz, 2001; Busenitz, 1996), the expertise and ignorance of individual founders (Hunt and Kiefer, 2017; Sarasvathy, 2008; Baron and Ensley, 2006; Freel, 2005; Sarasvathy, 2001; Tversky and Kahneman, 1974), and firm-level strategic unknowns (Hage, 1999; Barnett and Hansen, 1996). Environmental uncertainty also negatively impacts key firm-level outcomes such as the early-stage capitalization process (Townsend and Busenitz, 2015). While Knightian uncertainty may enable the identification of entrepreneurial opportunities, it may also limit the entrepreneur’s ability to exploit them (Miller, 2012). Although environmental uncertainty may have negative effects on the outcome of entrepreneurial actions, the introduction of new information can help entrepreneurs resolve or mitigate these negative impacts (Hunt and Song, 2015).

### 2.8 Risk and uncertainty in angel investment decisions

From the review so far, research on business angel investment decision making has focused mainly on the investment process and its stages, decision factors used by angel investors, and how these factors vary across different stages. Very little has been done to explore or investigate how these decisions are made in the face of the uncertainties in the businesses and the role uncertainty plays in the decision-making. We know that when business angels make investment decisions on early-stage ventures they do so under similar uncertain conditions faced by the entrepreneurs behind the business (Huang and Pearce, 2015). Although there is a lot of work done in the entrepreneurial action literature on the role of uncertainty in the decision-making of entrepreneurs, there is very little done in the early-stage venture finance space.
One of the few recognisable works in this space is by Huang and Pearce (2015). They conduct a three-part study (an inductive theory-development study, a field experiment, and a longitudinal field test) to test the effectiveness of angel investment decisions under extreme uncertainty (i.e., unknown-un knowns). They show that angel investors use both formal analysis and intuition (“gut feel”) to select and invest in a few extraordinarily profitable business opportunities. Their findings also show that while they use both expert intuition and formal analysis, when there is a conflict between their intuition and formal analysis, they defer to their intuitions. As Huang (2018) inductively find, this “gut-feel” is an elaborate “intuiting process” contrary to how it is described in prior research as being based on rapid and unconscious impulse.

An earlier work by Wiltbank and colleagues (2009) also focuses on how angel investors manage the uncertainties in the business opportunities they invest in. They investigate the use of predictive and non-predictive strategies by angel investors in their decision-making. While predictive strategies focus on the use of past data to predict the future, non-predictive strategies refer to efforts used by actors to control future outcomes under uncertain future conditions (Sarasvathy, 2001). Wiltbank and colleagues find that while those who use predictive control strategies are led to invest more, those that use non-predictive control strategies have fewer investment failures with a corresponding reduction in their number of successful investments. Business angels who employ effectual decision-making principles also experience significant increases in the valuation of investee ventures (Schmidt et al., 2018). An implication of this is that effectuation strategies are more effective in selecting business opportunities that turn out to be successful in the future.

There are two studies on how angel investors evaluate risks and rewards and its effects on their investment decisions. Jeffrey and colleagues (2016) find that business
angels take a two-step approach when evaluating risks and rewards of business opportunities. First, they take a compensatory approach when they use critical decision-factors in forming their assessments on venture risks and returns. However, in taking a decision on whether to proceed to the next stage of the investment process, they do not compensate, for instance, a low venture return with a low venture risk. Forrester et al. (2020) also find support for their hypothesis that investor experience is strongly associated with high risk-taking propensities of angel investors. They also find some evidence that investors with more experience also place a lot of value on the past experiences of founder which makes them take more risk.

There is some anecdotal evidence as well in the angel investor literature in relation to risk and uncertainty. For example, uncertainty influences how investors evaluate the quality of potential investment targets (Li and Mahoney, 2011; Zacharakis et al., 2007), including how they evaluate management teams (Matusik et al., 2008) and decide whether to replace them during the funding process (Pollock et al., 2009). BAs have been found to operate under time constraints and use short-cut heuristics to rapidly reject business opportunities in a multi-stage decision making process (Maxwell et al., 2011; Mason and Harrison, 2003; Mason and Rogers, 1997). This is against normative decision making since investors sometimes reject potentially promising opportunities. This is attributed to business angels not putting in the time to reduce their perceived uncertainties especially when they believe they have less uncertain opportunities available (Maxwell, 2016).

2.9 Summary and conclusion

The purpose of this chapter is to review the angel investment decision-making and the uncertainty literatures, to identify gaps in the literature, and how the current study addresses these gaps, and where the current study fits in the angel investing literature.
The literature review reveals that while in the entrepreneurial literature the role of uncertainty in entrepreneurial action has been well studied, little attention has been paid to it in the angel investing context. The concept of uncertainty is central to entrepreneurship research as it forms the basis for virtually every condition, context, and level of analysis (Townsend et al., 2018). Uncertainty has been used to explain the environments in which entrepreneurial activities operate (Gaglio and Katz, 2001), the expertise and ignorance of individual founders (Hunt and Kiefer, 2017), how different types of uncertainty affect entrepreneurial action (McKelvie et al., 2011) and firm-level strategic unknowns (Barnett and Hansen, 1996).

This study thus seeks to contribute to the literature with respect to the role that uncertainty plays in the decision-making of early-stage investors. Investors that finance early-stage ventures do so in the face of these uncertainties as these ventures are fraught with uncertainties. A few notable papers in the angel investment literature have focused on how business angels manage the uncertainties in the business as they make investment decisions (Huang and Pearce, 2015; Wiltbank et al., 2009). The use of heuristics and gut feeling (Huang and Pearce, 2015) and non-predictive control strategies (Wiltbank et al., 2009) to manage uncertainties are emphasised in these studies.

This study, however, focuses on how business angels interpret and perceive uncertainties and how they affect their investment decisions. Additionally, the literature review shows that business angels are heterogenous, and their backgrounds, motivations, and characteristics affect their decision-making process. As Drover et al. (2017) propose, the nuances of these on investor decisions need to be explicitly explored. To that extent, the study also explores how these backgrounds and characteristics affect how investors perceive the uncertainties in the ventures and how they affect their investments decisions. These gaps in the literature are addressed in the empirical chapters.
The review also shows that the current study is situated in the third generation of the business angel investing literature. This is because the study seeks to understand the uncertainty construct in the context of angel investing. The third generation of research focuses on a deeper understanding of the issues studied in the first and second generations among other methodological, analytical, and theoretical issues. Specifically, this study extends our knowledge in angel investing decision making by exploring how business angels think about uncertainty and how their perceptions of uncertainty affect their decision making.

Finally, it is important to note that the review in this chapter provides a general foundation for the methodological and empirical chapters. However, a more specific and detailed literature review will be done for each empirical chapter that covers the discussions for that chapter.
Chapter 3 – Research methodology, design, and data

This chapter discusses the research methodology adopted for the study as well as the details of the research design and data collection activities. The chapter starts with a discussion on research paradigm and philosophy adopted for the study. The methodological approaches used in angel investment decision making and uncertainty aversion research are also discussed. An appropriate methodological approach is then selected for the study. The rest of the chapter discusses the details of the research design, the data collection activities, ethical considerations of the research, and a summary of the data collected.

3.1 Research paradigm and philosophy

A research paradigm comprises ontology, epistemology, methodology and methods. While ontology refers to the assumptions about or the study of the nature of reality, epistemology deals with what constitutes acceptable, valid, and legitimate knowledge and how knowledge can be created and communicated (Cohen et al., 2013; Crotty, 1998). Every research paradigm relies on its own ontological and epistemological assumptions which inform what methodology and methods are employed for a study. Methodology involves the why, what, from where, when, and how data is collected and analysed, and methods are the specific techniques and approaches used in collecting and analysing data (Crotty, 1998). Hence, every research method can be traced back from its methodology, through its epistemological assumptions to its ontological position.

There are two extremes of philosophical assumptions that have dominated business research and social science research as a whole – objectivism and subjectivism. Objectivism is associated with the positivist ontological position of realism, which is the view that objects have an existence independent of the knower (Cohen et al., 2013).
Realism assumes that social entities exist independently of how we think of them, describe them and what we believe we know of them. The researcher undertakes a study with an impartial view of the phenomenon to discover an objective reality. This allows the discovery of the truth about the social world through observable and measurable facts from which generalisations of the social reality can be made (Saunders et al., 2016; Bryman and Bell, 2015; Collis and Hussey, 2013). Positivists employ methodologies that attempt to identify causal relationships and correlations between variables to formulate laws to enable objective predictions and generalisations. Methods employed by positivists include experiments and close-ended questionnaires to generate quantitative data for inferential analysis.

At the other extreme side, subjectivism is associated with the relativist position which takes the view that reality is subjective and differs from person to person (Guba and Lincoln, 1994). There is no single reality beyond what people and social actors attribute to it. Experiences of social actors differ and so do their realities, which leads to multiple realities (Saunders et al., 2016; Bryman and Bell, 2015; Collis and Hussey, 2013). The aim of a subjectivist researcher is to understand the different realities occurring from the continually changing social interactions. Typically, this position is associated with qualitative methods, including interviews, focus-groups, observations, textual analysis (books), and visual analysis.

This study, however, adopts the philosophical or research paradigm stance of pragmatism. Pragmatism seeks to reconcile objectivism and subjectivism through the considerations of research elements such as theories, concepts, ideas, hypotheses, and findings not in an abstract form but in terms of their practical significances in the real world (Saunders et al., 2015). The differences between objectivism and subjectivism are to some extent a result of divisions as well as differences in the specialised skills sets of
researchers, quantitative or qualitative (Hanson, 2008). In pragmatism, there are singular and multiple realities that can be studied. This is akin to the experiential world with different elements or layers, some objective, some subjective, and some a mixture of both (Dewey, 1925). For a pragmatist, the most important determinant for research design is the research problem and the research question to be addressed and what it means for the real world (Saunders et al., 2015). If the phenomenon has different layers, then different methods can be used to measure or observe them.

The central research question for this study is how perceptions of uncertainties in early-stage businesses by investors affect their investment decisions. There are two main elements of this research question – uncertainty perception and investment decisions. Early-stage or angel investment decisions can be seen from an objective perspective as this has been thoroughly studied over the years. As discussed in section 2.4, although angel investors may be said to be heterogeneous in nature, they practically follow the same structured process in their decision making and investment activities. From deal sourcing, screening, evaluation, deal structuring and post-investment activities, investors follow this structured process – whether they perform all these steps by themselves or outsource parts.

However, the other element of how they perceive uncertainty in early-stage businesses has not been studied so far as I can determine from my review of prior research. This poses a difficulty in the research design if I take a purely objectivist stance. As shown in section 2.6, uncertainty takes different dimensions in various fields from risk to ambiguity and to what Knight (1921) calls fundamental uncertainty. What do early-stage investors consider uncertainty in business opportunities? In what form does information contained in business plans signal uncertainty to early-stage investors? These questions call for a more subjective stance to explore and understand using qualitative
techniques such as interviews. Taking a pragmatist approach allows me to create a multi-stage research design in which findings from one stage can inform the design of the next stage. It allows the use of a mixed-methods approach - different methods for different aspects of the research as may be deemed appropriate. I discuss this further in section 3.2 where I review the methodological approaches used in angel investing and uncertainty aversion literatures to select the appropriate methodology for the study.

3.2 Methodological approaches – Review and methodology selection

This section focuses on methodological approaches employed by past researchers in angel investing research that can be adopted for the current research. Since the main objective of the study is to examine how uncertainty perceptions affect investor decisions, I also review the literature on how researchers measure investor attitudes towards uncertainty. In the final part of the section, I discuss the merits of the methodologies reviewed and select an appropriate methodology to be used based on the pragmatic philosophical stance of this study.

3.2.1 Methodological approaches in angel investing research

Research works into the investment decisions of Business Angels (BAs) have evolved over the past four decades. These have involved the use of a wide range of methodological approaches. Quantitative approaches dominate the business angel research literature. In a recent review of business angel research, Tenca and co-authors (2018) find that about 61% of the works they reviewed used a quantitative methodology. Qualitative approaches account for about 26% of the papers reviewed (Tenca et al., 2018). The rest are mainly research works that employ mixed-methods approaches and theoretical papers.
The quantitative approaches have involved mainly surveys while the qualitative approaches have mainly involved ex-post interviews. The qualitative works were employed at the early stage of business angel research to explore the then unstudied business angel investment process and decisions-making. This paved the way for more quantitative works to be conducted effectively to obtain a better understanding of the process. I discuss the specific methods that have mostly been used in business angel research in the following paragraphs to correctly understand how BA research has evolved over the years with respect to methodologies and methods.

The methods can be grouped into four: Interviews, surveys, real-time methods (examples include verbal protocol studies, conjoint analysis, and observation studies), and the use of secondary datasets. Interviews and surveys dominated the first- and second-generation research while real-times methods and secondary dataset approaches dominate the third and fourth generation research.

Early research used mainly surveys, interviews, and case studies to investigate and understand what investors considered the most important factors in their decision-making (van Osnabrugge and Robinson, 2000; Cressy and Olofsson, 1997; Mason and Harrison, 1994; Riding, 1993). These methods are used mainly for exploratory works when little is known about the subject, which is what was required at the early stages of business angel research. However, they have been criticised for their post-hoc nature. That is, participants are required to report how they make decisions way after those decisions were made. Criticisms include concerns of hindsight and confirmation biases (Wiltbank et al., 2009), that investors do not fully understand how they make decisions (Zacharakis and Meyer, 1998), that investors use less factors in decision-making than what they claim they do (Zacharakis and Meyer, 1998), and that decision factors vary from stage to stage in the investment decision process (Mason and Harrison, 1996a).
To address concerns with the use post-hoc surveys and interviews, some researchers have employed the use of real-time qualitative and quantitative methodological approaches. Verbal protocol analysis is one of the main real-time methods that have been widely used in business angel research. Verbal protocol analysis is used to capture what investors actually think about as they make investment decisions. Participants are asked to “think-out aloud” as they assess sample business opportunities. A detailed record of the verbal thoughts of participants as they undertake the tasks is collected in real-time and analysed to understand what factors drive decision making. This approach has been used by several angel investment research studies (Mason and Botelho, 2016; Harrison et al., 2015; Maxwell et al., 2011; Mason and Stark, 2004; Mason and Rogers, 1997). Criticism of verbal protocol analysis are two-fold: First, as one verbalises their thought, the cognitive processes typically used in normal processes are altered and decisions made cannot be deemed to be the same. The second criticism is that verbalisation only shows a moderate relationship with actual behaviour.

Conjoint analysis is another real-time method that have been used to address concerns with the use of post-hoc surveys and interviews. This method is widely used in marketing research to elicit preferences of product or service features by consumers. It has been used in venture capital studies on investment decisions (Shepherd and Zacharakis, 1999; Muzyka et al., 1996; Riquelme and Richards, 1992). In the BA research space, Landstorm (1998) also uses conjoint analysis to elicit the relative importance of previously identified factors in angel investor decision-making. Sampled angel investors in Sweden answered a questionnaire relating to either a set of 34 general decision-making criteria or 35 leadership criteria. Conjoint analysis was used to determine a relative ranking of these criteria as employed by investors. Another study that employs this method in angel investor decision making is from Hsu et al. (2014). Hsu and colleagues
examine whether economic potential, specific human capital, strategic readiness, and passion matter differently to venture capitalists and angel investors.

Recent BA research studies have seen the increasing use of secondary datasets. The datasets come from mainly three sources: publicly available investment databases like CrunchBase and angel investing platforms, social media platforms like Twitter, and data from investment activities of BAs in business angel networks. The use of secondary datasets has made it possible for hitherto more difficult studies in BA research to be conducted. Questions around angel investment returns (Antretter et al., 2020; Capizzi, 2015), group decision-making (Edelman et al., 2021; Block et al., 2019), and marketplace interactions between BAs and other market players (Capizzi et al., 2022; Cipollonea and Giordani, 2019; Edelman et al., 2018) can now be studied with real-life data. Capizzi (2015) for example uses data from Italian Business Angel Network to study the dynamics and determinants of angel investment returns. Block et al. (2019) combine investment data from CrunchBase and social media activities of BAs on Twitter to understand how the personalities of BAs affect their syndication choices. Another paper that combines multiple databases is from Capizzi et al. (2022). They combine data from Italian Business Angel Network surveys and CrunchBase to study how business angel investments enable follow-on investments from VCs.

3.2.2 Measuring attitudes towards uncertainty-methodological approaches

Research works that have measured decision-makers’ attitudes towards uncertainty have employed quantitative approaches mainly with the use of experiments. Most empirical measurements of uncertainty or ambiguity aversion rely on Ellsberg’s experiment model (Ellsberg, 1961). As explained in section 2.6, in Ellsberg’s 2-colour urn experiment, decision-makers are presented with pairs of urns with different
information on the composition of balls; one with known probability (risky urn) and the other with unknown probability (ambiguous urn). Choices made by decision-makers are used to measure how averse they are to uncertain information. In this case, a strict preference for the risky urn will be interpreted as aversion to ambiguity or uncertainty. A strict preference for the ambiguous urn will be interpreted as ambiguity or uncertainty seeking while ambiguity neutrality will be when a decision maker is indifferent about the two urns.

Since Ellsberg’s experiment, many researchers have conducted variations of the experiment under different conditions including respondents of different characteristics, varying levels of uncertain information, and incentivized experiments. It has also been employed in real life cases in economics, insurance, and finance. Others have measured uncertainty aversion by decomposing secondary data and analysing the effects ambiguity attitudes have on other parameters. Finally, there are works that have measured general attitudes towards uncertainty through psychometric tests, and then link these attitudes with the economic choices of decision-makers. I discuss these various approaches below.

In a paper to demonstrate gender differences in risk and ambiguity aversion, Borghans et al. (2009) conducted a variation of the Ellsberg 2-colour urn experiment to elicit strict ambiguity preferences. In the paper, participants are presented with four urns of 2 colours, blue and yellow. Each urn contains a total of 10 balls with different compositions of blue and yellow balls. There is one risky urn with exactly 5 blue balls and 5 yellow balls. The other three ambiguous urns contain balls with varying degrees of uncertainty in the probability of the balls: 40-60%, 20-80%, and 0-100%. For each urn, participants are made to bet on a colour and to give the minimum price for which they will be willing to sell the bet. The difference between the price for the risky urn and the uncertain urn is used as the measure of uncertainty aversion. In another experiment
modelled on the Ellsberg 3-colour urn, Oechssler and Roomets (2015) introduced the use of a mechanical randomization device with unknown distribution to both participants and experimenters to eliminate the effects of what they refer to as “strategic ambiguity”. The device is used to randomly allocate the distribution of the uncertain portions of the 3-colour urn, and the experimenter had no chance of knowing this beforehand. This eliminates any information asymmetries in relation to the experiment between experimenter and participants and measures what they refer to as “mechanical ambiguity”.

Outside of the lab, uncertainty aversion has been studied using different approaches but mostly through the choice between two options, the risky option and the uncertain option. Camerer and Kunreuther (1989) created a theoretical insurance market in which players could transfer potential losses to other players by paying a negotiated insurance premium. The probability of loss was presented as either known (e.g., 10%) or unknown (e.g., between 0 and 20%). In another study, Sarin and Weber (1993) tested the effects of uncertainty on prices in a market auction setting, auctioning off risky and uncertain lotteries using business students and bankers. The risky lottery contained five winning and five losing balls while the uncertain lottery contained balls with unknown composition. In another study, Muthukrishnan et al. (2009) test ambiguity aversion in a marketing setting using brands of different products by indicating a perceived more or less ambiguous brand quality. Participants indicated their preferred brand and how much they are willing to pay for it.

Another approach used in an out-of-lab uncertainty aversion research context is to measure general attitudes towards uncertainty through experiments and then link them to economic choices. Dimmock et al. (2016) established that ambiguity aversion is negatively related to stock market participation. Using a large representative sample, they
conduct an experiment to measure general ambiguity attitudes of participants by means of a tractable model of matching probabilities of ambiguous events. This is then used together with secondary data from a longitudinal internet study of the chosen sample to establish a correlation of their attitudes towards ambiguity and their financial asset decisions. Engle-Warnick et al. (2007), in a study of effects of ambiguity aversion on farming choices, find that Peruvian farmers who avoid ambiguity in an experimental task are less likely to adopt new varieties of crop. In a similar study, Ross et al. (2012) also measure general ambiguity attitudes of farmers in Laos and then measure their use of the new variety of rice. They find that participants with high aversion to ambiguity are less likely to use the new variety of rice and even when they do, use it less intensively than the less ambiguity-averse farmers.

Recently, the decomposition of secondary data to measure how uncertain information or signals affect decision making has also been used. Li et al. (2016) study the role ambiguity aversion plays in the determination of mutual fund investors’ response to fund performance. Multiple performance-based signals of uncertain precision are used as proxies for uncertainty in the future performance of a fund and used to measure how investors respond to them. The data is decomposed into the various performance signals and investor sensitivity to the worst performing signal in any period is used as a measure of ambiguity aversion. Izhakian and Yermack (2017) investigate the role of uncertainty in executive stock option exercise decisions. They empirically determine uncertainties or ambiguities around the underlying assets and estimate its relationship with the timing of individuals exercising their stock options.
3.2.3 Selection of methodology

From discussions in section 3.1, two important methodological considerations for the present study emerge. The first relates to an appropriate approach to measure the effects of uncertain information on investor decisions. The first methodological consideration is thus situated in the uncertainty aversion context and requires the manipulation of key critical factors that are associated with investment decisions in sample cases and real-time decisions taken by participants. This calls for a quantitative approach as discussed in section 3.2.2. The second methodological consideration is the operationalisation of uncertainty in the context of business angels. Discussions in section 3.2.2 indicate that researchers mainly operationalise uncertainty using the Ellsberg type approach, which may or may not be valid in the business angel context. This means an exploratory approach has to be adopted to elicit how business angels think about uncertainty.

Therefore, from a pragmatist perspective as explained in section 3.1, I adopt a sequential multi-phase research design (Saunders et al., 2016). This involves, in the first phase, a qualitative study to explore how business angels understand uncertainty in their context and also to help construct the business case scenarios to their standards. In the uncertainty aversion literature, the dominant operationalisation of uncertainty is based on ambiguity, which is the uncertainty around the probability of events. Is this how business angels understand uncertainties in the business opportunities they evaluate? Correctly operationalising the uncertainty construct in the study requires the use of a qualitative approach such as interviews. Constructing the business cases and the operationalisation of uncertainty accurately in the context of business angels contributes to the ecological validity of the study. Findings from the first phase then feed into the design of the second phase, which is a quantitative approach.
For the second phase, the use of an experiment is the most appropriate method compared to other available quantitative methods. The second phase requires the modelling of varying degrees of uncertainty in sample business cases to measure how investors perceive uncertainty and its effects on their investment decisions. The major approaches used in angel investing research as discussed in section 3.2.1 are surveys, interviews, verbal protocols, and conjoint analysis, which cannot be adequately used to examine the effects of uncertain information on investor decisions. Access to secondary data in the form of business angel activities from angel networks is also difficult making it not a viable alternative. An experiment, and in this context a policy capturing experiment, enables the variation of critical factors to create varying degrees of uncertainty while holding other factors constant and capturing the behavioural effects of the variation.

Policy-capturing is a regression-based decision-capturing methodology in which respondents make decisions based on a series of problem-solving scenarios. The goal is to capture, and report implicit judgements, behaviours and preferences based on manipulated variables (Aguinis and Bradley, 2014; Aiman-Smith et al., 2002; Zacharakis and Meyer, 2000). In policy capturing experiments, a scenario is simply a combination of the variables of interest where each variable is described by one of its assigned values. Decision outcomes from respondents are then regressed on the values of one or more variables in the scenarios, and inferences on the decision maker’s tendencies can be made using the resulting regression coefficients or weights. The significance of the variables in the decision making, how the variables affect the decision making, the relative importance of each variable in the decision process, and the interactive effects of these variables on the decisions can be examined in this methodology (Aguinis and Bradley, 2014; Aiman-Smith et al., 2002).
Policy capturing like any other method has its strengths and weaknesses. The main strengths of policy-capturing relative to other methods is its use and manipulation of specific variables of interest while controlling for any confounding variables (Aiman-Smith et al., 2002). Policy capturing experiments also provide a reasonable level of precision of measurement and, depending on the specific design used, generalisability of results from sample to population (Aiman-Smith et al., 2002). The most important weakness of the method is its inability to represent fully what happens in real life situation, that is its external validity. Since the hypothetical scenarios created by researchers usually are focused on the primary variables of interest, results are said not to be representative of actual cases decision makers face (Aguinis and Bradley, 2014; Aiman-Smith et al., 2002). That is, policy-capturing studies do not and cannot simulate all the richness of the social and environmental contexts in which real-life decisions are made; nor can they provide respondents with all the information that actual decisions makers would have at their disposal. I take steps in the research design sections (4.3 and 4.4) to address this weakness to make the experiment as close to reality as possible.

This method has been used in past and recent entrepreneurial finance studies (Huang and Pearce, 2015; Ding et al., 2014; Hsu et al., 2014; Zacharakis and Shepherd, 2001; Zacharakis and Meyer, 1998). Zacharakis and Shepherd (2001) study the effects of overconfidence in the decision making of venture capital fund managers. Participants were made to take decisions on scenarios that were created using between 4 and 8 information factors. The participants gauged on a 7-point Likert scale how likely they believed the potential ventures were going to succeed, as well as how confident they were in their own assessment. In a related study, Zacharakis and Meyer (1998) used policy capturing to provide insights on whether VCs have a proper understanding of how they make investment decisions. Similarly, participants were made to take decisions on
scenarios of ventures seeking funding after which they provide weightings on how they believe they use the information cues in the scenarios.

In more recent studies, Ding, and others (2014) compare angel investor decision making criteria in China and Denmark utilizing a comparative institutional perspective. They use a policy capturing experiment to understand how institutional backgrounds of investors in the two countries affect their decision choices. MBA students from both countries are made to examine 8 scenarios each and indicate their interests to further engage the business owners. Huang and Pearce (2015) also employ a policy capturing experiment in their study. In one part of a 3-part study, they use an experiment to investigate the interaction effects between business viability information and the investor’s assessment of the entrepreneur and their effect on investment decisions. They use a 2-page executive summary and create 4 different versions using a 2-by-2 design that captures different factor levels of plan-based business viability information and perceptions of the entrepreneur behind the business.

3.3 First phase – initial qualitative study

This section focuses on the first phase of the study – a qualitative pilot study. This involves the construction of an initial experimental design based on the dominant uncertainty construct of ambiguity – uncertainty around the probability of outcomes of events. The initial design is tested in a qualitative study with business angels using semi-structured interviews. Two key aspects of the initial design are of primary focus here – the ecological validity of the base case scenarios and the operationalisation of uncertainty in the cases. Findings from the qualitative study indicate that the scenarios are not unusual from what angel investors encounter in real life. “Real” here refers to what angel investors encounter in their daily life and not a fictional world or idealised world. However, the
operationalisation of uncertainty as ambiguity is found as not compatible with the manifestation of uncertainty in the business cases typically assessed by the business angels participating in my interviews. I end the section with a discussion of the implications of the findings for the main quantitative study.

3.3.1 Qualitative study design details

The main source of information for investors to make investment decisions on funding applications are business plans. Business plans come with executive summaries of the detailed plan, which is what investors review to get an understanding of what to expect in the details. Executive summaries have all relevant aspects of the detailed plan summarised on a page or two, and decisions whether to proceed with a detailed analysis can be taken by examining them. At the screening stage of the investment decision process, investors quickly review executive summaries of business cases to decide whether it is worth their time to do a full review and to meet the entrepreneurs behind the business (Harrison et al., 2015). I create scenarios similar to what investors encounter in real life using executive summaries of business cases as the format of the scenarios. The use of executive summaries for the creation of the base case scenarios makes the experiment as close to reality as possible. As explained in section 3.1, ecological validity is of paramount interest from a pragmatist’s philosophical point of view.

The base case scenarios are created from selected free online sample business plans on bplans.com, a known website for assisting business owners create effective business plans used for accessing external financing. The website has over 500 free samples of business plans across different industries. I selected samples from different industries, including manufacturing, education, medical equipment, health tech, and
fintech. I created 10 base scenarios that I test in the pilot study. An example of the base case scenario used in the pilot study is presented in Appendix 3.1.

I create different versions of the base case scenarios using different modelled uncertainty statements of selected critical decision factors – market growth, product innovation and product protectability. In the initial design, uncertainty is modelled based on the Ellsberg 2-urn experiment – a risky scenario against an ambiguous scenario. Selected critical parts of the cases are modelled to have statements that can be considered risky or ambiguous. A risky statement has a known probability of an event or outcome occurring while an ambiguous statement has an unknown or ambiguous probability of the same event or outcome occurring. Examples of these statements are shown in Table 3.1.

The market growth rate represents the rate at which the chosen market of the venture is expected to grow annually on the average. Evidence from the literature suggests that investors tend to favour market opportunities of substantial size with a high expected growth rates as they lead to solid revenue growth and high levels of value creation (Mason and Stark, 2004; Tyebjee and Bruno, 1981). Market growth rates usually come from public sources. A risky statement is modelled as one where there is a definite estimate of the chance of obtaining a specific growth rate (e.g., 30%) over a certain period against an ambiguous statement in which the chance of obtaining the same growth rate is not precisely known (e.g., 10% to 40%).

The uniqueness of a product and its benefits to customers is a key investment decision factor for BAs because they drive customer user acceptance and in effect sales, market growth and ultimately profits (Mason and Stark, 2004; Mason and Harrison, 2003; Landström, 1998). Estimates of the likelihood of success of product innovation usually come from the scientist and product development teams and experts in the field. Uncertainty in this factor is modelled as one where there is definite estimate of the chance
of product success (e.g., 30%) through user acceptance over a period against one where the chance of success is ambiguous (e.g., 20% to 40%).

Patents and patent applications represent efforts by the venture to secure an advantage in future markets through distinctive product/service offerings, cost advantages via proprietary process technologies, or revenues through licensing activities. The presence of patents or patent-related activities serves as a quality signal of the venture. Ventures with evidence of product innovation and associated patent protection are preferred by investors (Brush et al., 2012; Mason and Stark, 2004). Uncertainty is modelled as one where there is a definite estimate of the chance of obtaining a patent (e.g., 40%) over a certain period against one where the chance of obtaining the patent is not precisely known or ambiguous (e.g., 30% to 50%).

Table 3-1: Input variables with probability values for risky and ambiguous options

<table>
<thead>
<tr>
<th>Critical factor</th>
<th>Risky value</th>
<th>Ambiguous value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market growth</td>
<td>There is a 40% chance that both market segments will continue to grow at their current rates for the next 5 years.</td>
<td>There is a 20% to 60% chance that both market segments will continue to grow at their current rates for the next 5 years.</td>
</tr>
<tr>
<td>Product/Innovation Success</td>
<td>The Lead Scientist estimates that there is a 50% chance that the product will be successful and accepted by customers in the next year.</td>
<td>The Lead Scientist estimates that there is a 40% to 60% chance that the product will be successful and accepted by customers in the next year.</td>
</tr>
<tr>
<td>Product Protectability</td>
<td>From the Lead Legal Consultant, there is a 40% chance that we will obtain the patent for the product in the next year.</td>
<td>From the Lead Legal Consultant, there is a 30% to 50% chance that we will obtain the patent for the product in the next year.</td>
</tr>
</tbody>
</table>
3.3.2 The initial study

The qualitative study is conducted to primarily test the fundamental operationalisation of the uncertainty construct in the initial design and to understand to what extent angel investors find it realistic. The qualitative study was conducted between January and July 2019 with angel investors in the United Kingdom. In all, 9 angel investors were interviewed over the period. They were reached through personal referrals and via their LinkedIn profiles. Out of 9 investors interviewed in the qualitative study one is female. Participants have a wide range of backgrounds from academia, experienced entrepreneurs, serial investors, an investor with limited investing experience to an investor with a prior formal investing background. Further details of the investors and their background are provided in chapter 4. The interviews were done via face-to-face meetings or telephone conversations depending on what the participant preferred.

Participants completed an informed consent form prior to taking part in the interview. Details of the informed consent are discussed as part of ethical considerations in section 4.7. The interviews lasted between 30 minutes to 55 minutes depending on how much detail participants provided. Semi-structured interviews were conducted with all participants, which allowed me to explore the thoughts of participants without being confined to a defined set of structured questions for all participants. The interview guide for the interviews is presented in Appendix 3.2. The interviews were in two sections – the first section covers general questions about the investor and the second section was related directly to the scenarios presented to the participants. Each participant reviewed 5 scenarios and discussed their thoughts as they read through them.

I use a thematic analysis approach to analyse the data. Thematic analysis allows the identification of patterns of meaning (i.e., themes) in a dataset (Braun & Clarke, 2006). I explain the analysis in detail in section 4.4 later in the thesis. For the purpose of
the analysis and discussion in this section, wherever names of participants appear, I use pseudonyms to anonymise the information. Since there are only 9 participants who are all business angels, I create the pseudonyms using the first nine letters of the alphabets without letter “I”. Hence, the first participant will be referred to as investor A, the second participant will be referred to as investor B and so on.

On the issue of how realistic the scenarios were, all participants agreed that the format and content of the scenarios are largely as they usually receive from business owners. The concerns and issues they raise on the scenarios are not uncommon or unusual. As investor A points out, “I would recognise these scenarios. Any of those could turn up in my inbox. I see loads and loads that look a bit like that. So, they are all very normal to me.” Some wondered whether they were real business cases because they will be interested in getting to know the owners. Investor H had this to say about the cases – “There were some companies that I wondered if they were real companies because I will invest in them”.

Participants provided insightful feedback on how the format of the scenarios can be improved. Some feedback relates to the wordiness of the scenarios. Some participants suggested the use of bullet points and content limited to only key venture information. The use of bullet points made the executive summaries easy to read and key business information easy to find. Investor E explains, “I think executive summaries are less wordy like you have here. You have very few words to use so they are usually straight forward on the key information with sections and bullet points. You also have simple tables for the financials. I have never received any executive summary that is full of words like we have in your case. They are usually less on the narrative than they are on the key facts.”
3.3.3 Information cues that cause uncertainty

On the modelled uncertainty cues in the scenarios, participants could not make a
distinction between the risky cues and ambiguous cues. Participants found the modelled
uncertainty cues unusual, uncommon, and unattractive. Whether the uncertainty cue was
put in a certain probability statement (risky) or uncertain probability statement
(ambiguous) makes no difference to them as they could not make sense of them. Investor
E could not make sense of one such statement on an intellectual property (IP) application
in one of the cases. “One phrase which I found unusual here which was about the IP.
That there's a 30 to 60% chance that the patent application process will be successful. I
didn't really understand that as a statement. You either have an IP or you don't have an
IP.” For most participants, businesses typically do not communicate in this manner. They
typically communicate with some level of certainty and do not use probabilities in their
business proposals. Investor E says “First, I don't think anyone can predict with certainty
or to put a probability on it in terms of anything continuing to grow. Actually, I would
say that makes it far less attractive as a statement. I think as an investor what you need
to have a degree of certainty over is whether the market is going to grow.”

Participants were asked what information cues cause uncertainty in the business
cases. The presence or absence of certain information are the main drivers of uncertainty
for investors. With their backgrounds, experiences and motivations in mind, investors
start the review with certain pre-determined information cues they are searching for as
they review business opportunities. Investor D states “Everything I invest in is in the life
sciences so there's always a scientific component in the IPs that I invest in. So, what I am
always trying to do is to first identify a situation where the IP has value. You're not just
copying someone else's idea.” Another participant, investor H, had this to say: “I tend to
focus on two main things - is it in line with my pre-set investment strategy, which is around
something that is doing a social good and something that leverages technology. If it's not doing these two things, then it's pretty a NO from the onset for me.”

Investors make decisions based on information provided in the business cases. A decision whether to move on and reject the application or to know more about the business with the intention to eventually fund it is based on available information (Harrison et al., 2015). Since investors look out for particular information in every business case based on their preferences and backgrounds, missing information creates uncertainties about the future success of the business. Investor E had this to say: “The main premise of this business is the fact that elderly people don't take their medications well, but they don't explain why. I believe that if they knew why they would have put it in the executive summary.” Investor B makes a similar point: “What we don't get here is if there is any reassurance that the software has any USP (Unique Selling Point) or has any IP protection. If it had IP protection, they would have said so.” When they consider an information important and cannot find it, they consider that to mean the entrepreneur is either unaware or the information is simply not available. Investor B reiterates that point, “Nice idea but a lot of work to be done there before I consider. Too many missing information which creates uncertainties.” Another participant, Investor F, expresses similar sentiments: “Missing information can be very problematic for investment decisions. You can’t tell if it is deliberate, or the team are just not right for the business.”

Results from the pilot study suggests the presence of particular information can either be interpreted in a positive manner or in negative manner. For example, on the issue of patents either being available or applied for, investors had different interpretations of it and how it affects their decisions. Patents either obtained or applied for means there could be something positive in the business that increases the chances of success in the future and hence less uncertainties. Investor B says, “I also like that there have been
patents applied for because that means the product if it gets patented gets an edge over competition.” Investor C makes a similar point: “There is talk about a patent application being in the process. I'm not clear what it means exactly but that seems to indicate that at least some work has been done. The fact that they are doing a patent application sends a certain signal that there's something in there.” In general, the presence of information can either heighten or reduce the uncertainty in the business. Investor C said the following on the revenue model for one of the business cases. “The basic concept of a royalty-based revenue is that it's a percentage of money someone else makes. And you have no control over that. So that brings a high degree of uncertainty.” Investor D had this to say about the management team: “So that's what the uncertainty for me within the management team is. Do they have the right skills, do they have the right set of experience? And if they don't then that's okay because you can't expect everyone to have that.”

3.3.4 Summary and Implications for main study

The qualitative study confirms that the base case scenarios chosen are close to reality. Participants find the scenarios real with all the issues that come with business plans. However, they find the modelled uncertainty in the cases unrealistic and unusual. From their experience, modelling uncertainty of the Ellsberg type using certain and uncertain probability statements in business cases does not happen in real life as they do not make sense to them. Instead, what creates uncertainty for them is the absence or presence of particular information cues. For example, if the investor considers product protectability issues important for the success of the venture, then the absence of what the entrepreneur is doing to protect the core intellectual property of the business creates uncertainty in the future success of the business.
The findings thus have a critical implication for the design of the second phase of the study - the experimental survey. They require that I shift from the ambiguity aversion literature which models uncertainty as uncertainty around the probabilities of events occurring to a more fundamental modelling of uncertainty as the absence of critical information. Missing information is known to be the fundamental driver of uncertainty in economics. Uncertainty is an attribute of information that relates to missing or incomplete information. The type of uncertainty that can be observed in the first phase of this study is akin to what Milliken (1987) described as state uncertainty – a perceived environmental uncertainty about the unpredictability of the state of the world. Unclear, incomplete, or missing information creates the world that cannot be objectively or accurately be predicted as prescribed in normative decision making. This is very much the case in businesses at their very early stage of development with no proven products or services and sometimes unproven markets. This forms the basis for creating the uncertainty cues in the business cases used in the main experimental survey. Cues or statements in the business cases that provide what is considered required information are coded as low uncertainty cues and those that do not are coded as high uncertainty cues.

3.4 Second phase – main quantitative study

This section focuses on the second phase of the study. This is the quantitative part of the study. The design of this part of the study is informed by findings from the initial qualitative study in the first phase. In this section, I first describe in detail the base case scenarios used in the experimental study in section 3.4.1. As explained in section 3.3, the base case scenarios are simply executive summaries of business opportunities that participants will review and take decisions on. While the basic structure of the business cases/scenarios remains the same from the qualitative study, there are a few differences.
The structure of the 5 cases selected from the initial set of 10 is the same but less wordy with bullet points as part of the feedback received from participants in the qualitative study.

Next, I discuss the manipulated decision factors and their attributes in section 3.4.2. Uncertainty is modelled as the presence or absence of three key decision factors. The manipulated decision factors used are product protectability, route to market, and relevant entrepreneurial experience. Manipulating these factors is critical to finding how business opportunities with different uncertainty levels affect investor decisions. In section 3.4.3, I provide details of the study design. These include how the different versions of the base cases are created, how they are put into different blocks of cases, and the survey structure and flow. Finally, in section 3.4.4, I detail the data collection approach including issues of sampling and details of the data collection process.

3.4.1 Base case scenarios

As discussed in section 3.3.1, executive summaries of business cases are used as the format for the scenarios. A total of 5 different base cases are selected from the 10 initially created and tested during the pilot study. Out of 5 base cases, one is used as an anchor case and parts of the other four are manipulated to create different versions. The anchor case has no manipulated factors and is shown first to serve as the base for the participants to understand the nature of the survey and to measure individual response levels. In the qualitative study, participants typically used their responses to the first case as an anchor for their subsequent assessments. I observed from the qualitative study that when participants move to subsequent cases, they ask themselves what their assessment of the first case was. They try to recollect the main drivers that informed their decisions in the previous cases and use that as a measure to assess the present one.
Prior to settling on the number of cases to be used, two design choices were considered – 4 cases against 8 cases. As I explain later in section 3.4.2, I use 3 decision factors to create the different versions of the cases. Each decision factor has two levels which leads to a $2^3$ factorial experimental design. A full factorial design means each base case will have 8 different versions. To have an ecologically valid experiment would require 8 cases to create the different case versions. As I explain in section 3.4.3, participants cannot review the different versions of the same base cases. Therefore, taking a full factorial design approach will result in each participant reviewing at 8 cases each. However, from the first phase of the study it was evident that presenting 8 cases in addition to the anchor case and the post-experiment aspects of the survey to each participant will result in the survey taking a long time to complete. With the full factorial option, I estimate that the survey could take between 30 and 45 minutes to complete. This will make the survey unattractive, and target participants are likely to drop out midway through the survey, and completion rates will be lower than expected. The target participants as described later in section 3.4.4 are known to be typically business executives with a busy life, to whom surveys of this length will be unattractive. I therefore settled on a fractional factorial design which I explain in section 3.4.3. This leads to the choice of the 4-case option as the estimated time to complete the survey will be between 20 and 30 minutes, which is found to be a reasonable compromise. This ensures that experimental study yields a good completion rate.

In selecting the specific cases it is important to make the choices representative of different sectors or industry. Different investors have different preferences for different sectors and industries depending on their background, motivations, and past experiences. Having cases from different sectors and industries ensures we have a diverse set of cases for the different investors that could take part in the survey. The final base case scenarios for UK respondents are presented in Appendix 3.3. There are a few variations in the
versions used for US respondents mainly related to the location of the business and the currency used in the cases. A summary of the cases and their sectors is presented in Table 3.2.

Table 3-2: Base cases descriptions

<table>
<thead>
<tr>
<th>Case</th>
<th>Company Name</th>
<th>Core business</th>
<th>Sector / Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case A</td>
<td>RST Tech</td>
<td>Tracking Device Maker</td>
<td>Engineering / Manufacturing</td>
</tr>
<tr>
<td>Case B</td>
<td>ABC Matrix</td>
<td>Medical Software</td>
<td>Life Sciences</td>
</tr>
<tr>
<td>Case C</td>
<td>EduToy</td>
<td>Children's Educational Toys</td>
<td>Education</td>
</tr>
<tr>
<td>Case D</td>
<td>MedSpenser</td>
<td>Medicine Dispenser</td>
<td>Health care technology</td>
</tr>
<tr>
<td>Case E</td>
<td>BXID Tech</td>
<td>I.D. Verification Technology</td>
<td>FinTech</td>
</tr>
</tbody>
</table>

Base Case A is used as the anchor case. In this case I do not manipulate any factors. For base cases B to E, I manipulate the selected decision factors to create different versions of the cases to elicit how they affect investor decisions. I explain how I arrive at the selected decision factors and their associated attributes in the next section.

3.4.2 Manipulated factors and attributes

I select the decision factors that I manipulate in the base cases from the eight critical factors identified by Maxwell et al. (2011). The eight critical factors are low market potential, limited evidence of product adoption, lack of product protectability, limited entrepreneur experience, excessive time to market, lack of viable route to market, limited customer engagement, and financial forecasts that indicate the venture will run out of funds. The selected factors are product protectability, route to market, and relevant entrepreneur experience. They can be grouped into two - the factors that are directly related to business viability (product protectability, and route to market) and entrepreneur experience.
related (relevant entrepreneur experience) similar to Huang and Pearce (2015). As Maxwell et al. (2011) summarise it, the presence of these factors is positively correlated to the success of the business and their absence correlated to its failure.

The factors that are not selected are for the following reasons. The product status variable is dropped because all cases to be used will be at the very early stage where the products are not finished or fully developed and hence will not require any variation. The product adoption and the customer engagement factors are closely related to the route-to-market factor which was shown to be a factor that investors from the pilot study reacted more to with respect to uncertainties in the early-stage ventures, and hence we drop both. The market potential cannot be modelled as there is no objective way of determining what large market and a small market is in the context of uncertainty. What one investor may consider as a large market may be considered as small by another. Finally, evidence from the pilot study suggests that investors usually do not believe financial projections in business proposals and hence are less sensitive to its associated potential uncertainties in their decision making. Therefore, I drop the financial model factor as well. Additionally, only a limited number of factors can be adequately modelled in an experiment as they create large numbers of possible combinations of factor values. This leaves three dimensions on which uncertainty will be modelled in the experiment: product protectability, route to market and relevant entrepreneur experience. I explain this further in the following sub-sections.

3.4.2.1 Product protectability

From the qualitative study, we learn that investors recognise patents and patent applications as efforts by the venture to secure an advantage in future markets through distinctive product or service offerings, cost advantages via proprietary process
technologies, or revenues through licensing activities. A patent on a product or service can create some barriers to entry from potential competitors in the future if it is commercially successful in the long term. This is typically achieved through patents and IP protections and other barriers like trade secrets (Sudek, 2006). The presence of patents or patent-related activities serve as a quality signal of the venture and reduces the uncertainties in the future success of the business. However, some investors from the qualitative study, although recognising the importance of protecting the product or service, noted that early-stage businesses sometimes do not have the financial capabilities to fight much bigger firms that infringe on their IP. Yet, findings in the literature suggest that ventures with evidence of product innovation and associated patent protection are preferred by investors (Brush et al., 2012; Mason and Stark, 2004). The values of this factor will be one that either has a patent approval or has applied for a patent (low uncertainty) and the other in which case no such information is provided, or the information provided is unclear as to when and how the product or service can be protected (high uncertainty).

3.4.2.2 Route to market

Another critical factor for the success of any business is how the venture intends to deliver the product or service to the target customers (Maxwell et al., 2011). As mentioned severally by angel investors in the qualitative study, without a viable route to market even the best of products will fail. The route-to-market factor includes a realistic marketing plan with identified distribution partners and channels and how to access them (Mason and Stark, 2004; Landström, 1998). Investors in the qualitative study also note that for ventures at the very early stage of development without any evidence of sales, having clearly identified distribution partners and channels and a plan to access them
provides some level of certainty of sales when the product is ready for the market. The values of this factor will be one that either has a clear marketing plan with identified distribution channels with or without agreements (low uncertainty) and one with limited to no thought on marketing and distribution channels (high uncertainty).

3.4.2.3 Relevant entrepreneur experience

The relevant experience of the entrepreneur and the management team have been identified by many researchers as a critical factor for the future success or otherwise of the business (Cassar, 2014; Mason and Stark, 2004). Most investors essentially take bets on the entrepreneur and the management team and not so much on the idea itself (Mittness et al., 2012a; Harrison and Mason, 2017). As emphasised by investors in the pilot study, relevant industry experience does not only ensure that the right product is developed to address a relevant need but also comes with the advantage of understanding the target market and its accompanying network potentials. Investors deem entrepreneurs with relevant industry experience as those that understand the nuances of the industry, which reduces the uncertainties in the future fortunes of the venture. As noted by Carpentier and Suret (2015), entrepreneurs that receive funding typically have extensive industry experience. The factor manipulated in the experiment will take on values where either there is evidence of the entrepreneur and senior management having significant relevant experience in the industry (low uncertainty) or one where there is experience and knowledge but in a different industry (high uncertainty).

3.4.2.4 Factor levels

The design requires that selected factors that can affect the uncertainties in the future success of business opportunities are manipulated to test how investors perceive
them and how they affect their decision making. As discussed in section 3.3, investors react to information cues that are either incomplete or missing. Huang and Pearce (2015) model uncertainty in investment information using two experimental conditions. The certain condition is operationalised as an investment opportunity associated with clear information regarding the organisation’s prospects and the uncertain condition being one presented as an investment opportunity lacking clear information about the venture’s prospects (Huang and Pearce, 2015). I follow Huang and Pearce (2015) and create two experimental conditions for the selected critical decision factors representing two states of the world – one that denotes a case that creates high perceived uncertainty and one that denotes a case that creates low perceived uncertainty. Huang and Pearce (2015) call theirs the Less Certain and More Certain conditions. This is supported by evidence from the pilot study discussed in section 3.3, that found that the presence and absence of certain critical factors either heightens or reduces the perceived uncertainties in the likely success of a business. The complete factor levels for the selected factors are shown in Appendix 3.4.

3.4.3 Quantitative study design setup details

3.4.3.1 Case versioning

As explained in section 3.4.1, I use 5 base case scenarios for the experiment. One of the base cases is used as an anchor case and therefore has no manipulated factors. The other four cases all have four versions with different values of the manipulated factors. Version 1 (V1) of the manipulated cases has the low uncertainty values of the manipulated factors while version 4 (V4) of the cases has the high uncertainty values of the manipulated factors. This is to create two extreme versions of the cases. The version 2 (V2) cases have low uncertainty values of the product protectability and the route to
market factors but have the high uncertainty value of the relevant entrepreneur experience variable. The version 3 (V3) cases have low uncertainty values of the product protectability and high uncertainty values for the route to market and relevant entrepreneur experience variables. The versions 2 and 3 create progressively higher uncertainty versions from V1 to V4. Table 3.3 summarises how the various versions of the base cases will be created.

Table 3.3: The combination of values of the manipulated factors for each case versions

<table>
<thead>
<tr>
<th>Version</th>
<th>Product Protectability</th>
<th>Route to Market</th>
<th>Relevant Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version 1</td>
<td>Low Uncertainty</td>
<td>Low Uncertainty</td>
<td>Low Uncertainty</td>
</tr>
<tr>
<td>Version 2</td>
<td>Low Uncertainty</td>
<td>Low Uncertainty</td>
<td>High Uncertainty</td>
</tr>
<tr>
<td>Version 3</td>
<td>Low Uncertainty</td>
<td>High Uncertainty</td>
<td>High Uncertainty</td>
</tr>
<tr>
<td>Version 4</td>
<td>High Uncertainty</td>
<td>High Uncertainty</td>
<td>High Uncertainty</td>
</tr>
</tbody>
</table>

I do not use a full factorial design as a $2^3$ experimental design leads to 8 versions of the cases. Four possible versions were omitted. Versions 2 and 3 of the cases have similar characteristics of the omitted versions of the cases. The characteristics here means, two low-uncertainty values and one high-uncertainty value in version 2 and one low-uncertainty value and two high-uncertainty values for version 3. For example, there are two omitted versions similar to Versions 2 of the cases. The first is a version with low-uncertainty values for product protectability and relevant experience factors but a high-uncertainty value for route to market factor. The second is a version with low-uncertainty values for route to market and relevant experience factors but a high-uncertainty value for product protectability. These two versions have similar characteristics to that of Version 2 as they both have two low-uncertainty values and one high-uncertainty value. This is same for the other two omitted versions that are similar to version 3.
The focus of the research is not to test how the specific factors modelled in the cases affect the perception of uncertainty of investors but how different levels of the hypothesised uncertainties affect their perceptions. Using base cases B to E, I create a total of 16 different case versions – four base cases with four different versions each. Since base case A is used as the anchor case, there is only one version of case A as no factors are manipulated in it.

3.4.3.2 Scenario blocks

The different versions of the cases are put into four blocks which includes one version of all base cases. As described in section 3.4.1 and summarised in Table 3-2, there are 5 cases, named Case A, Case B, Case C, Case D, and Case E. Case A is the anchor case with only one version while cases B, C, D, and E all have four versions. I name the various versions of the cases as follows; version 1 of Case B is called Case B_V1, version 2 of Case C is called Case C_V2, version 3 of Case D is called Case D_V3 and so on.

Every block is constructed to have a low uncertainty extreme case (V1), high uncertainty extreme case (V4) and a moderately low uncertainty case (V2) and a moderately high uncertainty case (V3). This means if we have for example Case C_V2 in a block then we cannot have versions 2 of the other cases in the same block. Each block is also constructed to only one version of each case. This means if we have Case D_V1 in a block, then the other case versions of Case D cannot be in the same block. These two rules ensure that all participants get to review at least one version of each case while also reviewing cases constructed to have different uncertainty levels (that is, V1, V2, V3, and V4).

Finally, each block starts with the anchor case, Case A, followed by the different versions of the other cases as per the descriptions in Table 4.4. Table 3.4 summaries how
the different versions of the cases are put into the different blocks. I show the details of
the full case versions and their respective blocks in Appendix 3.5.

Table 3-4: How the case versions will be placed in blocks

<table>
<thead>
<tr>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
<th>Block 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case A</td>
<td>Case A</td>
<td>Case A</td>
<td>Case A</td>
</tr>
<tr>
<td>Case B_V1</td>
<td>Case B_V2</td>
<td>Case B_V3</td>
<td>Case B_V4</td>
</tr>
<tr>
<td>Case C_V2</td>
<td>Case C_V3</td>
<td>Case C_V4</td>
<td>Case C_V1</td>
</tr>
<tr>
<td>Case D_V3</td>
<td>Case D_V4</td>
<td>Case D_V1</td>
<td>Case D_V2</td>
</tr>
<tr>
<td>Case E_V4</td>
<td>Case E_V1</td>
<td>Case E_V2</td>
<td>Case E_V3</td>
</tr>
</tbody>
</table>

3.4.3.3 Tolerance of ambiguity test

Participants take the 13-item MSTAT-II scale, which is a Tolerance of Ambiguity
(TA) psychometric test, originally created by McLain in 2009, to determine their general
attitudes towards ambiguity. See Appendix 3.6 for details of the scale. TA is a well-
established construct in the psychology literature and defined as “the tendency to perceive
ambiguous situations as desirable” or “a range, from rejection to attraction, of reactions
to stimuli perceived as unfamiliar, complex, dynamically uncertain or subject to multiple
conflicting interpretations” (McLain, 2009, p. 976).

TA is usually measured through self-reporting questionnaires that results in a one-
dimensional scale with people who perceive ambiguous situations as desirable,
challenging, and interesting on one end of the scale and those who are intolerant to
ambiguity and see such situations as a source of threat and discomfort on the other end of
the scale (Furnham and Marks, 2013). An individual’s tolerance of ambiguous events has
been shown to have a positive correlation with their propensity to take risks (Altinay et
al., 2012). People who have a high tolerance for ambiguity will perceive less uncertainty
than those with low TA for the same level of uncertainty.
3.4.3.4 Post-experiment questionnaire

The survey also involves a questionnaire to collect participant characteristics and their associated past investment activities. The questionnaire has two sections – one on investor characteristics and the other on investment activities. The investor characteristics section focuses on general demographic questions such as age, gender, and education background. The investment activities section includes angel investment experience (number of past investments and years of angel investing), types of investments (stage of business and sectors of interests), investor motivations, networking activities (angel network membership and participation in syndicate investing), typical investment size and whether BAs are involved in investee businesses after an investment has been made. The full post-experiment questionnaire is presented in Appendix 3.7.

3.4.3.5 Survey structure and flow

The survey is structured in three major section – Pre-experiment, Experiment and Post-experiment. Figure 3.2 shows how the different elements of the survey are put together. The pre-experiment section includes the informed consent page that ensures that participants understand fully the nature of the survey and have duly consented to participating in the survey. Once a participant agrees to take part, the survey presents the instructions that guide the survey. After the instructions, one block of cases is randomly presented to the participant, who is required to review all cases in that block. For every case, participants are asked to answer 6 questions, which include questions that measure their perceptions of uncertainties in the business cases as well as their assessment of the opportunity the business potentially provides. It also has questions that measure their willingness to know more about the business and their willingness to invest. There are two control questions for every scenario that ask participants how familiar they are with
the industry in which the business operates and whether the business fits with their own investment criteria and motivations. Table 3.5 lists the scenario specific questions as well as the response types.

After responding to the scenarios, the MSTAT-II tolerance of ambiguity scale is presented to participants. Participants then respond to the post-survey questionnaire, after which the survey ends. At the end of the survey, participants are offered the opportunity to volunteer to take part in a post-study interview to further understand their choices in the experiment. Feedback on the experiment is also sought at this stage to help address any unexpected anomalies in the responses obtained.

![Figure 3-1: Experimental survey flow](image-url)
Table 3-5: Scenario-specific questions and response types

<table>
<thead>
<tr>
<th>Number</th>
<th>Question</th>
<th>Response Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>In your assessment what is the level of uncertainty of this business? (Zero, having the lowest level of uncertainty and 100 being the highest level of uncertainty)</td>
<td>Slider (0 to 100)</td>
</tr>
<tr>
<td>2</td>
<td>What is your assessment of the opportunity in this business? (Zero, having the lowest level of opportunity and 100 being the highest level of opportunity)</td>
<td>Slider (0 to 100)</td>
</tr>
<tr>
<td>3</td>
<td>Based on the available information, how willing are you to know more about the business?</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>4</td>
<td>How likely are you willing to invest in the business if satisfied after your due diligence and engagement with the entrepreneurs?</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>5</td>
<td>How familiar with the industry in which the business operates?</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>6</td>
<td>How does this opportunity fit with your own personal criteria/motivations?</td>
<td>Likert scale (5 points)</td>
</tr>
</tbody>
</table>

3.4.4 Data collection approach

3.4.4.1 Sampling approach and sample

There are various sampling methods used in research, which are classified as either probability or nonprobability sampling techniques (Blaikie, 2010). In probability sampling, each member of the population has a known non-zero probability of being selected while in a nonprobability sampling technique, members are selected from the population in a non-random manner with no known probability of being selected (Bryman and Bell, 2015; Easterby-Smith et al., 2008). Probability methods include random
sampling, systematic sampling, and stratified sampling, while non-probability methods include convenience sampling, judgment sampling, quota sampling, and snowball sampling. This study adopts a non-probability sampling approach mainly because the target group (business angels / angel investors) is hard to reach. It combines convenience sampling (the sample is selected because they are convenient or easy to reach) and snowball sampling (relying on referrals from initial participants to generate additional participants) to select participating investors.

I use real business angels for the study as this addresses an important aspect of representativeness of policy capturing experiments. For ecologically valid results, experts in early-stage investment decision makers are required. Business angels are high-net-worth individuals who invest their own money in businesses at their very early stage – typically idea stage or prototype stage. They make these investments either alone or with other investors and may take on an active role in the business post-investment as board members or advisors (Mason and Harrison, 2008; Landström, 2007). Compared to formal early-stage investors, such as venture capital firms, BAs typically invest relatively smaller amounts of finance in these firms (Mason and Harrison, 2000; van Osnabrugge and Robinson, 2000; Sohl, 1999). For firms at the very early stage, BAs have been shown to be the largest external providers of early-stage risk capital, substantially dwarfing investments made by professionally managed venture capital firms (Mason and Harrison, 2015; Sohl, 2003; Mason and Harrison, 2000). Since they do not incur the transaction costs of venture capital firms, they are able to make smaller seed and start-up stage investments, well below the minimum deal sizes and stages considered by venture capital fund managers (Mason and Harrison, 1997). They also include individuals that have years of experience in the early-stage investment industry and are best placed to be used as the targets to investigate the objectives of this research.
Business angels in the United Kingdom (UK) and the United States (US) are the primary focus of this study. The business angel investment markets in these two countries are the most developed. For a study that seeks to test a known phenomenon (effects of uncertainty on decision making) in a new context (early-stage investments) it is important to use a well-developed market to avoid results being confounded by other unknown factors in less developed markets. The UK is estimated to have about 8000 business angels as of 2017 (EBAN, 2017) who are associated with 67 business angel networks. The actual population is estimated to be much higher, as only a small percentage of BAs are affiliated to any network or association. The EBAN estimates the visible population to be only about 10% of the entire population. This means the “invisible population” in the UK could be about 80,000. Mason and Harrison (2017) estimate this “invisible” market to be between 20,000 and 40,000 business angels. Sohl (2015) also estimates the US business angel market to have about 320,000 participants.

Issues of sampling in angel investment research have been raised by some researchers (Avdeitchikova et al., 2008; Farrell et al., 2008). The main concern of these researchers is the over-reliance on business angel networks and associations for angel research. They contend that these samples are not representative of the angel population. Angel networks and associations are self-selecting registers, and investors who are not part of these networks are missing from research samples. Farrell and others (2008) recommend the use of publicly available sources such as business registration data to improve the representativeness of samples used in angel research. Other recommendations include the use of a combination of different data sources (e.g., angel syndicates, angel networks and tax incentive schemes). In this study, I reach investors through their social media accounts (mainly LinkedIn profiles). This approach avoids the use of a sample that is exclusively from angel networks and provides a good coverage and the needed diversity in samples for angel research.
3.4.4.2 Data collection details

The experiment is conducted online using the Qualtrics survey platform and distributed via a web link to participants. The Qualtrics platform is an established platform used for various online surveys in both academic and non-academic settings. The platform is hosted in the UK, which enables the data collected to be stored and managed on UK servers. This is an important requirement for UK data protection laws and regulations. The target participants were early-stage investors in the United Kingdom and the United States.

Participants were contacted mainly via their LinkedIn profiles. The recruitment process starts with an invitation to connect on LinkedIn with an explicit message that invites participants to take part in survey if they choose to. Once they accept to connect, I send a formal invitation to take part in the survey directly into their LinkedIn profile inboxes. Some investors provide their email addresses and ask that I send the survey invitation directly to them via this channel. The ability to send the survey invitations directly to their electronic inboxes (LinkedIn or Emails) enables participants to access the experiment on their personal computers, tablets, or smartphones wherever they are. The survey experiment can therefore be done in the natural environment of respondents which improves the validity of results as the issue of representativeness of the experimental survey is enhanced in this context.

The data collection took place over 5 months between April and August 2020. A total of 3228 investors were contacted and 244 responses were recorded in the end out of which 232 were completed responses. The 11 incomplete recorded responses are omitted from the analysis. These responses were mainly from participants who only read the instructions but failed to proceed to take part in the survey. The response rate for recorded responses is thus 7.6%. The response rate may have been higher had the survey not taken
place during the peak of the COVID-19 pandemic. Angel investors with portfolio companies reported that they were mainly busy supporting their investee firms during the period. The response rate is good, however, considering the experimental nature of the study and the international approach adopted for the study.

3.5 Ethical considerations of research

Issues of ethics are an integral part of business and management research as they concern researcher-participant relationships, confidentiality, data protection and reporting, and dissemination of research findings. There are ten principles that govern these ethical issues and its consequences for policy and practice (Easterby-Smith et al., 2008; Bryman and Bell, 2015). These include no harm to participants; respecting dignity of participants; seeking informed consent; privacy of research subjects; data confidentiality; protecting the anonymity of individuals or organisations; avoiding deception; declaration of affiliations; honesty and transparency; and avoidance of any misleading or false reporting of research findings.

As my research design requires the use of primary data that involves participation of humans, I sought ethics approval from the OU Human Research Ethics Committee (HREC) for both the qualitative study and the quantitative study. The goal of the qualitative study was to test and develop the research instrument designed for the quantitative study. The qualitative study involved interviews with angel investors to investigate how realistic the details in the base case scenarios were in relation to the research design and to elicit how investors understood the concepts of uncertainty and ambiguity. HREC provided a favourable opinion (Ref: HREC/3505/Arthur-Annobil) on my application to conduct the qualitative study in December 2018 based on the fact that
the target participant are not a vulnerable group and the major concern for the study is on confidentiality and data protection.

After the qualitative study, significant changes to the research design for the quantitative study informed by findings from the qualitative study were made as discussed in section 3.4. Another ethics application was made to HREC for the final design for the quantitative study. I obtained another favourable opinion (same Ref as that for the qualitative study) from HREC dated 30/03/2020 for the quantitative study. Key published ethics and legal guidelines that I followed during my data collection activities are the ‘OU Ethics Principles for Research Involving Human Participants’ and the ‘OU Code of Practice for Research at the Open University’. As part of the approval process, I submitted a data management plan to guide how I collect, store, and manage data from the research. This also served as a guideline for the data collection activities.

Two ethical issues arise from my research design – informed consent of participants and incentivising participants. For both the qualitative and quantitative studies, I ensure that participants provide their consent before taking part. For the qualitative study, they completed it in hard copy before the face-to-face interviews were conducted. For those that were done via telephone, a soft copy of the informed consent form was sent to them for completion before the scheduled interview date. In the quantitative study, the informed consent form is presented first in the online survey as described in Figure 3.2 under section 3.4.3.5. The informed consent used is presented in Appendix 3.8. It was constructed in accordance with OU HREC ethics guidelines, which requires that key aspects of the consent are separated so participants can provide consent to each separately.

Incentives are an integral part of experimental surveys. Typically, surveys involving students provide monetary incentives that compensate participants for the time
spent on the survey. Best practice requires that the nature of the incentive is commensurate with the time spent as if participants are paid more than required, results can be biased. For this study, the target group are business angels, who tend to be high-net-worth individuals that cannot be compensated with the typical monetary incentives used for students. Participants in this study are compensated with the results of the study. They are asked at the end of the study to provide an email address if they want a copy of the results of the study. The summarised report for this purpose also includes the relative rank of ambiguity attitudes of participants. This allows participants to know how they rank relative to other participants in the survey on their attitudes towards uncertain or ambiguous information.

### 3.6 Exploring the personal and business characteristics of participants

As indicated in section 3.5.2, 232 early-stage investors completed the survey experiment. The participants were angel investors in the United Kingdom and the United States. A total of 45 investors from the UK participated while 187 investors participated from the United States. The ratio of participants from the UK to that from the US is about 1:4. This can be explained by the ratio of UK to US participants that I was able to reach for the survey, which is approximately 1:5. It is estimated that the UK has between 40,000 to 80,000 angel investors while the US is estimated to have between 3 to 6 times this number. The two countries are known to have the most developed market for early-stage investments.

#### 3.6.1 Business angel Characteristics

The participating investors sampled are predominately male. This appears to be roughly in line with the population of early-stage investors, which have been known to
be dominated by the male gender. As presented in Table 3.6, my sample is made up of 84% male and 14% female participants, similar to many other surveys. In the most comprehensive survey on angel investor activities in the UK done in 2017, 91% of the respondents were male with only 9% being female (UKBAA, 2017). The typical fraction for females in UK surveys is between 10% and 15%. This survey has 20% of respondents from the UK being female. A similar survey for US investors in 2017 had 78% male and 22% female Huang et al. (2017). In this survey, 86% of US respondents are male and 13% are female. The remaining 1% did not provide this information.

Also shown in Table 3.6 is the age profile of respondents. About 80% of respondents are at least 40 years or older. As discussed in earlier sections, angel investors are typically high-net-worth investors who have accumulated their wealth over a long period of time or through their own entrepreneurial activities. The profile of the respondents in my sample is consistent with other industry surveys and research work. In the UKBAA (2017) survey, 75% of respondents were at least 45 years and above while in the survey by Huang et al. (2017) 70% were at least 50 years or older. There is, however, a growing population of relatively young angel investors. They are well represented in this sample - 16% of the sample are below 40 years. In the UKBAA report, 25% of respondents were below the age of 44, which is similar to this sample, in which 22% of respondents in the UK are below 40 years.
Table 3-7 shows the educational and entrepreneurial background of investors in the survey. Typically, angel investors are highly educated (Huang et al., 2017). This is evident in this study as only 3% of respondents have less education than a bachelor’s degree. About 98% of respondents from the US have at least a bachelor’s degree, which is similar to results from Huang and colleagues who had 97%. Similar results are seen for UK respondents with 93% of respondents with at least a bachelor’s degree. There is evidence from previous work and surveys that angel investors themselves have considerable experience as entrepreneurs. 84% of respondents to this survey say they have prior entrepreneurial experience. This is much higher than what Huang et al. (2017) had in their survey, which was about 55%.
Table 3-7: Background of investors

<table>
<thead>
<tr>
<th>Investor background</th>
<th>Count</th>
<th>Percent</th>
<th>Count</th>
<th>Percent</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UK</td>
<td>US</td>
<td>Total</td>
<td>UK</td>
<td>US</td>
<td>Total</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>187</td>
<td>232</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Entrepreneur</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>37</td>
<td>157</td>
<td>194</td>
<td>82%</td>
<td>84%</td>
<td>84%</td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>29</td>
<td>37</td>
<td>18%</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>187</td>
<td>232</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diploma or below</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>7%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Undergraduate degree</td>
<td>14</td>
<td>44</td>
<td>58</td>
<td>31%</td>
<td>24%</td>
<td>25%</td>
</tr>
<tr>
<td>Postgraduate certificate</td>
<td>3</td>
<td>12</td>
<td>15</td>
<td>7%</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Master's degree</td>
<td>24</td>
<td>95</td>
<td>119</td>
<td>53%</td>
<td>51%</td>
<td>51%</td>
</tr>
<tr>
<td>Doctoral degree</td>
<td>1</td>
<td>23</td>
<td>24</td>
<td>2%</td>
<td>12%</td>
<td>10%</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>8</td>
<td>8</td>
<td>0%</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>187</td>
<td>232</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

There is also a growing use of angel networks and syndicated investments by angel investors. This is shown in this study as well. As presented in Table 3.8, 67% of respondents report that they are part of an angel investment network. The numbers are very similar for UK (69%) and US (66%) investors. Although 67% of respondents are part of an angel investor network, only 45% of them typically invest as part of a syndicate. This shows that sampled respondents mainly use the networks as a source of potential good deals but not necessarily to benefit from potential syndicated investments opportunities that angel networks provide. US investors in my sample are more likely to invest as part of a syndicate than their counterparts in the UK – 47% against 38%. Syndicated investing enables investors to pool their risks, knowledge, and skills together to mitigate potential risks and uncertainties in the business.
Table 3-8: Investor network activities

<table>
<thead>
<tr>
<th>Network activities</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UK</td>
<td>US</td>
</tr>
<tr>
<td>Angel Network</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>31</td>
<td>124</td>
</tr>
<tr>
<td>No</td>
<td>14</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>187</td>
</tr>
<tr>
<td>Syndicated Investments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>17</td>
<td>87</td>
</tr>
<tr>
<td>No</td>
<td>28</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>187</td>
</tr>
</tbody>
</table>

An important characteristic of angel investors is their investing experience, which is shown in how long they have been investing and how many investments they have made in the past. Table 3.9 shows the breakdown of investors according to how long they have been investing as business angels and the number of past angel investments. The sampled investors can be said to be diverse but quite experienced. About 71% of respondents have at least 4 years of angel investing experience. 32% of participants report that they have at least a decade of experience as angel investors. These numbers are quite similar to what was obtained by Huang and others with their US sample. Their sample had 75% of respondents having at least 4 years of experience and 20% being in the industry for 18 years or more (Huang et al., 2017). Investors in the UK sample in the UKBAA report are less experienced compared to the UK sample in this survey – 56% with at least 5 years’ experience against 64% with at least 4 years of investing experience.

This level of experience of sampled angels also shows in the number of past investments made. Almost all (99%) of participants have made at least 1 investment in the past. About 28% of investors have made 5 investments or less in the past. The UKBAA reports a much higher figure of about 42% having 5 or fewer investments. This is, however, similar to UK respondents in my survey, who report a figure of around 38%.
Investor venture stage and typical investment size preferences are shown in Table 3.10. 93% of respondents invest in ventures that are at the post-revenue stage – that is prior to the growth stage. This confirms the typical profile of angel investors, who are known to invest in ventures at the very early stage of development. About 48% of respondents invest in businesses that either have an idea or only a prototype, with 45% preferring ventures that have started earning some revenue. This can potentially affect the results of the survey. All cases presented in the survey are at the idea or prototype stage of development.

UK respondents typically invest less than £25k in one investment (38% of respondents). This is in line with the UKBAA report, which also finds that investors in the UK typically invest about £25k in a single company. 84% of UK respondents invest £100k or less in a single investment which is very similar to US respondents, who have 81% of them investing less than $100k in a single company (Huang et al., 2017). The
median investment size for participants in the survey by Huang et al. was also around $25k with the middle 50% of respondents investing between $15k and $37.5k. The middle 50% for the US sample in this research invest between $18k to $76k.

Table 3-10: Investor venture stage and investment size preferences

<table>
<thead>
<tr>
<th>Investor Preferences</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UK</td>
<td>US</td>
</tr>
<tr>
<td>Idea-Stage</td>
<td>16</td>
<td>48</td>
</tr>
<tr>
<td>Prototype-Stage</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>Post-revenue Stage</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td>Growth-Stage</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Mature-Stage</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>187</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investment Size (UK)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Below £25k</td>
<td>17</td>
<td>17</td>
<td>38%</td>
<td>38%</td>
</tr>
<tr>
<td>£25k - £50k</td>
<td>10</td>
<td>10</td>
<td>22%</td>
<td>22%</td>
</tr>
<tr>
<td>£50k - £100k</td>
<td>11</td>
<td>11</td>
<td>24%</td>
<td>24%</td>
</tr>
<tr>
<td>£100k - £250k</td>
<td>7</td>
<td>7</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>£250k - £500k</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Above £500k</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>45</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investment Size (US)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Below $10k</td>
<td>17</td>
<td>17</td>
<td>9%</td>
<td>38%</td>
</tr>
<tr>
<td>$10k - $20k</td>
<td>39</td>
<td>39</td>
<td>21%</td>
<td>87%</td>
</tr>
<tr>
<td>$20k - $50k</td>
<td>70</td>
<td>70</td>
<td>37%</td>
<td>156%</td>
</tr>
<tr>
<td>$50k - $100k</td>
<td>27</td>
<td>27</td>
<td>14%</td>
<td>60%</td>
</tr>
<tr>
<td>$100k - $200k</td>
<td>20</td>
<td>20</td>
<td>11%</td>
<td>44%</td>
</tr>
<tr>
<td>$200k - $500k</td>
<td>3</td>
<td>3</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td>Above $500k</td>
<td>7</td>
<td>7</td>
<td>4%</td>
<td>16%</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>4</td>
<td>4</td>
<td>2%</td>
<td>9%</td>
</tr>
<tr>
<td>Total</td>
<td>187</td>
<td>187</td>
<td>100%</td>
<td>416%</td>
</tr>
</tbody>
</table>
3.6.2 Descriptive statistics of key variables

I present descriptive statistics of key variables in the research for the final data from the online experiment. Table 3.11 has a description of the variables used in this section. A table containing more detailed variable definitions and data types is presented in Appendix 3.9.

Table 3.12 shows general descriptive statistics of the key variables in question. Generally, responses vary widely among participants. Most variables record scores for the lowest possible value or option and the highest possible value or option. This provides adequate variation for analysis.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>UncLevel</td>
<td>Uncertainty level</td>
<td>Continuous</td>
</tr>
<tr>
<td>OppLevel</td>
<td>Opportunity level</td>
<td>Continuous</td>
</tr>
<tr>
<td>KnowMore</td>
<td>Willingness to know more</td>
<td>Ordinal</td>
</tr>
<tr>
<td>WillInvest</td>
<td>Willingness to invest</td>
<td>Ordinal</td>
</tr>
<tr>
<td>FamLevel</td>
<td>Familiarity level</td>
<td>Ordinal</td>
</tr>
<tr>
<td>OppFit</td>
<td>Opportunity Fit</td>
<td>Ordinal</td>
</tr>
<tr>
<td>UL_A0</td>
<td>Uncertainty level for base case A0</td>
<td>Continuous</td>
</tr>
<tr>
<td>Age</td>
<td>Investor's age</td>
<td>Discrete</td>
</tr>
<tr>
<td>NoOfYears</td>
<td>Number of years of investing</td>
<td>Discrete</td>
</tr>
<tr>
<td>NoOfInvts</td>
<td>Number of investments</td>
<td>Discrete</td>
</tr>
<tr>
<td>TA_Score</td>
<td>Tolerance of ambiguity score</td>
<td>Continuous</td>
</tr>
<tr>
<td>ActvInPortf</td>
<td>Investor activeness in portfolio firms</td>
<td>Ordinal</td>
</tr>
<tr>
<td>BizRejectedPct</td>
<td>Percentage of business opportunities rejected</td>
<td>Continuous</td>
</tr>
</tbody>
</table>

The average perception of uncertainty level for the cases of interest is 68.75, while the average perception of opportunity level is 50.55. They also perceive more uncertainty in the base case A compared to the other cases. This is shown in the average perception of uncertainty in the base case A being 70.45 compared to 68.75 for the other cases. Figures 3.2 shows a distribution of UncLevel.
Participants are generally slightly or moderately familiar with the industries in which the fictitious businesses operate (Mean = 2.52, SD = 1.08). They express similar sentiments regarding how the businesses fit with their personal criteria and preferences (Mean = 2.34; SD = 1.14). In general, participants are more willing to know more about the business than they are willing to invest in them. At this stage of the investment process this is expected as they will require further engagement with the business owners and due diligence to be confident to invest. Participants are generally slightly or moderately willing to know more about the business (Mean = 2.50; SD = 1.20) and only slightly willing to invest in the businesses (Mean = 2.15; SD = 1.07).

As discussed in the preceding subsection, the sample can be described as a group of experienced early-stage investors. The average age of investors is around 50 years. On average, they have been early-stage investors for 7 years and have made about 14 early-stage investments. With respect to mentoring and coaching, they are also moderately active in their portfolio companies. They also reject about 82% of business opportunities they review at the screening stage of their investment process. Additionally, participants

Figure 3.2: Histogram of perception of uncertainty level.
are generally tolerant of ambiguous or uncertain conditions or situations. The average
tolerance of ambiguity score is 71.79.

In Table 3.13, I present Pearson correlation coefficients of the variables. Generally, correlation coefficients are significant at the 5% level. The notable exception is the number of past investments (NoOfInvts), whose correlation coefficients are not significant with any variables except for age and the number of years of investing. The uncertainty perception level is negatively correlated with the following variables: OppLevel, KnowMore, WillInvest, FamLevel and OppFit. Participants perceive more uncertainty in the business when they have a low perception of the opportunity in the business. This is similar when they are not familiar with the industry in which the business operates and when the opportunity does not fit with their personal criteria and preferences. The resultant effect is an unwillingness to proceed to know more about the business and to invest in the business.

The uncertainty perception level variable is positively correlated with the following variables: Age, NoOfYears, NoOfInvts, TA_Score and BizRejectedPct. Age is also positively correlated with the NoOfYears and NoOfInvts variables. This is expected as older and more matured investors have been investing for a longer period and also have more investee companies. Older and more experienced investors perceive more uncertainty in the business opportunities as shown by the positive correlation of these variables with UncLevel. Another interesting observation is the fact that participants who have more tolerance of ambiguity also perceive more uncertainty. Participants who report higher levels of rejection at the screening stage also perceive more uncertainty.
Table 3-12: General descriptive statistics of key variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Excess Kurtosis</th>
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<tr>
<td>UncLevel</td>
<td>0</td>
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<td>KnowMore</td>
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<td>1.07</td>
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<td>FamLevel</td>
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<tr>
<td>OppFit</td>
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<tr>
<td>UL _A0</td>
<td>15</td>
<td>100</td>
<td>70.45</td>
<td>20.47</td>
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<td>Age</td>
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<td>NoOfYears</td>
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<tr>
<td>NoOfInvts</td>
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<tr>
<td>TA_Score</td>
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<td>100</td>
<td>71.79</td>
<td>14.77</td>
<td>-0.77</td>
<td>1.00</td>
</tr>
<tr>
<td>ActvInPortf</td>
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<td>5</td>
<td>3.37</td>
<td>1.08</td>
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<tr>
<td>BizRejectedPct</td>
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<td>81.72</td>
<td>15.11</td>
<td>-2.26</td>
<td>7.82</td>
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Table 3-13: Pearson correlation coefficients of key variables

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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>10</th>
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<td>1 UncLevel</td>
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<tr>
<td>2 OppLevel</td>
<td>-0.359**</td>
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<td></td>
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<tr>
<td>3 KnowMore</td>
<td>-0.449**</td>
<td>0.658**</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>4 WillInvest</td>
<td>-0.444**</td>
<td>0.648**</td>
<td>0.848**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5 FamLevel</td>
<td>-0.163**</td>
<td>0.088**</td>
<td>0.258**</td>
<td>0.253**</td>
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<tr>
<td>6 OppFit</td>
<td>-0.260**</td>
<td>0.428**</td>
<td>0.666**</td>
<td>0.643**</td>
<td>0.453**</td>
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<tr>
<td>7 UL_A0</td>
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<td>-0.154**</td>
<td>-0.070*</td>
<td>-0.107**</td>
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</tr>
<tr>
<td>8 Age</td>
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<td>-0.122**</td>
<td>-0.177**</td>
<td>-0.022</td>
<td>-0.164**</td>
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<tr>
<td>9 NoOfYears</td>
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<td>0.081*</td>
<td>-0.112**</td>
<td>0.181**</td>
<td>0.542**</td>
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<td>10 NoOfInvts</td>
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<td>-0.025</td>
<td>-0.022</td>
<td>0.059</td>
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<td>0.025</td>
<td>0.263**</td>
<td>0.363**</td>
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<tr>
<td>11 TA_Score</td>
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<td>-0.037</td>
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<td>0.107**</td>
<td>0.033</td>
<td>0.076*</td>
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<tr>
<td>12 ActvInPortf</td>
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<td>-0.091**</td>
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<td>-0.063</td>
<td>0.019</td>
<td>0.241**</td>
<td>0.177**</td>
<td>0.166**</td>
<td>-0.008</td>
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<tr>
<td>13 BizRejectedPct</td>
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<td>-0.198**</td>
<td>-0.201**</td>
<td>-0.022</td>
<td>-0.162**</td>
<td>0.320**</td>
<td>0.107**</td>
<td>0.102**</td>
<td>0.093**</td>
<td>0.070*</td>
<td>0.051</td>
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</table>

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3.7 **Summary and conclusion**

This chapter focuses on the main research methodology adopted, the resultant research design, the data collection process, and the description of the data collected. I adopt the philosophical or research paradigm stance of pragmatism. Pragmatism reconciles differences between objectivism and subjectivism through the considerations of different research elements and adoption of the most suitable research designs that answers the central question of the research. For a pragmatist, the central research question and what it means for the real world is the most critical determinant of what research design to use (Saunders et al., 2016). There are two main elements of the central research question for this study – uncertainty perception and investment decisions. While investment decisions in early-stage investing have been studied for decades and can be looked at from an objectivist’s perspective, how early-stage investors perceive uncertainty in early-stage ventures is relatively unknown. Taking a pragmatist approach allows the creation of a multi-stage research design in which findings from one stage inform the design of the next stage. I use different methods to address different aspects of the research at different stages.

I set up a two-phase mixed methods study. The first phase is a qualitative study while the second phase employs a quantitative approach. The second phase is the main study. For the second phase, I use a policy capturing experiment methodology to investigate the research questions. In this survey-experiment approach, I model varying degrees of uncertainty in executive summaries of business cases to elicit behavioural responses to them. This enables the detection of effects of these variations on the perception of uncertainty in businesses and the ensuing effects on investment decisions. The initial design for the experimental study was tested in the first phase of the study using semi-structured interviews to understand how investors perceive uncertainty in the scenarios. The findings from the first phase meant that uncertainty should be modelled in
the form of missing information instead of the Ellsberg type that relies on ambiguities of probabilities.

I use real business angels for both phases of the study. The qualitative phase had 9 participants while the second phase had 232 respondents from the UK and the US. The participants are mainly male and experienced investors as in other research works that have used real business angels. Additionally, I recruited participants mainly through their LinkedIn profiles, which avoids the overreliance on business angel networks in past angel research. This makes the sample a more representative one compared to other similar research works in the business angel literature. The next three chapters are dedicated to a more detailed analysis of the results from the study and how they address the key research questions from section 0.
Chapter 4 – How angel investors think about uncertainty

4.1 Introduction and background

The purpose of the initial qualitative study is to explore and investigate how and what early-stage investors consider uncertainty in their investment decision process. While there has been a lot of work done to understand the role of uncertainty in entrepreneurial action, very little is known about the role of uncertainty in investment decisions of early-stage investors who invest in these start-up ventures at their earliest stage. Works by Huang and Pearce (2015) and the extension by Huang (2018) focused on the use of gut feeling to deal with uncertainty as investors make investment decisions. Investors were found to seek uncertainty mainly with the hope making extraordinary gains while fully conscious of the possibility of losing their investments (Huang and Pearce, 2015).

However, we do not know how early-stage investors think about uncertainty and which uncertainty dimension is useful in their context. This is crucial especially in the context of operationalising uncertainty in the business cases used for the main experimental study. The dominant uncertainty construct in finance and economics literature ranges from known knowns (risk), unknown knowns (ambiguity/uncertainty), and unknown unknowns (fundamental uncertainty). In both risk and ambiguity, the possible set of outcomes are known. The difference is whether the probability of the outcomes occurring are objectively known or unknown. In the case of risk, we known the probability of outcomes occurring while in ambiguity/uncertainty we do not know this (Ellsberg, 1961). In fundamental uncertainty, the possible set of future outcomes are not known ex ante (Knight, 1921).

Operationalising uncertainty in the context of entrepreneurship can thus be done as either uncertainty around the probabilities of future events occurring or as missing or
conflicting information relevant to the occurrence of future events. It is important for the validity of the main experimental work to understand which of these dimensions corresponds to how early-stage investors understand the uncertainty construct in their decision context. It is also possible that investors think about uncertainty quite differently from these two approaches to measuring uncertainty. Exploring these concepts with business angels is the focus of this qualitative study that precedes the main study.

4.2 Research objectives and questions

Following the discussion in section 4.1, the primary objective of the qualitative phase of the study is to operationalise uncertainty in the context of business angels. This helps to inform the development of the business case scenarios for the second phase which operationalise different levels of uncertainty in ways relevant to how business angels think about uncertainty. The secondary objective is to explore how business angels’ perceptions of uncertainty affect their investment decisions and behaviours. This will also form a basis for the main objective of the quantitative work in the second phase of the study. Thus, the qualitative study seeks to answer the following research questions:

1. How do angel investors think about risks and uncertainty during their investment decision process?

2. What kind of information cues from entrepreneurs do angel investors consider as uncertain?

3. How do angel investors relate the uncertainties in early-stage ventures to their investment decisions?
4.3 Research approach and method

I take a qualitative research approach for this part of the study as I seek to understand how angel investors recognise and interpret the uncertainty construct in the context of their decision-making. Qualitative research is most appropriate when the research seeks to understand and interpret how a phenomenon occurs within a particular context (Creswell and Creswell, 2017; Pratt, 2008). The objective of this part of the study is of an exploratory nature as we do not know how business angels interpret information cues in terms of uncertainty and what it means for their decision-making. Considering that this study uses real business angels and real-looking cases, which has rarely been done, a qualitative stage is useful to narrow down the direction of research and to form initial hypotheses that can then be studied quantitatively. Additionally, it serves as an opportunity to get business angels to peer-review the business cases and make them more relatable to what they encounter in their normal operations.

I adopt a semi-structured interview approach to explore the uncertainty construct through a set of business case scenarios. I explain the selection of the method for this part of the study in detail in section 3.2.3. A major source of information for business angels in their investment decision process are business plans from entrepreneurs (Harrison et al., 2015). Executive summaries of these business plans are usually reviewed by investors prior to a full review if investors believe it is worth their time to know more about the business. As part of the screening stage process as discussed in section 2.4.2, investors review executive summaries of business plans as a means of identifying the ventures with good potentials (Harrison et al., 2015).

I create the business case scenarios in the form of executive summaries of business plans. I provide details of how the cases were created in the section 3.3 of the methodology chapter. An example of the base case scenarios used in this part of the study
is presented in Appendix 3.1. To help explore the uncertainty construct in the context of business angel decision making, I create different versions of the base case scenarios using different modelled uncertainty statements of selected critical decision factors. The selected decision criteria are from the 8 critical decision factors used by Maxwell et al. (2011). As highlighted in section 3.3, they are low market potential or growth, limited evidence of product adoption, lack of product protectability, excessive time to market, lack of viable route to market, limited customer engagement, and financial forecasts that indicate the venture will run out of funds. I select market growth potential, product innovation or adoption, and product protectability to model uncertainty in the cases. I provide details of why I select these three in section 3.3 of the methodology chapter.

I model uncertainty based on the dominant ambiguity construct using the Ellsberg 2-urn experiment – a risky scenario against an ambiguous scenario (Ellsberg, 1961). Ambiguity is uncertainty about the probability of an event or decision outcome occurring based on a current act of a decision-maker. Parts of the cases that relate to the selected critical factors are modelled to have statements that can be considered risky or ambiguous. A risky statement will have a known probability of an event or outcome occurring while an ambiguous statement will have an unknown or ambiguous probability of the same event or outcome occurring.

For example, for market growth, A risky statement is modelled as one where there is a definite estimate of the chance of obtaining a specific growth rate (example 30%) over a certain period against an ambiguous statement in which the chance of obtaining the same growth rate is not precisely known (example 10% to 40 %). Similarly, for product uniqueness, uncertainty is modelled as one where there is definite estimate of the chance of product success (example 30%) through user acceptance over a period against one where the chance of success is ambiguous (example 20% to 40%). Finally, for
product protectability, uncertainty is modelled as one where there is a definite estimate of the chance of obtaining a patent (example 40%) over a certain period against one where the chance of obtaining the patent is not precisely known or ambiguous (example a 30 to 50 %). I show examples of these statements in Table 3-1 in the methodology chapter.

Participants were made to evaluate the cases as part of the interviews and to provide feedback on the nature and structure of the cases. These include whether the modelled uncertainty cues make sense to them, what information cues participants considered uncertain, and how the cases could be improved for the quantitative study. This is further explained in the next section.

4.4 Data collection and analysis

I collected the data for the study with angel investors in the United Kingdom between January and July 2019. I mainly reached participants through personal referrals and via their LinkedIn profiles. I also employed a snowballing sampling approach, which involved participants introducing me to other business angels who I could recruit to take part in the study. I interviewed 9 angel investors over the period face to face and by telephone depending on what the participant preferred. Participants have a wide range of backgrounds from experienced academics, experienced entrepreneurs, serial investors, an investor with limited investing experience to an investor with a prior formal investing background.

I conducted semi-structured interviews with all participants, which allowed me to explore the thoughts of participants, probed answers, and follow themes emerging in the interviews. The interviews lasted between 30 minutes and 55 minutes depending on how much detail participants provided.
The base case scenarios and the interview guide evolved throughout the process of data collection. Emerging themes from previous interviews required that I adjust the interview guide as I moved along. After every three interviews, I transcribed the audio recordings and analysed the interviews for feedback that can be used to improve the scenarios and to find emergent themes that could be explored further in subsequent interviews. I updated the scenarios based on the feedback provided by the participants to avoid the solicitation of similar comments from previous participants.

The interviews were structured in two sections – the first section covers general questions about the investor and their investment decision process while the second section was related directly to the scenarios presented to the participants. In the first part, I start the interview with an introductory question about investment preferences including the sector/industry, typical investment size and whether they preferred to invest alone or with other investors. I then ask about how they go about their investment decision process and how they think about risks and uncertainty during the process. I end the first part of the interview with questions about the kind of risks and uncertainty they are most concerned about when they review business opportunities.

In the second part of the interviews, I ask each participant to review 5 business cases and discussed their thoughts as they read through. I ask participants about which information cues in the business cases they believed are fraught with uncertainties and whether they are important for their decision-making. After this I ask participants whether they are able to decide on whether to proceed to the next stage of the investment process. For participants in the third round of interviews, I ask them to provide their perceptions of uncertainty in the cases on a scale of 0 to 10 (with 10 being the highest level of uncertainty). Finally, I ask all participants about how engaging the scenarios were and if they had any suggestions or comments on how to improve the scenarios.
I use an inductive thematic analysis approach for the data analysis instead of a deductive approach. Taking a deductive approach will require already identified themes from the literature with only the relevant part of the data that fits in these themes being the focus of the analysis (Braun and Clarke, 2006). There is very little known with respect to the role of uncertainty in angel investing literature and hence this research requires an inductive approach that explores the entire data to create themes. An inductive approach allows for the exploration of the entire data looking for themes that relate to or answer the research questions (Saunders et al., 2016). The objective of this study is to explore how angel investors think about uncertainty in their investment decision-making and the kind of information cues they consider uncertain which makes an inductive approach the most suitable option.

I use NVivo for the analysis. I go through the data in an iterative manner to code accordingly. I had three cycles of coding in all, which ensured that the initial coding in the first cycle were appropriate and consistent throughout the data. I then group the codes into two levels of categories: the main categories and associated sub-categories. The main coding categories are investor preferences and motivations, how investors think about uncertainty, kinds of information cues that are uncertain, and uncertainty perceptions and investor decisions. This forms the basis for the main thematic areas for the data analysis in section 4.5.

4.5 Results and findings

In the first section of the interview, I ask participants to describe their investment decision-making process in general terms and how they think about uncertainties during the process. I highlight a few key points before I present in detail the four main themes identified in the data analysis.
First, experienced angel investors (5 years or more in angel investing) indicate that they find angel investing inherently uncertain and risky. This, they say, is because they prefer to invest at the very early stage of the business, typically the seed stage or first round of investing. Businesses at this stage have prototypes of their products that are unproven and sometimes in unproven markets. The first thing for these investors is thus to embrace or accept this risk and uncertainty and its consequences of potentially losing their investment. As investor A says, “I think the first thing is that you have to accept you’re going to lose your money”. The focus for these investors then is on the opportunity in the business and whether, when it turns out to be successful, it can produce extraordinary gains. This is emphasised by investor A, “I would say I want something that can be big. Because we know that your winners will pay for everything, so it got to be big winners. So big market, big margins […]”. Thus, with the mindset of looking for big winners, experienced investors take uncertainty in early-stage venture as given and focus on two main aspects of the venture: the business opportunity and the team behind the opportunity.

While participants say their main focus is on the team as they describe their decision-making process, they act differently once they start to review the scenarios in the second part of the interview. They first start their review with the business opportunity, which comprises the problem that the business seeks to address, the solution to the problem (product or service being offered), the size of the target market, and how the market is growing. They assess the team once they are satisfied that there is a reasonable enough opportunity to exploit with a potentially “big” gain to make when successful. Investor D recognises this during the scenario review part of the interview and makes the following comment:
Yeah, I think that's the first thing. So actually, in a way, I probably ought to go back and modify what I was saying earlier about what I look at. The business model is obviously more important to me than I originally thought on top of my head. I kind of sit the business model with the opportunity in the market. What does it take to play in this industry? Does it make sense? If it does then I am kind of open to what might be possible and then I am looking at the team and the financing of these other things.

This is, however, not a case of one factor being more important than another. Angel investors do not necessarily find the team as being more important than the business opportunity and vice versa, but it is only a case of which one do they focus on or assess first in a sequential decision process. Different emphasis is placed on different parts of the venture under review at different stages of the process. What I find from this study is that investors say they focus on the team first because as they review the cases, they unconsciously assess the business opportunity and take that part of the process as given when satisfied with it. Investor E makes this comment when I draw his attention to the inconsistencies in his evaluation as he reviewed the cases, “But yes, you're absolutely right. In order to assess your team, it needs to go against an idea and there's no point in backing a team if there's no opportunity.”

I discuss the rest of the findings along the main coding categories or themes: investor preferences and motivations, how investors think about risks and uncertainty, what kind of information cues are considered uncertain, and what drives perceptions of uncertainty and investor decisions.
4.5.1 Investor preferences and motivations

Business angels have been described as heterogenous in nature and in their activities (Mason and Harrison, 2017; Riding et al., 2007). Participants in the study had different interests and industry preferences ranging from those who are “industry agnostic” as one participant mentioned to those who are exclusively focused on a specific sector. As investor D noted, “I am focused on the life sciences sector; health care in general and defined broadly from digital health through some big data AI applications and consumer MedTech service. So, the full range of healthcare sector.” The industry and sector preferences of some investors are influenced by their background prior to angel investing. Having prior knowledge and experience from a particular industry or sector makes investors competent to understand the nuances to that industry or sector, and it helps them to deal with the uncertainties in the ventures they invest in. Investors also make exceptions to their general position on industry or sector preferences. When they say they are open to all industries, they still have a list of industries they avoid. As investor E notes, “I am completely industry agnostic, so I invest in everything and anything. There are things that I tend to avoid (mainly, social media, consulting, recruitment, HR)”.

For those who are focused on specific industries, they are open minded about other sectors they find interesting. Investor C had this to say: “Based on my background I tend to invest a bit into high-tech software and internet, but I am not limited to that.”

Business angels have different reasons why they invest in early-stage ventures. Beyond the primary motive to create wealth, investors have other reasons for becoming angel investors. Investors with entrepreneurial background often become angel investors because they understand the difficulties in raising funds when they started. When they are successful, they join the angel investor community to help provide the needed funding for other entrepreneurs. Investor G makes the point, “My motivation was because I have been a Tech founder before, and I knew how hard it was to raise funding. So, I wanted to
be one of the angels that made fund availability easier.” Other participants are also motivated by the value in backing entrepreneurs that they believe have what it takes in making a difference in society. As investor F puts it “I genuinely feel backing the right people is a good way to sort of balance an overall portfolio. It is a good method of creating value.” Investor B cites the favourable tax regime (in relation to EIS and SEIS) as a motivation for participating in angel investing. The Seed Enterprise Investment Scheme (SEIS) and the Enterprise Investment Scheme (EIS) operated in the UK allow investors in early-stage ventures to claim part of their investments through tax breaks. The protection of invested funds by the EIS and SEIS programme makes “a much easier decision because of the risk profile of the businesses.” This also has an effect on how investors perceive uncertainty in the early-stage ventures and also on their attitudes towards risk and uncertainty. Investors E and F, for example, mentioned that they are guaranteed between 50% and 70% of the invested amount, which gives them the comfort to back ventures that they believe can be successful, knowing that a large part of their investment is protected if things do not go as expected.

Participants report that they invest small amount of funds, typically a few thousands of pounds, over multiple rounds of funding in businesses at their very early-stage. Cumulatively, some of the participants say they can invest up to £100k in a single company. As investor A explained, “it is important to be prepared to back investee firms when things are going well”. So, while most of the participants had a strict preference for ventures at the very early-stage of their development, which are raising funds for the first time, they continue to invest in these ventures at later funding rounds until the late pre-IPO stage when they sell off their interest to venture capital funds. Their funding activities are done through their personal networks (pitch events and angel networks) and social media networks. Investor E describes his deal sourcing process as “I have three main streams of sourcing potential deals; pitching events mainly through Angel Investor
Group among others, my LinkedIn profile as an angel investor and my own network of investors who share good opportunities with me.” Trusted sources serve as a good way to avoid bad ventures and also to deal with risk and uncertainties in early-stage ventures. When a venture is recommended by a trusted network, investors believe some level of due diligence has already been done by their trusted source. Some participants also engage in syndication as a way to deal with the uncertainties in the ventures they invest in. Investor D, for example, says “I will typically invest as part of a syndicate. I have a small syndicate that I usually invest with.”

4.5.2 How investors think about uncertainty

In their decision-making process, how investors think about uncertainty can be grouped under 4 different sub-themes. First, investors think about the uncertainty in the business opportunity and its future viability. Second, they consider the uncertainties in the management team and their ability to execute the business plan to achieve the desired success. Thirdly, they jointly look at the team characteristics and the business opportunity and assess how they fit together. Finally, they employ internal and external measures to cope with the uncertainties in the business.

When investors review business plans, they are first concerned about the opportunity that the entrepreneurs behind the business seek to exploit. They are concerned about the business when information concerning the opportunity is unclear. As investor G puts it, “At the back of my mind, this could be a big market, or it might not be a big market, I don't know. So that's why I am a bit concerned about the opportunity in the market.” Others also worry about the long-term viability of the opportunity in the market that creates uncertainty about the future success of the business. “That is the big uncertainty for this business. There may be an opportunity for a period of time once the
placements are getting sorted out. But is the value in this business in the long term?” (Investor D).

The next focus is the uncertainties in the management team. Investors are not only interested in issues about the founder but the team around the founder. Indeed, some investors consider ventures backed by only a single founder as potentially problematic. As investor A notes as he reviews a business case, “If it had been that it is just one person with an idea, then I would have immediately discounted that probably as an opportunity.” Another source of uncertainty around the team is whether they will have the interest of the investors. Agency risks issues are a source of uncertainty for some investors as well. “Having said that the main thing I look for is the team. That I would regard as people who will do the right thing.” (Investor J). Issues of adaptability of the team to the uncertainties in entrepreneurship are also a source of uncertainty. Investor C argues that entrepreneurship is inherently fraught with uncertainties, and his concern is the ability of the team to cope with these uncertainties. “The biggest one is how people (that is the Team) will cope. Because as I said uncertainty and risk is a given when it comes to start-ups. Now the question is, will the team be open enough to make changes when things don’t work.”

The third focus for investors is to jointly assess the characteristics of the team and the business opportunity. “What is the background of the team and then relate that back to the opportunity?” (Investor G). The interest here is to match the experience of the team to what investors believe are the right set of skills to exploit the opportunity. Investors are not only interested in the relevant experience of the management team but also the diversity of their experiences. Investor C makes this comment as he reviews one of the cases presented to him: “[...] they have a team which is scientifically led and also, they have the technical aspect then certainly I am little more interested in what the
opportunity is.” BAs assess the background and the experiences of the team members relative to the core business opportunity.

Investor D summarises this point: “When I look at a business case, I ask myself is there an opportunity there to create the IP? Is there an unmet need? Are we doing something novel? Or you might be using a piece of IP from a services perspective to drive revenue [...] And then the question is what is the background of the team, and can the team execute the strategy? I am always trying to figure out very early if this is the right team or is there an individual to build the team around?”

Finally, investors also think about how they can deal with the uncertainties in early-stage businesses when they are interested in investing in them. To help cope with the uncertainties in early-stage ventures, investors rely on or use internal and external strategies and paths. Internally, some investors adopt a portfolio approach to their angel investing activities. This requires also investing in early-stage ventures that they consider are less uncertain in nature. However, these ventures do not provide the extraordinarily high returns that are typically of interest to angel investors.

Investor D again describes how he manages the uncertainties in his portfolio of early-stage ventures: “That's the nature of the uncertainty. But I look to offset some of those risks in my portfolio because I do take very much a portfolio approach to angel investing [...] I diversify my portfolio which allows me to invest in very high-risk deals where the chances of failure are very high, but I will also offset that risk by investing in say services industry or say the supply of reagents to life sciences companies which are typically lower risk. So how I manage to cope with uncertainty is by having some lower risk, lower return deals in my portfolio.”

Other investors also seek business opportunities that have the potential to lead to other growth opportunities. For these investors, this helps to deal with the uncertainties
in early-stage ventures. Ventures with business ideas with potentially multiple outlets means when one product or service fails, there are several others that may work.

Investor B said about the kind of opportunities he prefers, “I am more interested in the problem that exists, and the size associated with it. And even more than the idea I like spaces. As in, I like to invest in an area where it is at the cross of several problems or things that will allow for pivoting. So, I don’t like the single idea type of business. For me, it's far more important that the idea is at the centre of a few trends that if one fails to be correct as a hypothesis may be another will succeed.”

Some investors rely on the favourable tax schemes in the UK to mitigate the effects of uncertainties in their angel investing activities. As explained earlier, the SEIS and EIS programmes provide some protection against failure of investments into early-stage businesses in the UK. “Obviously with the tax breaks you get with SEIS and EIS it makes you bit more laid back on things like potential failure because you kind of get between 70% to 80% of your cash back anyway. So, you can be a bit more liberal, and you don't need to put in a lot of defensive strategies to protect yourself on the downside.” (Investor F)

4.5.3 What kind of information cues are uncertain?

Investors make decisions based on information provided by entrepreneurs through business plans or at pitch events. As they review business plans, they interpret the information provided based on their background, motivations, and preferences. A decision whether to move on and reject the application or to know more about the business is thus based on available information and investor interpretations. Whether consciously or unconsciously, they interpret information provided in the context of uncertainty about the success of the venture should they invest in.
The results show that participants are unable to distinguish between risky cues and ambiguous cues when we model uncertainty cues based on Ellsberg’s 2-urn approach. The participants interviewed found the cues in this format as unusual, uncommon, and unattractive. Whether the uncertainty cue is modelled in a certain probability statement (risky) or uncertain probability statement (ambiguous) makes no difference to them as they could not make sense of them. Investor E for example was unable to make sense of one such statement on intellectual property (IP) application in one of the cases. “One phrase which I found unusual here which was about the IP. That there’s a 30 to 60% chance that the patent application process will be successful. I didn't really understand that as a statement. You either have an IP or you don't have an IP.” For most participants, businesses typically do not communicate in this manner. They communicate with some level of certainty and do not use probabilities in their business proposals. “First, I don't think anyone can predict with certainty or to put a probability on it in terms of anything continuing to grow. Actually, I would say that makes it far less attractive as a statement. I think as an investor what you need to have a degree of certainty over is whether the market is going to grow.” (Investor J)

While participants found the modelled uncertainty cues in the cases unusual and unreal, what creates uncertainty for them is the absence or presence of particular information cues. From the study, we can thus group what drives uncertainty in the minds of investors as they review the cases into two categories: the absence of certain information and the presence of certain information. Certain information here means specific or information.
4.5.3.1 The absence of certain information

Investors look out for certain information in every business case based on their preferences and backgrounds. Missing information creates uncertainties about the future success of the business. For example, not providing all information about the potential opportunity in the market creates uncertainties for the investor. As investor G argues, “Also, when I am looking at the market, they say it is forecasted to grow between 10% and 14% year on year over the next 5 years. The problem is I don’t know what that means quantitatively - is it 10% of £1 or £100m? I don’t know exactly what we are talking about, and I don’t know where the market is as well, globally, or just in the UK? Depending on where this market is, we will be able to tell how attractive it is. I am looking at all these gaps in information which creates uncertainties in my mind.”

When investors consider an information important and cannot find it, they consider that to mean the entrepreneur is either unaware or the information is simply not available. In reviewing a specific business case, an investor who believes this business needs to have product innovativeness and product protectability to be successful in their chosen industry had the following to say. “What we don’t get here is if there is any reassurance that the software has any USP [Unique Selling Point] or has any IP protection. If it had IP protection, they would have said so.” In this case, investor B believes having an innovative product with intellectual property protection reduces the uncertainties in business environment.

In general, investors make decisions based on information provided in the business cases. Thus, information that investors consider important but cannot readily find creates uncertainties in the minds of investors.
“The main premise of this business is the fact that elderly people don't take their medications well, but they don't explain why. I believe that if they knew why they would have put it in the executive summary.” (Investor E)

“On the financials, I don't know what your breakeven point is although you talk about some forecasted sales numbers with no price points. At this stage I will rather you don't speak about any sales which is ironic. Unless you're going to tell me about prices and when you're going to breakeven, don't talk to me about sales.” (Investor G)

“Nice idea but a lot of work to be done there before I consider. Too much missing information which creates uncertainties.” (Investor B)

“Missing information can be very problematic for investment decisions. You can’t tell if it is deliberate, or the team are just not right for the business.” (Investor F)

Investor decisions are mainly based on information provided by the entrepreneur. Since investors look out for particular information when they review business opportunities, missing information creates uncertainties about the future success of the business.

4.5.3.2 The presence of certain information

The presence of certain information in business plans can either heighten or reduce uncertainties. For example, the presence of information about product protectability through patent applications reduces the uncertainties in the businesses for some investors. When entrepreneurs indicate that they have applied for or obtain patents, it sends positive signals to investors. It increases the chances of success in the future for the venture and hence leads to less uncertainty. As investor B puts it, “I also like that there have been patents applied for because that means the product if it gets patented gets
an edge over competition. What we don't know is whether it works or not because it hasn't been fully developed." Patent applications are a good quality signal to investors as it gives them some assurance of the product being unique enough to warrant protection. “There is talk about a patent application being in the process. I'm not clear what it means exactly but that seems to indicate that at least some work has been done. The fact that they are doing a patent application sends a certain signal that there's something in there.” (Investor C)

However, for other investors patent applications do not mean much for their decision making depending on their investment preferences. As investor H explains, “I am very aware that a lot of investors are very interested in patents and IP. I guess because I tend to focus on technology businesses, I therefore tend to believe that the value is more in the team that built the technology and the space that it occupies rather than any patents that could be associated with that. [...] So, for me having a patent doesn't really mean that your business has value.”

This is because some investors do not believe that patents provide the needed protection and hence reduce the uncertainties in the business as early-stage business do not have the strength to enforce the patents. Investor D argues, “Patent information is typically not valuable to be me because a company of this size cannot defend it. The presence of a patent information is of little value to my decision making. [...] What I want to know is if you have a plan to sell the product and whether you have the right people to sell”. For these investors, a patent’s value is in the protection it provides against competitors copying a proprietary product. Without the ability of the business to enforce the patent when breaches occur, patents have no value.

Sometimes the presence of some information leads to other questions which create uncertainty about the business. Investor G had this to say about the presence of
information which should hitherto be interpreted in a positive light in terms of the experience of the team and their ability to succeed: “they say the lead entrepreneur has founded, built and run an enterprise software company before but within a different industry. Did they exit successfully or are they still running it? If they are still running it, how are they going to manage both. The inclusion or exclusion of information then leads to another set of questions.” In general, the presence of information can either heighten or reduce the uncertainty in the business. “The basic concept of royalty-based revenue is that it's a percentage of money someone else makes. And you have no control over that. So that brings a high degree of uncertainty.” (Investor C)

The quality of information provided also affects how investors perceive uncertainties in the businesses. For example, if information about an aspect of the business has different dimensions, then providing one dimension without the other creates uncertainties for investors. Investor E summarises this as he reviews one of the cases presented. “There is information about the growth like it's growing steadily at a 6% rate, but we don't know the size of the market. So, for me, it doesn't mean anything. It goes in the bucket of ambiguous.” This suggests to investors that the business is not fully developed, or the entrepreneurs are probably not competent enough. “As it is written it is quite normal to see opportunities like that, but I find it quite off-putting because it suggests to me that the business isn't that far developed. They've got a solution, but they don't quite know what the problem is.” (Investor D)

4.5.4 How perceived uncertainty affects investors decisions

Investors form subjective perceptions of uncertainty in the businesses they review. While this may not be an explicit or conscious process, their interpretations of the information provided in the business proposals affect their subjective perceptions. When
investors are familiar with the industry in which the business operates, they tend to have a favourable disposition towards it. As investor D explains, “I have looked at a lot of recycling and other materials businesses in the past, so I know enough about this industry and actually have an investment in a recycling business.” In that same light, personal preferences also have the same effect on investor attitudes towards the business. Investor G for example looked favourably at one of the scenarios that was in an industry that is of keen interest to him: “I am personally interested in this space so they will have to a lot to not make me want me to put my money in it. I have got questions already but because I am very interested in this space, I am willing to give them a lot of room.” Past successful investment experience also tends to make investors have a positive outlook towards a business opportunity. They are more likely to view the business in a good light under these circumstances than when they have not successful invested in the industry before. Investor remarks “I quite like MedQuip because I have been quite successful with medical investments before. […] there is a useful management team in MedQuip. You have a product which is in quite a busy market with a lot of potentials. It is a market which is expanding and that's encouraging.” Investors thus perceive less uncertainty when they have had a successful investment in the industry in which the venture operates.

The team members behind the venture and their past experiences also affect investor perceptions of uncertainty and their resultant decisions. Having the right team is important for the future success of the business. While the individuals in the team matter, investors are more interested in having the right mix of individuals for the team. As investor J puts it, “So, it's not really about the individuals but it's more about the way the team is constructed.” This means that the team has the relevant past experience to ensure that the goals of the business are achieved. Not having the right mix of individuals with relevant industry experience creates uncertainties about the business. “So that's what the uncertainty for me within the management team is. Do they have the right skills, do they
have the right set of experience?” (Investor D). Relevant industry experience demonstrates the capacity of the team to thrive in an uncertain environment for an early-stage business. Investor A remarks, “So, for this case, they have the relevant experience in the industry. They founded and successfully sold a previous company within the industry. That's good so you have a track record there in setting up a company within the same industry. So, you're looking for relevant experience.” Businesses with a team that has a track record are more likely to get a favourable decision from investors. “They have come out from the industry and have a track record. There is enough there that makes me think, that's worth a conversation and getting to know more.” (Investor J)

Another important result is that investors seek uncertainty when they assess the venture to potentially produce extraordinary gains. A perception of high uncertainty does not necessary mean that investors will avoid it. Even in cases where investors may feel less competent in the industry of the business, they are inclined to invest in it because of the potential upside.

As investor F remarks about one such case, “this is not a market I know much about. However, it ticks the box of technology and to the extent that it deals with fraud I believe it is good for society as well. I can also imagine it will be scalable. From my perspective I will give it an uncertainty level of 8 because I don't know anything about the sector. However, I would like to consider knowing about it. It has a lower valuation and revenue growth target of 8% per annum is pretty modest. But I can see that being something that I will be interested in even though I consider quite uncertain especially as I think it is quite cheap relative to the potential upside.”

Indeed, perceptions of lower uncertainty do not lead to an investment. For example, investor F assessed a case to have a low uncertainty as the business operates in a space with stable revenue streams. “In terms of uncertainty, this strikes me as much lower compared to the others. I could easily see this as being a successful business and
being acquired by one of the waste management companies. The uncertainty level will be a 3 for me.” However, when asked whether he will make an investment he retorted in the negative because the business does not have the potential upside for the investor. “This wouldn’t be the type of project that I will invest in because it is not a scalable business [...] I see that it can raise bonds in the future with a more stable cash-flow. So, for me I don’t see where the big X will come from. It doesn’t tick my tech box which makes it a scalable piece.” Investor A makes similar comments about the same business. “So, this to me seems to be a kind of viable commercial proposition. I wouldn’t invest in it though. I won’t because I am not sure that the upside will be big enough to take the risk. I could imagine other investors investing.” As investor F explains, it is more about what the business can potentially produce and less about the robustness of the business model. “It is less about whether there is a robust business model now and more about what will appeal to the future investors coming in. Sometimes you get opportunities with lower and more stable return but for me I might just put my money into some fund. So, for me I need to see that there’s a 100X potential in the business.”

Sometimes investors reject ventures not because they are not investment-ready or not good enough but simply because of their personal preferences. Investor characteristics affect investor decisions. Investor background shapes investor competencies in different industries which in turn affects their investment preferences and their decisions. As investor A explains, “I think business angels are heterogeneous and you get people who have had some successes in say chains of restaurants and they know how it works and look for things like that. And they don’t understand technology, so they don’t like that.” Investor backgrounds shape investor preferences which is typically in terms of which sector or industry they prefer to invest in. “Bearing in mind what I said about my sector focus, I certainly wouldn’t be interested in this [...] I do know a lot of investors who like the space. It’s just not something that I do like.” (Investor D) So even when they
believe the business is capable of doing well, they avoid it nonetheless. Investor J remarks, “Let's say this should be a 5 on the uncertainty level. I could quite easily imagine that this business could actually be an okay business model. It's just that I wouldn't go into it because of my own rationale.”

There are also industry events and stories in the media that affect investor perceptions and their investment decisions. For example, investor F is averse to anything MedTech because of the events around a start-up company in that industry. “The ABC Matrix will be a no for me straight away - do you know why? Purely because I literally just finished reading the book Bad Blood about Theranos so I will never touch MedTech based on reading that book. It's too fresh in my memory and I am too nervous about that sector.” Their interpretation of happenings in an industry also affects their perceptions of uncertainty and their investment decisions. “With all the IoT stories going around I just don't buy this. I am not sure this is a sector that will do well as it is being hyped [...]. For me it's more sector uncertain than it is business uncertain so I will probably give it an 8 because it is quite uncertain for me.” (Investor H).

4.6 Discussion and conclusion

The primary objective of this phase of the study is to explore through a qualitative study how to operationalise uncertainty in the context of business angels. That is, determining which dimension of uncertainty is useful in the context of business angels is crucial for the validity of the main study. The secondary objective is to explore how business angels’ perceptions of uncertainty affect their investment decisions and behaviours mainly to develop themes for further studies in the second phase of the study.

The study finds that angel investors do not think about uncertainties in terms of probability of events occurring. Business angels find modelled uncertainty of the Ellsberg
type in the cases as unrealistic and unusual. Business angels do not encounter this type of uncertainty in real life, evidenced by the aspects of the business cases that do not make sense to them. Early-stage entrepreneurs do not present information in this format and even if entrepreneurs did, it would not make sense to business angels. Instead, what creates uncertainty for investors is the absence or presence of information cues that are important for decision-making. For example, if the investor considers product protectability issues important for the success of the venture, then the absence of what the entrepreneur is doing to protect the core intellectual property of the business creates uncertainty in the future success of the business.

Generally, when business angels review venture proposals they think about the uncertainties in the opportunity, the team behind the business, and jointly the opportunity and the team. While business angels take uncertainty as given for early-stage businesses, they evaluate the opportunity at hand and assess whether the team is the right fit to deliver the potential gains in the opportunity. In line with the existing literature (Mitteness et al., 2012a), some angel investors indicated that the team is more important than the opportunity. This suggests that issues around the entrepreneur and the team behind the venture are of more concern to investors than the business idea itself. However, this is not necessarily the case. Indeed, angel investors assess the opportunity against their investment preferences and their return expectations. When investors are satisfied with their assessment of the business opportunity, they assess the competencies of the team to deliver the opportunity. So, it is not the case of the team being more important than the opportunity or vice versa but a case of which investors evaluate first. As reported by Maxwell et al. (2011), angel investor decision-making is a multi-stage process and investors use different factors at different stages of the investment process.
Investor characteristics affect the perceptions of uncertainty in business proposals. Investor background and prior experiences form the basis for their motivations, which in turn inform investor preferences. Investor background, motivations, and preferences thus affect their perceptions of uncertainty and their investment decisions. For example, when an investor is familiar with the industry in which the business operates, the investors tend to have a more favourable perception of the uncertainty in the business. Similarly, past success in investing in an industry leads to a favourable perception of uncertainty in the business. This also means that past failure in investing in an industry can lead to higher perceived uncertainty.

Finally, we find that investors seek uncertainty with the hope of making extraordinary gains when successful. This is in line with the findings of Huang and Pearce (2015). Angel investors are fully aware that they could lose their investments and hence are more interested in ventures that have the potential to deliver extraordinary gains. Business angels seek ventures that potentially can be disruptive, and these ventures are fraught with uncertainties. This means perceptions of greater uncertainty do not necessarily lead to a rejection as long as investors perceive the opportunity in the venture to be one with a potentially high return. Nonetheless, there are some investors who deal with the uncertainties in their angel investment portfolio by investing in some ventures that they consider having low uncertainty with low return to diversify their portfolio.

To conclude, uncertainty is an attribute of information that relates to missing or incomplete information. The type of uncertainty that can be observed in the angel investing space is akin to what Milliken (1987) described as state uncertainty – a perceived environmental uncertainty about the unpredictability of the state of the world. Unclear, incomplete, or missing information creates the world that cannot be objectively predicted as espoused in normative decision making. This is very much the case in
businesses at their very early stage with no proven products or services and sometimes unproven markets.

The main findings have a critical implication on the design of the second phase of the study. They require that I pivot the design away from the ambiguity aversion literature where uncertainty is modelled as doubts around the probabilities of events occurring to a more generic and fundamental modelling of uncertainty as the absence of critical information. Missing information is known to be the fundamental driver of uncertainty in economics. This forms the basis for creating the uncertainty cues in the business cases used in the main experimental survey. Cues or statements in the business cases that provide what is considered required information are coded as low uncertainty cues and those that do not are coded as high uncertainty cues.
Chapter 5 – Uncertainty perception and investor experience

5.1 Introduction and background

This chapter empirically examines how the characteristics of angel investors affect their perceptions of uncertainty in the business opportunities that come their way. In Chapter 4, where we explore how early-stage investors think about uncertainty during their investment decision process, we find evidence that some investor characteristics affect how they perceive uncertainty. We know from the angel investor decision-making literature that angel investors are heterogeneous in nature (Maxwell, 2016). This means that some angel investors’ decision-making and behaviour may be investor dependent. This chapter therefore extends the preliminary findings in chapter 4 by empirically testing them in an experiment.

At the screening stage of the investment process, there is evidence that angel investors only scan through executive summaries of the business cases with the aim of assessing whether the proposal merits further time and engagement for a more detailed assessment (Harrison et al., 2015). I also observed a similar process during the qualitative study. Business angels start the search of information with some pre-set objectives, including how the business fits with their own investment objectives and criteria. As they undertake this process, I contend that business angels consciously or unconsciously form subjective assessments of the uncertainties surrounding the future success of the business which has currently not been studied in the literature. This assessment of uncertainty levels translates into whether an investment opportunity is rejected or proceeds to the next stage of the investment process. It is therefore important to understand how investor background and experiences influence these subjective perceptions of uncertainties in these businesses.
Experience, defined as how much knowledge, skills, and understanding a decision maker has in relation to the situation under consideration, has been shown to influence decision-makers’ attitudes towards uncertainty (Abdellaoui et al., 2011; de Lara Resende and Wu, 2010). For example, Heath and Tversky (1991) ran a set of experiments in which subjects gave probability assessments for natural events they knew a lot or little about. They were subsequently asked whether they would like to bet on the event or on a chance device constructed to have the same probability as the event. Uncertainty avoiders should always choose or bet on chance devices since natural events are inherently uncertain. However, participants who knew a lot about a domain of events preferred to bet on the events and those who knew little preferred to bet on the chance device. This suggests that decision-makers prefer betting on natural events when they are knowledgeable or experienced in that domain, and hence become uncertainty-seeking under these conditions. Aversion to uncertainty is thus reduced or eliminated when decision-makers feel competent about a domain. This finding has been replicated in other forms and contexts with similar results (Abdellaoui et al., 2011; de Lara Resende and Wu, 2010; Fox and Weber, 2002).

There is also extensive literature on how experience affects behaviour and judgements of decision makers such as entrepreneurs and venture capitalists (Fern et al., 2012; Cassar and Craig, 2009; Goldfarb et al., 2007; Bergemann and Hege, 1998). There are two dimensions of experience related to angel investors comparable to that of entrepreneurs and venture capitalists. The first one relates to the experiences and background of investors prior to commencing their angel investing activities. These include past entrepreneurial experience, industry specific or professional experience, and education (Avdeitchikova et al., 2008; Sørheim and Landström, 2001). These experiences shape investor motivations and set their investment objectives and preferences. The second relates to experiences of investors in their angel investing activities. This is mainly
seen in the making and monitoring of investments by business angels. Typically, this is measured by the number of investments made in the past or how long they have been angel investors (Harrison et al., 2015).

Most early-stage businesses seeking finance have little or no operating history, and estimating their value is left to the subjective judgement of the investor. The main source of information for early-stage investors is the business plan submitted by entrepreneurs to support their application for funding. Communications about planning activities in a business plan convey information about the business and influence investor funding decisions. The details of this information serve as the basis for the evaluation of the business by the investor. The inclusion of information in a request for funding indicates that the entrepreneur believes that this information is an important signal to an investor. Investors also look out for certain information they consider important for the success of the venture and for their decisions depending on their backgrounds and experiences. Therefore, different investors will interpret the information cues provided differently depending on their background and experiences, which then informs their investment behaviours.

5.2 Research objective and questions
Following the discussion in section 5.1, the objective of this chapter is to examine how the characteristics of angel investors affect their perceptions of uncertainty in the business opportunities that come their way. This chapter therefore seeks to answer two main questions. First, how do the backgrounds of investors affect their perceptions of uncertainty? The background of investors includes their past professional work experiences, their educational background, and whether they have an entrepreneurial background. These experiences prior to their angel investing activities shapes how they
process information from different sources. Information from familiar sources is looked on more favourably than that from less familiar sources. Second, how do angel investment experiences of investors affect their perceptions of uncertainty? As explained earlier these are observed in the number of investments they have made in the past and how long they have been involved in angel investing (Harrison et al., 2015).

5.3 Literature review and hypothesis development

Investors come into angel investing with different backgrounds relating to their education, professional, and entrepreneurial activities. There is evidence in the angel investing literature on how these characteristics of investors affect their decision-making and behaviours in diverse ways. For example, investor background and experience affect how they participate in angel syndication (Block et al., 2019) and their motivations to join and participate in business angel network activities (Bonnet et al., 2019). Additionally, investor background and experience also influence how they use investment decision factors. While investors with more entrepreneurial experience focus on the entrepreneurial passion of the entrepreneur, investors with more investing experience focus on the passion of the entrepreneur for the products (Warnick et al., 2018).

Another related paper is from Mitteness et al. (2012a). They find that having an operating industry experience (i.e., working in the same industry as the business opportunity under consideration) has a positive moderating effect on how business angels assess the business opportunity. However, when business angels have started a business before in the same industry as the business opportunity, it has the opposite effect. Mitteness et al. (2012a) argue that investors with past entrepreneurial experience in the same industry as the business opportunity tend to be more critical of the opportunity and entrepreneurs because they have experience of how work should be done in the industry.
However, as we find in Chapter 4, evidence from the qualitative study suggests that in general, the background of investors (professional, education and entrepreneurial) negatively affects investors perception of uncertainties in investment opportunities. Investors with past skills and knowledge acquired through educational, professional, or past entrepreneurial life within the sector of the business venture under consideration feel more competent to evaluate it. Additionally, when business angels find potential gaps in the businesses, they feel that they have the requisite skills to fill those gaps through direct or indirect involvement in the business.

Having a working knowledge or experience in a specific industry makes investors more inclined to invest in opportunities in that sector (Aernoudt, 1999). Investors have been shown to have an interest beyond just simply investing in business opportunities. Angel investors have a desire to contribute to the development of their investee firms post investment (White and Dumay, 2020; Mason and Stark, 2004). Thus, business angels are inclined to invest in businesses in which they feel competent to have a meaningful impact. Thus, decision makers with a working knowledge of the industry in which the business operates have a more favourable perception of the viability of the business (White and Dumay, 2020; Mitchell and Shepherd, 2010). Working knowledge and experience is acquired through working in the industry as a professional or starting a business in the industry.

However, it is important to note that Mason et al. (2017) did not find any direct relation between investors’ characteristics (education, professional, and entrepreneurial experience) and their reasons for rejecting business opportunities. Their research suggests that reasons for rejections are not influenced by the personal characteristics of the investors but are only associated with the characteristics of the investment opportunity.
This means that investor experiences do not affect their decision-making. This may also apply to their perception of uncertainty in the businesses.

The mixed results from the literature call for further studies which is what this study addresses. Additionally, how investor characteristics affect investor behaviour has not been studied in the context of uncertainty. Overall, I believe that investors’ prior investing experiences will negatively moderate their perceptions of uncertainty based on the literature and evidence from the initial qualitative study. Based on this discussion I propose the following hypotheses.

**H1a:** In early-stage investment decisions, investors who are familiar with the industry in which the early-stage businesses operate perceive less uncertainty compared with those who are not familiar with the industry.

**H1b:** In early-stage investment decisions, investors with entrepreneurial backgrounds perceive less uncertainty compared with those without entrepreneurial backgrounds.

Angel investing experience also influences how angel investors make investment decisions. For example, Harrison et al. (2015) study investment decisions of three groups of investors – experienced investors (made at least five investments), novice angels (made only one investment) and nascent angels (interested, but yet to make an investment). They find that experienced investors made quicker investment decisions and placed more emphasis on investor fit than novice or nascent angels while the latter two focused more on cues related to financial information.

As investors make more investments and review many more business opportunities, they learn from their past experiences and from working with other investors (Botelho et al., 2021b; Harrison et al., 2015). What could hitherto make them
anxious in the past about the success of a business will now have less effect in that sense as their experiences and skills acquired from past investments make them feel more competent to deal with it. Experienced investors develop ways to deal with uncertainties in business opportunities including post-deal contracting and monitoring (Carpentier and Suret, 2015). In the face of uncertainty, experienced decision makers believe in their own ability to control the odds of fate through a series of actions that remedies possibly unsuccessful outcomes (Shapira, 1995).

Additionally, experienced investors could potentially suffer from biases (overconfidence, illusion of control, belief in the law of small numbers) that entrepreneurs face when they decide to start new ventures (Simon et al., 2000). For example, overconfident experienced investors could overestimate their ability to influence the course of an investee venture even in the face of heightened uncertainty. They can use their successes in past ventures as the basis for their ability to do same when they review current opportunities. These successes may be small compared to the failures in other investee ventures. However, these biases can cause decision makers to perceive less uncertainty than they should. This leads to the next hypothesis:

**H2: In early-stage investment decisions, investors with more investing experience perceive less uncertainty compared with those with relatively less investing experience.**

5.4 Method and data analysis

5.4.1 Method and data collection

In this section, I briefly describe the relevant method employed and the data collection process for this chapter. The focus of this chapter is to understand how investor characteristics influence perceptions of uncertain information in the business opportunities BAs review. This is the first part of the second phase of the study, the
quantitative study. As described in Chapter 3, this requires the manipulation of key critical factors that are associated with investment decisions in sample cases and real-time decisions taken by participants. This calls for the use of an experiment for this part of the study. As explained in the methods chapter (Chapter 3), this method has been used in past entrepreneurial finance studies (Huang and Pearce, 2015; Ding et al., 2014; Hsu et al., 2014; Zacharakis and Shepherd, 2001). I develop and test the experimental survey through a qualitative pilot study with real business angels (see Chapters 3 and 4 for details of the qualitative study). This ensures that the operationalisation of the uncertainty construct in the angel investment decision context is accurate and realistic.

I create scenarios similar to what investors encounter in real life using executive summaries of business cases as the format (see Chapter 3 for details of the experiment). I employ a total of 5 base case scenarios for the experimental survey. Out of 5 base cases, one is used as an anchor case, and parts of the other four cases are manipulated to create version with different degrees of uncertainty. The anchor case has no manipulated factors and is shown first to serve as the base for the participants to understand the nature of the experiment and to measure the differences in individual levels of responses.

I manipulate three decision factors in the cases to create varying levels of uncertainty in the cases. The three decision factors are product protectability, route to market, and relevant entrepreneur experience. I create two experimental conditions for the selected critical decision factors representing two states of the world – one that denotes a case that creates high perceived uncertainty and one that denotes a case that creates low perceived uncertainty based on the presence or absence of particular information. This is supported by evidence from the qualitative study, which finds that the presence and absence of information on critical factors either heighten or reduce the perceived uncertainties in the likely success of a business. For example, a low uncertainty
factor information on route to market include information on how the venture will distribute its products while a high uncertainty one will have no such information in the case.

All the base cases, except the anchor case, have four versions with different values of the manipulated factors. For example, version 1 (V1) of the cases has the low uncertainty values of the manipulated factors while version 4 (V4) of the cases has the high uncertainty values of all three manipulated factors. Versions 2 and 3 create progressively higher uncertainty versions from V1 to V4. Table 3.3 in Chapter 3 summaries how we create the various versions of the base cases. I put the different versions of the cases into four blocks which includes one version of all base cases. Participants in the experiment evaluate a random block of business cases rather than randomised business cases to achieve a balanced design. As mentioned earlier, each block starts with the anchor case, followed by the different versions of the other cases. Every block is constructed to have a low-uncertainty extreme case (V1), high-uncertainty extreme case (V4) and a moderately low-uncertainty case (V2) and a moderately high-uncertainty case (V3). See Table 3.4 in Chapter 3 on how the different versions of the cases are put into the different blocks.

For every case, participants are asked to provide their assessment of the uncertainty level in that case on a scale from 0 to 100, with 100 being the highest level of uncertainty. There are also asked about how familiar they are with the industry in which the business operate. While this question relates to investor characteristics, it is case-dependent as it can only be measured or observed in the context of specific business cases. Participants are also asked to provide information about their entrepreneurial background as well as their past investment activities including the number of past investments and the number of years of angel investing.
Business angels in the United Kingdom (UK) and the United States (US) are the focus of this study. The business angel investment markets in these two countries are highly developed. For this study, it is important to use a well-developed market to avoid results being confounded by other unknown factors in less developed markets. In this study, I reach investors through their social media accounts. I contact participants mainly through their publicly available LinkedIn profiles. This approach avoids the use of samples that are exclusively from angel network and provides a good coverage and the needed diversity in samples for angel investing research. The data collection took place over a 5-month period between April and August 2020. A total of 3228 investors were contacted with 232 completed responses. I discuss the sample and data collection in more detail in section 3.4.4 of the methods chapter.

5.4.2 Data analysis and development of econometric models

The data analysis is in two parts. The first part relates to the general characteristics of the data collected while the second part relates to the econometric analysis to answer the research questions in section 5.2. For the first part, I present descriptive statistics of relevant key variables for this part of the study in Table 5.1 (see Chapter 3 for definitions of these variables). While the number of responses obtained from the survey is 238, the total number of data points is 928, as every respondent contributes 4 points from evaluating 4 different cases. For the purposes of the analysis, responses to the anchor case are omitted from the data points and are only used as a control variable. As seen in Table 5.1, the responses vary widely among participants with scores for the lowest possible value/option and the highest possible value/option for all variables. The average perception of uncertainty level for the cases of interests is 68.75. Participants are generally slightly or moderately familiar with the industries in which the businesses operate (Mean
= 2.52, SD = 1.08) and also have entrepreneurial background (Mean = 0.84, SD = 0.37). Also, on the average, participants have been early-stage investors for about 7 years, and they have made about 14 early-stage investments.

Table 5.1: Descriptive statistics for key variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Excess Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty Perception</td>
<td>928</td>
<td>0</td>
<td>100</td>
<td>68.8</td>
<td>22.2</td>
<td>-0.7</td>
<td>-0.2</td>
</tr>
<tr>
<td>Familiarity of industry</td>
<td>928</td>
<td>1</td>
<td>5</td>
<td>2.5</td>
<td>1.1</td>
<td>0.3</td>
<td>-0.6</td>
</tr>
<tr>
<td>Entrepreneurial Background</td>
<td>231</td>
<td>0</td>
<td>1</td>
<td>0.8</td>
<td>0.4</td>
<td>-1.9</td>
<td>1.5</td>
</tr>
<tr>
<td>Number of years of investing</td>
<td>232</td>
<td>1</td>
<td>15</td>
<td>7.3</td>
<td>4.6</td>
<td>0.4</td>
<td>-1.2</td>
</tr>
<tr>
<td>Number of Investments</td>
<td>230</td>
<td>0</td>
<td>50</td>
<td>13.9</td>
<td>13.4</td>
<td>1.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

In Table 5.2, I present Pearson correlation coefficients of the variables. Generally, correlation coefficients are significant at the 5% level. Investor perceptions of uncertainty are negatively correlated with the familiarity of investors with the venture’s industry, and whether an investor has an entrepreneurial background. Also, investor perceptions of uncertainty are, however, positively correlated with the number of years of investing (NoOfYears) and the number of past investments (NoOfInvest). The positive correlation between investor perceptions uncertainty and the two investing experience variables is however surprising. It suggests that more experienced investors perceive more uncertainty in the business opportunities contrary to what I predict. I look at this further in detail in the econometric analysis later in this section. The generally low correlation levels mean that issues of multicollinearity are not pronounced in this case.
Table 5-2: Pearson correlation coefficients of key variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Uncertainty Perception</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Familiarity of industry</td>
<td>-0.16***</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Entrepreneurial Background</td>
<td>-0.03</td>
<td>0.10***</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Number of years of investing</td>
<td>0.08**</td>
<td>0.08**</td>
<td>0.13***</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5 Number of Investments</td>
<td>0.023</td>
<td>0.06*</td>
<td>-0.04</td>
<td>0.36***</td>
<td>1</td>
</tr>
</tbody>
</table>

*** Correlation is significant at the 0.01 level (2-tailed).
** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.10 level (2-tailed).

The second part of the analysis starts with a baseline model to check whether the manipulated uncertainty cues have the desired effect on participants’ perceptions of uncertainty in the cases. From case version 1 (V1) to version 4 (V4) we replace low uncertainty information cues with high uncertainty information cues to increase the perceived uncertainty in the cases, and we expect perceptions of uncertainty to increase in the same manner. I test this manipulation check with a simple model.

Model 5.1

\[ \text{UncLevel}_{ij} = \alpha_{ij} + \beta \text{Uncertainty}_i + \delta \text{Case}_j + \varepsilon_{ij}, \]

where \( \text{UncLevel}_{ij} \) is the perceptions of uncertainty level for version \( i \) of case \( j \).

For now, I omit an index that denotes participants for clarity. We run model 5.1 using three different versions of the manipulated uncertainty variable, UncertCond_Ind1, UncertCond_Ind2, and dummies for the uncertainty conditions manipulated in the base cases. UncertCond_Ind1 represents the varying levels of manipulated uncertainty in the business cases from conditions 1 to 4. UncertCond_Ind2 is a dummy for uncertainty condition 1 against the rest of the conditions (2, 3 and 4). Finally, UncertCond2, UncertCond3, and UncertCond4 represent dummies for uncertainty conditions 2, 3, and 4 respectively.
I use clustered standard errors for the estimations instead of normal standard errors. While the experiment is randomised at the individual level, every participant contributes 4 observations to the data under consideration. This means observations from the same participants will be correlated which will violate the assumption of independence of residuals for OLS estimations. This type of data will lead to standard errors that are smaller than the normal OLS standard errors and in effect smaller p-values (Cameron and Miller, 2015). To correct this, I adjust the standard errors for the possible correlation of the error terms across the outcomes from the same participants by clustering around individual respondents as this comes from the experimental design (Abadie et al., 2017).

I present estimation results for model 5.1 in Table 5.3. In all three versions, the results are significant which means that the manipulation had the desired effect. Additional uncertainty cues lead to higher perceptions of uncertainty in the cases. For example, for every additional uncertainty cue introduced in the cases, investor perceptions of uncertainty increase by 1.20 on the uncertainty perception scale for UncertCond_Ind1. Similarly, uncertainty perceptions increase by 3.50 on the uncertainty perception scale when at least one additional uncertainty cue is introduced into a case.
Table 5-3: Estimations results for general uncertainty perceptions

<table>
<thead>
<tr>
<th>Uncertainty Perception</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>UncertCond_Ind1</td>
<td>1.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.49)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind2</td>
<td>3.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.20)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond2</td>
<td></td>
<td>2.66</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.51)*</td>
<td></td>
</tr>
<tr>
<td>UncertCond3</td>
<td></td>
<td>4.40</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.55)***</td>
<td></td>
</tr>
<tr>
<td>UncertCond4</td>
<td></td>
<td>3.43</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.52)**</td>
<td></td>
</tr>
<tr>
<td>Case C</td>
<td>1.57</td>
<td>1.58</td>
<td>1.59</td>
</tr>
<tr>
<td></td>
<td>(1.68)</td>
<td>(1.67)</td>
<td>(1.66)</td>
</tr>
<tr>
<td>Case D</td>
<td>4.80</td>
<td>4.87</td>
<td>4.86</td>
</tr>
<tr>
<td></td>
<td>(1.59)***</td>
<td>(1.61)***</td>
<td>(1.60)***</td>
</tr>
<tr>
<td>Case E</td>
<td>-4.24</td>
<td>-4.22</td>
<td>-4.18</td>
</tr>
<tr>
<td></td>
<td>(1.47)***</td>
<td>(1.47)***</td>
<td>(1.47)***</td>
</tr>
<tr>
<td>Intercept</td>
<td>65.21</td>
<td>65.60</td>
<td>65.60</td>
</tr>
<tr>
<td></td>
<td>(2.05)***</td>
<td>(1.80)***</td>
<td>(1.80)***</td>
</tr>
<tr>
<td>F-test (model)</td>
<td>6.013</td>
<td>6.252</td>
<td>4.284</td>
</tr>
<tr>
<td>p-value (model)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.021</td>
<td>0.022</td>
<td>0.021</td>
</tr>
</tbody>
</table>

Notes: This table presents results for an OLS regression for the effects of manipulated uncertainty on uncertainty perceptions. I run uncertainty perception (UncLevel) as dependent variables with various uncertainty conditions measures as regressors. The effects are shown with clustered standard errors at investor level in parentheses. Significance level: *** p<0.01, ** p<0.05, and * p<0.10.

To test the hypotheses in this chapter, the parameter of interest is the interaction term between manipulated uncertainty and investor characteristics. I run the baseline model with the interaction terms below.

$$\text{UncLevel}_{ij} = \alpha_i + \beta \text{Uncertainty}_i + \gamma \text{InvestCharc}_{ij} +$$

$$\delta \text{InvestCharc}_{ij} \text{Uncertainty}_i + u_j + \varepsilon_{ij}$$

The interaction terms between manipulated uncertainty and all the investor characteristics of interest are not significant. These results are not shown in the thesis.
The nature of the experimental design makes the baseline models inadequate. By design, this experiment makes different participants respond to different versions of the different base cases. In a typical experiment, there is a control group and an experimental group – randomisation ensures the characteristics of participants for both groups are similar and hence any differences in outcome between the groups is caused by the experimental condition or treatment. However, in this experiment participants are randomly assigned to different blocks of business cases with different experimental conditions. This is because we require participants to review multiple cases and it will be unrealistic for participants to review different versions of the same case. Hence, in comparing uncertainty levels for the different experimental conditions, we need to account for differences in the participants. This is because in any experimental condition we have different groups of participants responding to different business cases.

There are three alternative specifications of the baseline model that can account for unobserved differences in participants. The first two controls for the differences in persons using participants’ responses to the anchor case while the third one includes controlling for fixed person effects. As explained in section 5.4.1, every participant irrespective of the block of cases assigned to respond first to the same neutral base case A. From the qualitative study, it was evident that participants tend to anchor their subsequent perception levels on the previous cases they review. I observed during the interviews that as they move to subsequent cases to review and assess the uncertainty levels in the business, they ask themselves what their score for the previous cases were. They try to recollect the main drivers that informed their decisions in the previous cases and use that as a measure to assess the present one. That is one of the motivations for placing the same base case A before the manipulated cases of interest. The perceptions of uncertainty for base case A (ULA0) can therefore be interpreted as a participant’s
tendency to perceive uncertainty. Controlling for this variable can thus be used to account for differences between participants.

The first alternative specification takes a difference of scores or change scores approach. I take the difference between the perception of uncertainty levels ($UncLevel$) for the manipulated cases (cases B to E) and the anchor case A ($ULA0$) which has no manipulated uncertainty. The new variable ($UncLevelDiff$) is used as the dependent variable instead of the uncertainty level for the manipulated cases as seen in the baseline model. The second alternative model controls for the perception of uncertainty in the base case A ($ULA0$) as a regressor instead. As explained earlier this variable can be seen as a participant’s tendency to perceive uncertainty and can simply be controlled for in the model. In the third alternative specification, I include a control for fixed person effects to the second alternative model. A fixed-effect model uses each individual as his or her own control and enables the elimination of all personal characteristics, measured or unmeasured, that are constant across observations. Since the primary goal of the hypotheses in this chapter is to understand the interaction effects of the uncertainty conditions ($UncertCond$) and investor characteristics on uncertainty perception of investors ($UncLevel$), eliminating unwanted fixed person heterogeneity leads to a model with an error term that has a lower variance.

There are two main issues with the use of difference of scores (change scores) approach as a dependent variable; low reliability and spurious regression effects (Allison, 1990). Difference scores tend to be less reliable than the constituent variables. Constituent variables are usually positively correlated as it is in this study ($\rho = 0.425$, $p < 0.01$) and hence the resultant difference score is less reliable. There is also usually the phenomenon of regression towards the mean for pre-test and post-test measurements. Individuals with low pre-test values tend to move up in post-test and vice versa (Allison, 1990). This
results in spurious negative relationships whenever any variable is correlated with pre-
test scores. For example, the uncertainty level difference score variable (UncLevelDiff) is negatively correlated with investor experience as measured by number of years of investing ($\rho = -0.083, p<0.05$). This could be as a result of the correlation between the uncertainty level for base case A (ULA0) and the number of years of investing ($\rho = 0.181, p<0.01$). The spurious regression problem is resolved once the model is correctly specified without the anchor case variable as a regressor. Correctly taking differences takes away factors that are constant between the outcomes of the cases of interest and that for the anchor case and in effect eliminating the spurious regression problem. That is differencing the entire equation and not simply subtracting the anchor base case from the baseline model.

For the second and third alternative specifications, simply controlling for the uncertainty perceived in the anchor case (ULA0) does not fully account for differences between say UL1-ULA0 and UL4-ULA0, where UL1 and UL4 are uncertainty perceptions for cases with uncertainty condition 1 and 4 respectively. ULA0, as explained earlier, can be seen as representing a person’s tendency to perceive uncertainty, and their subsequent assessments are anchored around it. It is, therefore, the difference relative to the anchor that truly captures the effects of the treatments, or in this case the manipulated uncertainty, on the individual perceptions of uncertainty. Finally, the primary concern is to control for an individual’s tendency to perceive uncertainty which can be proxied by ULA0. However, controlling for fixed person effects does more than that when it controls for fixed unobservable characteristics.

The choice between a difference score approach or regressor method is essentially dependent on each case and only considerations of both methods should inform a choice. As Allison (1990, p. 110) puts it, “Even then, the choice may not be clear cut”. I therefore
select the difference scores approach and use the other two specifications as robustness checks.

I develop the model specification for the difference scores approach in the following steps. I start with the baseline model with interaction term.

\[ \text{UncLevel}_{ij} = \alpha_i + \beta \text{Uncertainty}_i + \gamma \text{InvestCharc}_{ij} + \delta \text{InvestCharc}_{ij} \text{Uncertainty}_i + u_j + \epsilon_{ij} \quad (1) \]

where \( \alpha_i \) is the base case version of business case \( i \) presented to participant \( j \), \( \text{UncLevel}_{ij} \) is participant’s \( j \) perception of uncertainty for business case \( i \), and \( u_j \) is an unobserved person-specific effect. There are four different base cases, which are represented by a set of dummy variables. The regressor \( \text{Uncertainty}_i \) is the uncertainty level of business case \( i \). The number of different business cases varies depending on the definition of the uncertainty level (i.e., number of base cases \( \times \) number of uncertainty levels). The parameter of interest is \( \delta \), while \( \text{InvestCharc}_{ij} \text{Uncertainty}_i \) is the interaction of uncertainty in a business case and an investor-investment characteristic.

Similarly, that for the anchor case can be represented as follows.

\[ \text{UncLevel}_{0j} = \alpha_0 + \beta \text{Uncertainty}_0 + \gamma \text{InvestCharc}_{0j} + \delta \text{InvestCharc}_{0j} \text{Uncertainty}_0 + u_j + \epsilon_{0j} \quad (2) \]

Subtracting equation 2 from 1, we obtain equation 3 below:

\[ \text{UncLevel}_{ij} - \text{UncLevel}_{0j} = \alpha_i - \alpha_0 + \beta(\text{Uncertainty}_i - \text{Uncertainty}_0) + \gamma(\text{InvestCharc}_{ij} - \text{InvestCharc}_{0j}) + \delta(\text{InvestCharc}_{ij} \text{Uncertainty}_i - \text{InvestCharc}_{0j} \text{Uncertainty}_0) + \text{error}_{ij} \quad (3) \]

But since we do not know \( \text{Uncertainty}_0 \), which is the uncertainty condition of the anchor case, we cannot assume it to be zero or any arbitrary value because this value does not cancel out. For the \( \beta \) term, \( \beta \times \text{Uncertainty}_0 \) is a constant as it does not vary across observations and hence will be consumed by the intercept in the model. The new intercept
will become a composite parameter of these two constant terms, but this is unproblematic as it is not a parameter of interest. However, the $\delta$ term with the interaction term is more complicated. If we now treat $InvestChar_{ij} \times Uncertainty_i$ and $InvestChar_{0j}$ as separate regressors and $\delta \times Uncertainty_0$ as a parameter, then the parameter $\delta$ will be identified separately from the (composite) parameter $\delta \times Uncertainty_0$. In other words, we estimate the uncertainty level of the base case jointly with $\delta$, while the interaction-term parameter of interest, $\delta$, is identified on its own. Let’s represent $UncLevel_{ij} - UncLevel_{0j}$ with $ULD_{ij}$ and separate the $\delta$ term in equation 3 to obtain equation 4.

$$ULD_{ij} = (\alpha_i - \alpha_0 - \beta Uncertainty_0) + \beta Uncertainty_i + \gamma (InvestChar_{ij} - InvestChar_{0j}) + \delta InvestChar_{ij} Uncertainty_i - \delta InvestChar_{0j} Uncertainty_0 + error_{ij} \quad (4)$$

Since the term $\alpha_i - \alpha_0 - \beta Uncertainty_0$ varies by base case, it can be captured by a set of dummy variables, one for each base case. Thus equation 4 simplifies to model 5.2 below

**Model 5.2**

$$ULD_{ij} = \alpha + \beta Uncertainty_i + \gamma (InvestChar_{ij} - InvestChar_{0j}) + \delta InvestChar_{ij} Uncertainty_i - \delta InvestChar_{0j} Uncertainty_0 + Case_i + error_{ij}$$

It is important to consider whether the investor characteristics are case dependent or not. For investor characteristics that are case-dependent, such as familiarity of the investor with a business case, $InvestChar_{0j} Uncertainty_0$ represents investor responses to the anchor case for that investor-investment characteristic. For investor-investment characteristics that are not case dependent, such as the number of past investments, $InvestChar_{ij}$ becomes equal to $InvestChar_{0j}$, which eliminates the $\gamma$ term. Additionally, $\delta InvestChar_{0j} Uncertainty_0$ becomes a constant which is
consumed by the intercept. Model 5.2 is reduced to Model 5.3 below under these conditions.

Model 5.3

\[ ULD_{ij} = \alpha + \beta Uncertainty_i + \delta InvestCharc_{ij} Uncertainty_i + Case_i + error_{ij} \]

5.5 Empirical results

5.5.1 Investor background and uncertainty perception

For hypothesis 1, we are interested in the effects of prior investment experience of investors on their perceptions of uncertainty. I predict that having relevant prior experience should negatively moderate investor perceptions of uncertainty. I use two proxies to measure prior investment experience. The first one is how familiar an investor is with the industry in which the business operates. Having an educational background or professional working knowledge in the industry in which the business operates should generally reduce uncertainty perceptions all other things being equal. The second proxy is prior entrepreneurial background. Investors who are former entrepreneurs have the experience of going through the tasks of entrepreneurship and should feel confident about dealing with uncertainties in early-stage ventures. This should lead lower perceptions of uncertainty.

I run model 5.2 to test hypothesis 1a (H1a) and present the results in Table 5.4. The moderator of interest here, familiarity with industry, is dependent on the cases presented, so model 5.2 is required. I employ different measures of manipulated uncertainty. As explained earlier, UncertCond_Ind1 is a linear measure of the various uncertainty conditions (versions 1 to 4) while UncertCond_Ind2 is a dummy for uncertainty condition 1 against the rest of the conditions. While all three versions of the
model are significant, the estimated parameters are not significant. The interaction term between manipulated uncertainty and familiarity of the industry is the focus for the test of H1a. The results for the interaction effect are not significant for all three versions. The results are similar when I control for the anchor case as regressor and when I control for fixed-person effects, so I do not show the results in the thesis. The results suggest that how familiar an investor is with the industry has no significant moderating effects on investor perceptions of uncertainty.

Table 5-4: Estimation results for the moderating effects of investor familiarity of industry on uncertainty perceptions.

<table>
<thead>
<tr>
<th>Model version</th>
<th>Uncertainty Perception Difference (ULD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.2a</td>
</tr>
<tr>
<td>UncertCond_Ind1</td>
<td>1.02 (1.43)</td>
</tr>
<tr>
<td>UncertCond_Ind2</td>
<td></td>
</tr>
<tr>
<td>UncertCond2</td>
<td></td>
</tr>
<tr>
<td>UncertCond3</td>
<td></td>
</tr>
<tr>
<td>UncertCond4</td>
<td></td>
</tr>
<tr>
<td>FamLevel_Diff</td>
<td>-2.43 (1.58)</td>
</tr>
<tr>
<td>UncertCond_Ind1:FamLevel</td>
<td>0.09 (0.54)</td>
</tr>
<tr>
<td>UncertCond_Ind2:FamLevel</td>
<td></td>
</tr>
<tr>
<td>FamLevel_A0</td>
<td>-1.45 (1.96)</td>
</tr>
<tr>
<td>CaseC</td>
<td>1.94 (1.68)</td>
</tr>
<tr>
<td>CaseD</td>
<td>5.50 (1.59)**</td>
</tr>
<tr>
<td>CaseE</td>
<td>-3.15 (1.51)</td>
</tr>
<tr>
<td>Intercept</td>
<td>-2.15 (4.94)</td>
</tr>
<tr>
<td>F-test (model)</td>
<td>4.60</td>
</tr>
<tr>
<td>p-value (model)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.0265</td>
</tr>
</tbody>
</table>

Notes: This table presents results for an OLS regression with uncertainty level difference between manipulated cases and base case A as dependent variable with various measures of uncertainty conditions and investor familiarity of industry as regressors and controls for base cases. FamLevel_A0 is the familiarity level for the anchor case and FamLevel_Diff is the difference between the familiarity level for the manipulated cases (cases B to E) and the anchor case A. The main and interaction effects are shown with clustered standard errors at investor level in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.
For hypothesis 1b (H1b), I run model 5.3 which is appropriate when the investor characteristic is not case-dependent. The moderator of interest here is the entrepreneurial background of the investor, which is constant for all responses to the cases. Results for all versions of the model are presented in Table 5.5. Similar to the results in H1a, while all three versions of the models are significant, the estimated parameters are all insignificant. For H1b, the interaction term between manipulated uncertainty and the entrepreneurial background of investors is of main interest. The results for the interaction effect are not significant for all three versions. The results are also not significant for the alternative specifications as well, although the positive direction of the interaction effects remains the same. I do not show the results of alternative specifications as they are not significant. The results mean the entrepreneurial background of investors industry has no significant moderating effects on their perceptions of uncertainty.
Table 5.5: Estimation results for the moderating effects of investor entrepreneurial background on uncertainty perceptions.

<table>
<thead>
<tr>
<th>Uncertainty Perception Difference (ULD)</th>
<th>Model version</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.3a</td>
</tr>
<tr>
<td>UncertCond_Ind1</td>
<td>0.16 (1.05)</td>
</tr>
<tr>
<td>UncertCond_Ind2</td>
<td></td>
</tr>
<tr>
<td>UncertCond2</td>
<td></td>
</tr>
<tr>
<td>UncertCond3</td>
<td></td>
</tr>
<tr>
<td>UncertCond4</td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind1:Entrepreneur</td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind2:Entrepreneur</td>
<td></td>
</tr>
<tr>
<td>CaseC</td>
<td>1.60 (1.68)</td>
</tr>
<tr>
<td>CaseD</td>
<td>5.01 (1.59)**</td>
</tr>
<tr>
<td></td>
<td>-4.17</td>
</tr>
<tr>
<td>CaseE</td>
<td>(1.48)***</td>
</tr>
<tr>
<td></td>
<td>-5.27</td>
</tr>
<tr>
<td>Intercept</td>
<td>(2.01)***</td>
</tr>
<tr>
<td>F-test (model)</td>
<td>5.18</td>
</tr>
<tr>
<td>p-value (model)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.0221</td>
</tr>
</tbody>
</table>

Notes: This table presents results for an OLS regression with uncertainty level difference between manipulated cases and base case A as dependent variable with various measures of uncertainty conditions and investor entrepreneurial background as regressors and controls for base cases. The main and interaction effects are shown with clustered standard errors at investor level in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.

5.5.2 Investment experience and uncertainty perception

I use two proxies of angel investment experience to test the hypotheses 2. There are two main approaches to measuring investment experience, the number of years of investing and the number of investments (Harrison et al., 2015). I present the results for number of years of investing and number of investments as moderators using model 5.3 in Tables 5.6 and 5.7 respectively. Here again, I use model 5.3 for the analysis since the moderators for hypothesis 2 are not case dependent. In Table 5.6, the manipulated uncertainty terms are all positive and significant. This suggests that when we pivot
participants' perceptions of uncertainty of the manipulated cases to the unmanipulated case they review first, uncertainty perceptions rise with higher manipulated uncertainty.

As shown in Table 5.6, the interaction terms of interest in testing hypothesis 2 are negative and significant for all versions of the model. This indicates that more experienced investors perceive less uncertainty as modelled uncertainty increases in the business cases. For example, relative to the base case A, participants perceive about 0.15 less uncertainty for every year of additional investing experience, as additional uncertainty cues are introduced into the cases (for UncertCond_Ind1). Similarly, participants perceive about 0.47 less uncertainty for every year of additional investing experience, when at least one additional uncertainty cue is introduced into the cases (for UncertCond_Ind2). However, for the interaction terms, these results are not robust for the alternative specifications as shown in Table 5.9 in the Appendix 5.1. In other words, the interaction terms are not significant when we use the alternative models. Although the interaction effects from the alternative models are not significant the signs are all negative as we had for the main model.
### Table 5-6: Estimation results for the moderating effects of number of years of investing on uncertainty perceptions.

<table>
<thead>
<tr>
<th></th>
<th>Uncertainty Perception Difference (ULD)</th>
<th>5.3a</th>
<th>5.3b</th>
<th>5.3c</th>
</tr>
</thead>
<tbody>
<tr>
<td>UncertCond_Ind1</td>
<td></td>
<td>2.31 (0.82)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind2</td>
<td></td>
<td>6.81 (2.29)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond2</td>
<td></td>
<td></td>
<td>3.77 (1.66)**</td>
<td></td>
</tr>
<tr>
<td>UncertCond3</td>
<td></td>
<td></td>
<td>6.61 (2.10)***</td>
<td></td>
</tr>
<tr>
<td>UncertCond4</td>
<td></td>
<td></td>
<td>6.75 (2.48)***</td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind1:No_Of_Years</td>
<td></td>
<td>-0.15 (0.09)*</td>
<td>-0.15 (0.09)*</td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind2:No_Of_Years</td>
<td></td>
<td>-0.45 (0.26)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CaseC</td>
<td></td>
<td>1.45 (1.67)</td>
<td>1.39 (1.67)</td>
<td>1.48 (1.66)</td>
</tr>
<tr>
<td>CaseD</td>
<td></td>
<td>4.61 (1.58)***</td>
<td>4.71 (1.61)***</td>
<td>4.67 (1.59)***</td>
</tr>
<tr>
<td>CaseE</td>
<td></td>
<td>-4.38</td>
<td>-4.29</td>
<td>-4.32</td>
</tr>
<tr>
<td>Intercept</td>
<td></td>
<td>(1.49)***</td>
<td>(1.49)***</td>
<td>(1.49)***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-5.14 (2.01)***</td>
<td>(1.80)***</td>
<td>-3.68 (1.93)*</td>
</tr>
<tr>
<td>F-test (model)</td>
<td></td>
<td>5.85</td>
<td>5.88</td>
<td>4.40</td>
</tr>
<tr>
<td>p-value (model)</td>
<td></td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td></td>
<td>0.0255</td>
<td>0.0257</td>
<td>0.0250</td>
</tr>
</tbody>
</table>

Notes: This table presents results for an OLS regression with uncertainty level difference between manipulated cases and base case A as dependent variable with various measures of uncertainty conditions and investing experience (number of years of investing as proxy) as regressors and controls for base cases. The main and interaction effects are shown with clustered standard errors at investor level in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.

When we use the number of past investments as proxy for investment experience, the results are not significant. I present the results in Table 5.7. The interaction effects are positive compared to that for number of years of investing although not significant as well. The number of investments does not appear to be a good measure of investment experience for two main reasons. First, the number of investments variable has a weak correlation with the number of years of investing variable (ρ = 0.36) as shown in Table 3-13. There are investors who start their angel investor journey aggressively by making a lot of investments in a short period of time. There is some evidence of this from the qualitative study as discussed in chapter 4. This means, in terms of learning and its effects on investor decisions, these investors may not have learned a lot as learning in angel
investments also comes from pre-investment and post investment activities. Merely investing a lot may not necessarily indicate that the investor has developed the required skills and knowledge through learning which is what leads to their lower perceptions of uncertainty (Harrison et al., 2015). Second, the number of investments as an explanatory variable relative to investor perceptions of uncertainty can be endogenous. Investor general attitudes towards uncertainty can affect the number of investments they make. Investors who perceive more uncertainty are likely to make less investments and vice versa. This means using the number of past investments as a proxy for investment experience can be partially tainted by people’s attitudes towards uncertainty.

Table 5-7: Estimation results for the moderating effects of number of investments on uncertainty perceptions.

<table>
<thead>
<tr>
<th>Model version</th>
<th>Uncertainty Perception Difference (ULD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UncertCond_Ind1</td>
<td>1.06 (0.63)</td>
</tr>
<tr>
<td>UncertCond_Ind2</td>
<td>3.18 (1.74)</td>
</tr>
<tr>
<td>UncertCond2</td>
<td>2.63 (1.56)</td>
</tr>
<tr>
<td>UncertCond3</td>
<td>4.19 (1.75)**</td>
</tr>
<tr>
<td>UncertCond4</td>
<td>3.01 (1.94)</td>
</tr>
<tr>
<td>UncertCond_Ind1:No_Of_Invts</td>
<td>0.01 (0.03)</td>
</tr>
<tr>
<td>UncertCond_Ind2:No_Of_Invts</td>
<td>0.02 (0.10)</td>
</tr>
<tr>
<td>CaseC</td>
<td>1.51 (1.70)</td>
</tr>
<tr>
<td>CaseD</td>
<td>4.80 (1.58)***</td>
</tr>
<tr>
<td>CaseE</td>
<td>(1.47)***</td>
</tr>
<tr>
<td>Intercept</td>
<td>-4.89 (2.00)**</td>
</tr>
<tr>
<td>F-test (model)</td>
<td>4.38</td>
</tr>
<tr>
<td>p-value (model)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.0181</td>
</tr>
</tbody>
</table>

Notes: This table presents results for an OLS regression with uncertainty level difference between manipulated cases and base case A as dependent variable with various measures of uncertainty conditions and investing experience (number of investments as proxy) as regressors and controls for base cases. The main and interaction effects are shown with clustered standard errors at investor level in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.
I run an alternative model to address the challenges of using the number of investments as a proxy for investment experience. While the second challenge cannot be addressed as it is difficult to disentangle investor attitudes towards uncertainty from number of investments, I address the first challenge by controlling for number of years of investing. The alternative model is an extension of model 5.3 that accounts for the effects of number of years of investing on the number of investments variable. It includes two additional interaction terms between number of years and uncertainty as well as a consolidated investing experience variable called Experience and uncertainty. Experience is simply the product of the number of years and number of investments variables. I present the results in Table 5.8. Again, the interaction effects of interest between the number of investments and manipulated uncertainty are not significant for all versions of the model. The results are also not robust for the alternative specifications which I do not show in the thesis.
Table 5-8: Estimation results for the moderating effects of number of investments on uncertainty perceptions (extended model).

<table>
<thead>
<tr>
<th>Uncertainty Perception Difference (ULD)</th>
<th>Model version</th>
<th>5.3a</th>
<th>5.3b</th>
<th>5.3c</th>
</tr>
</thead>
<tbody>
<tr>
<td>UncertCond_Ind1</td>
<td></td>
<td>1.18 (1.13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind2</td>
<td></td>
<td>3.77 (3.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond2</td>
<td></td>
<td>2.74 (1.81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond3</td>
<td></td>
<td>4.42 (2.61)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond4</td>
<td></td>
<td>3.36 (3.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind1:No_Of_Invts</td>
<td></td>
<td>0.10 (0.07)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind1:No_Of_Years</td>
<td></td>
<td>-0.07 (0.13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind1:Experience</td>
<td></td>
<td>-0.01 (0.006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind2:No_Of_Invts</td>
<td></td>
<td>0.29 (0.24)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind2:No_Of_Years</td>
<td></td>
<td>-0.23 (0.40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind2:Experience</td>
<td></td>
<td>-0.02 (0.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CaseC</td>
<td></td>
<td>1.43 (1.71)</td>
<td>1.44 (1.70)</td>
<td>1.44 (1.69)</td>
</tr>
<tr>
<td>CaseD</td>
<td></td>
<td>4.63 (1.58)***</td>
<td>4.79 (1.60)***</td>
<td>4.67 (1.59)***</td>
</tr>
<tr>
<td>CaseE</td>
<td></td>
<td>-4.23 (1.49)***</td>
<td>-4.10 (1.50)***</td>
<td>-4.18 (1.49)***</td>
</tr>
<tr>
<td>Intercept</td>
<td></td>
<td>-4.83 (2.02)***</td>
<td>-4.64 (1.80)***</td>
<td>-4.55 (2.11)***</td>
</tr>
<tr>
<td>F-test (model)</td>
<td></td>
<td>4.77</td>
<td>4.68</td>
<td>3.90</td>
</tr>
<tr>
<td>p-value (model)</td>
<td></td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td></td>
<td>0.0279</td>
<td>0.0273</td>
<td>0.0276</td>
</tr>
</tbody>
</table>

Notes: This table presents results for an OLS regression with uncertainty level difference between manipulated cases and base case A as dependent variable with various measures of uncertainty conditions and investing experience (number of investments as proxy) as regressors and controls for base cases. This also includes controlling for the effect of number of years of investing on number of investments. The Experience variable is the product of number of investments and number of years of investing variables. The main and interaction effects are shown with clustered standard errors at investor level in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.

5.6 Discussion of empirical results

This chapter relates to how investor background and experience moderate the relationship between uncertain information cues in business proposals and investor perceptions of uncertainty. Angel investors have been shown to be heterogeneous in nature and in behaviours (Maxwell, 2016). This is because they have different
experiences and backgrounds that influence their motivations for investing. This in turn affects their investment behaviours. There are two broad sources of experiences for angel investors: experiences gained prior to becoming angel investors and those acquired as a result of their angel investing activities. I predict that these experiences will affect how they perceive uncertainties in business cases that come their way.

The results from this part of the quantitative study are mixed. For example, I hypothesize that relevant working knowledge of the industry in which a business operates negatively moderates investor perceptions of uncertainty. That is, investors with relevant working knowledge of the venture industry will perceive less uncertainty. Industry specific knowledge gained by working in a particular industry enables the capacity of investors to assess opportunities in that industry (Ronstadt, 1988). With a better appreciation of how the industry operates and an awareness of industry trends, we expect investors to perceive less uncertainty when they encounter opportunities within their familiar territory. I, however, find no such evidence from the experiment to confirm this. Mitteness and colleagues (2012a) find evidence that operating industry experience makes investors assess opportunities more favourably. However, with respect to perceptions of uncertainty, I find no such evidence. This is somewhat related to evidence from Mason and others (2017) which found that investor professional backgrounds are not related to their investment behaviours but more to do with the attributes of the opportunity. This finding should, however, be taken with caution due to the sample size of the study. I discuss this further in section 7.5 as part of the limitations of the study.

Again, I find no evidence about the moderating effects of investor entrepreneurial background on investor perceptions of uncertainty. I hypothesise that having prior entrepreneurial background should make investors perceive less uncertainty. I find no evidence to support this hypothesis. The results show that prior entrepreneurial has no
moderating effects on investor perceptions of uncertainty. This is contrary to the findings from Mitteness et al. (2012a) that investors with start-up experience in the focal industry in which the business opportunity operates are more critical because they understand the nuances of the industry better.

The results for the moderating effects of angel investing experience on investor perceptions of uncertainty are also mixed. I hypothesise that investors with more angel investing experience perceive less uncertainty. I find evidence for this hypothesis when I use the number of years of investing as a proxy for investing experience. For every additional year of investing experience, investors perceive less uncertainty as uncertain information cues increase in the opportunities. This I believe is because as investors gain experience through their investing activities, they learn and feel more competent with time (Botelho et al., 2021b; Harrison et al., 2015). Business angels learn through past investments and their post-investments interactions with entrepreneurs. They learn through various learning opportunities. These may come through relationships with the entrepreneur, an investment that went bad, an exit event, among others. When confronted with uncertainty, experienced investors believe they have the competence to deal with the uncertainties in the ventures post-investment (Carpentier and Suret, 2015). Experienced investors deal with uncertainty through the nature of the contracts employed at the contracting stage and through their direct involvement in the venture post-investing.

While there is evidence to support this hypothesis when the number of years of investing is used as a proxy for investing experience, this is not the case when the number of past investments made is used instead. From the descriptive statistics shown in Table 5.2, the correlation of the number of investments with uncertainty perception is not significant. There is a potential endogeneity problem here as investors who are uncertainty averse are likely to invest less. Thus, attitudes towards uncertainty can
influence the number of past investments. The use of the number of investments variable as a proxy for post-investing experience is limited. There is also evidence from the qualitative study that there are investors who start their angel investing career aggressively with the hope of obtaining successful exits early. This could be a way of establishing a reputation quickly in the angel investor market similar to what young venture capital firms do (Gompers, 1996). Therefore, the number of investments does not necessarily signal a longer period of investing experience which drives learning and in effect lower perceptions of uncertainty. As argued by Botelho et al. (2021b), the number of investments is insufficient in and of itself to capture knowledge gained from learning and its effects on decision-making. This suggests that the effects of learning on decision-making for investors comes with time on the job and not merely the number of investments made (Harrison et al., 2015). When I control for the effects of number of years of investing on the number of investments made in the model, the results remain insignificant.

It is, however, important to be cautious in generalizing these findings. While in the results there is evidence to support the hypotheses that investor experience (both prior and post-investing experience) affects investors’ perceptions of uncertainty, the effects are small and not robust to alternative specifications. With the exception of the difference-of-scores model, the other models do not produce significant results. Generally, interaction effects are difficult to detect especially in small samples. Additionally, the nature of the experiment also means these effects are small to detect compared to the noise from the other information cues in the scenarios. I discuss this further in the limitations of the study in section 7.5 as part of the discussions on limitations of the study.
5.7 Conclusion

Understanding the role of uncertainty is important to improving early-stage investor decision-making. In this chapter, we respond to the call by Drover et al. (2017) to further investigate the nuances of the effects of investor background and experiences on their decision-making and behaviours. We do so in the context of how they perceive uncertainties in early-stage businesses. Perceptions of uncertainty determine investor decisions. For example, for an investor who is averse to uncertainty, perceiving more uncertainty will lead to higher rejection of funding opportunities. Therefore, understanding how investor characteristics affect their perceptions of uncertainty is important to their decision-making and to access to funding for entrepreneurs.

In conclusion, while the results provide some evidence to support the hypotheses (i.e., interaction effect between uncertainty conditions and investor experience), it is small and not robust to alternative specifications. It is important to note that with studies of this nature, it is difficult to obtain robust results considering the sample size obtained from the online experiment. It will be important to investigate how experience moderates the relationship between investor perceptions of uncertainty and their investment decisions.
Chapter 6 – Uncertainty and angel investor decisions

6.1 Introduction and background

The overall objective of this study is to investigate how perceptions of uncertainty in early-stage ventures affect the decisions of investors. In Chapter 4, I explored how early-stage investors (specifically, angel investors) think about uncertainty and what information cues they consider as uncertain in the first phase of the study. This allowed the operationalisation of the uncertainty construct in the context of angel investors for the field experiment. The findings from Chapter 4 lead to the operationalisation of uncertainty as missing and unclear information. The first part of the experiment in the second phase of the study (discussed in Chapter 5) focuses on how investor background and experiences shape their perceptions of uncertainty in the businesses they encounter. This chapter builds on Chapter 5 and focuses on how these perceptions of uncertainty affect investment decisions of business angels when they review early-stage business opportunities.

Investor decision-making has been studied extensively across the spectrum of early-stage private equity, from venture capital (Zacharakis and Shepherd, 2001; Zacharakis and Meyer, 1998) to informal venture capital investors like business angels (Brush et al., 2012; Mitteness et al., 2012a; Maxwell et al., 2011; Mason and Harrison, 1996a). The concept of uncertainty and its effects on early-stage investor decision has, however, not been studied thoroughly although it plays an important role in entrepreneurial action (Townsend et al., 2018; Packard et al., 2017; McKelvie et al., 2011). As explained in the literature review chapter, the concept of uncertainty is fundamental to entrepreneurship research as it forms the basis for virtually every condition, context, and level of analysis (Townsend et al., 2018). Understanding the effects of uncertainty on early-stage investor decisions is important to improving
investment decisions as it has potential to reduce behavioural biases in early-stage
investment decisions such as overconfidence.

In Chapter 2, we find that research on business angel investment decision-making
has focused mainly on the investment process and its stages (Maxwell et al., 2011; Riding
et al., 2007; Tyebjee and Bruno, 1984), decision-factors used by angel investors (Mason
and Stark, 2004; Feeney et al., 1999; Mason and Harrison, 1996a), and how these factors
vary across different stages (Maxwell et al., 2011; van Osnabrugge, 2000). Not much
research has been done to explore or investigate how these decisions are done in the face
of uncertainties and the role of uncertainty if any in the decision-making. Research to
understand the effects of uncertainty on decision-making will require either an
experiment or secondary data. Experiments are normally difficult to conduct as they can
be expensive and time consuming. Secondary data in the business angel market is also
difficult to obtain if it even exists. This may be the reason why researchers have stayed
away from this area.

The few works done to understand business angel decision-making in the face of
uncertainty have primarily focused on strategies employed by investors to make such
decisions. For example, Huang and Pearce (2015) show that angel investors use both
formal analysis and intuition (“gut feel”) to select and invest in a few extraordinarily
profitable business opportunities. Wiltbank et al. (2009) also focuses on how business
angels employ the use of predictive and non-predictive control strategies in their decision-
making to deal with uncertainty. While these works show how investors make decisions
in the face of uncertainty, we do not know how uncertainty itself affects these decisions.
This is the gap that this chapter addresses by explicitly measuring uncertainty and
examining its effect on investor decisions.
6.2 Research objective and questions

Based on the discussion in the previous section, the primary objective of this chapter is to investigate how angel investor perceptions of uncertainty in potential business opportunities affect their investment decisions. The secondary objective is to understand how investor background and experiences affect investor decisions in the face of uncertain information cues. Business angels are heterogeneous in nature and are often influenced by individual personalities, motivations, background, experiences when they make investment decisions (Maxwell, 2016). The secondary objective is thus to examine how these backgrounds and experiences influence investor decisions relative to uncertainty. This in response to the call by Drover and co-authors (2017) to explicitly explore the effects of investor backgrounds, motivations, and characteristics on investor decisions.

This chapter thus answers two main questions. First, how do the perceptions of uncertainty in early-stage businesses affect investor decisions? Second, how do investor background, experiences, and preferences affect their investment decisions relative to uncertain information cues?

6.3 Literature review and hypothesis development

How investors perceive the uncertainties in an early-stage venture should affect their investment decisions. Investors take up equity stakes in these ventures and assume the uncertainties surrounding their future success. They use information cues in business proposals and other information sources to assess these uncertainties and what they mean for their investments. It has been shown that in a choice decision under uncertainty, mostly under lab conditions, decision makers prefer the less uncertain option to the more uncertain one (Chew et al., 2017). In various finance and investment domains, decision
makers have been shown to avoid uncertainty. These include low stock market participation to avoid the uncertainties in stock markets (Dimmock et al., 2016), insurance professionals avoiding deals with imprecise information (Cabantous, 2007) and the impact of ambiguous information on portfolio holdings and asset prices in the financial market (Bossaerts et al., 2010).

There is, however, evidence in the entrepreneurship literature where entrepreneurs have been found to seek uncertainty instead of avoiding it (Koudstall et al., 2016). The very nature of entrepreneurship suggests a situation of exploiting an opportunity in the face of uncertain environmental factors with mostly unknowable future outcomes. Entrepreneurs nonetheless exploit these opportunities with the hope of being successful. As Knight (1921) explains, for entrepreneurs to make profits beyond normal returns it has to be done under conditions of uncertainty. Entrepreneurial actions are undertaken in the face of uncertainty based on intuition or gut feeling with the expectation of extraordinary gains. Decision-making to fund these early-stage ventures is also done under highly uncertain conditions. But are early-stage investors also seeking uncertainty as entrepreneurs, or do they avoid uncertainty like other decision-makers?

In the context of angel investor decision-making for example, Huang and Pearce (2015) find that experienced business angels seek uncertainty in the face of unknowable future outcomes with the aim of realizing extraordinary returns like entrepreneurs. They report that business angels believe that most of the businesses they invest in are likely to fail and hope that the few that are successful can produce huge returns. There is thus an important context here for when business angels seek uncertainty. Business angels seek uncertainty for ventures that they believe have the potential to be big when successful. There is evidence of this also in the qualitative study discussed in Chapter 4. Some participants in the qualitative study seek uncertainty when they assess the venture to
potentially produce extraordinary gains. A high perception of uncertainty does not necessary mean that investors will avoid it as long as they view the venture to have the capacity to deliver high returns. Hence, it is investors’ judgement on the potential opportunities in the ventures that make them bet on these ventures notwithstanding any high uncertainty conditions. In general, however, angel investors will avoid uncertainty like other decision makers and not seek it if they do not consider the business to have the potential to produce a high return when successful. This discussion leads to the next hypothesis:

**H3: Investors in early-stage business generally avoid uncertainty. Ventures with more uncertain information cues will be less attractive to investors.**

When investors first review business cases, they make decisions on whether to proceed to the next stage of the investment decision process. This decision is determined partly by the information provided in the business plan/proposal and partly by the characteristics of investors, including their background, past experience and investment preferences. The focus here is on how the interpretation of the former by investors affects their decision-making. Since the decisions of early-stage businesses are done in the face of uncertainty, decision-makers will form subjective perceptions of uncertainties of the businesses consciously or unconsciously. They also form subjective perceptions of the potential opportunities the venture presents. The decision to proceed to the next stage is thus influenced by investors’ subjective views of the uncertainties in the venture and the potential opportunity that the venture presents.

I refer to investors’ interpretation of the uncertainties about the future success of the business both internally (relating to the characteristics of the business) and externally (relating to the environment in which the business operates) as investor perceptions of
uncertainty. I also refer to investors’ interpretations or belief of the venture to make extraordinary gains as investor perceptions of opportunity. Uncertainties in early-stage businesses are inextricably linked to the opportunities they come with. In entrepreneurship, one cannot have an opportunity without uncertainty (McMullen et al., 2007). Essentially, when investors invest in early-stage ventures, they make a bet in the face of uncertainties on the future success of business with the hope of exploiting these opportunities (Knight, 1921).

As explained in the preceding paragraphs, investors interpret business information cues in relation to the uncertainties in the ventures and the potential opportunity that exists in the ventures. Therefore, uncertain information cues can be hypothesized to drive investor perceptions of uncertainty and opportunity which in turn affects their decision-making. Thus, the path of the decision-making process is from the uncertain information cues in the business proposals through how investors interpret them to their investment decisions on the proposals. This path is that of a mediation one as it explains how the investment decision is arrived at after a business proposal is reviewed. With this, measuring uncertainty perceptions can serve as a means to understand the thinking process of early-stage investors as they review business proposals. I show the path in Figure 6.1.

Figure 6-1: The mediation path for investor decision-making.
Investor decisions are thus driven by how they interpret information cues from the entrepreneur in terms of uncertainties and opportunities which in turn affects investor decision-making. This leads to the hypothesis 4 (H4).

**H4: In early-stage investment decisions, investor perceptions of uncertainty mediate the relationship between business information cues and investor decisions.**

As mentioned earlier in this section, investor decisions are partly determined by the characteristics of investors including their background, past experience and investment preferences. For example, the educational and professional background of an investor can influence his or her investment preferences (White and Dumay, 2020; Warnick et al., 2018). This can be attributed to investors focusing on venture opportunities for which their past experiences and competencies can be useful for the venture post-investment (Mason and Harrison, 1996a). Additionally, this can also be driven by the investor’s competency to evaluate venture opportunities in industries for which they have past professional experience (Mason and Stark, 2004). Thus, opportunities in industries familiar to investors may generally be more favourable to them. The past investment experiences of investors also affect their decision-making (Harrison et al., 2015). Investors with more investing experience may feel more competent to evaluate venture opportunities based on their experiences from past investments. Investors learn as they make investments and work with entrepreneurs, and this has an effect on their subsequent investment decisions (Harrison et al., 2015).

Investor characteristics will thus moderate the relationship between uncertain information cues in business proposals and investor decisions. They tell us under what conditions uncertain information cues affect investor decisions. The direct effect between uncertain information cues and investor decisions can be reduced, strengthened, or the
established direction of the effect can be reversed when investor characteristics are considered. I show the moderating path of the effect of these investor characteristics on the direct relationship between uncertain information cues and investor decisions in Figure 6.2.

![Figure 6-2: The moderating path for investor decision-making.](image)

This is thus hypothesised as follows:

**H5a:** In early-stage investment decisions, how the business opportunity fits with the investor’s personal preferences moderates the relationship between business information cues and investor decisions.

**H5b:** In early-stage investment decisions, how familiar the investor is with the industry in which the business opportunity operates moderates the relationship between business information cues and investor decisions.

**H5c:** In early-stage investment decisions, investors’ past investing experience moderates the relationship between business information cues and investor decisions.

### 6.4 Method and data analysis

#### 6.4.1 Method and data collection

As explained in section 6.2, the focus of this chapter is to understand how perceptions of uncertainty in early-stage business opportunities affect the investment decisions. This is the second part of the quantitative phase of study. As explained in
Chapter 2, this part of the study requires the manipulation of key critical factors that are associated with investment decisions, and thus the use of an experiment is the most appropriate choice compared to other research methods. In an experiment, we can model varying degrees of uncertainty in sample business cases to measure how investors perceive them and study the resultant effects on investment decisions. See Chapter 3 for the details of the experiment used for this study. For the rest of the current section, I summarise the main components of the experiment and the data collection process.

I create five base case scenarios similar to what investors encounter in real life using executive summaries of business cases as the format. One of these base cases is used as an anchor case, and parts of the other cases are manipulated to create different versions. I manipulate three decision factors (product protectability, route to market, and relevant entrepreneur experience) in the four cases of interest to create varying levels of uncertainty. As explained in section 3.4.2, the selected factors of interest are drawn from eight critical factors identified by Maxwell et al. (2011). For every decision factor, we have an information cue that denotes low uncertainty and another that denotes high uncertainty depending on the presence or absence of certain information. In all, we have four versions of each manipulated case from version 1 with all low uncertainty values and version 4 with all high uncertainty values. See Table 3.3 in Chapter 3 for details of how we create the various versions of the base cases based on the different factors.

I put the different versions of the cases into four blocks which includes one version of all base cases. This is to create a balanced assignment of cases to participants. Each block starts with the anchor case to serve as the base for the participants to understand the nature of the survey and to measure the individual levels of responses. For the purposes of tracking and analysis, version 1 of Case B is called Case B_V1, version 2 of Case C is called Case C_V2 and so on. Every block is constructed to have a low-uncertainty
For every case, participants are asked to answer six questions, which include questions that measure their perceptions of uncertainty and opportunity in the business cases. I also ask questions that measure investors’ willingness to know more about the business and their likelihood to invest. There are two other questions that relate to investor characteristics in the context of the cases. They relate to how familiar participants are with the industry in which the business operates and whether the business fits with their own investment criteria and motivations. The survey also involves a questionnaire mainly to collect participant characteristics such as their associated past investment activities. Here I collect information relating to how long participants have been angel investors. Participants take part in the experiment before their personal characteristics are collected.

Business angels in the United Kingdom (UK) and the United States (US) are the focus of this study. The business angel investment markets in these two countries are the most developed. For a study that seeks to test a known phenomenon (i.e. effects of uncertainty on decision-making) in a new context (i.e. early-stage investments) it is important to use a well-developed market to avoid results being confounded by other unknown factors in less developed markets. I reach investors through their social media accounts mainly through their LinkedIn profiles. This avoids issues with the representativeness of samples used in past angel investing research (Avdeitchikova et al., 2008; Farrell et al., 2008). The approach does not rely on any business angel network and association as in past angel research. The data collection took place over a 5-month period between April and August 2020. A total of 3228 investors were contacted with 232 completed responses recorded.
6.4.2 Data analysis and development of econometric models

Similar to the approach in section 5.4.2, the data analysis is in two parts: analysis of the general characteristics of the data collected and econometric analysis of the data to address the research questions in this chapter. Due to the complexities of this chapter, I reproduce the definitions of the key variables from the experiment used in this chapter in Table 6.1.

Table 6-1: Definitions of key variables for chapter 6

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Levels/Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty condition</td>
<td>This is the varying levels of manipulated uncertainty in a base case using combinations of known critical decision factors.</td>
<td>V1, V2, V3 and V4</td>
</tr>
<tr>
<td>Investor investing experience</td>
<td>This is the number of years the investor has engaged in angel/early-stage investing activities.</td>
<td>25 years and above</td>
</tr>
<tr>
<td>Uncertainty perception level</td>
<td>The investor's perception of uncertainty in a business case presented in the survey experiment.</td>
<td>Slider (0 to 100)</td>
</tr>
<tr>
<td>Opportunity perception level</td>
<td>The investor's perception of opportunity in a business case presented in the survey experiment.</td>
<td>Slider (0 to 100)</td>
</tr>
<tr>
<td>Willingness to know more</td>
<td>The investor's willingness to move the business opportunity to the next stage primarily to obtain more information prior to investing.</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>Willingness to invest</td>
<td>The investor's willingness to invest in the business opportunity assuming that due diligence and entrepreneur engagement activities do not materially change investor's assessment of the proposal.</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>Familiarity of industry</td>
<td>This is the investor's assessment of how familiar they are with the industry in which the business opportunity operates.</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>Business opportunity fit</td>
<td>This is investor's assessment of how the business opportunity fits with their own personal criteria and motivations.</td>
<td>Likert scale (5 points)</td>
</tr>
</tbody>
</table>

For the first part of the data analysis, I present descriptive statistics of the relevant key variables as used in this chapter in Table 6.2. The total number of data points is 928.
Each of the 232 respondent contributes 4 points from evaluating 4 different cases. For the purposes of the data analysis, I omit responses to anchor case from the data points. Responses to the anchor case is only used as a control variable. As shown in Table 6.2, all variables record scores for the lowest possible value/option and the highest possible value/option. This provides adequate variations for analysis.

The average perception of uncertainty is 68.8% while that for perception of opportunity is 50.6%. Participants are generally slightly or moderately familiar with the industries in which the businesses operate (Mean = 2.5, SD = 1.1). Participants also express similar sentiments regarding how the businesses fit with their personal criteria and preferences (Mean = 2.3, SD = 1.1). Participants are generally slightly or moderately willing to know more about the business (Mean = 2.5, SD =1.2) or invest in them (Mean = 2.2, SD = 1.1). Finally, on average, participants have been early-stage investors for about 7 years which represents an experienced set of investors (Harrison et al., 2015).

<table>
<thead>
<tr>
<th>Table 6-2: Descriptive statistics for key variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Uncertainty Perception level</td>
</tr>
<tr>
<td>Opportunity Perception level</td>
</tr>
<tr>
<td>Willingness to know more</td>
</tr>
<tr>
<td>Willingness to invest</td>
</tr>
<tr>
<td>Familiarity of industry</td>
</tr>
<tr>
<td>Business opportunity fit Number of years of investing</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

In Table 6.3, I present Pearson correlation coefficients of the variables. Generally, correlation coefficients are significant at the p=0.05 level. As expected, investor
perceptions of uncertainty are negatively correlated with all the variables except for the number of years of investing. Participants perceive more uncertainty in the business when they have a low perception of the opportunity in the business. Similarly, when investors are not familiar with the industry in which the business operates and when the opportunity does not fit with their personal criteria and preferences. The expected effect is a general unwillingness to proceed to know more about the business and to invest in it.

For the econometric analysis, the main treatment variable is manipulated uncertainty in the business cases. This variable has varying levels of uncertainty conditions from level 1 to 4 with increasing order of uncertainty. As in Chapter 5, I represent manipulated uncertainty by UncertCond_Ind1, UncertCond_Ind2, as well as dummies for the four uncertainty conditions. UncertCond_Ind1 is the numerical value of the varying levels of manipulated uncertainty in the business cases, ranging from 1 to 4. UncertCond_Ind2 is a dummy for uncertainty condition 1 against the rest of the conditions (2, 3 and 4). I also use other dummy variables for the individual uncertainty conditions. They are UncertCond1, UncertCond2, UncertCond3, and UncertCond4 for

Table 6-3: Pearson correlation coefficients of key variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty Perception level</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity Perception level</td>
<td>-0.36***</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willingness to know more</td>
<td>-0.45***</td>
<td>0.66***</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willingness to invest</td>
<td>-0.44***</td>
<td>0.65***</td>
<td>0.85***</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Familiarity of industry</td>
<td>-0.16***</td>
<td>0.09***</td>
<td>0.26***</td>
<td>0.25***</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Opportunity Fit</td>
<td>-0.26***</td>
<td>0.43***</td>
<td>0.67***</td>
<td>0.64***</td>
<td>0.45***</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Number of years of investing</td>
<td>0.08**</td>
<td>-0.05</td>
<td>-0.09***</td>
<td>-0.11***</td>
<td>0.08**</td>
<td>-0.11***</td>
<td>1</td>
</tr>
</tbody>
</table>

*** Correlation is significant at the 0.01 level (2-tailed).
** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.10 level (2-tailed).
uncertainty conditions 1, 2, 3 and 4 respectively. The treatment variables are the main independent variables for all analyses in this chapter.

For this part of the study, there are two main response variables; investor willingness to know more about the business and investor likelihood of investing in the business. These two represent observed investor decisions from reviewing the business cases. Also as shown in the correlation table (Table 6.3), when investors have a favourable opinion or perception of the opportunity in a business, they tend to have a positive or favourable disposition or inclination to invest in the business. This is seen in the strong positive correlation between investor perceptions of opportunity and the two observed response variables: investor willingness to know more ($\rho = 0.66$) and investor willingness to invest ($\rho = 0.65$).

Because of these strong correlations, I create a composite scale which is a combination of investor willingness to know more (KnowMore), investor willingness to invest (WillInvest) and their perceptions of opportunity (OppLevel) in the business. I call this new variable Investor Inclination to Invest (IncInvest) which indicates the prospect of an investor proceeding through the investment decision process and eventually investing. The three variables used can be said to be different measures of the same underlying construct that predicts the propensity of investors to eventually invest in a business. I standardize the three component variables in question and take an average to create the new variable (IncInvest). The Cronbach alpha for the standardized component variables is 0.88, which shows how closely related the three variables are. The outcome variables for the analysis are thus investor willingness to know more (KnowMore), willingness to investment (WillInvest), and investor inclination to invest (IncInvest). Investor perceptions of opportunity are, however, not included in the list of outcome
Investor perceptions of uncertainty in the cases will be a mediating factor for hypothesis 4, while three investor characteristics are considered to be relevant for investigations as moderators for hypotheses 5a to 5c. The first investor characteristic relates to how familiar investors are with the industry in which the venture operates. The second is how the venture under review fits with the personal preferences of the investor. Finally, I use the number of years of investing as a proxy for investor past investing experience.

For hypothesis 3, I measure the direct effects of manipulated uncertainty in the cases on investor decision-making. Without accounting for any intermediary effects, how do angel investors generally respond to increasing uncertain information cues? We know from Chapter 5 that investor perceptions of uncertainty increase as we make the information cues in the cases more uncertain. I follow the analysis approach selected in Chapter 5 and use the difference-of-score method to analyse the data with respect to hypothesis 3. I contextualise the model in the following steps for this case. Let $DV_{ij}$ be the response variable (or dependent variable) for the base case version for business case $i$ presented to participant $j$. Then one can relate that to manipulated uncertainty in the following way for both manipulated cases and the anchor case.

\[ DV_{ij} = \alpha_i + \beta \text{Uncertainty}_i + \epsilon_{ij} \quad (6.1) \]

\[ DV_{0j} = \alpha_0 + \beta \text{Uncertainty}_0 + \epsilon_{0j} \quad (6.2) \]

where $\alpha_i$ is the base case version of business case $i$ presented to participant $j$.

There are four different base cases (five including the anchor case), which are represented by a set of dummy variables. The regressor $\text{Uncertainty}_i$ is the uncertainty level of
business case $i$. The number of different business cases varies depending on the definition of the uncertainty level (i.e., number of base cases $\times$ number of uncertainty levels).

Subtracting equation 6.2 from 6.1 gives us,

$$DV_{ij} - DV_{0j} = (\alpha_i - \alpha_0) + \beta(Uncertainty_i - Uncertainty_0) + error_{ij} \quad (6.3)$$

Since $\beta \times Uncertainty_0$ is a constant that does not vary across observations we can rearrange equation 6.3 to obtain 6.4 below.

$$DV_{ij} - DV_{0j} = (\alpha_i - \alpha_0 - \beta Uncertainty_0) + \beta Uncertainty_i + error_{ij} \quad (6.4)$$

The intercept from equation 6.4, $\alpha_i - \alpha_0 - \beta Uncertainty_0$ varies by base case and can be captured by a set of dummy variables, one for each base case. This leads to model 6.1 below.

Model 6.1

$$DV_{ij} - DV_{0j} = \alpha + \beta Uncertainty_i + Case_i + error_{ij}$$

For hypothesis 4, I test for the mediating effects of perceptions of uncertainty on investor decisions. I use the 4-step (causal step) method from Baron and Kenny (1986) and confirm it with a causal mediation analysis (Imai et al., 2010a; Imai et al., 2010b). In step 1 of the causal step approach, I first estimate the relationship between the independent variable and dependent variable to establish the existence of the suspected mediated relation. In step 2, I estimate the relationship between the independent variable and the mediator. I then estimate the relationship between the mediator and dependent variable controlling for the independent variable in step 3. I expect the effect of the dependent variable on the independent variable to decrease with the inclusion of mediator in the model for a partially mediated relationship or become zero for a fully mediated relationship. In the final step, I do a reversal of step 1 and estimate the relationship between the dependent variable and the independent variable controlling for the mediator.
For mediation effects, I do not expect a reverse casual relation and hence I expect the effects here to be non-significant. I then estimate the average causal mediation effects (ACME) and the average direct effects (ADE) using the bootstrapping approach (Imai et al., 2010a; Imai et al., 2010b) to confirm the existence of any mediation effects.

For hypotheses 5a to 5c, I assess the potential moderating effects of investor characteristics on the relationship between manipulated uncertainty and investor decisions. Similar to the analysis on the effects of investor characteristics on uncertainty perception in Chapter 5, I use the difference-of-score approach. I adopt model 5.2 and 5.3 in this context to obtain models 6.2 and 6.3 below.

Model 6.2

\[ DV_{ij} - DV_{0j} = \alpha + \beta \text{Uncertainty}_i + \gamma (InvestCharc_{ij} - InvestCharc_{0j}) \]

\[ + \delta \text{InvestCharc}_{ij} \times \text{Uncertainty}_i - \delta \text{InvestCharc}_{0j} \text{Uncertainty}_0 \]

\[ + \text{Case}_i + \text{error}_{ij} \]

Model 6.3

\[ DV_{ij} - DV_{0j} = \alpha + \beta \text{Uncertainty}_i + \delta \text{InvestCharc}_{ij} \times \text{Uncertainty}_i + \text{Case}_i \]

\[ + \text{error}_{ij} \]

where \( DV_{ij} \) is the response variable for base case version for business case \( i \) presented to participant \( j \) and \( \text{Uncertainty}_i \) represents manipulated uncertainty and \( \text{InvestCharc}_{ij} \) the various investor characteristics of interest in the study. For investor characteristics that are case-dependent, such as familiarity of the investor with the industry of a business case, \( \text{InvestCharc}_{0j} \text{Uncertainty}_0 \) represents investor responses to the anchor case for that characteristic. For investor characteristics that are not case-dependent, such as the number of past investments, \( \text{InvestCharc}_{ij} \) becomes equal to
\( InvestCharc_{0j} \), which eliminates the \( \gamma \) term. Additionally, \( \delta InvestCharc_{0j}Uncertainty_{0} \) becomes a constant that is consumed by the intercept. This reduces model 6.2 to model 6.3. Hence, we use model 6.2 for moderators that are case-dependent and model 6.3 for those that are not.

6.5 **Empirical results**

6.5.1 Investor attitudes toward uncertainty

Hypothesis 3 relates to investor attitudes towards uncertain information. I predict that ventures with more uncertain information cues will be less attractive to investors. For hypothesis 3, I estimate different versions of model 6.1 using the three response variables (KnowMore, WillInvest, and IncInvest) as the dependent variables and the various uncertainty condition measures as independent variables. Estimation results are shown in Table 6.4. Generally, the signs of the beta estimates of the uncertainty measures are negative which suggests that investors are less likely to invest when additional uncertain information cues are introduced into the cases. The results show that uncertain information cues lead to lower willingness of investors to know more about the business and to invest in them. For example, compared to version 1 of the base cases, the introduction of every additional uncertainty cue change investor willingness to know more about the business by about 0.18 times its standard deviation. Similarly, compared to uncertainty condition 1, when at least one additional uncertainty cue is introduced, it leads to a change of about 0.21 times the standard deviation of investor willingness to know more about the business. This is slightly more when two additional uncertainty cues are introduced into the cases, about 0.23 times its standard deviation. The results for the UncertCond4 variable are, however, not significant relative to the reference uncertainty condition 1. The UncertCond4 variable from the experiment represents the extreme case.
versions in which all three manipulated factors have high uncertainty cues. This could mean that additional uncertainty cues have diminishing effects on investor decisions and having one or two uncertain cues is enough for investor decisions and behaviour.

In columns 4 to 9 in Table 6.4, we find similar results for investor willingness to invest and investor inclination to invest, although the effects are smaller compared to those for investor willingness to know more. The results for the linear uncertainty condition indicator (UncertCond_Ind1), are all not significant for the various response variables as seen in columns 1, 4, and 7. The effects are difficult to detect as explained earlier because of the potential diminishing effects of additional uncertainty cues in the cases. Generally, the results are also robust for alternative specifications. The beta estimates and significance level are similar when we control for the base case as a regressor and for fixed person effects. I show the results for the alternative specifications in Tables 6.8 and 6.9 in Appendix 6.1.

The low adjusted R-squared for the models comes from the noise in the experiment as we chose to use a simple model for the analysis. The information cues that are manipulated in the cases form a small fraction of the information cues that are available to participants to review. The effects of interest are thus small in this case.
<table>
<thead>
<tr>
<th>Model version</th>
<th>KnowMore_Diff</th>
<th>WillInvest_Diff</th>
<th>IncInvest_Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind1</td>
<td>-0.04</td>
<td>-0.02</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.02)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>UncertCond_Ind2</td>
<td>-0.22</td>
<td>-0.17</td>
<td>-0.16</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.06)</td>
<td>(0.05)</td>
</tr>
<tr>
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</tr>
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</table>

Notes: This table presents results for an OLS regression model with three investor decisions measures (KnowMore_Diff, WillInvest_Diff, and IncInvest_Diff) as dependent variables with various uncertainty conditions measures as regressors. KnowMore_Diff is the difference between the willingness to know more for the manipulated cases and the anchor case, WillInvest_Diff is the difference between the willingness to invest for the manipulated cases and the anchor case, and IncInvest_Diff is the difference between the inclination to invest for the manipulated cases and the anchor case. The effects are shown with clustered standard errors at investor level in parentheses. Significance level: *** p<0.01, ** p<0.05, and * p<0.10.
6.5.2 The role of uncertainty perceptions

This section relates to hypothesis 4. I hypothesise here that perceptions of uncertainty mediate the relationship between business information cues and investor decisions. To test hypothesis 4, I use UncertCond_Ind2 as the measure of uncertainty condition as it has the strongest significant direct effect on investor decisions as seen from the preceding section. As a result of this choice, p-values in the following analyses should be interpreted as conditional on using UncertCond_Ind2 as the measure of uncertainty in the experiment. The results in section 6.5.1 show that UncertCond_Ind1 has no significant effect on investor decisions and thus will not be useful in this context. Additionally, in line with the analysis in the other parts of the quantitative study, I continue to use the differenced forms of the primary variables for the analysis in the section. The results for the mediation analysis are summarised in the path diagrams shown in Figures 6.3 to 6.5 with investor willingness to know more, investor willingness to invest, and investor inclination to invest respectively as dependent variables. The detailed results are also presented in Tables 6.10 to 6.12 in the Appendix 6.2.

The conditions for a mediated relationship are supported for all three dependent variables. There is a significant negative relationship between uncertainty condition and investor willingness to know more about the business, which is the direct effect (coef. = -0.23, SE = 0.11). Manipulated uncertainty also shows a significant positive relationship with investor perceptions of uncertainty, (coef. = 3.48, SE = 1.73). Investor perceptions of uncertainty however shows a negative significant relationship with investor willingness to know more (coef. = -0.03, SE = 0.002). Consequently, when the mediator (investor perceptions of uncertainty) is considered, the size of the direct effect (i.e., uncertainty condition and investor willingness to know more) is reduced from -0.23 to -0.13. This reduction comes from the average causal mediation effects (ACME) of perception of uncertainty which is -0.10. In the final step, there is no significant reverse
causal relationship between the manipulated uncertainty and investor willingness to know more.

The results are similar for investor willingness to invest and investor inclination to invest. In both cases, the direct effect between manipulated uncertainty and the outcome variables is -0.17. The direct effect is, however, reduced to -0.08 for investor willingness to invest and -0.13 for investor inclination to invest when perceptions of uncertainty are considered. These results are also confirmed by the causal mediation analysis where average causal mediation effects (ACME) in both cases are significant.

Figure 6-3: Results of mediation model for mediation path with investor willingness to know more (KnowMore) as dependent variable.

Notes: Average Causal Mediation Effects (ACME) = -0.10 (p < 0.01). Average Direct Effects (ADE) = -0.13 (p < 0.10). The effects are shown with standard errors in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.

Figure 6-4: Results of mediation model for mediation path with investor willingness to invest (WillInvest) as dependent variable.

Notes: Average Causal Mediation Effects (ACME) = -0.09 (p < 0.01). Average Direct Effects (ADE) = 0.08 (p < 0.10). The effects are shown with standard errors in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.
6.5.3 The role of investor characteristics

Hypothesis 5 relates to how investor characteristics affect investor decisions in the context of uncertain information cues. To test hypothesis 5, I run models 6.2 and 6.3 depending on whether the investor characteristic is case-dependent or not. As explained in section 6.4, I use model 6.2 when the characteristic is case-dependent and 6.3 when it is not.

For hypothesis 5a, I run model 6.2 to test the effects of investor opportunity fit on the relationship between manipulated uncertainty and various measures of investor decisions. I present the results in Table 6.5. These results show that the effects of interest are generally not significant. The effect of interest here is the interaction effect between investor opportunity fit (OppFit) and manipulated uncertainty on investor decisions. While the interaction effects are all negative, they are not significant except for columns 5 and 6 with investor willingness to invest as the dependent variable. The negative interaction effect between venture opportunity fit (OppFit) and manipulated uncertainty on investor willingness to invest is contrary to what we hypothesise about the relationship. The negative interaction effect means that holding uncertainty constant, the closer the

Figure 6.5: Results of mediation model for mediation path with investor inclination to invest (InvestInc) as dependent variable.

Notes: Average Causal Mediation Effects (ACME) = -0.04 (p < 0.01). Average Direct Effects (ADE) = -0.13 (p < 0.10). The effects are shown with standard errors in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.
opportunity fits with investor preferences, the smaller the likelihood that investors are willing to invest in the business. This suggests that investors whose preferences are met are more cautious than others. It is, however, important to note that the negative relationship between manipulated uncertainty and investor decisions found for hypothesis 3 is reversed when we account for investor opportunity fit as a moderator. This is seen in the positive sign of the estimated effect of manipulated uncertainty on all the outcome variables in row 1 from Table 6.5.

For hypotheses 5b again we run model 6.2 with the familiarity of investors with the industry in question (FamLevel) as the moderator. We show the results in Table 6.6. Again, the interaction effects in all cases here are negative and insignificant for all investor decision measures. The results are not different for hypothesis 5c where we run model 6.3 using the number of investments as the moderator. There are no significant moderating effects for the investing experience (NoOfYears) factor for all the investor decision variables. We present the results in Table 6.7. The results are also not different for the alternative specifications which I do not show in this thesis.
Table 6-5: Parameter estimates for moderating effects of business opportunity fit on investor attitudes towards uncertainty.

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<tr>
<th>Model version</th>
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<th>WillInvest_Diff</th>
<th>IncInvest_Diff</th>
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<td>2</td>
<td>3</td>
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<td>0.02</td>
<td>0.01</td>
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<tr>
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<td>(0.06)</td>
<td>(0.05)</td>
<td>(0.06)</td>
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<td>0.04</td>
</tr>
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<td>(0.17)</td>
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<td>-0.01</td>
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<td>(0.17)</td>
<td>(0.17)</td>
<td>(0.17)</td>
</tr>
<tr>
<td>UncertCond3</td>
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<td>0.26</td>
<td>0.08</td>
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<td>(0.17)</td>
<td>(0.17)</td>
<td>(0.17)</td>
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<td>-0.02</td>
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<td>(0.07)*****</td>
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<td>0.23</td>
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<td>(0.07)*****</td>
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<td>-0.39</td>
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<td>(0.19)****</td>
<td>(0.22)</td>
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Notes: This table presents results for a linear regression model with three investor decisions measures as dependent variable and business opportunity fit as moderators with various uncertainty conditions as regressors. KnowMore_Diff is the difference between the willingness to know more for the manipulated cases and the anchor case, WillInvest_Diff is the difference between the willingness to invest for the manipulated cases and the anchor case, and IncInvest_Diff is the difference between the inclination to invest for the manipulated cases and the anchor case. OppFit_Diff is the difference between the business opportunity fit for the manipulated cases and that for the anchor case (OppFit_A0). The effects are shown with clustered standard errors at investor level in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.
Table 6-6: Parameter estimates for moderating effects of familiarity of industry on investor attitudes towards uncertainty.

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Notes: This table presents results for a linear regression model with three investor decisions measures as dependent variables and familiarity level as moderator with uncertainty conditions as regressors. KnowMore_Diff is the difference between the willingness to know more for the manipulated cases and the anchor case, WillInvest_Diff is the difference between the willingness to invest for the manipulated cases and the anchor case, and IncInvest_Diff is the difference between the inclination to invest for the manipulated cases and the anchor case. FamLevel_Diff is the difference between familiarity of industry for the manipulated cases and that for the anchor case (FamLevel_A0). The effects are shown with clustered standard errors at investor level in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10
Table 6-7: Parameter estimates for moderating effects of investment experience on investor attitudes towards uncertainty.

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<tr>
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<td>(0.10)***</td>
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Notes: This table presents results for a linear regression model with three investor decisions measures as dependent variable and number of years of investing as moderator with uncertainty conditions as regressors. KnowMore_Diff is the difference between the willingness to know more for the manipulated cases and the anchor case. WillInvest_Diff is the difference between the willingness to invest for the manipulated cases and the anchor case, and IncInvest_Diff is the difference between the inclination to invest for the manipulated cases and the anchor case. The effects are shown with clustered standard errors at investor level in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10
6.6 Discussion of empirical results

This chapter focuses on how uncertain information in business opportunities affects investor decisions. Simply put, are angel investors averse to uncertainty or do they seek uncertainty? If investors avoid uncertainty, what is the role of investor perceptions of uncertainty in the investment decision process? And finally, how do investor backgrounds and experiences affect the relationship between uncertain information and investor decisions? While we know that generally decision-makers are averse to uncertain information, there are certain contexts in which they seek uncertainty. One such case is the angel investor context, where there is evidence that experienced angel investors seek uncertainty (Huang and Pearce, 2015).

Findings from this part of the study, however, suggest that business angels, like other decision-makers generally avoid uncertainty. Business angels are less inclined to move a business opportunity to the next stage of the investment process when they are faced with higher uncertainties. While Huang and Pearce (2015) find that business angels seek uncertainty, it is limited by two conditions. First, the focus of their work was on experienced business angels (at least 5 years of investing experience) and not just any business angel. Second, these investors seek uncertainty when they assess the business opportunity to have the potential to make them extraordinary gains. This study shows that outside of these two conditions, business angels are generally averse to uncertainty. The findings here are complementary to that of Huang and Pearce (2015) as they bring clarity to the context under which investors seek uncertainty. Therefore, for ventures that do not have the potential to make this kind of gain, investors are averse to the uncertainties that come with them.

Investors’ general aversion to uncertainty is, however, mediated by their perceptions of uncertainty. Their observed decisions, whether to know more about the
business or to invest in it, are precipitated through an unobserved process whereby they perceive the uncertainty in the businesses. Early-stage ventures, especially those at the pre-seed stage, are fraught with uncertainties about their future success. When early-stage investors take equity stakes in these ventures they assume these uncertainties. While early-stage investors may be unaware of their perceptions of uncertainty and how they affect their decisions, this may be the case in reality. During the review process of a proposed business opportunity, investors interpret information cues and subconsciously form subjective perceptions of uncertainty which then lead to their observed decisions. It can be argued that reported investment decision criteria or rejection criteria in angel investment literature are the basis for the formation of these subjective perceptions of uncertainty.

On the moderating effects of investor characteristics on investor decisions in the face of uncertain information cues, there is little evidence from this study. While in some of the models to test this phenomenon, we find that the degree to which a business opportunity fits investors’ personal preferences moderates the relationship between uncertain information cues in business proposals and investor decisions, this finding is not robust to alternative specifications. We know from past studies that BAs are heterogenous by nature and are influenced by their personal differences (White and Dumay, 2020; Warnick et al., 2018). While we predict that a favourable assessment of a business opportunity fit should lead to a greater inclination to invest, this is not the case. This could be the case of investors being more competent to understand the nuances of the business and in this case avoiding it if they do not believe they stand the chance to make extraordinary gains. The other investor characteristics of interest here, investors familiarity with the industry in which the business operates and past investment experience, do not have any significant moderating effects on investor decisions. However, in Chapter 5 we find that investment experience has a negative moderating
effect on the perceptions of uncertainty in the cases. I discuss this further in section 7.2 of the discussion chapter.

6.7 Conclusion

This chapter focuses on how uncertain information affects the decisions-making of angel investors. The uncertainty construct has not been thoroughly studied in early-stage financing literature. The few works that have studied it focus on how angel investors deal with uncertainty in their decision-making process (Huang and Pearce, 2015; Wiltbank et al., 2009). In this study, I extend previous work from Huang and Pearce (2015) by examining the role of uncertainty and its effects on early-stage investment decisions.

Findings from the study suggest that angel investors are generally averse to uncertain information cues from entrepreneurs. Although we know from Huang and Pearce (2015) that angel investors seek uncertainty, they do so in the context of opportunities that they consider have the potential to make them big gains. Outside of this domain, angel investors avoid uncertainty like other decision-makers. However, the study shows that investors’ aversion to uncertain information is mediated by their perceptions of uncertainty. These perceptions are not formed through an explicit process in the decision-making of angel investors. Business angels in their normal operations do not explicitly measure their perceptions of uncertainties but are however influenced by them. Finally, the study finds no evidence that investor characteristics moderate investor decision-making in the face of uncertainty although we find in chapter 5 that they influence investor perceptions of uncertainty.

In conclusion, understanding the role of uncertainty in early-stage investor decisions can improve investor decision-making. Perceptions of uncertainty are driven by
missing and incomplete information. Missing or incomplete information can thus be resolved when investors seek additional information. An awareness of the role of uncertainty is thus central to improving investor decisions and in effect access to finance.
Chapter 7 – Discussion and conclusion

7.1 Introduction

In this final chapter, I bring the main elements of the thesis together and discuss the key findings from the study. As discussed in section 1.2, the thesis has two main objectives. The primary objective is to investigate how business angels form their perceptions of uncertainty in early-stage businesses and how these perceptions affect their investment decisions and behaviour. The secondary objective is to examine how investor characteristics affect how investors form their perceptions of uncertainty and how these characteristics affect the resultant decisions in the face of uncertainty.

In the literature review (Chapter 2), we find that studies on the investment decision-making process of business angels dominate the angel investing literature. What is missing from this area of the angel investing literature is how uncertainty affects the decision-making of business angels. While the role of uncertainty has been studied extensively in the entrepreneurial decision-making literature, little has been done to understand how uncertainty affects the decisions of investors in these early-stage ventures. This is surprising considering that investor attitudes towards uncertainty can determine their investment decisions. We know that business angels make investments in very early-stage ventures that are typically fraught with uncertainties (Huang and Pearce, 2015; Wiltbank et al., 2009). This makes it important for the uncertainty construct to be thoroughly studied in the context of angel investor decision-making. The limited works in this stream that have studied angel investor decision-making in the face of uncertainty have primarily focused on strategies employed by investors to make decisions in the face of uncertainty (Huang and Pearce, 2015; Wiltbank et al., 2009). They do not examine how uncertainty affects investor decisions and behaviour.
This study thus addresses this research gap in the literature through a two-part mixed-method sequential study. The first part is a qualitative study that addresses how business angels form their perceptions of uncertainty while the second part builds on the first through a quantitative study to measure how these perceptions are formed and how they affect investor decisions. The study answers three broad research questions. First, how do business angels form their perceptions of uncertainty when they consider early-stage ventures for potential investments? Second, how do investor perceptions of uncertainty affect investor decisions in these early-stage ventures? Finally, how do investor backgrounds, experiences, and preferences affect their investment decisions in the face of uncertainty? The study thus extends the current literature by explicitly measuring investor perceptions of uncertainty and examining how they affect investor decisions.

In the rest of the chapter, I discuss the key findings from the study and how they address the research questions. I then discuss the key contributions from the study, empirical, methodological, and theoretical and what they mean for practitioners such as business angels and entrepreneurs, as well as policy makers. I finally discuss the limitations and delimitations of the study as encountered in the study and its implications for future research.

7.2 Key research findings: a discussion

7.2.1 What uncertainty means for business angels

The first part of the research is a qualitative study which is captured in Chapter 4. The main objective here is to operationalise uncertainty in the context of business angels. That is, how do angel investors think about risks and uncertainty and what kind of information cues they consider uncertain? To the best of my knowledge, no study has
operationalised the uncertainty construct in the angel investor context. In most works outside of this domain, uncertainty is operationalised in the context of the Ellsberg (1961) type. That is uncertainty about the probability of a future outcome occurring from acts by decision-makers now. Typically, when the probability is known, the situation is described as risky while it is described as ambiguous when the probability is unknown (Ellsberg, 1961). The question is whether this dominant approach is what occurs in the business angel context. Answering this question is important for correctly operationalising uncertainty in the context of business angels and to contributing to making the study ecologically valid.

In this qualitative study, I find that business angels do not think about uncertainty in terms of probability of events occurring as pertains in the ambiguity aversion literature. Instead, missing, and incomplete information cues are what drive investor perceptions of uncertainty. This is mainly driven by how entrepreneurs present information about their businesses. In practice, entrepreneurs do not present information to business angels using probabilities of future events occurring. Hence, gaps in the information presented by entrepreneurs are what creates uncertainties in the minds of business angels. For business angels, uncertainties in early-stage ventures are typically around the venture viability or the capacity of the entrepreneurs to deliver the business plan or both. Consequently, in the main study uncertainty is operationalised in the form of missing information or incomplete information.

There are two additional findings from the qualitative study. First, some investor characteristics and background affect or shape how investors perceive the uncertainties in business opportunities. For example, when an investor is familiar with the industry in which the business operates, they tend to have a more favourable perception of the uncertainty in the business. Favourable here means investors perceive less uncertainty.
This is in line with previous research that suggests that investors are drawn to ventures in familiar industries (White and Dumay, 2020; Aernoudt, 1999). Investors feel more competent to contribute to these ventures as they believe they can bring their expertise to bear in these circumstances. I test this finding in the quantitative study in Chapter 5 and discuss it later in this section.

Second, business angels are willing to bear uncertainty in the early-stage ventures with the hope of making supernormal returns when successful. This is similar to what Huang and Pearce (2015) find in the qualitative part of their study. This means that for business angels, higher perceptions of uncertainty do not necessarily lead to a rejection of a business opportunity. Investors are willing to bear the uncertainties in these ventures because although potential returns maybe unknown, they hope that somewhere in that uncertainty there may be a great profit. This finding contextualises the condition or domain under which investors seek uncertainty.

### 7.2.2 Effects of investor characteristics on uncertainty perceptions

The experimental study addresses two key gaps in the literature. First, how do investor background and characteristics shape the perceptions of uncertainty in early-stage businesses? This question is addressed in Chapter 5. Business angels are heterogeneous in nature and their backgrounds and experiences shape their investment behaviours. In this chapter, I examine how the professional and entrepreneurial backgrounds of business angels’ as well as their angel investing experiences shape their perceptions of uncertainty in early-stage ventures that come their way.

The results here are mixed. For example, I find that prior entrepreneurial experience of business angels has no effect on how they perceive uncertainty in early-stage ventures. I hypothesise that past entrepreneurial experience will negatively
moderate investor perceptions of uncertainties. We expect that former entrepreneurs are accustomed to the rudiments of entrepreneurship and hence will feel more competent to deal with uncertainties in early-stage ventures. However, I find no evidence to support this hypothesis. This result is contrary to the finding from Mitteness et al. (2012a) who show that investors with past entrepreneurial background are more critical when they review business proposals. Again, I find no evidence to support the hypothesis that familiarity with venture industry negatively moderates investor perceptions of uncertainty. We know from the literature that business angels consider their post-investment participation in the business as an important investment decision factor (White and Dumay, 2020; Mason and Stark, 2004). This means business angels should have a favourable perception of uncertainty in ventures that operate in industries that they have a working knowledge of. These two results are however in line with Mason et al. (2017) where they find that professional and entrepreneurial experiences are not directly related to investor decisions. Their results suggest that investor characteristics do not influence investor decisions but only venture characteristics do.

However, the finding from Mason et al. (2017) that investor characteristics do not affect investor decisions is not entirely the case. This is seen in the other key finding from Chapter 5 relating to the effects of angel investing experience on investor perceptions of uncertainty. I hypothesise that investors with more investing experience will perceive less uncertainty. Following previous works in the business angel research literature, I measure post-investing experience using two proxies – number of years of investing and number of investments made (Harrison et al., 2015). As predicted, I find that number of years of investing negatively moderates perceptions of uncertainty in business opportunities. This can be attributed to more experienced investors learning from their past investing activities (Bothelo et al., 2021b; Harrison et al., 2015) and thus feeling more competent to deal with uncertainty. Experienced decision makers are also known to suffer from
overconfidence where they are more confident in their estimates of the likelihoods of events occurring (Zacharakis and Shepherd, 2001; Simon et al., 2000). Thus, in the face of uncertainty, experienced decision makers are confident in their own ability to control the chances of negative outcomes (Shapira, 1995). They do so through a series of non-predictive control actions that they believe remedy the possibility of unsuccessful outcomes (Wiltbank et al., 2009).

Surprisingly, when I measure investing experience using the number of past investments, the results of interest (interaction effect between number of investments and uncertainty) are not significant. The data suggests that the number of investments as a measure of investment experience is somewhat dependent on the number of years of investing. This may be because as I find in the qualitative study, there are investors who start their angel investor journey aggressively by making a lot of investments in a short period of time. This could be driven by early career angel investors trying to establish a reputation quickly as we have with young venture capital firms (Gompers, 1996). Additionally, the number of investment variable could be endogenous relative to investor attitudes towards uncertainty which can drive investor perceptions of uncertainty. That is, investors who are averse towards uncertainty will generally invest less. Thus, investor perceptions of uncertainty can influence the number of past investments. While I am able to control for the number of years of investing it is difficult to disentangle the effects of investor attitudes towards uncertainty. I run another model that controls of the number of years of investing, but the results remain insignificant. The number of investments is thus a noisy proxy for angel investing experience which I discuss further in the methodological contributions and limitations of the study.
7.2.3 Effects of uncertainty on investor decisions and behaviour

As stated in the previous section, the experimental study addresses two main gaps in the literature. The first gap is addressed in chapter 5 as discussed in the previous section. The second gap focuses on how uncertain information cues in business opportunities affect investor decisions. This is discussed in Chapter 6. This chapter addresses three main questions following from the previous chapters. First, how do uncertain information cues affect angel investor decisions? Second, what is the role of investor perceptions of uncertainty in their investment decision-making process? Finally, do investor background and characteristics affect their investment decisions in the face of uncertainty?

There are three key findings from this part of the quantitative study. The first finding suggests that business angels, like other decision-makers, generally avoid uncertainty. This is contrary to the finding by Huang and Pearce (2015) who describe angel investors as seeking uncertainty. It is also contrary to what we know from entrepreneurial action research in which entrepreneurs are described as uncertainty-seeking actors (Townsend et al., 2018; Packard et al., 2017). As already discussed in relation to the qualitative part of the study, there is evidence that angel investors seek or are willing to bear uncertainty. The findings from this part of the quantitative study, however, suggest otherwise. This is because angel investors are willing to bear uncertainty given opportunities to which they can potentially achieve high multiples of initial investments. Potential here means the mere possibility of an event occurring without any probability attached as we have in a risk-return framework. Thus, investors tend to discount low uncertainty opportunities because usually these ventures are associated with potentially only modest returns. Therefore, outside this domain, business angels avoid uncertainty like other decision makers. This empirical evidence provides
clarity on the general attitudes of business angels towards uncertainty and the context in which they seek or bear uncertainty.

The second key finding from this part of the study relates to the role of investor perceptions of uncertainty on their decision-making. Whilst we find that investors generally avoid uncertain investment prospect, this aversion to uncertainty is mediated through their perceptions of uncertainty. Whereas in angel investor decision-making we can only observe the final decision, this decision is influenced by investor perceptions of uncertainty arising from their interpretations of the information provided by the entrepreneur. There is no study in the angel investing decision-making literature that finds that investors explicitly form perceptions of uncertainty as part of their decision-making process. However, I believe that investors do form these perceptions consciously or unconsciously which shows how they arrive at their decisions. This unobserved phenomenon in practice explains the nature of the relationship between uncertain information cues and observed investor decisions. As explained earlier in this section, I find from the qualitative study that investor perceptions of uncertainty are driven by missing and incomplete information. How entrepreneurs present information to angel investors is crucial to their success of raising funding as these information influence investor perceptions of uncertainty and in effect their investment decisions.

Finally, on the question of how investor background and characteristics affect investor decisions in the face of uncertainty, results are mixed and modest. I find some evidence that the degree to which a business opportunity fits investors’ personal preferences moderates the relationship between uncertain information cues in business proposals and investor decisions. While I predict that favourable assessment of a business opportunity fit should lead to a greater inclination to invest, this is not the case. I find a negative interaction effect between business opportunity fit and uncertain information
cues. This suggests that investors whose preferences are met are more cautious than others. The other investor characteristics of interest here, investors familiarity with the industry in which the business operates and past investment experience, do not have any significant moderating effects on investor decisions. I discuss this further in the limitations of the study as interaction effects are difficult to detect in small-sample data.

7.3 Research contributions of the thesis

This section reviews the key contributions from the research across the three empirical chapters. This study makes four empirical contributions, a theoretical contribution, and three methodological contributions. I discuss each area in the following sub-sections.

7.3.1 Empirical contributions

The first empirical contribution comes from the qualitative study in Chapter 4. This relates to the ecological validity of Ellsberg-type uncertainty in the context of business angels. In section 2.6 we find that there are different dimensions of uncertainty in the finance and economics literature. The most widely used dimension of uncertainty is the Ellsberg-type uncertainty, which is commonly known as ambiguity. This dimension of uncertainty focuses on the uncertainties or ambiguities about the probability of an outcome occurring based on choices made now (Ellsberg, 1961). In the context of business angels is this the type of uncertainty that prevails in practice? Huang and Pearce (2015) argue that due to the nature of early-stage ventures, the type of uncertainty that prevails in this space is that of unknown unknowns. They do not, however, empirically explore how the uncertainty that prevails in the business angel space can be operationalised. This is the primary focus of Chapter 4. Through an in-depth qualitative study, I find that business angels find Ellsberg-type modelled uncertainty unusual and
unrealistic compared to what they see in their professional life. What creates uncertainty for business angels is the absence or presence of particular information cues in business proposals or plans as communicated by entrepreneurs. This contributes to the angel investing literature as it sheds light on how business angels think about uncertainty and what business angels consider as uncertain in their investing operations.

The second empirical contribution relates to how investor background and experiences affect perceptions of uncertainty. In the angel investing decision-making literature, very few works have addressed how uncertainty affects decision-making of business angels. These works have focused mainly on strategies employed by business angels to deal with uncertainties during decision-making (Huang and Pearce, 2015; Wiltbank et al., 2009). There is no work that explicitly measures investor perceptions of uncertainty in early-stage ventures and the resultant effects on investor decisions and behaviour. Chapter 5 addresses this gap by examining how investor backgrounds and experiences affect investor perceptions of uncertainty. Chapter 5 thus sheds light on how these backgrounds and experiences shape investor perceptions of uncertainty.

The findings from Chapter 5 suggest that different investor backgrounds and experiences affect their perceptions of uncertainty differently. For example, while investors with more angel investing experience perceive less uncertainty than those with less experience, familiarity with the venture industry and entrepreneurial backgrounds have no effects on investor perceptions of uncertainty. These findings contribute to the angel investing literature as they show how different investor backgrounds and experiences shape investor perceptions of uncertainty. They expand our knowledge of the heterogeneity of business angels in their investment behaviours. While Mitteness et al. (2012a) show that entrepreneurial background and operating knowledge of industry affect investor decisions, Mason et al. (2017) show that investor characteristics do not affect
invest decisions. This thesis provides evidence around how some characteristics affect investor perceptions of uncertainty while others have no effect.

The third contribution relates to the role of perceptions of uncertainty in the investment decision process of business angels. The uncertainty construct has been neglected in the angel investor decision-making literature. This is surprising considering that business angels invest in ventures at the very stage where uncertainty is at the highest. The few works that have covered the uncertainty construct focus on strategies used by investors to take decisions in the face of uncertainty (Huang and Pearce, 2015; Wiltbank et al., 2009). Chapter 6 extends these works by measuring investor perceptions of uncertainty and examining how they affect investor decisions. I find that investor perceptions of uncertainty mediate the relationship between information presented in business cases and investor decisions. This contributes to the angel investing literature as it shows how investors’ decisions are arrived at in the face of uncertainty. Business angels interpret business information cues and form subjective perceptions of uncertainty either consciously or unconsciously. This then leads to investor decisions whether to proceed to the next stage of the investment process or to reject the venture. Perceptions of uncertainty thus serve as a mechanism through which an investment decision is made.

The final empirical contribution relates to business angels’ attitude towards uncertainty. This is also from the quantitative study in Chapter 6. Studies on the uncertainty construct find that in general decision-makers are averse to uncertainty. Decision-makers prefer the more certain option. However, there is evidence that entrepreneurs seek uncertainty when they undertake entrepreneurial ventures. Additionally, experienced business angels seek uncertainty in early-stage ventures by making small investments (Huang and Pearce, 2015). These investors seek uncertainty with the knowledge that they could lose their entire investments but hope that the few that
are successful have the potential to make them large gains. The current study takes this a
step further through an experiment to empirically examine business angels’ attitudes
towards uncertain information in general.

I find that business angels are generally averse to uncertainty like other decision-
makers. This extends the findings of Huang and Pearce (2015) by bringing clarity around
the conditions under which business angels seek uncertainty. First, the uncertainty-
seeking attitude may be limited to experienced business angels and not all business
angels. Second, it is also conditioned on the investors’ belief of the potential gains in the
ventures. This finding thus shows that beyond experienced business angels, investors like
other decision-makers avoid uncertainty. Additionally, business angels seek uncertainty
when they see the venture to have the potential to make them extraordinary gains.

7.3.2 Theoretical contribution

The thesis also makes a theoretical contribution to the angel investing decision-
making literature. Based on the key empirical findings, I propose a descriptive decision-
making model for business angel investment decision-making in the face of uncertainty.
This model is a moderated-mediation decision-making model as presented in Figure 7.1.
The model describes how business angels take decisions when faced with uncertain
business information.
Figure 7.1: A descriptive decision-making model under uncertain conditions.

The model starts with information provided by entrepreneurs in business cases and pitch decks. Typically, in practice what is observed is the final decision outcome from the business angel. The moderated mediation path in Figure 7.1 is not explicitly observed in practice. I describe this further in the following paragraphs.

First, as we find in Chapter 6, the final investor decision is first mediated by investor perceptions of uncertainty in the venture. Business angels interpret business information cues and consciously or unconsciously form perceptions of uncertainty and opportunity in the ventures. This process may not be explicitly observed in practice but however may take place in the minds of investors.

Second, as seen in Chapter 5, the formation of investor perceptions of uncertainty is moderated by angel investing experience. Investing experience negatively moderates investor perceptions of uncertainty. This means in the formation of perceptions of uncertainty, how long an investor has been in angel investing plays a role. The perceptions of uncertainty also mediate the relationship between uncertain business information and investor decisions and behaviours as seen in Chapter 6.
Overall, in practice investors review business information cues and make decisions. They use both intuitive and formal analysis to make their decisions (Huang and Pearce, 2015). However, in practice there is an unobserved moderated-mediation process that shows how the observed decision is arrived at.

7.3.3 Methodological contributions

The study makes three methodological contributions. First, I model uncertainty in the context of business angels as missing or incomplete information. That is, business proposals that either do not present information about critical decision factors or present the information in an unclear manner. Correctly modelling uncertainty in the context of business angels is a crucial part of the study. In the economics and finance literature, the dominant approach to operationalising uncertainty is ambiguity (Ellsberg-type), which is uncertainty about the probabilities of future outcomes occurring. However, in Chapter 4, we find that operationalising uncertainty as the Ellsberg-type is unusual and unrealistic for business angels. This is the first study that addresses the gap through an empirically derived approach to operationalising uncertainty in the context of business angels. Although the Ellsberg approach to measuring uncertainty has been used extensively in prior work, this study proposes a very novel and ecologically valid approach to operationalising uncertainty.

Second, the experiment employed in the quantitative study in chapters 5 and 6 was designed with insights from a sample of business angels. This methodological approach enhances the ecological validity of experimental studies. Chapter 4 was used to gather insights from business angels on how to operationalise uncertainty and to design the overall experiment. Business angels contributed to the structure of the scenarios used in the experiment and the kind of content that is useful for the study. The study was then
conducted using a sample of business angels rather than naïve participants such as business students. This approach ensures that the findings of the study are generalisable to the target population and their practice context.

Finally, the usefulness of the number of past investments as proxy or measure for investment experience is limited. In Chapter 5, I find that using the number of investments as a proxy for investing experience produces conflicting and insignificant results to that obtained from using the number of years of investing. The number of years of investing is a better and more realistic measure of investing experience. This is because findings from the qualitative study in Chapter 4 suggests that there are individuals that start their angel investing careers by making many investments quickly with the hope of realising an extraordinary gain quickly. This, however, does not translate into investing experience that implies that individuals learn from past investing activities. When business angels make investments, they participate and interact with the entrepreneurs after the investment has been made. Business angels are then able to see the results of their decisions, from which they take lessons to inform subsequent investments. This is, however, not the same for the number of investments, which could happen in a short period without much learning on the investors’ part.

7.4 Implications for practice

This section focuses on the implications of the findings of this thesis on practice for business angels, entrepreneurs, and business angel networks. I start with the practical implication of the thesis for the practice of business angels. I then discuss some implications for entrepreneurs and how to improve their chances of being funded by business angels. Finally, I look at how business angel networks can improve the operations of business angels and access to funding for early-stage ventures.
7.4.1 Business angels

The findings of the thesis can help improve the investment decision-making of business angels in two ways. First, understanding the effects of uncertainty on early-stage investor decisions is important to improving investment decisions as it can help reduce behavioural biases in early-stage investment decisions such as overconfidence. For example, one of the findings of the thesis is that investment experience negatively moderates investor perceptions of uncertainty. As business angels acquire more experience through their investments and interactions with the ventures and entrepreneurs, they become more competent in their subsequent decision-making. Experienced business angels may feel they have the skill to deal with the uncertainties in early-stage ventures and hence perceive less uncertainty. On the other hand, reduced perception of uncertainty may be a result of experienced business angels becoming overconfident in their abilities, which in turn may lead to inaccurate decision-making. This means for experienced business angels being mindful of this potential behavioural bias and taking steps to reduce its effect on decision-making can improve overall accuracy of decisions.

Second, being aware of how business information cues affect investor perceptions of uncertainty and in effect investor decisions can help improve the accuracy of investor decisions. This is especially important for new business angels with less angel investing experience. One of the findings of the thesis is that missing and incomplete information drives investor perceptions. For inexperienced business angels who perceive more uncertainty seeking additional information when faced with heightened uncertain conditions can help reduce their perceptions of uncertainty. Inexperienced business angels can adopt a strategy that seeks additional information to better inform their decisions instead of avoiding the business entirely. This may mean a much slower decision-making process for inexperienced business angels compared to their more
experienced counterparts. Additionally, inexperienced investors should consider working with experienced investors to understand how they manage investments with uncertain information (for example through syndicates). They can learn and adopt strategies employed by their more experienced colleagues. These strategies can help improve the overall decision-making process for these investors as they learn the trade of angel investing.

7.4.2 Entrepreneurs

The findings from this research affect entrepreneurs in two ways. First, knowing the effects of missing and incomplete information on investor perceptions of uncertainty and the associated decisions should affect how entrepreneurs present their business proposals and pitch decks. It should affect how information is presented or communicated in two ways. First, if information about an aspect of the venture is considered important for the investor, it is important that the status of that aspect be presented as it is. For example, if for the business having a patent is considered important but there has been no effort to obtain one, it is still important for the entrepreneur to present the information and explain why no effort has been made towards it. Completely leaving out anything relating to patents could create uncertainties in the minds of the business angel especially relating to the competence of the team behind the venture. In other words, trying to avoid areas of weakness in a business plan by not discussing them, is a poor strategy for seeking funding from investors. Second, information should be presented in a consistent manner. Conflicting information in business proposals creates uncertainties about the competency of the entrepreneur and the team behind the venture.

Another implication for entrepreneurs relates to the effects of investor characteristics on investor decisions and behaviour. For example, the qualitative study in
Chapter 4 reveals that some ventures do not receive funding, not because they are not investment-ready, but because they do not meet the preferences of some investors. Business angels are heterogenous and their backgrounds and experiences affect their decisions. This is seen in the effect of some investor characteristics on the perceptions of uncertainty in early-stage ventures. While investment experience reduces perceptions of uncertainty, having an entrepreneurial experience has the opposite effect. This means entrepreneurs should be more targeted in their search for financing. For example, entrepreneurs can strategically target experienced investors to increase their chances of obtaining funding. Also, entrepreneurs may want to target investors that prefer investing in the industry in which the venture operates. These strategies can increase the chances of the entrepreneur receiving funding.

7.4.3 Business angel networks

One of the findings from Chapter 5 is that angel investing experience negatively moderates investor perceptions of uncertainty. Also, we find in Chapter 6 that business angels are generally averse to uncertainty and prefer ventures that they consider less uncertain. Investing and working with entrepreneurs enhances learning for business angels and makes them more competent to deal with uncertainties. Given that investing experience reduces investor perceptions of uncertainty, early-career angels can accelerate their learning through interactions with more experienced business angels.

Business angel networks can play a crucial role in accelerating the learning and experiences of early-stage career angels. This can be achieved through the facilitation of angel education programmes, networking events, and mentorship programmes. In practice, business angels learn through learning opportunities whether formal and informal ones (Bothelo et al., 2021b). BANs can play a role in facilitating these learning
opportunities by exposing early career angels to their more experienced counterparts. Early-career angel investors can learn from these more experienced investors on how to deal with uncertainties. There is evidence that experienced business angels employ strategies to deal with uncertainties (Huang and Pearce, 2015; Wiltbank et al., 2009). They can quickly acquire strategies employed by their more experienced counterparts to deal with uncertainties. This will lead to reduced perceptions of uncertainty and in effect more investments in early-stage ventures.

7.5 Limitations and delimitations

This section focuses on the limitations and delimitations of the research and their associated impact on the contributions of this thesis. I identify three key limitations of the study and three key delimitations. The limitations are related to potential weakness of the study that are mainly out of the control of the researcher. However, the delimitations relate to how I limit the scope of the research. This means I define the limits and boundaries of this research to clearly establish the scope, what is covered and what is not. I discuss the limitations and delimitations in detail in the following paragraphs.

The first limitation of the study relates to the sample of the quantitative study. This study used actual business angels from the UK and the US. In the context of this research, business angels are considered an expert sample. Using an expert sample instead of a non-expert sample, such as MBA students, increases the ecological validity of the findings. However, this comes with the downside of obtaining a small sample size. Business angels are a hard-to-reach population as their operations are typically private and access to them is difficult. The sample size obtained in the study limits the robustness of some of the findings especially those that require interaction effects. For some of the
findings, the results were not significant for the alternative models employed. It may be that the lack of robustness some results can be attributed to the size of the sample.

The second limitation relates to the sourcing of the sample for the study. In Chapter 2, I discuss that one of the major issues raised in the angel investing literature is the non-representativeness of the samples (Avdeitchikova et al., 2008). Typically, research works in this space use business angel networks, as they are a relatively more visible part of the business angel market and an easier access route. This, however, limits the sample to members of the network who may not represent the much larger business angel community. To avoid this shortcoming, I reach out to business angels through their social media accounts. In this case, I do not target any particular business angel network and I am able to reach a more representative sample. Through this approach, participants come from different sections of the BA market; non-network linked BAs, BAs associated with networks, and BAs associated with syndicates. While sourcing the sample from social media avoids the issue of the non-representativeness of samples in business angel research, it comes with the challenge of authenticating the persons behind the accounts and whether they are truly business angels as they say. However, I used the same approach in the qualitative study, that is recruiting participants via social media. In qualitative study, I did not encounter any individual behind a social media account who was not truly a business angel.

The findings of this study may also be limited to individual decision-making and may not be applicable to group settings such as business angel networks and syndications. This is the third limitation of the study. The dynamics of group settings mean some of the findings may not applicable. In group decisions, less experienced business angels may be influenced by relatively more experienced investors whose characteristics may shape the group’s decisions. Therefore, findings around how investor characteristics affect
perceptions of uncertainty and investor decisions may not be applicable to group decision-making. This is because the characteristics of lead business angels may be the dominant influence on the group decisions.

Next, I discuss three delimitations of the study. First, the object of the study are business angels. While there are other sources of funding for early-stage ventures, I focus on business angels due to their importance to very early-stage ventures. Compared to other sources of funding, such as crowdfunding platforms, business angels provide not just the necessary funding but also add value after the investment by taking on board membership and other advisory roles. The choice to make business angels the focus of the study means the findings may not be applicable to investors providing other sources of funding.

The research also does not extend beyond investor decisions to invest or proceed to the next stage of the investment process. This is the second delimitation of the study. This study does not look at the effects of investor decisions on the financial performance of the ventures post the decisions. This is because the focus of the study is to examine how uncertain information affects investor decisions. How these decisions affect the financial performance of the ventures is not covered in the study.

Finally, the study focuses on how uncertain information in general affects investor perceptions and decisions. The study does not look at how uncertain information cues in different parts of venture affect investor perceptions and decisions differently. The decision to focus on uncertain information in general was to avoid an overly elaborate research design which will be difficult to execute.
7.6 Suggestions for future research

While the three empirical chapters provide new insights into business angels’ investment decision-making in the face of uncertainty, they also suggest questions that scholars could address in future. Chapters 4 and 5 both highlight how investor backgrounds and experiences affect perceptions of uncertainty and investor decisions in the face of uncertainty. The findings here are, however, limited to individual business angel’s decision-making. There is thus an opportunity to examine how diverse settings such as group decision-making as seen in angel networks and syndications affect decision-making under uncertainty. Are group decisions more influenced by the background and experiences of the lead business angel? Additionally, how does the perceptions of uncertainty of gatekeepers in business angel network affect their decisions on which investment proposals are presented to angel network members? Finally, angel group decision making has been found to be different from the traditional independent angel decision making (Carpentier and Suret, 2015). Angel group members focus more on market and execution risk and less on agency risk. How will uncertainty in different parts of a business affect angel group decision making? Will uncertainties in the business-related information mean more in group decisions than entrepreneur related information?

This study also does not examine how different aspects of the business affect investor perceptions. The focus of the study is on how increasing uncertainty affects investor perceptions and resultant decisions. Thus, there is an opportunity to investigate how other aspects or dimensions of the venture affect investors’ perceptions of uncertainty and their investment decisions. For example, do entrepreneur- and team-related uncertainties have a greater effect on investor perceptions than business-related uncertainties? Do different investor characteristics have different moderating effects on investor perceptions of different parts of the venture?
It is also important to explore how other emerging investors in early-stage ventures take decisions in the face of uncertainty, specifically, less sophisticated investors such as retail investors on crowdfunding platforms. Do investors on crowdfunding platforms have similar attitudes towards uncertain information? Are there any differences in how their characteristics affect their perceptions of uncertainty compared to business angels? This is important considering the fundamental differences between crowdinvesting and angel investing. As the crowdinvesting literature highlights, there are differences in how post-investment contracts are structured (Klöhn et al., 2016; Wong et al., 2009), levels of active involvement of investors post-investments, and the resulting degree of information asymmetries (Schwienbacher, 2018). Do these differences make crowd investors perceive more or less uncertainties compared to business angels? Also considering that crowd investors invest relatively smaller amounts compared to business angels, does uncertainty in business opportunities matter at all to crowd investors?

An important finding from chapter 5 relates to how investor experience as measured by the number of investing moderates perceptions of uncertainty. As argued in section 5.6, angel investor learning drives angel experience which moderates investor perceptions of uncertainty. However, as Bothelo et al. (2021b) show, measuring angel experience through proxies like number of years of investing do not fully account for how learning occurs and to what extent it impacts investment decisions. To that extent, what are the effects of learning on investor perceptions of uncertainty? Specifically, how do angels learn to deal with uncertainties in business opportunities when deciding to invest? Finally, what is the relationship between angel learning, investment decisions, and investment outcomes? How can business angels get better investment outcomes when they manage their biases towards perceptions of uncertainty?
7.7 Conclusion

Uncertainty is an important construct in economics and entrepreneurship but has, however, not received the needed attention from the early-stage venture financing literature. Understanding the role of uncertainty in investor decision-making is important to improving early-stage investor decision-making, as perceptions of uncertainty can determine investor decisions. The thesis addresses this gap through a two-part mixed-methods study that employs a qualitative study whose findings inform the design of the experiment used in quantitative part of the study.

In conclusion, understanding the role of uncertainty in early-stage investor decisions can improve investor decision-making and perhaps economic modelling of investor behaviour. Perceptions of uncertainty are driven by missing or incomplete information. Different characteristics of investors have different effects on investor perceptions. For example, angel investing experience can make investors perceive less uncertainty, while having an entrepreneurial background has no effect on investor perceptions of uncertainty. Also having a professional background in the industry in which a venture operates has no effect on investor perceptions of uncertainty. Additionally, investor perceptions of uncertainty are a mechanism through which investors make decisions. The study proposes a descriptive model that explains how early-stage investors make decisions in the face of uncertainty. These findings have implications for both early-career investors and for entrepreneurs. Early career investors can reduce the effects of uncertainty on their decision-making by working closely with their more experienced colleagues. Additionally, entrepreneurs can strategically target early-stage investors with the right profile that fits their business to improve their chances of obtaining funding.
Appendices

Appendix 3.1 – Sample case scenario for pilot study

ABC Matrix Limited

ABC Matrix is a startup venture based in the UK offering proprietary Digital Signal Processing (DSP) technology that dramatically improves the functionality and performance of biosensor devices. ABC Matrix’s core DSP algorithms solve several immediate problems in the medical devices market by significantly boosting the performance of biosensors without costly specialized hardware and additional chemicals. It is committed to providing software solutions for a critical hardware problem that affects millions of diabetic patients and hospital patients worldwide.

Opportunity & Market

Problems in the hospital blood analyzer market are more related to the lack of the comprehensiveness and accuracy of the devices, which results in reduced adoption levels. ABC Matrix’s value proposition for this market is: devices that are more accurate and sensitive will stand a higher chance of being more readily adopted. ABC Matrix will operate as a technology licensing company, deriving royalty revenue streams based on device makers’ consumables sales. Revenues will be acquired from the sale of the technology to home blood glucose device makers and hospital point-of-care blood analyzer makers. We have approached two blood glucose monitor makers and one hospital point-of-care device manufacturer as potential customer targets. There are over 20 other major potential target companies we have not yet approached.

Products & Services

ABC Matrix’s solution, consisting of a suite of software modules, enables new functionality and dramatically improves the performance of biosensor devices. For the professional healthcare market, ABC Matrix offers the ability to improve the overall accuracy and sensitivity of hospital point-of-care analyzers. The Lead Scientist estimates that there is a 40% to 60% chance that the product will be successful and accepted by customers in the next year.

Management Team

A current team composed of three leading scientists pioneering the use of digital signal processing to improve biosensor technology, with an aggregate of over 40 years of direct DSP/biosensor research experience. It also includes entrepreneurs who have founded, built and run an enterprise software company. An additional technical team of three committed to joining the company post-seed financing, with technical management experience and an aggregate of over 25 years of commercial engineering experience.

Financials

A first round of Seed funding of £500k for a 20% stake required to commercialize current products. The company anticipates an investor liquidity event horizon at approximately five years consisting of (1) IPO, or (2) acquisition, or (3) Full Intellectual Property purchase by one of the larger companies in this space for an estimated 7X the current value.
Appendix 3.2 – Pilot study interview guide

Title: The Perceptions of Risks and Uncertainty in Innovation Finance

Pre-Scenarios validating Questions (General Questions)

- Can you please tell me the kind of investments you usually make in terms of Sector/Industry, Investment Size and whether you do syndication or invest alone?
- Briefly describe your usual investment decision making process specifically in relation to how you think about risks and uncertainty during the process?
- What kinds of risks and uncertainties are you most concerned with?

Scenarios validating questions (Specific to the scenarios)

- How engaging and real are these scenarios compared to cases that you usually review?
- Can you please tell me which information cues of the cases you mostly pay attention to?
- Can you indicate which information cues of the scenarios you consider as uncertain or ambiguous and whether there are important for an investment decision?
- On a scale of 1 to 10, 1 being the lowest uncertainty and 10 being the highest uncertainty, what is your perception of uncertainty in the business cases?
- Do you have any other general comments relating to the scenarios?
Appendix 3.3 – Final set of base case scenarios

Base Case A - RST Technologies Limited – Tracking Device Maker

Background & Opportunity

- RST Technologies (RST) is a UK based start-up company in the fast-growing field of Personal Tracking Devices.
- RST Technologies’ mission is to become the leading manufacturer of Personal Locator Devices worldwide.
- Industry analysts estimate the Personal Tracking Devices at over $22b last year.

Products & Services

- RST will develop and distribute miniaturized Personal Locator Devices.
- We have developed a proprietary technology that does not rely on cell towers to function. We have applied and obtained a patent for our proprietary technology.
- Initially, the manufacturing of our devices will be subcontracted, while we develop the supporting software and systems internally, although we plan to manufacture our products in-house in five years.

Market

- Our primary target markets include, but are not limited to, the family consumer, channel sales to original equipment manufacturers (OEMs), businesses tracking shipments or vehicles, the military, and the political arena.
- The combined number of potential customers for our products is well over 20million in the UK; we will focus on a more realistic and attainable 2-year sales goal of roughly 100k users and grow this by 15% per annum over the next 5 years.
- Because of our unique proprietary programming capabilities for each individual unit, we have already received indications of interest from several of these target markets.
- We are currently assessing our options to determine which target markets are best suited.

Management Team

- The two founders of RST Technologies have been associates for over 10 years which creates the perfect synergy to ensure the success of our company.
- The CEO is a Sales and Marketing Management veteran with more than 20 years of successfully penetrating previously unseen markets niches.
- The CTO is an Electronic Engineer with 20 years of experience and is considered an expert in his field, having previously designed devices for military applications, medical imaging systems, computers and more.

Financials & Funding Request

- By focusing on our strengths, our key customers, and our customers’ needs, we expect to generate about £500k sales within two years and grow that by 15% a year subsequently.
- A first round of SEIS Seed funding of £150k for a 12% stake required.
The funds will be used to further develop our range of products, legal costs, payroll, marketing, and typical expenses associated with opening our first office.

The company targets a strategic trade sale in 7 years.

**Base Case B - ABC Matrix Limited – Medical Software**

**Background & Opportunity**

- ABC Matrix is a UK based start-up venture offering proprietary Digital Signal Processing (DSP) technology.
- Problems in the hospital blood analyser market are more related to the lack of the comprehensiveness and accuracy of the devices, which results in reduced adoption levels.
- ABC Matrix's core DSP algorithms significantly improves the functionality and performance of biosensor devices.

**Products & Services**

- Our suite of software modules enables new functionality and improves the performance of biosensor devices.
- <Insert manipulated variable statement>

**Market**

- Our value proposition for this market is: devices that are more accurate and sensitive will stand a higher chance of being more readily adopted.
- ABC Matrix will operate as a technology licensing company, deriving royalty revenue streams based on device makers' consumables sales.
- UK Blood Analyser market forecast to grow at 10% per year over the next 5 years.
- <Insert manipulated variable statement>
- Future targets include the large immunoassay and implantable biosensor sectors; as well as other vertical industries that heavily rely on biosensors.
- We have identified no direct competitors; however, we indirectly compete against other biosensor-enhancing technologies including advances in physical designs.

**Management Team**

- <Insert manipulated variable statement>
- An additional technical team of three committed to joining the company post-seed financing, with an aggregate technical management and commercial experience of over 20 years.

**Financials & Funding Request**

- Revenues will be acquired from the sale of the technology to home blood glucose device makers and hospital point-of-care blood analyser makers.
- A first round of SEIS Seed funding of £100k for a 10% stake required to commercialize current products.
- The funds will be used for further development of the technology, business development and operations.
- The company anticipates an investor liquidity event horizon at approximately seven years by one of the larger companies in this space.
**Base Case C - EduToy Limited - Children's Educational Toys**

**Background & Opportunity**

- EduToy Limited is a UK based start-up company that has developed a line of educational tools for children.
- It is our mission to make the highest quality and most affordable educational toys.
- Our products are educational tools that develop core skills within the youngster users while they have fun

**Products & Services**

- EduToy is initially offering three different educational toys: NumberToy, LetterToy and PhonicToy.
- Initial prototype sales have received very positive feedback from end users. (Average 4 Star rating).
- While prototypes will be designed and manufactured in house, production will be outsourced.
- *<Insert manipulated variable statement>*

**Market**

- Our value proposition for this market is the more children that learn basic functions from our toys, the better they become and the more successful we are.
- We have identified two target customer segments: individuals and wholesalers.
- The individual customer segment is estimated to grow at 14% per year and currently has over 3 million prospective customers.
- The wholesale customer segment is growing annually at 6% with over 6,000 potential customers.
- *<Insert manipulated variable statement>*

**Management Team**

- *<Insert manipulated variable statement>*
- An additional team of two committed to joining the company after the current round of financing, with an aggregate of over 20 years of commercial experience.

**Financials & Funding Request**

- The company has conservatively forecasted sales to reach £400k in year two and grow rapidly at 14% a year for the next 5 years.
- A first round of SEIS Seed funding of £120k for a 10% stake required to commercialize current line of products.
- The funds will be used to complete and test the prototypes as well as conduct further market analysis and to setup the business operations of the company.
- The company targets a strategic trade sale in 8 years.
Base Case D - MedSpenser Limited – Medicine Dispenser

Background & Opportunity

- MedSpenser is a UK based home healthcare technology company dedicated to enhancing peoples' lives by bringing health care home.
- Our mission is to provide people the opportunity to live better and healthier lives using technology.
- The elderly often have multiple disease states and consume an average of three to five prescription drugs and two Over The Counter (OTC) drugs per day.
- Nearly 67% of all elderly patients fail to follow important dosage instructions for their medications with the risk of hospitalization almost 6 times greater than that for the general population.
- We will manufacture and market an automated pill dispensing unit and a companion monitoring service to stop the medication compliance problem.

Products & Services

- The key product (MedCase) is at the prototype development stage.
- <Insert manipulated variable statement>

Market

- The target market is the 65-and-over age group which is estimated to grow at 6% per year over the next 5 years.
- <Insert manipulated variable statement>
- We face competition in the medication compliance market from reminder devices, automated medication dispensers and compliance services.

Management Team

- <Insert manipulated variable statement>
- The other two management team members have a combined experience of over 20 years in growth-oriented technology, finance, sales and marketing.

Financials & Funding Request

- MedSpenser needs capital investment to bring the product to market.
- The founder has committed to invest an additional £50k to complete the testing of the prototype.
- A first round of SEIS Seed funding of £250k for a 15% stake required to commercialise the product.
- The funds will be used to complete and test the prototypes, conduct market analysis and initial product marketing expenses.
- The company targets a strategic trade sale in 10 years.
Base Case E - BXID Tech Limited – I.D. Verification Technology

Background & Opportunity

- BXID is a UK based biometric security company providing solutions to remedy identity theft and credit fraud.
- Credit and identity fraud cost banks and government an average of over $50 billion every year.
- BXID provides a cost-effective technology that eliminates the problem with the use of our proprietary Exigency Process. This approach processes and expresses the details of someone's finger as a unique algorithm, rather than matching it against a stored image on a database. This eliminates the need to store images of millions of individual fingerprints on a database, reduce operating costs, and maximise system-wide efficiency.

Products & Services

- BXID Corporation will initially market, license and retail three distinct products supporting our Exigency technology.
- They are Xenasys (Licensed technology primarily for use in credit card and financial transactions), Xenavex (Biometrically enhanced identification systems, protected by combining Exigency technology with potent Smart Cards) and BioXen Devices (Small, portable biometric devices in the form of adapters and keyboards).
- <Insert manipulated variable statement>

Market

- The biometric identification market is projected to exceed £4 billion within two years and grow at 20% per annum for the next 5 years.
- <Insert manipulated variable statement>

Management Team

- <Insert manipulated variable statement>
- Our two other management team members have extensive experience in technology development, sales and marketing.

Financials & Funding Request

- BXID projects to reach sales of £1m by year two and grow that by 10% per annum over the next 5 years.
- Our founder has invested up to £100k in the company and we are seeking additional private investment.
- A first round of SEIS Seed funding of £200k for a 12% stake required.
- The funds will be used to complete our patent process, and typical expenses associated with opening and running our first office.
- The company targets a strategic trade sale in 10 years.
### Appendix 3.4 – Factor levels for base cases

#### Base Case B

<table>
<thead>
<tr>
<th>Critical factor</th>
<th>Low Uncertainty Value</th>
<th>High Uncertainty Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Protectability</strong></td>
<td>We have currently applied for a patent for our proprietary DSP technology.</td>
<td>We are currently looking into ways to protect our proprietary DSP technology either through a patent or a trade secret arrangement.</td>
</tr>
<tr>
<td><strong>Route to Market</strong></td>
<td>We have signed up over 20 blood glucose monitor makers and hospital point-of-care device manufacturers.</td>
<td>We have started contacting blood glucose monitor makers and hospital point-of-care device manufacturers.</td>
</tr>
<tr>
<td><strong>Relevant Entrepreneur Experience</strong></td>
<td>The team comprises two leading scientists pioneering the use of DSP to improve biosensor technology with an aggregate of over 20 years of direct DSP/biosensor research experience.</td>
<td>The team comprises two leading scientists with an aggregate of over 20 years of technology research experience in fields adjacent to DSP technology.</td>
</tr>
</tbody>
</table>

#### Base Case C

<table>
<thead>
<tr>
<th>Critical factor</th>
<th>Low Uncertainty Value</th>
<th>High Uncertainty Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Protectability</strong></td>
<td>We have applied for patent application and are awaiting a decision.</td>
<td>We believe that we can obtain a patent for our products and are currently exploring the possibility of applying for one.</td>
</tr>
<tr>
<td><strong>Route to Market</strong></td>
<td>Our main distribution channel will be through traditional toy stores and online retailers such as Amazon. We intend to also sell through our own online shop by year 3.</td>
<td>[No information provided]</td>
</tr>
<tr>
<td><strong>Relevant Entrepreneur Experience</strong></td>
<td>The management team is led by its two founders - one with an engineering background and previously worked for HP and Nintendo and the other with a Master of Education degree - and brings extensive experience in educational tool development to EduToy.</td>
<td>The management team is led by its two founders - one with an engineering background and the other an entrepreneur with experience in the technology service sector. Both founders do not have a direct experience in the educational sector.</td>
</tr>
</tbody>
</table>
### Base Case D

<table>
<thead>
<tr>
<th>Critical factor</th>
<th>Low Uncertainty Value</th>
<th>High Uncertainty Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Protectability</td>
<td>We have applied and obtained a patent for our proprietary design to be used in the manufacturing of our products.</td>
<td>Since we believe that our proprietary design to be used for the manufacturing of the products is unique, we are considering applying for a patent.</td>
</tr>
<tr>
<td>Route to Market</td>
<td>Our route to market is to sell directly to consumers via online retailers, such as Amazon. Once we have established a market, we are planning to expand to include wholesalers and retailers. We also intend to access the market through the NHS.</td>
<td>We are currently assessing our options to access the market. We can sell directly to consumers via online shops or through known established wholesalers and retailers. The market can also be accessed via the NHS.</td>
</tr>
<tr>
<td>Relevant Entrepreneur Experience</td>
<td>The founder has worked in the healthcare industry as a medical doctor for 15 years and believes he can transfer his experience into this home healthcare business.</td>
<td>Although the founder does not have a direct experience in the healthcare industry, he has 15 years of experience in the tech industry which we believe is key to the success of this business.</td>
</tr>
</tbody>
</table>

### Base Case E

<table>
<thead>
<tr>
<th>Critical factor</th>
<th>Low Uncertainty Value</th>
<th>High Uncertainty Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Protectability</td>
<td>Due to the nature of the proprietary technology developed, we have applied for a patent and are awaiting approval.</td>
<td>Due to the nature of the proprietary technology developed, we are considering applying for a patent to protect our technology from other potential competitors.</td>
</tr>
<tr>
<td>Route to Market</td>
<td>The marketing plan for BXID is designed to attract new customers and capture new markets. Our identified markets for the first three years will be the financial and banking industry. We aim to attract banking and financial licensing contracts by implementing complimentary testing, upgrades and POS systems.</td>
<td>We are currently assessing our options to access the market. Our target markets for the first three years could be the financial and banking industry.</td>
</tr>
<tr>
<td>Relevant Entrepreneur Experience</td>
<td>Our founder has industry-specific expertise in fraud control, transaction processing and POS payment systems, having worked with Visa for 10 years.</td>
<td>The founder is a proven entrepreneur with experience in other technology service sectors, having founded two tech companies in the past.</td>
</tr>
</tbody>
</table>
Appendix 3.5 – Case Versions and associated blocks

Block 1

Case A - RST Technologies Limited – Tracking Device Maker

Background & Opportunity

- RST Technologies (RST) is a UK based start-up company in the fast-growing field of Personal Tracking Devices.
- RST Technologies’ mission is to become the leading manufacturer of Personal Locator Devices worldwide.
- Industry analysts estimate the Personal Tracking Devices at over $22b last year.

Products & Services

- RST will develop and distribute miniaturized Personal Locator Devices.
- We have developed a proprietary technology that does not rely on cell towers to function. We have applied and obtained a patent for our proprietary technology.
- Initially, the manufacturing of our devices will be subcontracted, while we develop the supporting software and systems internally, although we plan to manufacture our products in-house in five years.

Market

- Our primary target markets include, but are not limited to, the family consumer, channel sales to original equipment manufacturers (OEMs), businesses tracking shipments or vehicles, the military, and the political arena.
- The combined number of potential customers for our products is well over 20million in the UK; we will focus on a more realistic and attainable 2-year sales goal of roughly 100k users and grow this by 15% per annum over the next 5 years.
- Because of our unique proprietary programming capabilities for each individual unit, we have already received indications of interest from several of these target markets.
- We are currently assessing our options to determine which target markets are best suited.

Management Team

- The two founders of RST Technologies have been associates for over 10 years which creates the perfect synergy to ensure the success of our company.
- The CEO is a Sales and Marketing Management veteran with more than 20 years of successfully penetrating previously unseen markets niches.
- The CTO is an Electronic Engineer with 20 years of experience and is considered an expert in his field, having previously designed devices for military applications, medical imaging systems, computers and more.

Financials & Funding Request

- By focusing on our strengths, our key customers, and our customers' needs, we expect to generate about £500k sales within two years and grow that by 15% a year subsequently.
A first round of SEIS Seed funding of £150k for a 12% stake required.
The funds will be used to further develop our range of products, legal costs,
payroll, marketing and typical expenses associated with opening our first
office.
The company targets a strategic trade sale in 7 years.

Case B_V1 - ABC Matrix Limited – Medical Software

Background & Opportunity

- ABC Matrix is a UK based start-up venture offering proprietary Digital Signal
Processing (DSP) technology.
- Problems in the hospital blood analyser market are more related to the lack
of the comprehensiveness and accuracy of the devices, which results in
reduced adoption levels.
- ABC Matrix ’s core DSP algorithms significantly improves the functionality and
performance of biosensor devices.

Products & Services

- Our suite of software modules enables new functionality and improves the
performance of biosensor devices.
- We have currently applied for a patent for our proprietary DSP technology.

Market

- Our value proposition for this market is: devices that are more accurate and
sensitive will stand a higher chance of being more readily adopted.
- ABC Matrix will operate as a technology licensing company, deriving royalty
revenue streams based on device makers' consumables sales.
- UK Blood Analyser market forecast to grow at 10% per year over the next 5
years.
- We have signed up over 20 blood glucose monitor makers and hospital point-
of-care device manufacturers.
- Future targets include the large immunoassay and implantable biosensor
sectors; as well as other vertical industries that heavily rely on biosensors.
- We have identified no direct competitors; however, we indirectly compete
against other biosensor-enhancing technologies including advances in
physical designs.

Management Team

- The team comprises two leading scientists pioneering the use of DSP to
improve biosensor technology with an aggregate of over 20 years of direct
DSP/biosensor research experience.
- An additional technical team of three committed to joining the company post-
seed financing, with an aggregate technical management and commercial
experience of over 20 years.

Financials & Funding Request

- Revenues will be acquired from the sale of the technology to home blood
glucose device makers and hospital point-of-care blood analyser makers.
- A first round of SEIS Seed funding of £100k for a 10% stake required to
commercialize current products.
The funds will be used for further development of the technology, business development and operations.
The company anticipates an investor liquidity event horizon at approximately seven years by one of the larger companies in this space.

Case C_V2 - EduToy Limited - Children's Educational Toys

Background & Opportunity

- EduToy Limited is a UK based start-up company that has developed a line of educational tools for children.
- It is our mission to make the highest quality and most affordable educational toys.
- Our products are educational tools that develop core skills within the youngster users while they have fun

Products & Services

- EduToy is initially offering three different educational toys: NumberToy, LetterToy and PhonicToy.
- Initial prototype sales have received very positive feedback from end users. (Average 4 Star rating).
- While prototypes will be designed and manufactured in house, production will be outsourced.
- We have applied for a patent application and are awaiting a decision.

Market

- Our value proposition for this market is the more children that learn basic functions from our toys, the better they become and the more successful we are.
- We have identified two target customer segments: individuals and wholesalers.
- The individual customer segment is estimated to grow at 14% per year and currently has over 3 million prospective customers.
- The wholesale customer segment is growing annually at 6% with over 6,000 potential customers.
- Our main distribution channel will be through traditional toy stores and online retailers such as Amazon. We intend to also sell through our own online shop by year 3.

Management Team

- The management team is led by its two founders - one with an engineering background and the other an entrepreneur with experience in the technology service sector. Both founders do not have a direct experience in the educational sector.
- An additional team of two committed to joining the company after the current round of financing, with an aggregate of over 20 years of commercial experience.
**Financials & Funding Request**

- The company has conservatively forecasted sales to reach £400k in year two and grow rapidly at 14% a year for the next 5 years.
- A first round of SEIS Seed funding of £120k for a 10% stake required to commercialize current line of products.
- The funds will be used to complete and test the prototypes as well as conduct further market analysis and to setup the business operations of the company.
- The company targets a strategic trade sale in 8 years.

**Case D_V3 - MedSpenser Limited – Medicine Dispenser**

**Background & Opportunity**

- MedSpenser is a UK based home healthcare technology company dedicated to enhancing peoples' lives by bringing health care home.
- Our mission is to provide people the opportunity to live better and healthier lives using technology.
- The elderly often have multiple disease states and consume an average of three to five prescription drugs and two Over The Counter (OTC) drugs per day.
- Nearly 67% of all elderly patients fail to follow important dosage instructions for their medications with the risk of hospitalization almost 6 times greater than that for the general population.
- We will manufacture and market an automated pill dispensing unit and a companion monitoring service to stop the medication compliance problem.

**Products & Services**

- The key product (MedCase) is at the prototype development stage.
- We have applied and obtained a patent for our proprietary design to be used in the manufacturing of our products.

**Market**

- The target market is the 65-and-over age group which is estimated to grow at 6% per year over the next 5 years.
- We are currently assessing our options to access the market. We can sell directly to consumers via online shops or through known established wholesalers and retailers. The market can also be accessed via the NHS.
- We face competition in the medication compliance market from reminder devices, automated medication dispensers and compliance services.

**Management Team**

- Although the founder does not have a direct experience in the healthcare industry, he has 15 years of experience in the tech industry which we believe is key to the success of this business.
- The other two management team members have a combined experience of over 20 years in growth-oriented technology, finance, sales and marketing.

**Financials & Funding Request**

- MedSpenser needs capital investment to bring the product to market.
The founder has committed to invest an additional £50k to complete the testing of the prototype.

A first round of SEIS Seed funding of £250k for a 15% stake required to commercialise the product.

The funds will be used to complete and test the prototypes, conduct market analysis and initial product marketing expenses.

The company targets a strategic trade sale in 10 years.

Case E_V4 - BXID Tech Limited – I.D. Verification Technology

Background & Opportunity

- BXID is a UK based biometric security company providing solutions to remedy identity theft and credit fraud.
- Credit and identity fraud cost banks and government an average of over $50 billion every year.
- BXID provides a cost-effective technology that eliminates the problem with the use of our proprietary Exigency Process. This approach processes and expresses the details of someone’s finger as a unique algorithm, rather than matching it against a stored image on a database. This eliminates the need to store images of millions of individual fingerprints on a database, reduce operating costs, and maximise system-wide efficiency.

Products & Services

- BXID Corporation will initially market, license and retail three distinct products supporting our Exigency technology.
- They are Xenasys (Licensed technology primarily for use in credit card and financial transactions), Xenavex (Biometrically enhanced identification systems, protected by combining Exigency technology with potent Smart Cards) and BioXen Devices (Small, portable biometric devices in the form of adapters and keyboards).
- Due to the nature of the proprietary technology developed, we are considering applying for a patent to protect our technology from other potential competitors.

Market

- The biometric identification market is projected to exceed £4 billion within two years and grow at 20% per annum for the next 5 years.
- We are currently assessing our options to access the market. Our target markets for the first three years could be the financial and banking industry.

Management Team

- The founder is a proven entrepreneur with experience in other technology service sectors, having founded two tech companies in the past.
- Our two other management team members have extensive experience in technology development, sales and marketing.

Financials & Funding Request
- BXID projects to reach sales of £1m by year two and grow that by 10% per annum over the next 5 years.
- Our founder has invested up to £100k in the company and we are seeking additional private investment.
- A first round of SEIS Seed funding of £200k for a 12% stake required.
- The funds will be used to complete our patent process, and typical expenses associated with opening and running our first office.
- The company targets a strategic trade sale in 10 years.
Case A - RST Technologies Limited – Tracking Device Maker

Background & Opportunity

- RST Technologies (RST) is a UK based start-up company in the fast-growing field of Personal Tracking Devices.
- RST Technologies' mission is to become the leading manufacturer of Personal Locator Devices worldwide.
- Industry analysts estimate the Personal Tracking Devices at over $22b last year.

Products & Services

- RST will develop and distribute miniaturized Personal Locator Devices.
- We have developed a proprietary technology that does not rely on cell towers to function. We have applied and obtained a patent for our proprietary technology.
- Initially, the manufacturing of our devices will be subcontracted, while we develop the supporting software and systems internally, although we plan to manufacture our products in-house in five years.

Market

- Our primary target markets include, but are not limited to, the family consumer, channel sales to original equipment manufacturers (OEMs), businesses tracking shipments or vehicles, the military, and the political arena.
- The combined number of potential customers for our products is well over 20million in the UK; we will focus on a more realistic and attainable 2-year sales goal of roughly 100k users and grow this by 15% per annum over the next 5 years.
- Because of our unique proprietary programming capabilities for each individual unit, we have already received indications of interest from several of these target markets.
- We are currently assessing our options to determine which target markets are best suited.

Management Team

- The two founders of RST Technologies have been associates for over 10 years which creates the perfect synergy to ensure the success of our company.
- The CEO is a Sales and Marketing Management veteran with more than 20 years of successfully penetrating previously unseen markets niches.
- The CTO is an Electronic Engineer with 20 years of experience and is considered an expert in his field, having previously designed devices for military applications, medical imaging systems, computers and more.

Financials & Funding Request

- By focusing on our strengths, our key customers, and our customers' needs, we expect to generate about £500k sales within two years and grow that by 15% a year subsequently.
A first round of SEIS Seed funding of £150k for a 12% stake required.
The funds will be used to further develop our range of products, legal costs, payroll, marketing and typical expenses associated with opening our first office.
The company targets a strategic trade sale in 7 years.

Case C_V3 - EduToy Limited - Children's Educational Toys

Background & Opportunity

EduToy Limited is a UK based start-up company that has developed a line of educational tools for children.
It is our mission to make the highest quality and most affordable educational toys.
Our products are educational tools that develop core skills within the youngster users while they have fun

Products & Services

EduToy is initially offering three different educational toys: NumberToy, LetterToy and PhonicToy.
Initial prototype sales have received very positive feedback from end users.
(Average 4 Star rating).
While prototypes will be designed and manufactured in house, production will be outsourced.
We have applied for a patent application and are awaiting a decision.

Market

Our value proposition for this market is the more children that learn basic functions from our toys, the better they become and the more successful we are.
We have identified two target customer segments: individuals and wholesalers.
The individual customer segment is estimated to grow at 14% per year and currently has over 3 million prospective customers.
The wholesale customer segment is growing annually at 6% with over 6,000 potential customers.

Management Team

The management team is led by its two founders - one with an engineering background and the other an entrepreneur with experience in the technology service sector. Both founders do not have a direct experience in the educational sector.
An additional team of two committed to joining the company after the current round of financing, with an aggregate of over 20 years of commercial experience.

Financials & Funding Request
The company has conservatively forecasted sales to reach £400k in year two and grow rapidly at 14% a year for the next 5 years. A first round of SEIS Seed funding of £120k for a 10% stake required to commercialize current line of products. The funds will be used to complete and test the prototypes as well as conduct further market analysis and to setup the business operations of the company. The company targets a strategic trade sale in 8 years.

Case D_V4 - MedSpenser Limited – Medicine Dispenser

Background & Opportunity
- MedSpenser is a UK based home healthcare technology company dedicated to enhancing peoples’ lives by bringing health care home.
- Our mission is to provide people the opportunity to live better and healthier lives using technology.
- The elderly often have multiple disease states and consume an average of three to five prescription drugs and two Over The Counter (OTC) drugs per day.
- Nearly 67% of all elderly patients fail to follow important dosage instructions for their medications with the risk of hospitalization almost 6 times greater than that for the general population.
- We will manufacture and market an automated pill dispensing unit and a companion monitoring service to stop the medication compliance problem.

Products & Services
- The key product (MedCase) is at the prototype development stage.
- Since we believe that our proprietary design to be used for the manufacturing of the products is unique we are considering applying for a patent.

Market
- The target market is the 65-and-over age group which is estimated to grow at 6% per year over the next 5 years.
- We are currently assessing our options to access the market. We can sell directly to consumers via online shops or through known established wholesalers and retailers. The market can also be accessed via the NHS.
- We face competition in the medication compliance market from reminder devices, automated medication dispensers and compliance services.

Management Team
- Although the founder does not have a direct experience in the healthcare industry, he has 15 years of experience in the tech industry which we believe is key to the success of this business.
- The other two management team members have a combined experience of over 20 years in growth-oriented technology, finance, sales and marketing.

Financials & Funding Request
• MedSpenser needs capital investment to bring the product to market.
• The founder has committed to invest an additional £50k to complete the testing of the prototype.
• A first round of SEIS Seed funding of £250k for a 15% stake required to commercialise the product.
• The funds will be used to complete and test the prototypes, conduct market analysis and initial product marketing expenses.
• The company targets a strategic trade sale in 10 years.

Case E_V1 - BXID Tech Limited – I.D. Verification Technology

Background & Opportunity
• BXID is a UK based biometric security company providing solutions to remedy identity theft and credit fraud.
• Credit and identity fraud cost banks and government an average of over $50 billion every year.
• BXID provides a cost-effective technology that eliminates the problem with the use of our proprietary Exigency Process. This approach processes and expresses the details of someone’s finger as a unique algorithm, rather than matching it against a stored image on a database. This eliminates the need to store images of millions of individual fingerprints on a database, reduce operating costs, and maximise system-wide efficiency.

Products & Services
• BXID Corporation will initially market, license and retail three distinct products supporting our Exigency technology.
• They are Xenasys (Licensed technology primarily for use in credit card and financial transactions), Xenavex (Biometrically enhanced identification systems, protected by combining Exigency technology with potent Smart Cards) and BioXen Devices (Small, portable biometric devices in the form of adapters and keyboards).
• Due to the nature of the proprietary technology developed, we have applied for a patent and are awaiting approval.

Market
• The biometric identification market is projected to exceed £4 billion within two years and grow at 20% per annum for the next 5 years.
• The marketing plan for BXID is designed to attract new customers and capture new markets. Our identified markets for the first three years will be the financial and banking industry. We aim to attract banking and financial licensing contracts by implementing complimentary testing, upgrades and POS systems.

Management Team
• Our founder has industry-specific expertise in fraud control, transaction processing and POS payment systems, having worked with Visa for 10 years.
Our two other management team members have extensive experience in technology development, sales and marketing.

**Financials & Funding Request**

- BXID projects to reach sales of £1m by year two and grow that by 10% per annum over the next 5 years.
- Our founder has invested up to £100k in the company and we are seeking additional private investment.
- A first round of SEIS Seed funding of £200k for a 12% stake required.
- The funds will be used to complete our patent process, and typical expenses associated with opening and running our first office.
- The company targets a strategic trade sale in 10 years.

**Case B_V2 - ABC Matrix Limited – Medical Software**

**Background & Opportunity**

- ABC Matrix is a UK based start-up venture offering proprietary Digital Signal Processing (DSP) technology.
- Problems in the hospital blood analyser market are more related to the lack of the comprehensiveness and accuracy of the devices, which results in reduced adoption levels.
- ABC Matrix’s core DSP algorithms significantly improves the functionality and performance of biosensor devices.

**Products & Services**

- Our suite of software modules enables new functionality and improves the performance of biosensor devices.
- We have currently applied for a patent for our proprietary DSP technology.

**Market**

- Our value proposition for this market is: devices that are more accurate and sensitive will stand a higher chance of being more readily adopted.
- ABC Matrix will operate as a technology licensing company, deriving royalty revenue streams based on device makers’ consumables sales.
- UK Blood Analyser market forecast to grow at 10% per year over the next 5 years.
- We have signed up over 20 blood glucose monitor makers and hospital point-of-care device manufacturers.
- Future targets include the large immunoassay and implantable biosensor sectors; as well as other vertical industries that heavily rely on biosensors.
- We have identified no direct competitors; however, we indirectly compete against other biosensor-enhancing technologies including advances in physical designs.

**Management Team**

- The team comprises two leading scientists with an aggregate of over 20 years of technology research experience in fields adjacent to DSP technology.
An additional technical team of three committed to joining the company post-seed financing, with an aggregate technical management and commercial experience of over 20 years.

**Financials & Funding Request**

- Revenues will be acquired from the sale of the technology to home blood glucose device makers and hospital point-of-care blood analyser makers.
- A first round of SEIS Seed funding of £100k for a 10% stake required to commercialize current products.
- The funds will be used for further development of the technology, business development and operations.
- The company anticipates an investor liquidity event horizon at approximately seven years by one of the larger companies in this space.
Case A - RST Technologies Limited – Tracking Device Maker

Background & Opportunity

- RST Technologies (RST) is a UK based start-up company in the fast-growing field of Personal Tracking Devices.
- RST Technologies’ mission is to become the leading manufacturer of Personal Locator Devices worldwide.
- Industry analysts estimate the Personal Tracking Devices at over $22b last year.

Products & Services

- RST will develop and distribute miniaturized Personal Locator Devices.
- We have developed a proprietary technology that does not rely on cell towers to function. We have applied and obtained a patent for our proprietary technology.
- Initially, the manufacturing of our devices will be subcontracted, while we develop the supporting software and systems internally, although we plan to manufacture our products in-house in five years.

Market

- Our primary target markets include, but are not limited to, the family consumer, channel sales to original equipment manufacturers (OEMs), businesses tracking shipments or vehicles, the military, and the political arena.
- The combined number of potential customers for our products is well over 20million in the UK; we will focus on a more realistic and attainable 2-year sales goal of roughly 100k users and grow this by 15% per annum over the next 5 years.
- Because of our unique proprietary programming capabilities for each individual unit, we have already received indications of interest from several of these target markets.
- We are currently assessing our options to determine which target markets are best suited.

Management Team

- The two founders of RST Technologies have been associates for over 10 years which creates the perfect synergy to ensure the success of our company.
- The CEO is a Sales and Marketing Management veteran with more than 20 years of successfully penetrating previously unseen markets niches.
- The CTO is an Electronic Engineer with 20 years of experience and is considered an expert in his field, having previously designed devices for military applications, medical imaging systems, computers and more.

Financials & Funding Request

- By focusing on our strengths, our key customers, and our customers’ needs, we expect to generate about £500k sales within two years and grow that by 15% a year subsequently.
- A first round of SEIS Seed funding of £150k for a 12% stake required.
The funds will be used to further develop our range of products, legal costs, payroll, marketing and typical expenses associated with opening our first office. The company targets a strategic trade sale in 7 years.

Case D_V1 - MedSpenser Limited – Medicine Dispenser

Background & Opportunity
- MedSpenser is a UK based home healthcare technology company dedicated to enhancing peoples' lives by bringing health care home.
- Our mission is to provide people the opportunity to live better and healthier lives using technology.
- The elderly often have multiple disease states and consume an average of three to five prescription drugs and two Over The Counter (OTC) drugs per day.
- Nearly 67% of all elderly patients fail to follow important dosage instructions for their medications with the risk of hospitalization almost 6 times greater than that for the general population.
- We will manufacture and market an automated pill dispensing unit and a companion monitoring service to stop the medication compliance problem.

Products & Services
- The key product (MedCase) is at the prototype development stage.
- We have applied and obtained a patent for our proprietary design to be used in the manufacturing of our products.

Market
- The target market is the 65-and-over age group which is estimated to grow at 6% per year over the next 5 years.
- Our route to market is to sell directly to consumers via online retailers, such as amazon. Once we have established a market, we are planning to expand to include wholesalers and retailers. We also intend to access the market through the NHS.
- We face competition in the medication compliance market from reminder devices, automated medication dispensers and compliance services.

Management Team
- The founder has worked in the healthcare industry as a medical doctor for 15 years and believes he can transfer his experience into this home healthcare business.
- The other two management team members have a combined experience of over 20 years in growth-oriented technology, finance, sales and marketing.

Financials & Funding Request
- MedSpenser needs capital investment to bring the product to market.
• The founder has committed to invest an additional £50k to complete the testing of the prototype.
• A first round of SEIS Seed funding of £250k for a 15% stake required to commercialise the product.
• The funds will be used to complete and test the prototypes, conduct market analysis and initial product marketing expenses.
• The company targets a strategic trade sale in 10 years.

Case E_V2 - BXID Tech Limited – I.D. Verification Technology

Background & Opportunity
• BXID is a UK based biometric security company providing solutions to remedy identity theft and credit fraud.
• Credit and identity fraud cost banks and government an average of over $50 billion every year.
• BXID provides a cost-effective technology that eliminates the problem with the use of our proprietary Exigency Process. This approach processes and expresses the details of someone’s finger as a unique algorithm, rather than matching it against a stored image on a database. This eliminates the need to store images of millions of individual fingerprints on a database, reduce operating costs, and maximise system-wide efficiency.

Products & Services
• BXID Corporation will initially market, license and retail three distinct products supporting our Exigency technology.
• They are Xenasys (Licensed technology primarily for use in credit card and financial transactions), Xenavex (Biometrically enhanced identification systems, protected by combining Exigency technology with potent Smart Cards) and BioXen Devices (Small, portable biometric devices in the form of adapters and keyboards).
• Due to the nature of the proprietary technology developed, we have applied for a patent and are awaiting approval.

Market
• The biometric identification market is projected to exceed £4 billion within two years and grow at 20% per annum for the next 5 years.
• The marketing plan for BXID is designed to attract new customers and capture new markets. Our identified markets for the first three years will be the financial and banking industry. We aim to attract banking and financial licensing contracts by implementing complimentary testing, upgrades and POS systems.

Management Team
• The founder is a proven entrepreneur with experience in other technology service sectors, having founded two tech companies in the past.
• Our two other management team members have extensive experience in technology development, sales and marketing.
Financials & Funding Request

- BXID projects to reach sales of £1m by year two and grow that by 10% per annum over the next 5 years.
- Our founder has invested up to £100k in the company and we are seeking additional private investment.
- A first round of SEIS Seed funding of £200k for a 12% stake required.
- The funds will be used to complete our patent process, and typical expenses associated with opening and running our first office.
- The company targets a strategic trade sale in 10 years.

Case B_V3 - ABC Matrix Limited – Medical Software

Background & Opportunity

- ABC Matrix is a UK based start-up venture offering proprietary Digital Signal Processing (DSP) technology.
- Problems in the hospital blood analyser market are more related to the lack of the comprehensiveness and accuracy of the devices, which results in reduced adoption levels.
- ABC Matrix’s core DSP algorithms significantly improves the functionality and performance of biosensor devices.

Products & Services

- Our suite of software modules enables new functionality and improves the performance of biosensor devices.
- We have currently applied for a patent for our proprietary DSP technology.

Market

- Our value proposition for this market is: devices that are more accurate and sensitive will stand a higher chance of being more readily adopted.
- ABC Matrix will operate as a technology licensing company, deriving royalty revenue streams based on device makers’ consumables sales.
- UK Blood Analyser market forecast to grow at 10% per year over the next 5 years.
- We have started contacting blood glucose monitor makers and hospital point-of-care device manufacturers.
- Future targets include the large immunoassay and implantable biosensor sectors; as well as other vertical industries that heavily rely on biosensors.
- We have identified no direct competitors; however, we indirectly compete against other biosensor-enhancing technologies including advances in physical designs.

Management Team

- The team comprises two leading scientists with an aggregate of over 20 years of technology research experience in fields adjacent to DSP technology.
- An additional technical team of three committed to joining the company post-seed financing, with an aggregate technical management and commercial experience of over 20 years.

Financials & Funding Request
- Revenues will be acquired from the sale of the technology to home blood glucose device makers and hospital point-of-care blood analyser makers.
- A first round of SEIS Seed funding of £100k for a 10% stake required to commercialize current products.
- The funds will be used for further development of the technology, business development and operations.
- The company anticipates an investor liquidity event horizon at approximately seven years by one of the larger companies in this space.

**Case C_V4 - EduToy Limited - Children's Educational Toys**

**Background & Opportunity**
- EduToy Limited is a UK based start-up company that has developed a line of educational tools for children.
- It is our mission to make the highest quality and most affordable educational toys.
- Our products are educational tools that develop core skills within the youngster users while they have fun

**Products & Services**
- EduToy is initially offering three different educational toys: NumberToy, LetterToy and PhonicToy.
- Initial prototype sales have received very positive feedback from end users. (Average 4 Star rating).
- While prototypes will be designed and manufactured in house, production will be outsourced.
- We have applied for patent application and are awaiting a decision.

**Market**
- Our value proposition for this market is the more children that learn basic functions from our toys, the better they become and the more successful we are.
- We have identified two target customer segments: individuals and wholesalers.
- The individual customer segment is estimated to grow at 14% per year and currently has over 3 million prospective customers.
- The wholesale customer segment is growing annually at 6% with over 6,000 potential customers.

**Management Team**
- The management team is led by its two founders - one with an engineering background and previously worked for HP and Nintendo and the other with a Master of Education degree - and brings extensive experience in educational tool development to EduToy.
- An additional team of two committed to joining the company after the current round of financing, with an aggregate of over 20 years of commercial experience.
Financials & Funding Request

- The company has conservatively forecasted sales to reach £400k in year two and grow rapidly at 14% a year for the next 5 years.
- A first round of SEIS Seed funding of £120k for a 10% stake required to commercialize current line of products.
- The funds will be used to complete and test the prototypes as well as conduct further market analysis and to setup the business operations of the company.
- The company targets a strategic trade sale in 8 years.
Case A - RST Technologies Limited – Tracking Device Maker

Background & Opportunity

- RST Technologies (RST) is a UK based start-up company in the fast-growing field of Personal Tracking Devices.
- RST Technologies’ mission is to become the leading manufacturer of Personal Locator Devices worldwide.
- Industry analysts estimate the Personal Tracking Devices at over $22b last year.

Products & Services

- RST will develop and distribute miniaturized Personal Locator Devices.
- We have developed a proprietary technology that does not rely on cell towers to function. We have applied and obtained a patent for our proprietary technology.
- Initially, the manufacturing of our devices will be subcontracted, while we develop the supporting software and systems internally, although we plan to manufacture our products in-house in five years.

Market

- Our primary target markets include, but are not limited to, the family consumer, channel sales to original equipment manufacturers (OEMs), businesses tracking shipments or vehicles, the military, and the political arena.
- The combined number of potential customers for our products is well over 20million in the UK; we will focus on a more realistic and attainable 2-year sales goal of roughly 100k users and grow this by 15% per annum over the next 5 years.
- Because of our unique proprietary programming capabilities for each individual unit, we have already received indications of interest from several of these target markets.
- We are currently assessing our options to determine which target markets are best suited.

Management Team

- The two founders of RST Technologies have been associates for over 10 years which creates the perfect synergy to ensure the success of our company.
- The CEO is a Sales and Marketing Management veteran with more than 20 years of successfully penetrating previously unseen markets niches.
- The CTO is an Electronic Engineer with 20 years of experience and is considered an expert in his field, having previously designed devices for military applications, medical imaging systems, computers and more.

Financials & Funding Request

- By focusing on our strengths, our key customers, and our customers' needs, we expect to generate about £500k sales within two years and grow that by 15% a year subsequently.
- A first round of SEIS Seed funding of £150k for a 12% stake required.
The funds will be used to further develop our range of products, legal costs, payroll, marketing and typical expenses associated with opening our first office.

The company targets a strategic trade sale in 7 years.

Case E_V3 - BXID Tech Limited – I.D. Verification Technology

Background & Opportunity

- BXID is a UK based biometric security company providing solutions to remedy identity theft and credit fraud.
- Credit and identity fraud cost banks and government an average of over $50 billion every year.
- BXID provides a cost-effective technology that eliminates the problem with the use of our proprietary Exigency Process. This approach processes and expresses the details of someone’s finger as a unique algorithm, rather than matching it against a stored image on a database. This eliminates the need to store images of millions of individual fingerprints on a database, reduce operating costs, and maximise system-wide efficiency.

Products & Services

- BXID Corporation will initially market, license and retail three distinct products supporting our Exigency technology.
- They are Xenasys (Licensed technology primarily for use in credit card and financial transactions), Xenavex (Biometrically enhanced identification systems, protected by combining Exigency technology with potent Smart Cards) and BioXen Devices (Small, portable biometric devices in the form of adapters and keyboards).
- Due to the nature of the proprietary technology developed, we have applied for a patent and are awaiting approval.

Market

- The biometric identification market is projected to exceed £4 billion within two years and grow at 20% per annum for the next 5 years.
- We are currently assessing our options to access the market. Our target markets for the first three years could be the financial and banking industry.

Management Team

- The founder is a proven entrepreneur with experience in other technology service sectors, having founded two tech companies in the past.
- Our two other management team members have extensive experience in technology development, sales and marketing.

Financials & Funding Request

- BXID projects to reach sales of £1m by year two and grow that by 10% per annum over the next 5 years.
- Our founder has invested up to £100k in the company and we are seeking additional private investment.
- A first round of SEIS Seed funding of £200k for a 12% stake required.
- The funds will be used to complete our patent process, and typical expenses associated with opening and running our first office.
The company targets a strategic trade sale in 10 years.

Case B_V4 - ABC Matrix Limited – Medical Software

Background & Opportunity

- ABC Matrix is a UK based start-up venture offering proprietary Digital Signal Processing (DSP) technology.
- Problems in the hospital blood analyser market are more related to the lack of the comprehensiveness and accuracy of the devices, which results in reduced adoption levels.
- ABC Matrix’s core DSP algorithms significantly improves the functionality and performance of biosensor devices.

Products & Services

- Our suite of software modules enables new functionality and improves the performance of biosensor devices.
- We are currently looking into ways to protect our proprietary DSP technology either through a patent or a trade secret arrangement.

Market

- Our value proposition for this market is: devices that are more accurate and sensitive will stand a higher chance of being more readily adopted.
- ABC Matrix will operate as a technology licensing company, deriving royalty revenue streams based on device makers’ consumables sales.
- UK Blood Analyser market forecast to grow at 10% per year over the next 5 years.
- We have started contacting blood glucose monitor makers and hospital point-of-care device manufacturers.
- Future targets include the large immunoassay and implantable biosensor sectors; as well as other vertical industries that heavily rely on biosensors.
- We have identified no direct competitors; however, we indirectly compete against other biosensor-enhancing technologies including advances in physical designs.

Management Team

- The team comprises two leading scientists with an aggregate of over 20 years of technology research experience in fields adjacent to DSP technology.
- An additional technical team of three committed to joining the company post-seed financing, with an aggregate technical management and commercial experience of over 20 years.

Financials & Funding Request

- Revenues will be acquired from the sale of the technology to home blood glucose device makers and hospital point-of-care blood analyser makers.
- A first round of SEIS Seed funding of £100k for a 10% stake required to commercialize current products.
- The funds will be used for further development of the technology, business development and operations.
- The company anticipates an investor liquidity event horizon at approximately seven years by one of the larger companies in this space.
Case C_V1 - EduToy Limited - Children's Educational Toys

Background & Opportunity

- EduToy Limited is a UK based start-up company that has developed a line of educational tools for children.
- It is our mission to make the highest quality and most affordable educational toys.
- Our products are educational tools that develop core skills within the youngster users while they have fun

Products & Services

- EduToy is initially offering three different educational toys: NumberToy, LetterToy and PhonicToy.
- Initial prototype sales have received very positive feedback from end users. (Average 4 Star rating).
- While prototypes will be designed and manufactured in house, production will be outsourced.
- We have applied for patent application and are awaiting a decision.

Market

- Our value proposition for this market is the more children that learn basic functions from our toys, the better they become and the more successful we are.
- We have identified two target customer segments: individuals and wholesalers.
- The individual customer segment is estimated to grow at 14% per year and currently has over 3 million prospective customers.
- The wholesale customer segment is growing annually at 6% with over 6,000 potential customers.
- Our main distribution channel will be through traditional toy stores and online retailers such as Amazon. We intend to also sell through our own online shop by year 3.

Management Team

- The management team is led by its two founders - one with an engineering background and previously worked for HP and Nintendo and the other with a Master of Education degree - and brings extensive experience in educational tool development to EduToy.
- An additional team of two committed to joining the company after the current round of financing, with an aggregate of over 20 years of commercial experience.

Financials & Funding Request

- The company has conservatively forecasted sales to reach £400k in year two and grow rapidly at 14% a year for the next 5 years.
- A first round of SEIS Seed funding of £120k for a 10% stake required to commercialize current line of products.
- The funds will be used to complete and test the prototypes as well as conduct further market analysis and to setup the business operations of the company.
The company targets a strategic trade sale in 8 years.

**Case D_V2 - MedSpenser Limited – Medicine Dispenser**

**Background & Opportunity**

- MedSpenser is a UK based home healthcare technology company dedicated to enhancing peoples’ lives by bringing health care home.
- Our mission is to provide people the opportunity to live better and healthier lives using technology.
- The elderly often have multiple disease states and consume an average of three to five prescription drugs and two Over The Counter (OTC) drugs per day.
- Nearly 67% of all elderly patients fail to follow important dosage instructions for their medications with the risk of hospitalization almost 6 times greater than that for the general population.
- We will manufacture and market an automated pill dispensing unit and a companion monitoring service to stop the medication compliance problem.

**Products & Services**

- The key product (MedCase) is at the prototype development stage.
- We have applied and obtained a patent for our proprietary design to be used in the manufacturing of our products.

**Market**

- The target market is the 65-and-over age group which is estimated to grow at 6% per year over the next 5 years.
- Our route to market is to sell directly to consumers via online retailers, such as amazon. Once we have established a market, we are planning to expand to include wholesalers and retailers. We also intend to access the market through the NHS.
- We face competition in the medication compliance market from reminder devices, automated medication dispensers and compliance services.

**Management Team**

- Although the founder does not have a direct experience in the healthcare industry, he has 15 years of experience in the tech industry which we believe is key to the success of this business.
- The other two management team members have a combined experience of over 20 years in growth-oriented technology, finance, sales and marketing.

**Financials & Funding Request**

- MedSpenser needs capital investment to bring the product to market.
- The founder has committed to invest an additional £50k to complete the testing of the prototype.
- A first round of SEIS Seed funding of £250k for a 15% stake required to commercialise the product.
- The funds will be used to complete and test the prototypes, conduct market analysis and initial product marketing expenses.
- The company targets a strategic trade sale in 10 years.
### Appendix 3.6 – MSTAT-II Tolerance of Ambiguity Scale

13-item MSTAT-II scale for measuring Tolerance of Ambiguity

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Item Description</th>
<th>Stimulus Type</th>
<th>Score Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I don’t tolerate ambiguous situations well.</td>
<td>G1</td>
<td>Reverse Score</td>
</tr>
<tr>
<td>2</td>
<td>I would rather avoid solving a problem that must be viewed from several different perspectives.</td>
<td>I1</td>
<td>Reverse Score</td>
</tr>
<tr>
<td>3</td>
<td>I try to avoid situations that are ambiguous</td>
<td>G2</td>
<td>Reverse Score</td>
</tr>
<tr>
<td>4</td>
<td>I prefer familiar situations to new ones</td>
<td>N1</td>
<td>Reverse Score</td>
</tr>
<tr>
<td>5</td>
<td>Problems that cannot be considered from just one point of view are a little threatening.</td>
<td>I2</td>
<td>Reverse Score</td>
</tr>
<tr>
<td>6</td>
<td>I avoid situations that are too complicated for me to easily understand</td>
<td>C1</td>
<td>Reverse Score</td>
</tr>
<tr>
<td>7</td>
<td>I am tolerant of ambiguous situations.</td>
<td>G3</td>
<td>Normal Score</td>
</tr>
<tr>
<td>8</td>
<td>I enjoy tackling problems that are complex enough to be ambiguous.</td>
<td>C2</td>
<td>Normal Score</td>
</tr>
<tr>
<td>9</td>
<td>I try to avoid problems that don’t seem to have only one “best” solution</td>
<td>I3</td>
<td>Reverse Score</td>
</tr>
<tr>
<td>10</td>
<td>I generally prefer novelty over familiarity.</td>
<td>N2</td>
<td>Normal Score</td>
</tr>
<tr>
<td>11</td>
<td>I dislike ambiguous situations</td>
<td>G4</td>
<td>Reverse Score</td>
</tr>
<tr>
<td>12</td>
<td>I find it hard to make a choice when the outcome is uncertain</td>
<td>U1</td>
<td>Reverse Score</td>
</tr>
<tr>
<td>13</td>
<td>I prefer a situation in which there is some ambiguity</td>
<td>G5</td>
<td>Normal Score</td>
</tr>
</tbody>
</table>

Source: McLain (2009)
Appendix 3.7 – Post-experiment questionnaire

Investor Characteristics Section

Gender

1) Male
2) Female
3) Other (Please specify)
4) Prefer not to say

Age

1) Under 30
2) 31 – 40
3) 41 – 50
4) 51 – 60
5) 61 – 70
6) Above 70
7) Prefer not to say

Please indicate the highest level of education you have achieved: (UK Version)

1) GCSE
2) A level or equivalent
3) HND/HNC/HE Certificate/Diploma
4) Postgraduate certificate/diploma
5) Undergraduate degree
6) Master's Degree
7) Doctoral Degree
8) Others (Please specify)
9) Prefer not to say

Please indicate the highest level of education you have achieved: (US Version)

1) High School Diploma or equivalent
2) HND/HNC/HE Certificate/Diploma
3) Postgraduate certificate/diploma
4) Undergraduate degree
5) Master's Degree
6) Doctoral Degree
7) Others (Please specify)
8) Prefer not to say

Have you founded a business before?

1) Yes
2) No
Investment Activities Section

Which stage of ventures do you/your company invest in?

1) Idea-stage (does not yet have a working prototype or customers)
2) Prototype-stage (has a working prototype but not yet earned revenue)
3) Post-revenue stage (has customers and functioning revenue models but not yet cash-flow positive)
4) Growth-stage (is operating at scale and was typically cash flow positive)
5) Mature stage
6) Other (Please specify)

What are your main motivations for becoming an early-stage investor?

1) Potential financial returns
2) To give back to society
3) To support entrepreneurs
4) As a hobby
5) Other (Please specify)

Roughly how long have you been an investor in the above capacity?

1) Less than 1 year
2) 1 – 3 years
3) 4 – 6 years
4) 7 – 9 years
5) 10-14 years
6) 15 years or more

In what industries do you / your company invest? (Multiple answers are possible)

1) Agritech
2) Civtech / Public Sector Innovation
3) Cleantech/Energy and the Environment
4) Construction
5) Creative Industries and Design
6) Cyber Security
7) Digital (including generalist AI & generalist blockchain)
8) Education
9) Engineering and Manufacturing
10) Extractive industries (mining, oil & gas, fishing, forestry)
11) Fintech (including insurance tech)
12) Food
13) Health and Wellbeing
14) Internet of Things (IoT)
15) Leisure
16) Life Sciences
17) Marketing technology
18) Retail and e-commerce
19) Smart Cities
20) Space and Satellite Technology
21) Telecommunication
22) Transport
23) Others - please specify

What is your typical investment size? UK-Version

1) Below £25k
2) £25k - £50k
3) £50 - £100
4) £100k - £250k
5) £250k - £500k
6) Above £500k

What is your typical investment size? US-Version

1) Below $10k
2) $20k - $50k
3) $50 - $100
4) $100k - $200k
5) $200k - $500k
6) Above $500k

How many businesses/ventures have you invested in?

1) None
2) 1 – 5
3) 6 – 10
4) 11 – 20
5) 21 – 50
6) More than 50

Are you part of an angel investment network?

1) Yes
2) No

Do you typically invest as part of a syndicate?

1) Yes
2) No

How active are you in your portfolio firms with respect to mentoring and coaching?
1) Extremely active
2) Very active
3) Moderately active
4) Slightly active
5) Not active at all

What proportion of business opportunities you review do you typically reject at the screening stage of your investment decisions? Slider (0 to 100 %)

To what extent do you use your gut feeling when you make early-stage investment decisions?

1) Strongly agree
2) Agree
3) Somewhat agree
4) Neither agree nor disagree
5) Somewhat disagree
6) Disagree
7) Strongly disagree

What is/are the source(s) of the money you use for early-stage investment? (tick all applicable choices)

1) Wealth accumulated over my career
2) Inheritance or bequest
3) Returns from previous entrepreneurial ventures
4) Other people's funds invested on their behalf
5) Other (Please specify)
6) Prefer not to say

Do you treat your angel investments independent of your other investment portfolio allocations or do you consider them as part of your larger investment portfolio?

1) Independent of investment portfolio
2) Part of investment portfolio
3) Others (please specify)

This is the end of the survey. Clicking on the next arrow button will submit your responses and you will no longer be able to change them. If you wish to review or edit any of your answers, you may use the back button.

If you are happy to be contacted by us regarding the results of the study, please give your email address below. Please note that the information from this question will be stored separately and not linked to the main survey data, so providing your email address does not compromise your anonymity.

Finally, do you have anything else to share regarding this survey?

End of Survey Message

We thank you for your time spent taking this survey. Your response has been recorded.
Appendix 3.8 – Survey consent form

Before you start, kindly provide your consent to participate in this study. Taking part in the study involves taking part in an online survey experiment as explained in the participant information sheet. Data from this study may be used in an anonymised and aggregate form maybe used in anonymized form for presentation at conferences, publications, and other research outputs. No information that can identify you will be shared beyond the research team and stored on secure servers.

1) I have read and understood the information above and on the participant information sheet. I understand I can ask questions about the study via email and any concerns I may have, have been answered to my satisfaction. □ Yes / □ No

2) I give permission for the data that I provide to be deposited in a specialist data center after it has been anonymized, so it can be used for future research and learning. □ Yes / □ No

3) I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time up until data have been fully anonymized, without having to give a reason. □ Yes / □ No
### Appendix 3.9 – Variables definitions and data types

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Definition</th>
<th>Type</th>
<th>Levels/Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>BaseCase</td>
<td>Base Case</td>
<td>This represents a specific business opportunity unique and different from other cases.</td>
<td>Categorical</td>
<td>CaseA, CaseB, CaseC, CaseD and CaseE</td>
</tr>
<tr>
<td>UncLevel</td>
<td>Perception of Uncertainty Level</td>
<td>The investor's perception of uncertainty in a manipulated business case presented in the survey experiment.</td>
<td>Continuous</td>
<td>Slider (0 to 100)</td>
</tr>
<tr>
<td>UL _A0</td>
<td>Perception of Uncertainty Level for Case A</td>
<td>The investor's perception of uncertainty for the unmanipulated base case A.</td>
<td>Continuous</td>
<td>Slider (0 to 100)</td>
</tr>
<tr>
<td>OppLevel</td>
<td>Perception of Opportunity Level</td>
<td>The investor's perception of the opportunity in a business case presented in the survey experiment.</td>
<td>Continuous</td>
<td>Slider (0 to 100)</td>
</tr>
<tr>
<td>KnowMore</td>
<td>Willingness to Know More</td>
<td>The investor's willingness to move the business opportunity to the next stage primarily to obtain more information prior to investing. The investor's willingness to invest in the business opportunity assuming that due diligence and entrepreneur engagement activities do not materially change investor's assessment of the proposal.</td>
<td>Ordinal</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>WillInvest</td>
<td>Willingness to invest</td>
<td>This is the investor's assessment of how familiar they are with the industry in which the business opportunity operates. The investor's assessment of how the business opportunity fits with their own personal criteria and motivations.</td>
<td>Ordinal</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>FamLevel</td>
<td>Familiarity Level</td>
<td>This is the investor's assessment of how familiar they are with the industry in which the business opportunity operates.</td>
<td>Ordinal</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>OppFit</td>
<td>Investment Opportunity Fit</td>
<td>This is the investor's assessment of how the business opportunity fits with their own personal criteria and motivations.</td>
<td>Ordinal</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Definition</td>
<td>Type</td>
<td>Levels/Measures</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Age</td>
<td>Investor's Age</td>
<td>This is how old an investor is in years</td>
<td>Discrete</td>
<td>25 years and above</td>
</tr>
<tr>
<td>NoOfYears</td>
<td>Number of years of angel investing</td>
<td>This is the number of years the investor has engaged in angel/early-stage investing activities.</td>
<td>Discrete</td>
<td>25 years and above</td>
</tr>
<tr>
<td>NoOfInvts</td>
<td>Number of past investments</td>
<td>The number of angel/early-stage investments the investor has made in the past.</td>
<td>Discrete</td>
<td>Zero and above</td>
</tr>
<tr>
<td>Entrepreneur</td>
<td>Investor entrepreneurial experience</td>
<td>This represents the investor's prior entrepreneurial experience/background with &quot;Yes&quot; being one with entrepreneurial experience.</td>
<td>Binary</td>
<td>Categorical (Yes/No)</td>
</tr>
<tr>
<td>InvstMotvtn</td>
<td>Investor Motivations</td>
<td>The investor's primary motivations for being an angel/early-stage investor.</td>
<td>Binary</td>
<td>Financial / Non-Financial</td>
</tr>
<tr>
<td>TA_Score</td>
<td>Tolerance of ambiguity score</td>
<td>The investor's tolerance of uncertain/ambiguous information or situations as measured by the MSTAT psychometric test.</td>
<td>Continuous</td>
<td>Slider (0 to 100)</td>
</tr>
<tr>
<td>ActvInPortf</td>
<td>Investor activeness in portfolio firms</td>
<td>This is how active an investor is in his/her portfolio firms.</td>
<td>Ordinal</td>
<td>Likert scale (5 points)</td>
</tr>
<tr>
<td>BizRejectedPct</td>
<td>Percentage of business opportunities rejected</td>
<td>This is the percentage of business opportunities rejected at the screening stage by an investor.</td>
<td>Continuous</td>
<td>Slider (0 to 100)</td>
</tr>
</tbody>
</table>
### Appendix 5.1 – Alternative models for robustness check in chapter 5

*Table 5.9 Estimation results for the moderating effects of number of years of investing on uncertainty perceptions using alternative specifications.*

<table>
<thead>
<tr>
<th>UncLevel</th>
<th>Alt. Model 1a</th>
<th>Alt. Model 1b</th>
<th>Alt. Model 1c</th>
<th>Alt. Model 2a</th>
<th>Alt. Model 2b</th>
<th>Alt. Model 2c</th>
</tr>
</thead>
<tbody>
<tr>
<td>UncertCond_Ind1</td>
<td>1.77 (1.00)</td>
<td></td>
<td>1.77 (1.15)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>UncertCond_Ind2</td>
<td></td>
<td>4.56 (2.31)**</td>
<td></td>
<td>4.56 (2.66)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond2</td>
<td></td>
<td>3.22 (1.68)*</td>
<td></td>
<td>3.22 (1.93)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond3</td>
<td></td>
<td>5.53 (2.27)**</td>
<td></td>
<td>5.53 (2.62)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond4</td>
<td></td>
<td>5.12 (3.00)*</td>
<td></td>
<td>5.12 (3.46)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No_Of_Years</td>
<td>0.21 (0.33)</td>
<td>0.13 (0.30)</td>
<td>0.21 (0.33)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind1:No_Of_Years</td>
<td>-0.08 (0.11)</td>
<td>-0.08 (0.11)</td>
<td>-0.08 (0.13)</td>
<td></td>
<td>-0.08 (0.13)</td>
<td></td>
</tr>
<tr>
<td>UncertCond_Ind2:No_Of_Years</td>
<td>-0.15 (0.28)</td>
<td></td>
<td></td>
<td>-0.15 (0.33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CaseC</td>
<td>1.51 (1.68)</td>
<td>1.52 (1.69)</td>
<td>1.53 (1.66)</td>
<td>1.51 (1.94)</td>
<td>1.52 (1.95)</td>
<td>1.53 (1.92)</td>
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<tr>
<td>CaseD</td>
<td>4.71 (1.58)**</td>
<td>4.82 (1.62)**</td>
<td>4.77 (1.59)**</td>
<td>4.71 (1.83)**</td>
<td>4.82 (1.87)**</td>
<td>4.77 (1.84)**</td>
</tr>
<tr>
<td>CaseE</td>
<td>-4.31 (1.47)**</td>
<td>-4.24 (1.48)**</td>
<td>-4.25 (1.47)**</td>
<td>-4.31 (1.70)**</td>
<td>-4.24 (1.70)**</td>
<td>-4.25 (1.70)**</td>
</tr>
<tr>
<td>UL_A0</td>
<td>0.46 (0.05)**</td>
<td>0.46 (0.05)**</td>
<td>0.46 (0.05)**</td>
<td>-1.72</td>
<td>-1.64 (0.22)**</td>
<td>-1.72</td>
</tr>
<tr>
<td>Fixed person effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Intercept</td>
<td>31.27 (4.71)**</td>
<td>32.22 (4.11)**</td>
<td>32.19 (4.12)**</td>
<td>168.57</td>
<td>164.20</td>
<td>169.42</td>
</tr>
<tr>
<td>F-test (model)</td>
<td>34.23</td>
<td>34.40</td>
<td>26.85</td>
<td>3.738</td>
<td>3.75</td>
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<tr>
<td>p-value (model)</td>
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<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.2006</td>
<td>0.2014</td>
<td>0.2006</td>
<td>0.4108</td>
<td>0.4119</td>
<td>0.4114</td>
</tr>
</tbody>
</table>

Notes: This table presents results for OLS regression using alternative models. Alternative model 1 controls for uncertainty level for anchor case. Alternative model 2 controls for fixed person effects. Uncertainty Perceptions Level is the dependent variable and number of years of investing as moderator and various measures of uncertainty conditions as regressors. The effects are shown with clustered standard errors at investor level in parentheses. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.
## Appendix 6.1 – Alternative models for robustness check in chapter 6

Table 6.8: Parameter estimates for alternative specification 1 to test investor attitudes towards uncertainty

<table>
<thead>
<tr>
<th>Model version</th>
<th>KnowMore</th>
<th>WillInvest</th>
<th>IncInvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>UncertCond_Ind1</td>
<td>-0.04</td>
<td>-0.02</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.02)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>UncertCond_Ind2</td>
<td>-0.22</td>
<td>-0.17</td>
<td>-0.16</td>
</tr>
<tr>
<td></td>
<td>(0.07)**</td>
<td>(0.06)**</td>
<td>(0.05)**</td>
</tr>
<tr>
<td>UncertCond2</td>
<td>-0.25</td>
<td>-0.22</td>
<td>-0.20</td>
</tr>
<tr>
<td></td>
<td>(0.09)**</td>
<td>(0.08)**</td>
<td>(0.07)**</td>
</tr>
<tr>
<td>UncertCond3</td>
<td>-0.28</td>
<td>-0.21</td>
<td>-0.20</td>
</tr>
<tr>
<td></td>
<td>(0.09)**</td>
<td>(0.08)**</td>
<td>(0.07)**</td>
</tr>
<tr>
<td>UncertCond4</td>
<td>-0.13</td>
<td>-0.06</td>
<td>-0.09</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.08)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>KnowMore_A0</td>
<td>0.24</td>
<td>0.24</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>(0.05)**</td>
<td>(0.05)**</td>
<td>(0.05)***</td>
</tr>
<tr>
<td>WillInvest_A0</td>
<td>0.23</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>(0.05)**</td>
<td>(0.05)**</td>
<td>(0.05)**</td>
</tr>
<tr>
<td>IncInvest_A0</td>
<td>0.24</td>
<td>0.24</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>(0.05)**</td>
<td>(0.05)**</td>
<td>(0.05)**</td>
</tr>
<tr>
<td>Case C</td>
<td>-0.44</td>
<td>-0.44</td>
<td>-0.36</td>
</tr>
<tr>
<td></td>
<td>(0.10)**</td>
<td>(0.10)**</td>
<td>(0.08)**</td>
</tr>
<tr>
<td>Case D</td>
<td>-0.37</td>
<td>-0.37</td>
<td>-0.29</td>
</tr>
<tr>
<td></td>
<td>(0.09)**</td>
<td>(0.09)**</td>
<td>(0.08)**</td>
</tr>
<tr>
<td>Case E</td>
<td>0.50</td>
<td>0.49</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>(0.09)**</td>
<td>(0.09)**</td>
<td>(0.08)**</td>
</tr>
<tr>
<td>Intercept</td>
<td>2.08***</td>
<td>2.14</td>
<td>2.14</td>
</tr>
<tr>
<td></td>
<td>(0.17)</td>
<td>(0.16)**</td>
<td>(0.16)**</td>
</tr>
<tr>
<td>F-test (model)</td>
<td>30.07</td>
<td>31.25</td>
<td>22.63</td>
</tr>
<tr>
<td>p-value (model)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.1355</td>
<td>0.1403</td>
<td>0.1404</td>
</tr>
</tbody>
</table>

Notes: This table presents results for an OLS regression model with three investor decisions measures (KnowMore, WillInvest, and IncInvest) as dependent variables with various uncertainty conditions measures as regressors. In this specification we control for responses for the anchor case as a regressor. KnowMore_A0 is the willingness to know more for the anchor case, WillInvest_A0 is the willingness to invest for the anchor case, and IncInvest_A0 is the inclination to invest for the anchor case. The effects are shown with clustered standard errors at investor level in parentheses. Significance level: *** p<0.01, ** p<0.05, and * p<0.10
Table 6.9: Parameter estimates for alternative specification 2 to test investor attitudes towards uncertainty

<table>
<thead>
<tr>
<th>Model version</th>
<th>KnowMore</th>
<th>WillInvest</th>
<th>IncInvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>UncertCond_Ind1</td>
<td>-0.04</td>
<td>-0.02</td>
<td>-0.03</td>
</tr>
<tr>
<td>UncertCond_Ind2</td>
<td>-0.22</td>
<td>-0.17</td>
<td>-0.16</td>
</tr>
<tr>
<td>UncertCond2</td>
<td>-0.25</td>
<td>-0.22</td>
<td>-0.20</td>
</tr>
<tr>
<td>UncertCond3</td>
<td>-0.28</td>
<td>-0.21</td>
<td>-0.20</td>
</tr>
<tr>
<td>UncertCond4</td>
<td>-0.13</td>
<td>-0.06</td>
<td>-0.09</td>
</tr>
<tr>
<td>WillInvest_A0</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
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<td>WillInvest_A0</td>
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<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>IncInvest_A0</td>
<td>-0.44</td>
<td>-0.36</td>
<td>-0.37</td>
</tr>
<tr>
<td>Case C</td>
<td>0.49</td>
<td>0.43</td>
<td>0.42</td>
</tr>
<tr>
<td>Case D</td>
<td>0.50</td>
<td>0.43</td>
<td>0.42</td>
</tr>
<tr>
<td>Case E</td>
<td>0.50</td>
<td>0.43</td>
<td>0.42</td>
</tr>
<tr>
<td>Fixed person effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Intercept</td>
<td>-3.32</td>
<td>-3.26</td>
<td>-3.26</td>
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<tr>
<td>F-test (model)</td>
<td>2.894</td>
<td>2.949</td>
<td>2.912</td>
</tr>
<tr>
<td>p-value (model)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.3244</td>
<td>0.3307</td>
<td>0.3314</td>
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</table>

Notes: This table presents results for an OLS regression model with three investor decisions measures (KnowMore, WillInvest, and InvestInc) as dependent variables with various uncertainty conditions measures as regressors. In this specification we control for both responses for the anchor case as a regressor and fixed person effects. KnowMore_A0 is the willingness to know more for the anchor case, WillInvest_A0 is the willingness to invest for the anchor case, and IncInvest_A0 is the inclination to invest for the anchor case. The effects are shown with clustered standard errors at investor level in parentheses. Significance level: *** p<0.01, ** p<0.05, and * p<0.10.
### Appendix 6.2 – Results for mediation analysis

Table 6.10: Parameter estimates for the mediating effects of uncertainty perception on investor attitudes towards uncertainty with investor willingness to know more as DV

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
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<th>4</th>
<th>Bootstrapping</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>KnowMore_Diff</td>
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<td>KnowMore_Diff</td>
<td>UncertCond</td>
<td>Quasi-Bayesian</td>
</tr>
<tr>
<td>UncertCond</td>
<td>-0.23</td>
<td>3.48</td>
<td>-0.13</td>
<td>0.001</td>
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</tr>
<tr>
<td></td>
<td>(0.11)**</td>
<td>(1.73)**</td>
<td>(0.08)</td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>ULD</td>
<td>-0.03</td>
<td></td>
<td></td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)***</td>
<td></td>
<td></td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>KnowMore_Diff</td>
<td></td>
<td></td>
<td></td>
<td>-0.02</td>
<td>-0.101**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.01)</td>
</tr>
<tr>
<td>ACME</td>
<td></td>
<td></td>
<td></td>
<td>-0.234**</td>
<td>-0.230**</td>
</tr>
<tr>
<td></td>
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<tr>
<td>ADE</td>
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<td>-0.133</td>
<td>-0.132</td>
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<tr>
<td>Total Effect</td>
<td>-0.234**</td>
<td>122.9</td>
<td>2.9580</td>
<td>0.0524</td>
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</tr>
<tr>
<td>Prop. Mediated</td>
<td>0.425*</td>
<td>0.427*</td>
<td></td>
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<tr>
<td>Intercept</td>
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<td>-4.32</td>
<td>0.03</td>
<td>0.75</td>
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<tr>
<td></td>
<td>(0.09)*</td>
<td>(1.50)***</td>
<td>(0.08)</td>
<td>(0.01)***</td>
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<tr>
<td>F-test (model)</td>
<td>4.562</td>
<td>4.035</td>
<td>122.9</td>
<td>2.9580</td>
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<td>p-value (model)</td>
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<td>0.045</td>
<td>&lt;0.001</td>
<td>0.0524</td>
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<td>Adj. R^2</td>
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<td>0.0033</td>
<td>0.2082</td>
<td>0.0042</td>
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</table>

Notes: This table presents results for linear regression models using the Baron and Kenny method for testing mediation with KnowMore as dependent variable, uncertainty perception (UncLevel) as mediator and uncertainty condition (UncertCond) as independent variable. Results from quasi-Bayesian monte-carlo simulation analysis and non-parametric bootstrapping casual mediation analysis are also shown. ACME average causal mediation effects and ADE is average direct effects. The effects are shown with standard errors in parentheses. It also shows results for causal mediation analysis. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.
Table 6.11: Parameter estimates for the mediating effects of uncertainty perception on investor attitudes towards uncertainty with investor willingness to invest as DV

<table>
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<tr>
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<th>WillInvest_Diff</th>
<th>ULD</th>
<th>WillInvest_Diff</th>
<th>UncertCond</th>
<th>Quasi-Bayesian</th>
<th>Nonparametric</th>
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<tr>
<td>UncertCond</td>
<td>-0.17 (0.10)*</td>
<td>3.48</td>
<td>-0.08</td>
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<tr>
<td>ULD</td>
<td>-0.03 (0.002)***</td>
<td></td>
<td></td>
<td>0.001</td>
<td></td>
<td>(0.001)*</td>
</tr>
<tr>
<td>WillInvest_Diff</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>ACME</td>
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<td>-0.093**</td>
<td>-0.093*</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>ADE</td>
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<td></td>
<td>-0.081</td>
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<td></td>
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<tr>
<td>Total Effect</td>
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<td></td>
<td>-0.174*</td>
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<td>0.534</td>
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<tr>
<td>Intercept</td>
<td>0.23 (0.09)***</td>
<td>-4.32 (1.50)***</td>
<td>0.12 (0.08)</td>
<td>0.68 (0.05)***</td>
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<td>F-test (model)</td>
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<td>0.2192</td>
<td>0.0042</td>
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Notes: This table presents results for linear regression models using the Baron and Kenny method for testing mediation with WillInvest as dependent variable, uncertainty perception (UncLevel) as mediator and uncertainty condition (UncertCond) as independent variable. Results from quasi-Bayesian monte-carlo simulation analysis and non-parametric bootstrapping causal mediation analysis are also shown. ACME average causal mediation effects and ADE is average direct effects. The effects are shown with standard errors in parentheses. It also shows results for causal mediation analysis. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10
Table 6.12: Parameter estimates for the mediating effects of uncertainty perception on investor attitudes towards uncertainty with investor inclination to invest as DV

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<tr>
<td></td>
<td>(0.08)**</td>
<td>(1.73)**</td>
<td>(0.06)*</td>
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<td></td>
<td></td>
<td>(0.001)***</td>
<td>(0.001)***</td>
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<td></td>
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<td>(0.05)***</td>
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</tbody>
</table>

Notes: This table presents results for linear regression models using the Baron and Kenny method for testing mediation with InvestProp as dependent variable, uncertainty perception (UncLevel) as mediator and uncertainty condition (UncertCond) as independent variable. Results from quasi-Bayesian monte-carlo simulation analysis and non-parametric bootstrapping casual mediation analysis are also shown. ACME average causal mediation effects and ADE is average direct effects. The effects are shown with standard errors in parentheses. It also shows results for causal mediation analysis. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.
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