Uncertainty and angel investor decisions

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May 2021

Abstract: This paper investigates how uncertainty in early-stage ventures affect investor decisions. Uncertainty is fundamental to entrepreneurship and innovation projects. Understanding investor perceptions of uncertainty and how it affects their behavior is critical to improving investment decisions and access to finance to businesses. We conduct an online policy capturing experiment using executive summaries of business proposals with different levels of modelled uncertain information cues to test this phenomenon. We find that early-stage investors (business angels) like other decision makers generally avoid uncertainty. However, this is through a mediated process that involves their perception of uncertainty. Some investor characteristics like familiarity with industry in which the business operates and business opportunity fit moderate this relationship while others like past investment experience have no such effect.

Keywords: angel investor, uncertainty, investment decisions, field experiments

JEL codes: C93; D80; G11; G24

1.0 Introduction

This paper investigates how the perceptions of risks and uncertainty by early-stage investors affect their investment decisions when they review early-stage business opportunities. Investor decision-making has been studied extensively across the spectrum on the early-stage private equity space, 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., 2012; Maxwell et al., 2011; Mason and Harrison, 1996). The concept of uncertainty and its effects on 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). Understanding the effects of uncertainty on early-stage investor decisions is crucial to improving investment decisions as it has to 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 financing very early-stage ventures. Ventures at the pre-seed stage are mostly financed by angel investors instead formal of venture capitalist who come in at later stages of venture development. Uncertainties in the ventures are at the highest at the pre-seed stage where business ideas and products are sometimes not even proven (Huang and Pearce, 2015). Considering the crucial role that angel investors play in the development of innovative firms it is important to understand how the uncertainties in these businesses affect their investment decisions.

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). It is the ability of the entrepreneur to interpret or perceive 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 that entrepreneurs take entrepreneurial actions in the face of inherently uncertain and unknowable futures (Sarasvathy et al., 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).

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, p 19-20) 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. For Knight, the rational response to uncertainty is to reduce it to risk ex ante or if it cannot be done then the entrepreneurial action should not be taken at all. To undertake an entrepreneurial action in the face of uncertainty is to do so on the basis of intuition or gut feeling and not a calculated expected profit.

Although, there is a lot work done in the entrepreneurial literature on the role of uncertainty in the decision-making of entrepreneurs, there is very little done in the early-stage venture finance space. When investors make investment decisions on these early-stage ventures they do so under similar uncertain conditions faced by the entrepreneurs behind the business. 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, 1996), and how these factors vary across different stages (Maxwell et al., 2011; van Osnabrugge, 2000). Very little 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.

One of the few works in this space is from Huang and Pearce (2015) and the extension by Huang (2018). 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-unknowns). 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-based intuition and formal analysis, when there is a conflict between their intuition and formal analysis, they defer to their intuitions. As Huang (2018) inductively finds, 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. While these works show how investors make decisions in the face of uncertainty, we do not know how uncertainty affects these decisions.

The primary objective of this paper is thus to investigate how angel investors perceive uncertain information cues in business plans and how their perceptions of uncertainty affect their investment decisions. The secondary objective is to understand how investor background, motivations, past experiences, and preferences affect their perceptions of uncertainty and their investment decision 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). This paper thus answers two main questions; how does the perceptions of uncertainty in early-stage businesses affect investor decisions, and how does investor background, experiences, and preferences affect their investment decisions relative to uncertain information?

We develop an experimental survey with business angels that uses executive summaries of business cases as the format of case scenarios. We manipulate information cues about

investment decision factors (product protectability, route to market, and relevant entrepreneurial experience) to create varying levels of uncertainties in the cases. Busines angels from the UK and US take part in the study where they review the cases and take decisions. Findings from the study suggests that business angels like other decision-makers generally avoid uncertainty. For business angels this relationship between uncertain information is mediated by the perceptions of uncertainty which is unobserved in the decision-making process. Additionally, some investor characteristics like how familiar an investor is with the industry in which the business operates determines the nature of the relationship. For example, familiarity with the industry leads investors to avoid uncertainty contrary to what we predict.

This paper contributes to theory, practice, and policy in diverse ways. First, 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). This paper contributes to knowledge by examining the role of uncertainty and its effects on early-stage investments decisions from a behavioral perspective. Additionally, the study also contributes to practice in the informal venture capital industry especially for business angels. An awareness and understanding of uncertainty aversion biases in their decision will lead to better and accurate decision making. Uncertainty aversion can lead to the risk of adverse selection – which is financing businesses which will subsequently fail and not financing businesses which will eventually become successful or has the potential be successful. Being aware of this should make decision-makers demand or seek additional information when they face heightened uncertainty to better inform their decisions instead of avoiding the business entirely. Finally, this study has implications for policy makers to better understand the supply side reasons of the ‘equity gap’ problem. It is argued that there are shortcomings in the investment decisions of investors in early stage

funding (NESTA, 2009). Understanding the effects of uncertainty in the decision making of investors brings a different and important perspective to this discussion for policy makers.

2.0 Literature and hypotheses 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 it means for their investments. It has been shown that in a choice decision under uncertainty[1], 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. Decision making to fund these early-stage businesses is thus done under highly uncertain conditions. 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

[1] Mostly under lab conditions

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 when successful. We contend that it is investors' judgement on the potential opportunities in the ventures that make them bet on these ventures notwithstanding the highly uncertain 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 leads to the first hypothesis,

H1: Investors in early-stage business generally avoid uncertainty.

When investors first review business cases, they make decisions on whether to proceed to the next stage of the investment decision process or not. 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. As the investment decision of early-stage businesses are done in the face of high uncertainty conditions, 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 in) as investor perceptions of uncertainty. Generally, investors avoid uncertainties and go for investments that they consider as less

uncertain (Chew et al., 2017; Dimmock et al., 2016). Experienced early-stage investors will however take up ventures with high uncertainties when they believe they stand to make extraordinary gains (Huang and Pearce, 2015) similarly to what entrepreneurs do (Koudstall et al., 2016). That belief comes from their interpretation of the opportunities in the venture. I also refer to this interpretation 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). The presence of uncertainty associated with the viability of an opportunity is an essential pre-condition for the very existence of the opportunity (Sorenson and Stuart, 2008). Essentially, when investors invest in early-stage ventures, they make a bet in the face of high uncertainties on the future success of business with the hope of exploiting these opportunities (Knight, 1921).

When investors review business opportunities for investments there are faced with uncertain information cues in the businesses plans. Without explicitly asking investors about their assessment of these cues, we do not know how investors interpret them in relation the uncertainties in the ventures and the potential opportunity that exists in them. Therefore, the uncertain information cues can be hypothesized to drive investor perceptions of uncertainty and opportunity which in turn affects their decision making. Thus, the general 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 general path in Figure 1.

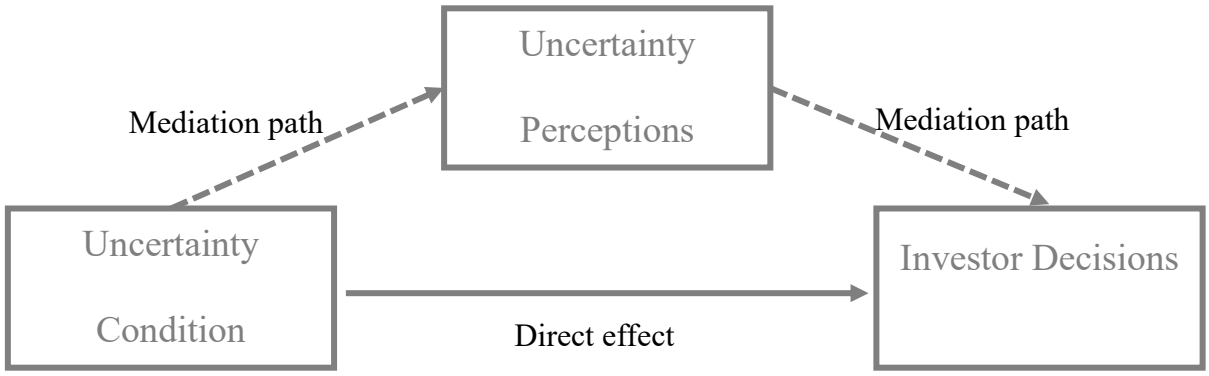

Figure 1: The general mediation path for investor decision-making.

Investor decisions are thus driven by how they interpret information cues from the entrepreneur in terms of uncertainties and opportunities which in turn affects their decision-making. This results in the next hypothesis 4:

H2: In early-stage investment decisions, investor perceptions of uncertainty mediate the relationship between business information cues and investor decisions.

As mentioned earlier, 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. 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, 1996). 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 in which they are familiar with may generally be more favorable to them. The past investment experiences of investors also affect their decision making (Harrison et al., 2015). Investors with more investing experience, 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 the cases and investor decisions. They tell us under what conditions uncertain information cues affects investor decisions. The direct effect between uncertain information cues and investor decisions can either be reduced or the established direction of the effect can be reversed when investor characteristics are considered as moderators. I show the general moderating path of the effect of these investor characteristics on the direct relationship between uncertain information cues and investor decisions in Figure 2.

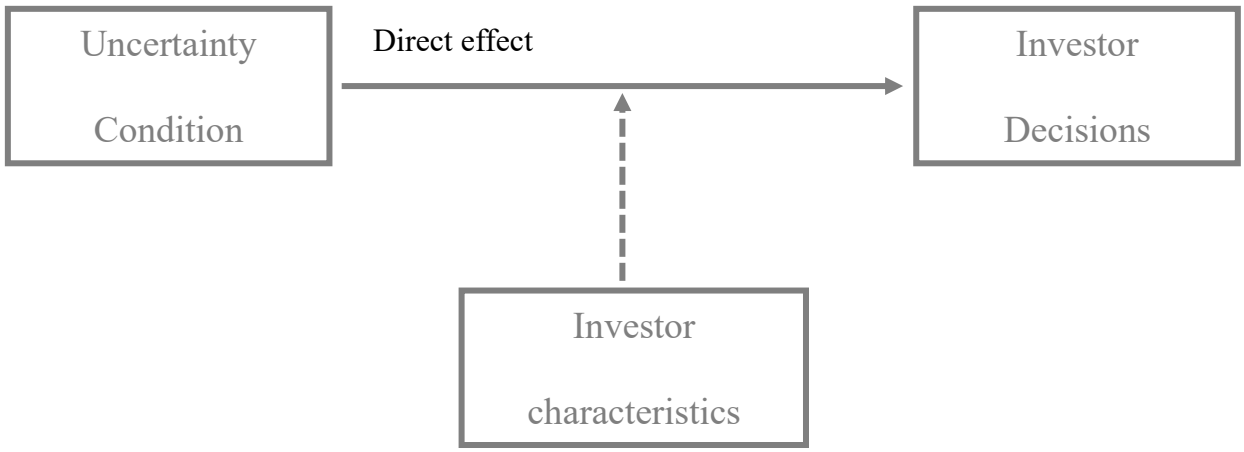

Figure 2: The general moderating path for investor decision-making.

This is thus hypothesized as follows:

H3a: In early-stage investment decisions, how the business opportunity fits with investor's personal preferences moderates the relationship between business information cues and investor decisions.

H3b: 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.

H3c: In early-stage investment decisions, investor's past investing experience moderates the relationship between business information cues and investor decisions.

3.0 Method and data collection

In this study we seek to understand how perceptions of uncertain information in business opportunities affect the investment decisions of early-stage investors. This is 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. The use of secondary data is not appropriate as the early-stage investor market is not visible due to how business angels operate (Mason and Harrison, 2008). The appropriate approach is to model varying degrees of uncertainty in sample business cases to measure how investors perceive them and its effects on their investment decisions. This makes the use of an experiment the most appropriate compared to other research methodologies.

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 (Aguinis and Bradley, 2014). 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). We develop and test the experimental survey through a qualitative pilot study with real business angels. This ensures that the operationalization of the uncertainty construct in the angel investment decision context is accurate and real.

We create scenarios similar to what investors encounter in real life using executive summaries of business cases as the format. At the screening stage of 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). The use of executive summaries for the creation of the base case scenarios makes the experiment as close to reality as possible. We 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 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 survey and to measure the individual levels of responses. From the pilot study, participants typically used their responses to the first case as an anchor to their subsequent assessments. We observed 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.

We 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. The selected factors of interest are drawn from eight critical factors identified by Maxwell et al. (2011). They can be grouped into two - the factors that are direct business viability related (Product protectability, and Route to market) and entrepreneur related (Relevant entrepreneur experience). This grouping is similar to what Huang and Pearce (2015) employ in their experimental field study. As Maxwell et al. (2011) summarize it, the presence of these factors is positively correlated to the success of the business and their absence correlated to their failure. The experimental design requires that selected factors that can affect the uncertainties in the future success or otherwise of business opportunities are manipulated to test how investors perceive them and how they affect their decision making.

From the pilot study, 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 operationalized as an investment opportunity associated with clear information regarding the organization's prospects and the uncertain condition being one presented as an investment opportunity lacking clear information about the venture's prospects. I follow Huang and Pearce 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, that find that the presence and absence of certain critical factors either heighten or reduce the perceived uncertainties in the likely success of a business.

All the base cases, except the anchor case, have four versions with different values of the manipulated factors. Version 1 (V1) of the cases have the low uncertainty values of the manipulated factors while version 4 (V4) of the cases have the high uncertainty values of all three manipulated factors. This creates 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 1 summaries how we create the various versions of the base cases.

Table 1: The combination of values of the manipulated factors for each case versions

Version	**Product Protectability**	**Route to Market**	**Relevant Experience**
Version 1	Low Uncertainty	Low Uncertainty	Low Uncertainty
Version 2	Low Uncertainty	Low Uncertainty	High Uncertainty
Version 3	Low Uncertainty	High Uncertainty	High Uncertainty
Version 4	High Uncertainty	High Uncertainty	High Uncertainty

We put the different versions of the cases into four blocks which includes one version of all base cases. Each block starts with the anchor case, Case A, followed by the different versions of the other cases as per the descriptions earlier. 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 extreme case(V1), high uncertainty extreme case (V4) and a moderately low uncertainty case (V2) and a moderately high uncertainty case (V3). Table 2 summaries how the different versions of the cases are put into the different blocks.

Table 2: How the case versions will be placed in blocks.

Block 1	**Block 2**	**Block 3**	**Block 4**
Case A	Case A	Case A	Case A
Case B_V1	Case B_V2	Case B_V3	Case B_V4
Case C_V2	Case C_V3	Case C_V4	Case C_V1
Case D_V3	Case D_V4	Case D_V1	Case D_V2
Case E_V4	Case E_V1	Case E_V2	Case E_V3

For every case, participants are asked to answer 6 questions which includes 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 asks 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. The survey also involves a questionnaire mainly to collect participant characteristics and their associated past investment activities. The questionnaire has two sections – investor characteristics section and the investment activities section. The investor characteristics section focuses on general demographic questions like 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 post-investments participation.

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 (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. According to survey done by EBAN[2] in 2017, the UK is estimated to have about 8000 business angels who are associated with 67 Business Angel Networks. The actual population is estimated to be much higher as only a small percentage of business angels are affiliated to any network or association. The EBAN estimates the visible market to be only about 10% of the entire market. This means the "invisible market" 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 concerns of these researchers is the over reliance of 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 like 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

[2] EBAN is a European business angel network association for the early-stage investor community with member associations from over 50 countries.

(e.g. angel syndicates, angel networks and tax incentive schemes). In this study, I reach investors through their social media accounts.[3] 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 and 244 responses were recorded at the end of the survey out of which 232 were completed responses. The 12 incomplete recorded responses are omitted from the data 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 appear low; however, the survey took place during the peak of the COVID-19 pandemic. Angel investors with portfolio companies were mainly busy supporting their investee firms through a surreal time. The response rate is however good considering the experimental nature of the study and the international approach adopted for the study.

4.0 Data analysis and results

The participants comprise 45 investors from the UK and 187 investors 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 40000 to 80000 angel investors (Mason and Harrison, 2017) while the US is estimated to have between 3 to 6 times this number (Sohl, 2015), The two territories are known to have the most developed market for early-stage investments. The participating investors sampled are predominately male. This is very much

[3] I contact participants mainly through their publicly available LinkedIn profiles.

in line with reality as the early-stage investor space has been known to be dominated by the male gender. Our sample is made up of 84% male and 14% female 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 are between 10 and 15%. Our 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). This survey has 86% of US respondents being male and 13% being female. The ratio of male to female participants is very much in line with reality and other similar surveys in the field.

The key variables from the experiment are defined in Table 3. We present descriptive statistics of key variables in the research for the final data from the online experiment in Table 4. Generally, responses vary widely among participants. Most 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 level for the cases of interests[4] is 68.75 while the average perception of opportunity level is 50.55. Participants generally believe the cases are more uncertain compared to the potential opportunities they offer. On how familiar they are with the industry in which the businesses operate, participants are generally slightly or moderately familiar with the industries (Mean – 2.52, SD – 1.08). They express similar sentiments with 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 in investing in them. At this very 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

[4] The cases of interest are cases B to E which are the ones with manipulated uncertainty.

(Mean – 2.15; SD – 1.07). The average age of investors is around 50 years. On the average, they have been early-stage investors for 7 years and they have about 14 past early-stage investments.

In Table 5, we present Pearson correlation coefficients of the variables. Generally, correlation coefficients are significant at the 5% level. Investor perceptions uncertainty (UncLevel) is negatively correlated with the following variables: perceptions of opportunity (OppLevel), investor willingness to know more about the business (KnowMore), investor willingness to invest (WillInvest), how familiar an investor is with the venture industry (FamLevel), and how the opportunity fits with the investor preferences and criteria (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 industry in which the business operates and when the opportunity does not fit with their personal criteria and preferences. The resultant effect is a general unwillingness to proceed to know more about the business and to invest in it. Investor perceptions uncertainty (UncLevel) is however positively correlated with how old an investor is (Age) and the number of years of investing (NoOfYears). The age of an investor is also positively correlated with the number of years of investing NoOfYears as older and more matured investors have been investing for a longer period. Older and more experienced investors perceive more uncertainty in the business opportunities as shown by the positive correlation of these variables with the perceptions of uncertainty (UncLevel).

Table 3: Descriptive statistics for key variables

Name	Description	Definition	Type	Levels/Measures
UncertCond	Uncertainty Condition	This is the varying levels of manipulated uncertainty in a base case using combinations of known different critical decision factors.	Ordinal	V1, V2, V3 and V4
NoOfYears	Investor Investing Experience	This is the number of years the investor has engaged in angel/early-stage investing activities.	Discrete	25 years and above
UncLevel	Perception of Uncertainty	The investor's perception of uncertainty in a business case presented in the survey experiment.	Continuous	Slider (0 to 100)
OppLevel	Perception of Opportunity	The investor's perception of opportunity in a business case presented in the survey experiment.	Continuous	Slider (0 to 100)
KnowMore	Willingness to Know More	The investor's willingness to move the business opportunity to the next stage primarily to obtain more information prior to investing.	Ordinal	Likert scale (5 points)
WillInvest	Willingness to invest	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.	Ordinal	Likert scale (5 points)
FamLevel	Familiarity level	This is the investor's assessment of how familiar they are with the industry in which the business opportunity operates.	Ordinal	Likert scale (5 points)
OppFit	Business opportunity fit	This is investor's assessment of how the business opportunity fits with their own personal criteria and motivations.	Ordinal	Likert scale (5 points)

Table 4: Descriptive statistics for key variables

Variables	Description	Min	Max	Mean	SD	Skewness	Excess Kurtosis
UncLevel	Uncertainty level	0	100	68.75	22.20	-0.71	-0.23
OppLevel	Opportunity level	0	100	50.55	25.33	-0.09	-0.98
KnowMore	Willingness to know more	1	5	2.50	1.20	0.30	-0.99
WillInvest	Willingness to invest	1	5	2.15	1.07	0.54	-0.66
FamLevel	Familiarity level	1	5	2.52	1.08	0.29	-0.60
OppFit	Opportunity Fit	1	5	2.34	1.14	0.35	-0.90
Age	Investor's age	25	75	50.27	11.58	-0.12	-0.60
NoOfYears	Number of years of investing	1	15	7.29	4.58	0.42	-1.22

Table 5: Pearson correlation coefficients of key variables

	Variable	1	2	3	4	5	6	7	8
1	**UncLevel**	1							
2	**OppLevel**	-0.36***	1						
3	**KnowMore**	-0.45***	0.66***	1					
4	**WillInvest**	-0.44***	0.65***	0.85***	1				
5	**FamLevel**	-0.16***	0.09***	0.26***	0.25***	1			
6	**OppFit**	-0.26***	0.43***	0.67***	0.64***	0.45***	1		
7	**Age**	0.12***	-0.10***	-0.12***	-0.18***	-0.02	-0.16***	1	
8	**NoOfYears**	0.08**	-0.05	-0.09***	-0.11***	0.08**	-0.11***	0.54***	1

***. 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 main treatment variable is manipulated uncertainty in the business cases. This has varying levels of uncertainty conditions from level 1 to 4 with increasing order of uncertainty. In the analysis we represent manipulated uncertainty by UncertCond which is a dummy for uncertainty condition 1 against the rest of the conditions (2,3 and 4). We also use other dummy variables for the individual uncertainty conditions. They are UncertCond1, UncertCond2, UncertCond3, and UncertCond4 for uncertainty conditions 1, 2, 3 and 4 respectively. The treatment variables are the main independent variable for the analysis. There are two main response variables from the experiment. These are investor willingness to know more about the business (KnowMore) and their willingness to investment in the business (WillInvest). These two represent investor decisions from reviewing the business cases.

We create a new 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. We call this new variable investor inclination to invest (InvestInc) 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. When investors have a favorable opinion or perception of the opportunity in a business, they also have a positive or favorable disposition or inclination to invest in the business. This is seen in the strong positive correlation between investor perceptions of opportunity (OppLevel) and the other two response variable: investor willingness to know more ($\rho = 0.66$) and investor willingness to invest ($\rho = 0.65$). We standardize the three component variables in question and take an average to create the new variable (InvestInc). 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 (InvestInc)

Investor attitudes towards uncertain information cues

We run the model 1 below using OLS regression to measure the effects of manipulated uncertainty on investor decision-making. This model assumes that the randomization in the experiment takes away the need to control for noise from other variables like the base cases and differences in person. This enables the use of a concise model with only the predictor variable of interest which is manipulated uncertainty.

Model 1

$$DV_i = \alpha + \beta Uncertainty + \varepsilon$$

Various versions of model 1 are estimated using the three response variables (KnowMore, WillInvest, and InvestInc) as the dependent variables and the various uncertainty condition measures as independent variables. Estimation results are shown in Table 6. The low adjusted R^2s 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.

Generally, the signs of the beta estimates of the uncertainty measures are negative and significant except for UncertCond4. The results show that uncertain information cues lead to lower willingness of investors to know more about the business and to invest in them. UncertCond4 from the experiment represents the extreme case versions where all three manipulated factors have high uncertainty cues. Relative to the reference case version (UncertCond1), the coefficients of UncertCond4 are not significant. However, UncertCond2

and UncertCond3 both have significant effects compared to UncertCond1. This could mean that additional uncertainty cues have diminishing effects on investor decisions. Having one or two uncertainty cues is enough for investor decisions similar to what Maxwell and colleagues (2011) describe as "fatal flaws" and investors at the early stage reject businesses based on just one of these.

Table 6: Linear regression model estimation results for model 1 (simple model) with various investors measures as dependent variable

	KnowMore		**WillInvest**		**InvestInc**	
Model version	1	2	1	2	1	2
UncertCond	-0.23 (0.09)**		-0.17 (0.08)**		-0.17 (0.07)**	
UncertCond2		-0.24 (0.11)**		-0.22 (0.10)**		-0.20 (0.08)**
UncertCond3		-0.30 (0.11)***		-0.23 (0.10)**		-0.22 (0.08)**
UncertCond4		-0.15 (0.11)		-0.07 (0.10)		-0.10 (0.08)
Intercept	2.67 (0.08)***	2.67 (0.08)***	2.28 (0.07)***	2.28 (0.07)***	0.13 (0.06)**	0.13 (0.06)**
F-test (model)	6.398	2.765	4.594	2.562	6.191	2.865
p-value (model)	0.012	0.041	0.032	0.054	0.013	0.036
Adj. R^2	0.006	0.006	0.004	0.005	0.006	0.006

Notes: This table presents results for a linear model with three investor decisions measures (KnowMore, WillInvest, and InvestInc) as dependent variables with various uncertainty conditions measures as regressors. The effects are shown with standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, and * p<0.10.

The role of uncertainty perceptions

We test for the mediating effects of perceptions of uncertainty on investor decisions using the 4-step (causal step) method from Baron and Kenny (1986) and confirm it with a causal mediation analysis (i.e., the bootstrapping non-parametric approach to testing mediation

effects). In step 1 of the causal step approach, we first estimate the relationship between the independent variable (IV) and dependent variable (DV) to establish the existence of the suspected mediated relation. In step 2, we estimate the relationship between the IV and the mediator (M). We then estimate the relationship between M and DV controlling for IV in step 3. We expect the effect of DV on IV to decrease with the inclusion of M in the model for a partially mediated relationship or become zero for a fully mediated relationship. In the final step, we do a reversal of step 1 and estimate the relationship between DV and IV controlling for M. We 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.

The results for the mediation analysis are summarised in the path diagrams shown in Figures 3 to 5 with investor willingness to know more (KnowMore), investor willingness to invest (WillInvest), and investor inclination to invest (InvestInc) respectively as DVs. The detailed results are also presented in Tables 7 to 9 in the Appendix. The conditions for mediated relationship are confirmed in all three cases. There is a significant negative relationship between manipulated uncertainty (UncertCond) and investor willingness to know more about the business (KnowMore) which is the main effect. Manipulated uncertainty also shows a significant positive relationship with investor perceptions of uncertainty, UncLevel (3.49, SE = 1.68). When the mediators are considered, the size of the direct effect is reduced from -0.23 to -0.15 for UncLevel. This reduction comes from the average causal mediation effects (ACME) of perception of uncertainty which is -0.08. In the final step, there is no significant reverse causal relationship between the manipulated uncertainty (UncertCond) and investor willingness to know more (KnowMore).

The results are similar for investor willingness to invest (WillInvest), and investor inclination to invest (InvestInc). In both cases, the direct effect between manipulated uncertainty and the

outcome variables is -0.17. This is however reduced to -0.10 when perceptions of uncertainty are considered. This is also confirmed by the results of the causal mediation analysis where ACME in both cases are significant.

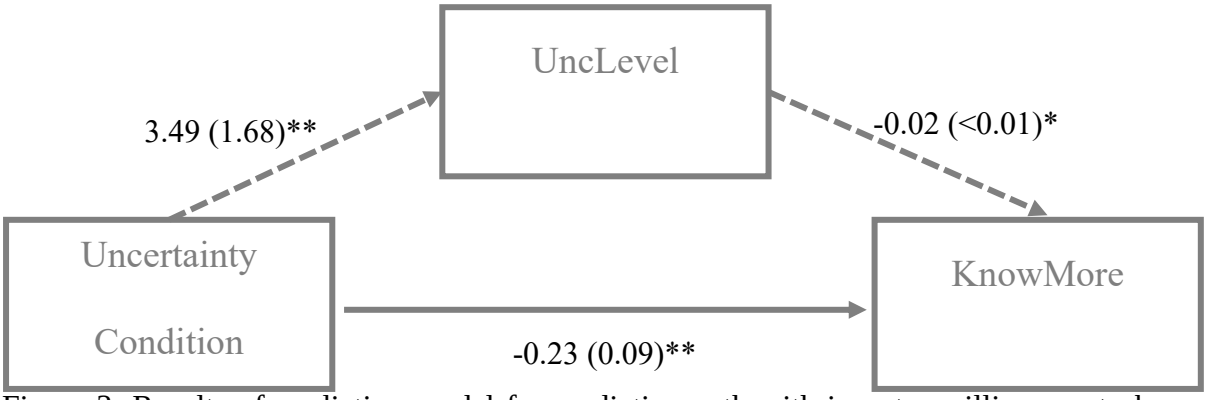

Figure 3: Results of mediation model for mediation path with investor willingness to know more (KnowMore) as dependent variable.

Notes: Average Causal Mediation Effects (ACME) = -0.084 ($p < 0.01$). Average Direct Effects (ADE) = 0.15 ($p < 0.10$). The effects are shown with standard errors in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$.

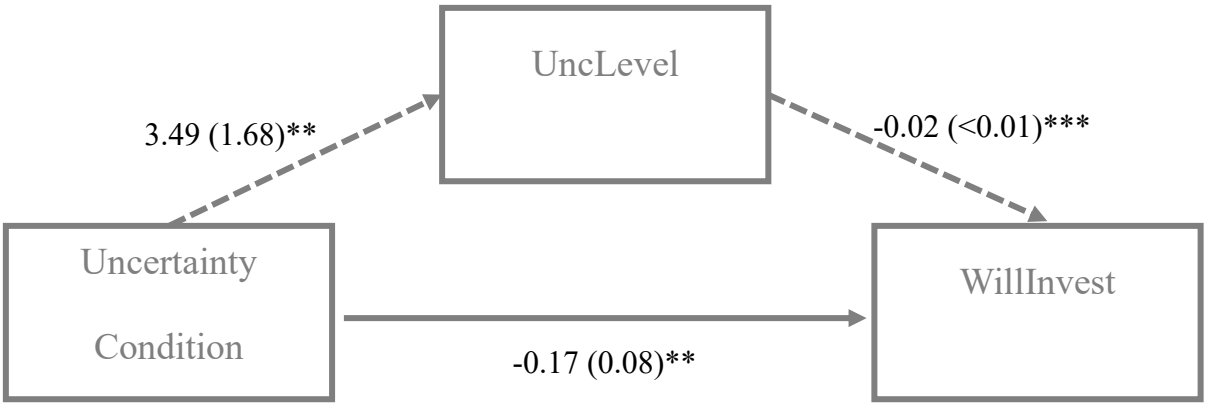

Figure 4: Results of mediation model for mediation path with investor willingness to invest (WillInvest) as dependent variable.

Notes: Average Causal Mediation Effects (ACME) = -0.074 ($p < 0.01$). Average Direct Effects (ADE) = 0.10 ($p < 0.10$). The effects are shown with standard errors in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$.

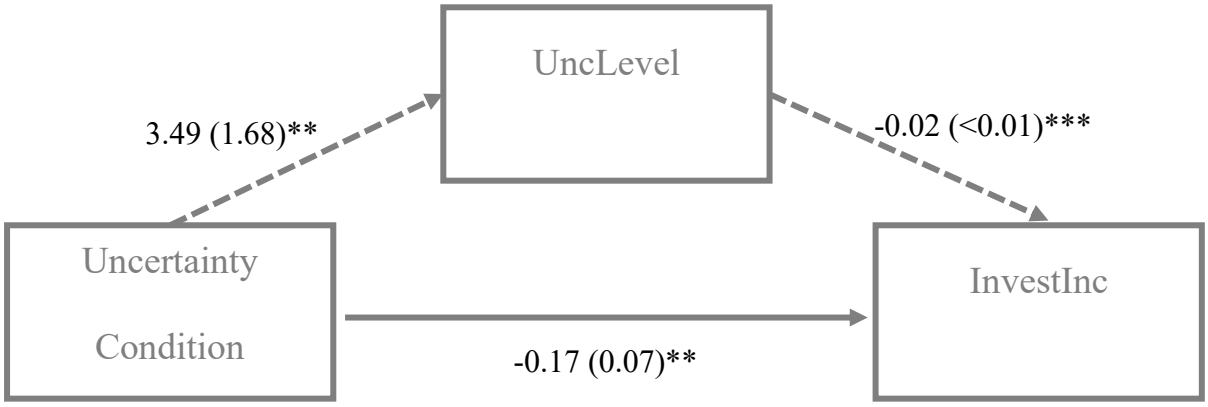

Figure 4: Results of mediation model for mediation path with investor inclination to invest (InvestInc) as dependent variable.

Notes: Average Causal Mediation Effects (ACME) = -0.07 ($p < 0.01$). Average Direct Effects (ADE) = 0.10 ($p < 0.10$). The effects are shown with standard errors in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$.

The role of investor characteristics

For hypotheses 3, we run model 2 to assess the potential moderating effects of investor characteristics on the relationship between manipulated uncertainty and investor decisions.

Model 2

$$DV_i = \alpha + \beta_i Uncertainty + \gamma_{ij} InvestCharc_j + \delta_{ij} Uncertainty * InvestCharc + \varepsilon$$

Where $Uncertainty$ represents manipulated uncertainty and $InvestCharc_j$ the various investor characteristics of interest in the study.

The results of the OLS regressions for model 2 are shown in Table 10. The results here are mixed. With how the opportunity fits with the personal preferences of the investor (OppFit), the negative relationship between manipulated uncertainty and KnowMore is reversed and the interaction effect is significant. The negative interaction effect between venture opportunity fit (OppFit) and manipulated uncertainty (UncertCond) on investor interest to know more about the business is contrary what we hypothesize about the relationship. The negative interaction

effect means that holding uncertainty constant, the closer the opportunity fits with investor preferences, the less likelihood they are willing to know about the business. This suggests that investors whose preferences are met are more cautious than others. Business opportunity fit however, has no significant interaction effects for the other investor decision measures (WillInvest and InvestInc).

With how familiar investors are with the industry in question (FamLevel), again the negative relationship between manipulated uncertainty and investor decision measures is reversed although not significant. The interaction effects here are also negative and significant for investor willingness to invest (WillInvest) and investor inclination to invest (InvestInc) but not significant for investor willingness to know more (KnowMore). This suggests that the more familiar investors are with the industry in which the busines operates, the less likelihood they are inclined to invest in the business contrary to what we expect. There are no significant moderating effects for the investing experience (NoOfYears) factors for all the investor decision variables.

Table 10: Linear regression model estimation results with KnowMore as dependent variable with various moderating factors

	KnowMore			**WillInvest**			**InvestProp**		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
UncertCond	0.11 (0.16)	0.07 (0.22)	-0.33 (0.17)*	0.04 (0.14)	0.17 (0.20)	-0.24 (0.15)	<0.01 (0.12)	0.12 (0.17)	-0.22 (0.13)*
OppFit	0.79 (0.05)***			0.66 (0.05)***			0.55 (0.04)***		
FamLevel		0.38 (0.07)***			0.35 (0.06)***			0.27 (0.05)***	
NoOfYears			-0.03 (0.02)*			-0.03 (0.02)*			-0.02 (0.01)*
UncertCond:OppFit	-0.12 (0.06)**			-0.07 (0.05)			-0.06 (0.05)		
UncertCond:FamLevel		-0.12 (0.08)			-0.14 (0.07)*			-0.11 (0.06)*	
UncertCond:NoOfYears			0.01 (0.02)			0.01 (0.02)			0.01 (0.01)
Intercept	0.76 (0.14)***	1.72 (0.20)***	2.91 (0.15)***	0.69 (0.13)***	1.38 (0.17)***	2.52 (0.13)***	-1.19 (0.10)***	-0.55 (0.15)***	0.30 (0.11)***
F-test (model)	252.60	25.20	4.74	221.00	24.03	5.56	221.70	19.34	4.90
p-value (model)	<0.001	<0.001	0.0027	<0.001	<0.001	0.0009	<0.001	<0.001	0.0022
Adj. R^2	0.4488	0.0726	0.0120	0.4159	0.0694	0.0145	0.4166	0.0560	0.0125

Notes: This table presents results for a linear regression model with three investor decisions measures (KnowMore, WillInvest, and InvestProp) as dependent variable and various measures of investor characteristics (opportunity fit, familiarity level and number of years of investing) as moderators and uncertainty conditions as regressors. The effects are shown with standard errors in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$

5.0 Discussion and conclusion

Findings in this paper suggest that business angels, like other decision-makers generally avoid uncertainty. They are less inclined to move a business opportunity to the next stage of the investment process when they are faced with information cues that drive uncertainty. While Huang and Pearce (2015) find that experienced business angels seek uncertainty, it is important to note that they do so when they assess the business opportunity to have the potential to make them extraordinary gains. This paper shows that outside of this domain, business angels are generally averse to uncertainty.

Their aversion to uncertainty is however mediated through their perceptions of uncertainty. Their observed investment decisions, whether to know more about the business or to invest in it, is precipitated through an unobserved process where 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 investors may be unaware of their perceptions of uncertainty and how it affects 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 leads to their observed decisions. Reported investment decision criteria or rejection criteria in angel investment literature are part of the formation of these subjective perceptions of uncertainty.

There is also some evidence that some personal characteristics moderate investors' aversion to uncertainty in this context. How a business opportunity fits with their personal preferences for example, moderates the relationship between uncertain information cues in business proposals and investor decisions. BAs are heterogenous by nature and are influenced by their personal differences. While we predict that favorable assessment of a business opportunity fit should

lead to a more favorable 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. Similarly, when investors are familiar with the industry in which the business operates, it leads to a less favorable inclination to invest. There is, however, no evidence about the effects of past investment experience on this relationship.

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. Investors are thus prone to issues of adverse selection where businesses that will eventually fail are financed and those that will actually succeed are not. Missing or incomplete information can thus be resolved when investors seek additional information. An awareness of the role of uncertainty is thus crucial to improving investor decisions and in effect access to finance.

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Appendix

Table 7: Linear regression model estimation results with KnowMore as dependent variable and UncLevel as mediator

	1	2	3	4	
	KnowMore	**UncLevel**	**KnowMore**	**UncertCond**	**Bootstrapping**
UncertCond	-0.23 (0.09)**	3.49 (1.68)**	-0.15 (0.08)*		
UncLevel			-0.02 (<0.01)***	0.001 (<0.01)	
KnowMore				-0.02 (0.01)*	
ACME					-0.084*
ADE					-0.146*
Total Effect					-0.230**
Prop. Mediated					0.366*
Intercept	2.67 (0.08)***	66.13 (1.46)***	4.26 (0.13)***	0.76 (0.07)***	
F-test (model)	6.398	4.303	119.1	3.753	
p-value (model)	0.012	0.038	<0.001	0.024	
Adj. R^2	0.0058	0.0036	0.2030	0.0059	

Notes: This table presents results for linear 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. The effects are shown with standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, and * p<0.10.

Table 8: Linear regression model estimation results with WillInvest as dependent variable and UncLevel as mediator

	1	2	3	4	
	WillInvest	**UncLevel**	**WillInvest**	**UncertCond**	**Bootstrapping**
UncertCond	-0.17 (0.08)**	3.49 (1.68)**	-0.10 (0.07)		
UncLevel			-0.02 (<0.01)***	0.001 (<0.01)	
WillInvest				-0.02 (0.01)	
ACME					-0.07*
ADE					-0.10*
Total Effect					-0.17**
Prop. Mediated					0.43*
Intercept	2.28 (0.07)***	66.13 (1.46)***	3.68 (0.11)***	0.73 (0.07)***	
F-test (model)	4.594	4.303	114.6	3.085	
p-value (model)	0.032	0.038	<0.001	0.046	
Adj. R^2	0.0039	0.0036	0.1969	0.0045	

Notes: This table presents results for linear 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 casual mediation analysis are also shown. The effects are shown with standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, and * p<0.10.

Table 9: Linear regression model estimation results with InvestProp as dependent variable and UncLevel as mediator

	1	2	3	4	
	InvestProp	**UncLevel**	**InvestProp**	**UncertCond**	**Bootstrapping**
UncertCond	-0.17 (0.07)**	3.49 (1.68)**	-0.10 (0.06)*		
UncLevel			-0.02 (<0.01)***	0.001 (<0.01)	
InvestProp				-0.03 (0.02)*	
ACME					-0.07**
ADE					-0.10*
Total Effect					-0.17**
Prop. Mediated					0.38*
Intercept	0.13 (0.06)**	66.13 (1.46)***	1.36 (0.09)***	0.70 (0.05)***	
F-test (model)	6.191	4.303	128.3	3.639	
p-value (model)	0.013	0.038	<0.001	0.027	
Adj. R^2	0.0056	0.0036	0.2155	0.0057	

Notes: This table presents results for linear 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. The effects are shown with standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, and * p<0.10.