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The Value of Human Capital Signals for Investment Decision Making under Uncertainty* – An analysis of cross-border venture capital investments in Europe and sub-Saharan Africa –

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Abstract: In this paper, we analyze the interaction between human capital signals of entrepreneurial founding teams with the contextual experience of potential investors, aiming to explain investment decision making. We use the case of cross-border venture capital (VC) investments in volatile and uncertain environments as our empirical setting. A large body of research from behavioral economics illustrates that when faced with uncertain and complex decision problems, investors tend to rely on simple heuristics and rules-of thumb, derived by easily accessible and assessable signals. Yet, with increasing experience, investors improve their heuristics and develop more sophisticated and contextual decision making procedures. Previous research in the context of VC investments particularly points at human capital signals of the founding team as an important criteria considered by venture capitalists. Among those signals, a high-class university education is considered as the easiest to access, yet evidence suggests a very loose association between educational achievements and entrepreneurial success. We address the question if more experienced investors cope with uncertainty by relying on different signals than their less experienced peers. We do so by contrasting cross-border VC investments by the same investors in a selection of sub-Saharan African countries with their investments in European economies. Using a propensity score matching procedure, we match every observed investor-company investment pair with a similar pair that did lead to an investment. Based on Crunchbase investment data, we gather via LinkedIn and further sources detailed information on the founders professional and education background. We find human capital signals from the entrepreneurs to be of higher importance for investors when investing in uncertain environments. The effect is stronger for specific than for generic human capital. We further find this effect to be moderated by the investors' country-specific previous experience.

Keywords: venture capital, cross-border investments, entrepreneurship, decision making under uncertainty, human capital

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1 Introduction

One of the most fundamental economic issues is the decision to invest or not and the determinants of these decisions. In this paper, we analyze the interaction between human capital signals of entrepreneurial teams with the contextual experience of potential investors on their investment decision making under high uncertainty. We use the case of cross-border venture capital (VC) investments in volatile and uncertain environments as our empirical setting to illustrate these problem areas. A generic approach to mitigate asymmetric information and principal agent problems in investor-investee relationships and in investment decisions is to assess quality indicators (Polanyi, 1966). In the same vein, a large body of research from behavioral economics illustrates that when faced with uncertain and complex decision problems, investors tend to rely on simple heuristics and rules-of thumb, derived by easily accessible and assessable signals (Tversky and Kahneman, 1974, 1992). Yet, with increasing experience, investors improve their heuristics and develop more sophisticated and contextual decision making procedures (Hain and Mas Tur, 2016). Previous research in the context of VC investments particularly points at human capital related signals of the entrepreneurial team as the most important ones considered by venture capital firms (VCF's) (Hsu, 2007; Mason and Stark, 2004). Drawing from human capital theory, a large body of research suggests previous entrepreneurial and management expertise as well as the educational achievements of a venture's founding team to highly increase the probability of attracting VC investments (eg. Gimmon and Levie, 2010). We address this question, but also if experience matter on the investor side regarding if more experienced investors cope with uncertainty by relying on different signals than their less experienced peers.

Basically we propose that in uncertain contexts where information allowing investors and entrepreneurs to make predictions (market research, other forecasts) is scant the signals provided by what in human capital theory is termed specific human capital (experience) is more important than generic human capital (education). This proposition is elaborated later in the paper. To research these issues, we explore determinants of cross-border VC investments in a selection of sub-Saharan African countries that can be characterized as highly volatile and uncertain investment environments (Hain and Jurowetzki, 2015; Park et al., 2016). We compare these to the cross-border investments carried out by the same VCF's in advanced economies, which serves as a baseline of investment decision making compared to a selection of more uncertain contexts. Using a propensity score matching (PSM) procedure, we match every observed investment by a VCF with a potential investment in a similar firm, which did not receive external funding. To do so, we leverage the graph-structure of Crunchbase (CB) data to, in addition to commonly used firm level variables, gather detailed information on the founding team. We link these data to the LinkedIn profile of founders and obtain further information on their professional and educational background. This research is relevant and important in light of the internationalization of venture capital and the rapid increase of venture capital investments specifically in sub-saharan Africa, as further explained in section 2.

We find evidence that human capital is generally an important investment criterion. This is of no surprise. However, we separate human capital into specific and generic human capital and find that when investing in sub-Saharan Africa, VCF's were more inclined to base their decisions on specific human capital than when investing in Europe. Consequently, human capital signals from the founding team appear to be of higher importance for investments in uncertain environments. This effect is stronger for specific (experience) than for generic (education) human capital. We further find this effect to be moderated by the VCF's country specific previous experience.

We inform the theoretical discussion on investor decision making in several ways. First, we provide an analysis of the information that investor and investee build upon in highly uncertain investment environments. Despite the fact that investment criteria of VCF's is one of the most extensively researched topics in the VC literature there is a lack of specification of the human capital that investors assess. Previous literature in this area has primarily been concerned with comparing business angels and institutional VC (Fiet, 1995; Hsu et al., 2014; Van Osnabrugge, 2000) whereas we extend this literature to comparing investments into different contexts. Secondly, we contribute to the understanding of cross-border VC investments. The literature has pointed to the impact of proximity on investment decisions, and that cross-border investment often takes place through spear-head organizations in syndicated investments in order to cope with the agency problems associated with investing at a distance (Chemmanur et al., 2016; Christensen, 2007; Hain et al., 2016; Li et al., 2014; Mäkelä and Maula, 2008; Meuleman et al., 2017). We add to this literature by incorporating the type of information that forms decision making. Thirdly, we link these issues regarding the characteristics of the investee company and human capital of founders back to the human capital of investors. We explore if investors with a particular background tend to go into investments where founders have similar background. Wiltbank et al. (2009) show similarly that investors with a long experience from starting and running entrepreneurial start-ups value predictive information less than investors with other backgrounds, contrary value effectual information higher. Fourth, we investigate VC investments in a geographical area, sub-Saharan Africa, which is rarely analyzed. We use this geographical area as a case of a highly uncertain investment context. Finally, we provide quantitative results regarding investment decision making, which is otherwise difficult to study without experiments, verbal protocol

analysis, or (other) qualitative methodologies. Moreover, our results are based on revealed, objective preferences rather than survey-based subjective judgments.

The findings provide implications for entrepreneurs searching for external capital, particularly on what to emphasize in their application and pitch in order to attract cross-border venture capital investments. For VC firms expanding to foreign markets findings have implications both regarding the choice of spearhead syndication partner (Meuleman et al., 2017) and regarding what type of investment managers to recruit. Lastly, policy makers might find inspiration in how to attract foreign venture capital by encouraging interaction between certain types of VCF's and startups seeking for funding. In addition, our findings may inform policy regarding how to attract foreign venture capital by targeted foreign education, returnee attraction, and VC-matching programs.

The remainder of the paper is structured as follows. In section 2 we provide some background on the internationalization of VC particularly in emerging economies, and present our case region of sub-Saharan African countries. Section 3 explains our theoretical point of departure and -development. Section 4 explain data, sampling and our empirical strategy. The results of the analysis are presented and discussed in section 5. The final section 6 concludes, provides implications, and points towards the limitations of our research as well as avenues for future research.

2 Background: The Internationalization of Venture Capital and cross-border Investments in Sub-Saharan Africa

2.1 The global expansion of venture capital

During the last decade, cross-border VC investments have increased substantially, in terms of numbers of deals and capital invested as well as industry and geographical reach (Aizenman and Kendall, 2008; Chemmanur et al., 2016; Guler and Guillén, 2005, 2010).While VC was seen as a Western economy phenomenon until the beginning of this century, nowadays venture capital industries and investments became increasingly international, and can also be found in many emerging economies (Ahlstrom and Bruton, 2006). Chemmanur et al. (2016) even argue that a large proportion of the increase in international VC is explained by investments into emergent markets. For example, they refer to that the share of all VC investments that are cross-border increased from 10% in 1991 to 22.7% in 2008, however the number of venture capital investments by international investors into emerging nations increased from 8.7% of the total venture capital investments in 1991 to 56% in 2008. These markets include countries such as Brazil (de Lima Ribeiro and Gledson de Carvalho, 2008), Taiwan (Saxenian and Sabel, 2008), India (Dossani and Kenney, 2002), and China (Xiao, 2002). As the latest of these developments, the VC industry has expanded it's reach to sub-Saharan countries such as Kenya and Nigeria (Gugu and Mworia, 2017; Jurowetzki and Hain, 2015; Park et al., 2016). The influx of foreign VC in emergent markets with limited indigenous venture capital has been said to be an important driver of the upsurge of growth-oriented, technology firms in these regions (Meuleman et al., 2017). However, while we are witnessing the emergence of dynamic start-up ecosystems and rapidly growing domestic markets in these countries (Ndemo, 2017), they are also characterized by a high degree of political and market instability (Ernest and Young, 2016), underdeveloped investor and property protection Peng (2001), corruption (Johan and Najar, 2010), weak security and basic infrastructure as well as vastly diverging business models, ethics, and practices (Ahlstrom and Bruton, 2006; Dai and Nahata, 2013).

As a consequence of the high uncertainty oversea investments into these countries represent a challenge for western[1] VC investors, requiring them to adjust their routines regarding deal selection (Dai et al., 2012), structure (Khavul and Deeds, 2016), monitoring, and providing managerial support. More broadly, existing funding models are in need to evolve and emerging funding models to forge new frontiers Drover et al. (ming).

Hence, venture capitalists display skepticism to invest in start-ups in less-developed countries, due to differences in general business practice, particularly diverging or lacking local entrepreneurial and managerial competences, and general lack of solid institutional systems and regulation supporting an attractive investment climate. One response to this uncertainty is to syndicate with local partners in the investment target country. This has become a common strategy, which is part of the explanation of a rapid growth in cross-border venture capital syndications (Chemmanur et al., 2016; Liu and Maula, 2016; Meuleman et al., 2017).

2.2 Uncertain contexts: VC investments in the KINGS Countries

Because we are concerned with investment decision making under high uncertainty our empirical analyses are embedded in what is arguable an environment characterized by high uncertainty; the most risky type of VC investments in emergent, turbulent industries in a geographical area known for flux and uncertain business environments. Specifically, we focus on what is often termed the "KINGS countries" (Osiakwan, 2017), which

[1] It should be noted that there is now also a focus on and trend towards increasing activity from African diaspora who invest directly into start-ups in their country of origin.

is Kenya, Ivory Coast, Nigeria, Ghana, South Africa, and we focus on cross-border investments into digital economy ventures. The KINGS countries have been said to be the hot-bed of digital economy developments on the African continent, but at the same time they are, according to indicators such as the Venture Capital Attractiveness Index (Groh et al., 2010) and the World Bank's "Ease of Doing Business" indexes[2] rather unstable and uncertain areas for investments. For example, according to Ernest and Young "Attractiveness survey for Africa" (**?**) the popularity of Africa as an investment destination has decreased recently. According to this source European investors remain dominant in the region although there is increasing interest from US investors. Additionally, both South Africa and Nigeria, the two largest economies in Africa, have experienced a general economic slowdown in recent years as well as declining inflow of FDI (**?**). As investments into the KINGS countries are also characterized by need of local knowledge the cross-border investments into these countries make up an extra dimension of the uncertainty associated with these investments.

We study venture capital investments in these countries but as a contrast, we compare with venture capital investments into a selection of European countries. The selection of these countries is based on the criteria that they score high on investment attractiveness indicators and that doing business in these countries is easy. They are characterized by stable markets allowing entrepreneurs to produce predictive information to a larger extent than in the KINGS country counterparts.

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3 Theory & Hypotheses

3.1 Asymmetric information and principal agent issues in investment decision making

Imperfections stemming from asymmetric information and adverse selection problems have for long been realized and acknowledged by scholars as a generic source of market failure in buyer-seller (Akerlof, 1970) as well investor-investee capital markets (Myers and Majluf, 1984). Moreover, it is now almost a century ago since Knight (1921) pointed to the management risk in entrepreneurship and that such risks implies principal-agent problems. Four decades ago Jensen and Meckling (1976) and later Fama (1980) spurred renewed interest in agency problems (e.g., Eisenhardt, 1989).

Applied to the issue investment decision making under uncertainty, the consequences of asymmetric information have primarily been discussed in relation to the micro-economic case, where financiers are faced with entrepreneurial projects for which they have little possibility of estimating the returns, as well as poor options to cover the risk by way of collateral. From an investor perspective, investing in firms in uncertain environments is associated with higher information asymmetries between firm and investor, and related with higher risk and uncertainty leading potentially to a higher variance of returns.

Subsequently it was pointed out in the literature that the context impact the principal-agent relations. However, prior literature has not been very precise in specifying which contexts impact principal-agent relations, and how, which is why we are particular interested in the impact of contextual factors in this study.

3.2 Decision making under uncertainty, bounded rationality, and herding

The research area investment decision under uncertainty has been of interest to academics and practitioners alike roughly as long as the economic profession is old. When J.M. Keynes in his "The General Theory of Employment, Interest and Money" (Keynes, 1936, particularly chapters 3 and 12), pointed to the impact of what he termed "true" uncertainty on investment decisions, thereby spurring an economic school of thought, post-Keynesian economics. One of the implications of Keynes' theory was a renewed interest in what could be termed fundamental uncertainty. The distinction between risk and fundamental uncertainty goes back a hundred years but was subject to intense debate in the 1960^s and 1970^s. The debate involved scholar like Robert Clower, GLS Shackle and Paul Davidson. The insights from this debate is relevant to understanding investment processes under uncertainty.

When faced with imperfect knowledge agents need guidelines for behavior to make predictions less uncertain. The principal guidelines for behavior under uncertainty are institutions such as conventions, but to base formation of expectations to the future on conventions can in some situations be inexpedient as the stability of conventions can be questioned. Conventions are influenced internally, by changes in belief in the convention, or in other words, the co-existence of more than one convention on the same subject, and externally, by other institutional changes (Keynes, 1936, p.172). Routinized behavior may change in periods of crises in conventions and the transformation from one convention to a new through learning processes adjust old behavior to a new situation. The old convention is usually not totally abandoned but some adjustments take place based upon experience

[2] http://www.doingbusiness.org/rankings

through partaking in social practices (hence expectations about behaviour is dependent on, and formed by context (Lawson, 1985).

Along the same line, but with a different perspective, a long tradition of research on behavioral finance has demonstrated that the investment decision making processes cannot adequately be modeled and understood as an objective optimization process pursued by fully rational agents. The arguments for this statement are at least threefold. First, capital market inefficiencies means that the set of information needed to fully assess a given investment's outcome is in most cases incomplete (Jaffee and Russell, 1976). While a fair share of necessary information on future technology, market, and policy developments is just non-existent and therefore not available *per se*, also existing information tends to be asymmetrically distributed among market participants, leading to principal-agent issues between investors and firms. Second, investors make decisions under "bounded rationality" (Simon, 1955), meaning that even in hypothetical presence of complete information, investment complexity tends to exceed the investors capacity to fully process and evaluate the available information. Third, decision making is also subject to a set of cognitive biases (McFadden, 2001) caused by the investors beliefs, historical experiences, and social influences. Generally, previous research has shown that with decreasing complexity and uncertainty of the problem, simple heuristics become more important in the decision making process.

Consequently, agents subject to bounded rationality do not search for optimal solutions, rather limit their search for optimal choices and stick to satisfactory solutions (Simon, 1982, p.131f.). Rational behavior would, under these circumstances, be to concentrate on creating well-working procedures for obtaining a choice set and decision-making rather than focusing on a one-time selection of a solution. This distinction is between procedural and substantive rationality, respectively, as Simon (1982) denotes it. Consequently, agents will have different rationalities because of differences in how far back they remember analogue situations, and differences in how past learning and forgetting processes have formed their routines, opinions, and ways of reacting to new situations. Hence, experience and learning is essential in connection to the formulation of choice sets. Agents grade information according to experience because they recognize patterns from the past, similar to the situation in question. Due to a feedback mechanism agents learn about the effectiveness of these procedures (instincts, rules-of-thumb, habits, administrative rules, etc.) and adjust them accordingly (Katona, 1975; **?**).

On the other hand, Heiner (1983) demonstrates how uncertainty impact on decision making, reaching somewhat different conclusions. The basic argument is that uncertainty may in fact contribute positively to predictability of investor decisions. Due to what he terms a competence-difficulty gap in uncertain situations, there is a tendency for agents to fall back to established, known conventions. Hence, behavior under strong uncertainty is not necessarily less predictable but is likely to rely on other foundations. Similar considerations are found in the later works of Simon (1982). Although he points to bounded rationality due to information access and processing limitations as outlined above, he also point out that this narrows the scope of possible behavior. On a general level therefore, increased uncertainty often leads to more heavy reliance on institutions and established routines.

The implication for our analysis is that we can justify inferring homogeneous behavior within the groups of agents we study, venture capital investors. However, this is likely to be modified by their experience base as agents behave for a large part based on experience, our stock of knowledge, compared to the type of information available. Importantly, this homogeneity is not only formed by subjective, individualistic preferences, rather by the impact of common conventions, available information, the cost structure of additional information, and context. Hence, Hutchison (1979) build on Keynes' distinction between direct and indirect knowledge when he proposes that expectations are not solely based on individual choice. The impact of the social system and institutional framework in which the individual lives and obtains knowledge is vital and behavior is not a random choice (Hutchison, 1979). Agents learn in different ways, with different intensity and with varying interaction with the surroundings. However, the variation in behavior is substantially modified by conventions and interactions with other agents.

Specifically, the venture capital industry has been debated in this perspective. Gorman and Sahlman (1989) pointed to a herding behavior where venture capital firms (in fear of type II errors) prefer to follow the behavior of other venture capital firms. Terjesen et al. (2013) study venture capital decisions based on 139 business plans in the US. They find evidence that venture capital firms exhibit "normative rationality" i.e. decisions tend to become homogeneous and based upon norms and traditions spurred by a "macro-culture" in the venture capital industry (Bruton et al., 2005). Therefore, venture capital firms may pay more or less attention to past performance or various economic indicators as compared to human capital factors. This may in turn be explained not only be rational calculations of the cost of information (Hayek, 1945), but also by the way behavior is formed by uncertain circumstances and by the impact of context and conventions.

These conflicting views of the factors underlying investment decisions accentuate the present study. Insights from general studies of decision making have previously been applied to venture capital decisions as indicated above. We use knowledge produced in these studies but focus on cross-border venture capital investments. This allows us to be more specific on the investment criteria used and to focus on how to deal with asymmetric information and agency problems. Hence, the literature on cross-border VC syndication, Khavul and Deeds (2016) test the risk mitigating effects of economic and social signals on the choice of initial co-investment ties among domestic and foreign VCF's in an emerging market. Related, we look into the investment criteria in such

investment situations.

3.3 The role of signals in decision making under uncertainty

Firms considered for VC finance are typically young start-ups in dynamic, knowledge and technology intensive sectors with high growth ambitions and potential. Against this background, one characteristics generally surrounding VC investments is the lack of of the factual, or "hard", information, such as a firm's future cash flows, market share estimations, financial sensitivity analysis etc. is not available when assessing creditworthiness, survival rates and projected performance. In such cases, when codified signals and track records are often absent (Uzzi, 1999; Uzzi and Lancaster, 2003), firms may face substantial obstacles in obtaining external financing.

To mitigate hesitation of potential investors caused by asymmetric information and resulting principal-agent issues, firms searching for external finance are in need to communicate their merits to financiers, which is usually done by providing quality signals. However, the means of doing this vary greatly. A number of different signals of quality have been pointed to in the literature, but the instruments for alleviating information asymmetries and principal-agent problems is subject to strategic reasoning as well as differences among types of investors. For example, putting parts of personal wealth into the project can act as a signal that the entrepreneur believes in the venture and will behave in accordance with agreements. Further, an emerging stream of literature focuses on the patenting behavior of firms as a mean of overcoming these informational barriers (Harhoff, 2011; Häussler et al., 2014), especially in the early stage of development (Hoenen et al., 2014). Likewise, Lahr and Mina (2016) find that VCF's follow patent signals to invest in companies with commercially viable know-how.[3]

Podolny (1993) argues that with increasing inability to assess the quality of a producer or product and the resulting uncertainty, market participants will to a larger extend rely on the producer's status as a signal to make inferences about quality. In a similar vein, previous research on the context of venture capital investments particularly points at human capital related signals of the entrepreneurial team as the most important ones considered by venture capitalists (Hsu, 2007; Mason and Stark, 2004). Consequently, in line with previous research, we expect different forms of en entrepreneurial team's human capital to be a particularly important quality signal considered for VCFs investment decisions.

We further expect the value of human capital signals to be stronger in a highly uncertain context for at least two reasons. First, as stressed in the literature, with increasing uncertainty and complexity surrounding a decision problem, investors (and other decision makers) are subject to bounded rationality tend to rely on simple heuristics and sound signals to "shortcut" the decision making process. Second, in situations where "hard" information such as financial track records enabling a more causal-predictive decision making process are scarce, investors need to revise their strategy regarding what to emphasize when taking investment decisions. More specifically, we expect what we term "effectual" factors (Sarasvathy, 2001; Wiltbank et al., 2009) to get more weight in the evaluation. [4] We therefore investigate if in extreme uncertainties the predictive information is of less value (Wiltbank et al., 2009) as opposed to the signals that the entrepreneurs' background provides. These signals around the networks and experience of entrepreneurs are, according to reasoning around effectual execution of entrepreneurship, particular valuable in situations where solid predictions are difficult.

Consequently, we propose that:

Proposition 1 *The impact of human capital related signals on investment decision making:*

(a) Human capital signals of an entrepreneurial team positively impacts an investors' decision to invest in the new venture.

(b) This positive impact of human capital signals is higher in environments characterized by high uncertainty and asymmetric information.

However, our research design, as specified later, does not allow us to test this proposition directly. Rather, in the following we attempt to disentangle the impact of certain human capital signals on heterogeneous investors, given the contextual degree of uncertainty.

3.4 Nuances in human capital signals: generic vs. specific

However, literature has also stressed that there exists no single capturing all aspects human capital. A distinction particularly made is the one between general human capital and specific human capital. The former is e.g. formal qualifications, educations etc. and the latter relevant experience and task-specific training. Generally, investors can be expected to be heterogeneous in their valuation of these different forms of human capital.

[3] Additionally, the literature on relationship banking Berger and Udell (1995) point to that repeated transactions can build trust that alleviate agency problems. Other means include third-party opinions and referrals. However, the means are often not available in the empirical setting we study.

[4] The alternative behavior would be to emphasize to a higher degree the predictive information and use that as a selection criterion; only the limited number of entrepreneurs who are able to provide this type of information would get funding.

Particularly, it has been pointed towards differences in investment criteria among business angels and institutional venture capital firms, arguing that controlling the agency problems are primarily linked to specific human capital (hence angel investors valuing this more). Further, institutional VCFs to a larger extent rely on other control mechanisms like financial performance milestones, staged investments etc. (generally outcome-oriented factors) to reduce principal-agent goal conflicts (Eisenhardt, 1989; Hsu et al., 2014). Venture capital firms weigh "economic risk" hence economic factors and financial potential of the proposal higher than angel investors who put greater weight on human factors (Hsu et al., 2014). Principal-agent goal conflicts and asymmetric information can be mitigated by closely monitoring the investee firm.[5]

In our case, we are particularly interested in the importance more or less experienced investors give to generic and specific human capital. Starting with what we label generic human capital, a large body of literature provides evidence that the entrepreneurial teams' educational background is (provided it matches the character of the business) an important determinant of VCFs' investment decisions. For instance, Hsu (2007) finds founding teams with a doctoral degree holder are more likely to be funded via a direct VC tie and receive higher valuations, suggesting a strong signaling effect, which might be of particular value in otherwise uncertain environments. The assessment of academic education represents a comparably easy task, since the signal is already provided by the certifying institution. Yet, a body of evidence (e.g., again Hsu, 2007) suggests achievements in education and academia to be not, or at best loosely, connected with entrepreneurial success.

With increasing investment experience, investors generally improve their heuristics and develop more sophisticated and contextual decision making procedures (Hain and Mas Tur, 2016). Consequently, it can be expected that with growing experience, investors attribute less value on this straightforward signal

Hypothesis 1

(a) The impact of the entrepreneurial teams' generic human capital on an investors' decision to invest in the new venture is moderated by the investors' experience, such that it decreases with investor experience.

(b) This moderation is stronger in environments characterized by high uncertainty.

In contrast, we suggest specific human capital, in our case entrepreneurial and managerial experience, to be a fuzzy signal, since performance is not easily observable by existing indicators, and generally the whole assessment of its value requires some amount of contextual understanding, in terms of how certain positions in certain companies provide useful skills for the startup. While previous research suggests specific human capital to be particular important in investment decisions (Dimov, 2010; Franke et al., 2008; Hall and Hofer, 1993) as well as predictive for a venture's success (Gimmon and Levie, 2010), it also highlights variations of the extend to which it is valued by investors. We again link this heterogeneity to variations in investor experience. We argue that more experienced investors will have more sophisticated routines, which enable them to properly assess more fuzzy signals. Consequently, we expect to see an increasing impact of the entrepreneurial teams' specific human capital with growing investor experience on the VCFs' investment decision.

Hypothesis 2

(a) The impact of the entrepreneurial teams' specific human capital on an investors' decision to invest in the new venture is moderated by the investors' experience, such that it increases with investor experience.

(b) This moderation is stronger in environments characterized by high uncertainty.

Further, as already stressed, VCF's are a heterogeneous group of equity investors, characterized by individual investment rationales and preferences, but also differences in their knowledge base and experience with respect to specific countries, technologies, and industries. Consequently, the evaluation of available information on the venture might be interpreted and weighted differently, depending on their general investment experience, but also specific (contextual) experience regarding the targeted country, technology, and industry (Hain and Mas Tur, 2016). Since an investors' specific experience (in this case interpreted as investment experience in the target country) can be interpreted as a more nuanced contextual understanding of an investment environment, we expect the moderating effect on the valuation of human capital signals to be stronger for specific than for general experience.

Hypothesis 3

(a) The positive moderation of investor experience and entrepreneurial teams' specific human capital on an investors' decision to invest in the new venture will be stronger for contextual that for general investor experience.

(b) The negative moderation of investor experience and entrepreneurial teams' specific human capital on an investors' decision to invest in the new venture will be stronger for contextual than for general investor experience.

[5] Interestingly, for consumer banks, Grilli (2005) finds that human resources possessed by Internet founders does not represent an important driver for gaining access to bank credit and they do not affect the amount of the incurred debt. In summary, investors are heterogeneous in the way if and how they factor different components of human capital into their investment decision.

4 Data and Method

4.1 Data and sample

To investigate VC and business angel investments in the KINGS countries, and contrast them with investments in selected EU countries, we utilize data provided by CrunchBase (CB). CB is the open, community-curated database of TechCrunch – currently containing profiles of 650.000 companies, investors, and people around the world – with detailed activity and technology descriptions. According to own statements CB has 2 million monthly users and around 50.000 active contributors, editing the database in a peer-review type process. In addition to providing well-structured entity profile information, the graph architecture of CB allows us to extract multi-modal relationships between all contained entities, such as *company–funding round–investor*, *company–founder*, *founder–Press articles*. While rather patchy during the last decade, newer investment and company data after 2010 has been found to be rather complete and comparable to other traditionally utilized commercial equity investment databases such as Thompson Reuter's *Thompson ONE* or Bureau van Dijk's *ZEPHYR*, and is nowadays frequently used in VC research (e.g., Block and Sandner, 2009; Croce et al., 2016; Cumming et al., 2016; Ter Wal et al., 2016).

For the present study, we constructed a dataset by crawling the graph structure of CB, starting with all funding rounds classified as *seed*, *angel*, or *venture capital* (153) targeting start-up companies (134) in the KINGS countries, and their investors (169). Of these investors, 112 where located in countries other than the KINGS, mostly from the United States and western European countries. In a next step, we expanded the dataset by further cross-border funding rounds (targeting companies not located in the investors' country of origin) of these non-KINGS investors, carried out in the selected EU countries Germany and the United Kingdom. For all these funding rounds, we extract additional information on all investors involved, the targeted companies, and their founders. As a result, we end up with a dataset containing all funding rounds of non-KINGS investors targeting KINGS companies, and the same investors funding rounds in the EU countries Germany and the United Kingdom.

To obtain further data on human capital related signals of the targeted companies (KINGS and EU), we extract information on the founders entrepreneurship experience, managerial experience, and education from LinkedIn.

In the past few years there have been profound changes in the venture capital investment markets. Business angels and early stage funds have moved closer together as investment partners in order to pool resources and compensate for the lack of formal venture capital firms as investors who can bring companies to the next stage. Moreover, increasingly angels form investment groups and syndicates allowing them to invest in the segment where formal venture capital firms used to operate and to take firms through several funding rounds without being diluted by outsiders. There are indications that in some areas such as North America and Scotland, the trend is for an increasing number and importance of angel groups, and that these angel groups act more professionally and similar to venture capital funds. This has caused some authors to point to a fundamental change in the way angel markets are organized (Mason et al., 2013; Sohl, 2012). As a consequence we dismantle in our analyses the distinction between different VC investors and group institutional venture capital funds and angel investors in one.

Our research questions regarding investment criteria in uncertain contexts could have been analyzed by comparing investment behavior in two periods of time, for example during and after the financial crisis. Instead we define the difference in uncertain contexts as spatial, comparing different geographical areas that arguably are characterized by different levels of uncertainty.

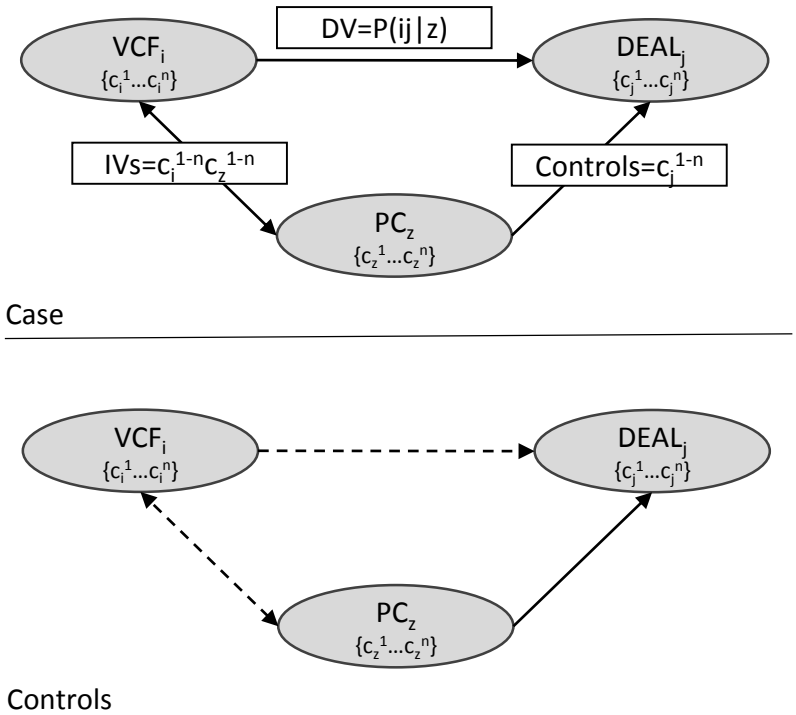
Another methodological choice we make is that we focus exclusively on analyzing the initial investment (Mason and Harrison, 2003). This choice is made to reduce noise from the impact of the reputation of the lead investor. When investments are done in a syndication the recommendations regarding further funding rounds from a reputable lead investor is likely to be an important signal for other investors relative to the information on the founders. Naturally, this effect is not eliminated from focusing on the initial investment, but it is likely to be smaller than in subsequent funding rounds.

4.2 Econometric strategy

Our aim is to identify investment decision making criteria of VCFs and BAs in environments with varying degree of uncertainty and availability of information. To do so, we apply a comparative approach, where we contrast investments in countries generally characterized by low (EU) and high (KINGS) uncertainty. Possibilities to analyze investment decisions are traditionally limited by the fact that we only observe positive investment decisions, but not their counterfactual of negative investment decisions. Optimally, such research would utilize all applications for funding an investor receives, and aim for identify criteria which are associated with a positive investment decision or rejection. In lack of such data, most research on VC and BA investment criteria are consequently based on interviewing or surveying investors (e.g., Fiet, 1995; Mason and Stark, 2004; Mason and Harrison, 2003; Van Osnabrugge, 2000). Despite their merits and usefulness, such approaches generally rely on the potentially systemic willingness of VCFs to participate, hence are in risk of suffering from response bias.

Furthermore, since investment decisions are bundles of various components (Hsu et al., 2014), investors might not be able to correctly quantify the value of single components of such complex decision problems (Zacharakis and Meyer, 1998; Zacharakis and Shepherd, 2001).

Figure 1: Illustration of case-control logic, DV, IVs and CVs



Note: The triangles illustrate the data structure. The solid lines represent observed participation, and the dotted lines represent potential but unrealized participation of an VCF in an observed deal.

We instead deploy a case-control approach[6] where we aim to estimate the probability that an investor decided to invest in a portfolio company (PC), given the characteristics of the associated deal (total amount invested, deal type and stage, time), as well as the joint characteristics of the VC-PC pair.

In each case-control set, the investor remains constant. Yet, we alter the deal and associated portfolio company such that we can compare every deal an investor participates in with 5 others where the particular investor did not participate. To exploit mainly the variation of VCF and PC characteristics, we carry out a propensity-score matching (PSM) to select control-deals of similar characteristics. This approach is illustrated in figure 1.

Since this approach compares a VCs observed and hypothetically possible participations in deals which nevertheless happened with a different set of VCs, it cannot be used to identify general investment preferences of VCs in particular deal structures or PCs. Yet, the interaction between VC and PC characteristics in a given deal provides opportunities to uncover heterogeneous revealed investment preferences of the VCs.

By further comparing two geographical samples of deals with varying (assumed) uncertainty and information asymmetry, we can also make inferences on the impact of context-dependent environmental factors on the investment decision.

As estimation technique for the econometric exercise, the nature of our sample and dependent variable suggest to deploy a generalized linear model (GLM) (McCullagh, 1984). GLM estimators are essentially generalizations of nonlinear least squares, and as such are optimal for a nonlinear regression model with homoskedastic additive errors, yet, also appropriate for other types of data which exhibit intrinsic heteroskedasticity Nelder and Baker (1972). They are a set of very flexible maximum likelihood estimators that are based on a density in the linear exponential family, and include the normal (Gaussian) and inverse Gaussian for continuous data, Poisson and negative binomial for count data, Bernoulli for binary data (including logit and probit) and Gamma for duration data. Due to the nature of our dependent variable, we in this paper use a logit link.

[6] Which is conceptually similar to the one by Sorenson and Stuart (2008), where they utilize a case-control approach to the context of VC syndications, where they compare a syndication triad between $VC_i \rightarrow VC_j$ conditional to its context, which is in this case the portfolio company they jointly invest in.

Variables

Dependent variable

Our dependent variable is dichotomous of nature, and represents the probability ($P(ij)$) we observe a participation of VC i in deal j, which can represent a stand-alone as well as a joint investment of several VCs in PC z.

Independent variables

We attempt to explain this probability by three sets of variables, (i.) the characteristics of the VC, (ii.) the characteristics of the PC including human capital related signals from the founder team, and (iii.) the interaction of characteristics of a VC-PC pair.

VC characteristics: In this paper, we focus on experience related VC characteristics, where the total number of previous investments carried out by the VC (*inv.exp*) represents general experience, and the previous investments in the destination country (DC) of the PC (*inv.exp.dc*) represents context-specific experience.

PC characteristics: Given a specific deal structure, we limit ourself to PC characteristics related to human capital related signals of the founder team. In the case of multiple founders, we always use the maximum observed value within a PC's founder team. First, *pers.entrp* measures entrepreneurial experience by the number of previous startups founded by a team member. Further, *pers.mng* captures managerial experience by the number of years a founder worked in a managerial position. Since managerial experience might be provide a weaker signal in the case this experience was gained within a company which is totally unknown to the VC, we only include positions in a company listed in the Furtune-Global-500 list[7] of the corresponding time-period. The variable *pers.edu.dgr* accounts for education related experienced, measured on a scale from zero to three (0=no tertiary education, 1=bachelor, 2=master, 3=Ph.D. or equivalent level). Again, we limit ourselves to universities among the top-100 in the "QS World university Ranking" list[8] of the corresponding time-period. Finally, we account for attention related signals, by including the number of times the company or a founder was mentioned in newspaper articles *comp.press*.

Control variables:

We further include a set of standard control variables related to deal characteristics, namely dummies for the DC *country*, the*round.type* (seed,angel,venture), the overall amount invested in the deal (*round.usd*, 1000 US$, transformed by its natural logarithm), and the number of investors participating in the deal *inv.sum*.

5 Results

5.1 Descriptive Statistics

Table 1 provides descriptive statistics on the subsample of investment rounds in the KINGS countries, while table 2 provides statistics on the investments rounds targeting the selected EU countries. By first glance we see that investments in the EU are, compared to investments in KINGS countries, on average characterized by higher amounts invested (*round.usd*). In both samples, this variable further shows a high left skewness. Consequently, in the regression models we use this variable transformed to its' natural logarithm. We also find the team of founders in EU countries to be higher educated, while their KINGS counterparts possess on average more managerial experience. Our set of foreign investors shows a far higher average country experience in the KINGS countries than in the EU. This might suggest the increased need for geographical focus and specialization in the less familiar and more uncertain context the KINGS represent for the these investors.

5.2 Regression results

Table 3 summarizes the results of a set of GLM regression models (logit link) on the post-PSM sample, with the probability that an investor participates in an existing funding round with given characteristics as the dependent variable. All models are run separately for the sample of EU deals (odd model numbers) and KINGS deals (even model numbers). We first ran a set of baseline models (1-2), including the controls for deal characteristics, the VC characteristics, and the human capital signals of the PC's founder team. In the following models (3-4) we introduce interaction terms between the human capital signals of the PC's founder team and the VCs general experience, and finally (5-6) with the VCs country specific experience.

[7] http://beta.fortune.com/global500/
[8] https://www.topuniversities.com/qs-world-university-rankings

Table 1: Descriptive Statistics: Investments in KINGS countries (Foreign only)

Statistic	N	Mean	St. Dev.	Min	Max
round.usd	149	14,350.000	56,940.000	1	400,000
inv.sum	149	8.235	7.105	1	24
comp.press	149	19.310	47.720	0	368
comp.age	149	4.651	4.268	0	25
pers.entrp	149	0.483	0.768	0	4
pers.edu.top	149	0.034	0.181	0	1
pers.edu.dgr	149	0.152	0.024	0	2
pers.mng	149	1.154	2.064	0	9
inv.exp	149	20.100	68.320	0	216
inv.exp.dc	149	0.523	1.318	0	8

Table 2: Descriptive Statistics: Investments in EU countries (KINGS investors only)

Statistic	N	Mean	St. Dev.	Min	Max
round.usd	167	19,231.000	74,280.000	16	568,000
inv.sum	167	2.209	1.772	1	9
comp.press	167	43.680	103.700	0	481
comp.age	167	3.455	2.973	0	20
per.entrp	167	0.473	1.217	0	6
per.edu.top	167	0.127	0.164	0	1
pers.edu.dgr	167	0.655	0.627	0	3
pers.mng	167	0.838	1.884	0	7
inv.exp	167	45.980	62.700	0	218
invr.exp.dc	167	9.945	7.701	0	28

Due to our case-control setting, most of the controls in model 1-2 are not of interest. The VC's country specific experience *inv.exp.dc* might vary between case and control cases, and is thus worth considering. In line with previous findings (e.g., Hain et al., 2016), this variable shows a positive coefficient significant on the 1% level, suggesting path dependent geographical specialization of investors, which appears to be stronger in the sample of KINGS deals.

When introducing interaction terms between the human capital signals of the PC's founder team and the VCF's experience in model 3-4, we find – against our initial expectation articulated in hypothesis 1:a and 2:a – no significant effects of human capital signals for the sample of developed countries. However, in our sample of KINGS countries reflecting a more uncertain investment environment, we see in line with hypothesis 2:b a positive coefficients for the interaction between VCF experience and both specific human capital measures entrepreneurial and managerial experience, significant on the 10% and 5% level. Further, the formerly insignificant coefficient of *per.entrp* turns significant at the 5% level, suggesting in line with proposition 1:b a primary effect of the signal as well as an interaction effect with VC experience. According to hypothesis 1:a and 1:b, we would expect an impact of the interaction between education signals and VC experience. However, we find no acceptable level of statistical significance to support this hypothesis.

In the last set of models 5-6, while keeping the variables for the PCs human capital signals, we exchange the interaction terms from general to country specific (contextual) VC experience, which leads us to the following results. As in the previous set of models, the EU sample (5) indicates no significant main and interaction effect of neither general nor specific human capital, and again lending no support to hypothesis 1:a and 2:a. Yet, for the KINGS sample (6), we find similar results as for the interaction with general VC experience, yet more pronounced. Both the main as well as the interaction effect with entrepreneurial and managerial experience is positive and significant on the 5% level, providing support for hypotheses 2:b.

Further, in this model also the main effect of education signals is positive and significant, while the interaction with VC experience turns negative and significant. This suggests that foreign VCs indeed value signals provided by high-class education of the entrepreneur in question, yet that this signal is by far more appealing for investors with limited country experience and contextual knowledge, as stated in hypothesis 1:b. In this set of models, we also find support for hypotheses 3:a and 3:b, indicating the moderating function of context specific experience to be higher than the one of general experience.

In summary, we find mixed evidence regarding our two main hypothesis 1 and 2, where we only find some

Table 3: GLM regression results (link=Logit): Investments (Foreign only, Post-PSM)

	Dependent variable: Investor participates in round					
	EU	KINGS	EU	KINGS	EU	KINGS
	(1)	(2)	(3)	(4)	(5)	(6)
	Deal characteristics (controls)					
round.seed	−0.349	−0.660*	−0.292	−0.687*	−0.375	−0.650
	(0.658)	(0.394)	(0.666)	(0.396)	(0.666)	(0.399)
round.venture	0.021	−0.563	0.021	−0.637	0.080	−0.561
	(0.722)	(0.437)	(0.727)	(0.441)	(0.725)	(0.444)
inv.sum	−0.042	0.039**	−0.067	0.041**	−0.069	0.043**
	(0.072)	(0.016)	(0.076)	(0.017)	(0.076)	(0.017)
log(round.usd)	−0.126	0.0002	−0.063	0.008	−0.117	−0.001
	VC characteristic					
inv.exp	−0.010***	−0.0005	−0.009***	−0.006	−0.011***	−0.0005
	(0.003)	(0.001)	(0.003)	(0.004)	(0.003)	(0.001)
inv.exp.dc	0.171***	0.254***	0.182***	0.274***	0.181***	0.210***
	(0.021)	(0.076)	(0.023)	(0.078)	(0.024)	(0.080)
	PC human capital signals					
	(0.104)	(0.059)	(0.106)	(0.060)	(0.105)	(0.060)
comp.press	0.001	−0.0004	0.004*	−0.001	0.003	0.001
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
per.entrp	−0.141	0.275	−0.061	0.444**	−0.295	0.392**
	(0.208)	(0.195)	(0.247)	(0.215)	(0.303)	(0.221)
per.edu	0.109	−0.096	0.097	−0.114	0.187	0.110**
	(0.151)	(0.085)	(0.196)	(0.093)	(0.211)	(0.064)
per.mng	−0.022	−0.001	0.034	−0.071	0.012	−0.025
	(0.090)	(0.076)	(0.132)	(0.083)	(0.134)	(0.082)
	*VC * PC interaction terms*					
per.entrp*inv.exp			−0.004	0.015*		
			(0.007)	(0.008)		
comp.press*inv.exp			−0.0001*	0.0001*		
			(0.0001)	(0.0001)		
per.edu*inv.exp			−0.001	−0.0004		
			(0.006)	(0.003)		
per.mng*inv.exp			−0.001	0.006**		
			(0.004)	(0.003)		
per.entrp*inv.exp.dc					0.023	0.108**
					(0.028)	(0.047)
comp.press*invr.exp.dc					−0.0003	−0.009
					(0.0002)	(0.007)
per.edu*inv.exp.dc					0.012	−0.140**
					(0.021)	(0.157)
per.mng*inv.exp.dc					−0.002	0.173**
					(0.012)	(0.081)
comp.country	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	1,002	894	1,002	894	1,002	894
Log Likelihood	-229.100	-376.900	-224.700	-342.600	-227.900	-314.100

Note: *p<0.1; **p<0.05; ***p<0.01 , standard errors in parentheses

support in our KINGS sample representing an uncertain environments in model 4 and 6 (hypotheses 1:b and 2:b), but non in the more certain EU context in model 3 and 5 (hypotheses 1:a and 2:a).

By contrasting model 4 and 6, we find consistent support for hypothesis 3, indicating the positive as well as the negative moderation contextual VC experience to be higher that of generic experience, where contextual experienced investors tend to value specific human capital while disregarding general human capital.

6 Conclusion

We were interested in what is at the base of investment decisions when investors are faced with high uncertainty and informational deficiencies. We looked into this topic by analyzing venture capital investments in a selection of African countries that represents a context arguably characterized by high uncertainty. We compared investments in this area with similar investments in two European countries. This is accomplished using a propensity score matching procedure, where we create a counterfactual to every observed investment as represented by an investor-company pair, by matching it with a similar pair that did lead to an investment. We leverage the graph-structure of Crunchbase data, and in addition to the commonly used variables, extract detailed information on the founders professional and education background from LinkedIn.

Based upon earlier research on investment decisions and criteria for venture capital investments we derived hypotheses for our empirical analyses. Overall, we expected the specific human capital and execution capabilities, operationalized as the technological and managerial experience of the founder, to be a stronger, positive signal to investors in uncertain contexts than it would in environments where other types of information is more readily available.

We found evidence that human capital is generally an important investment criterion, and indeed the investors in the African setting were more inclined to base their decisions on specific human capital than investors in Europe. Human capital signals from the founders seem to be of higher importance for investors when investing in uncertain environments, and the effect is stronger for specific than for generic human capital. We further find this effect to be moderated by the investors country specific previous experience. We ascribe these findings to the fact that predictive information on the development of the market etc. would anyway be highly uncertain, hence the value of such information is relatively small, and the marginal returns of trying to obtain it would not outweigh the costs.

We regard knowledge on investment criteria under uncertainty important for several reasons. First, entrepreneurs have better knowledge on how to present their ideas and what to emphasize in business plans and presentations hereof. It has been argued that it is of utmost importance to direct the content of business plans to the specific audience (investor) it is targeting (Mason and Stark, 2004). Likewise, we think that when Hayek (1945) long ago talked about that information can only be acquired at a cost his proposition is relevant in the present connection. Entrepreneurs in uncertain contexts should be careful not investing too much money, time and effort into providing factual, predictive information as it is likely that investors would be more interested in "effectual" information. Secondly, venture capital firms may think of what types of investment managers to recruit when entering investments in uncertain markets. Wiltbank et al. (2009) show that investors who themselves have entrepreneurial experience tend to value effectual information higher (and also that these investors are more critical in their judgement of predictive information). Therefore, a match between the type of information and projects that are in the deal flow of uncertain contexts should be sought aligned with the competences of investment managers. Thirdly, it is considered of particular importance in cross-border investments into uncertain investment areas that a spearhead syndication partner with local knowledge is used (Mäkelä and Maula, 2008). Information on the investment capabilities and criteria used is of importance to the choice of spearhead syndication partner (Meuleman et al., 2017). Finally, our results suggest that targeted policy strategies towards investment in foreign- and exchange programmes may – aside from the positive effects of capacity building and network development – result in increased attention by VCFs.

The study is limited in its scope as it is confined to a set of narrowly defined countries. This was, though, a deliberate choice as the narrow range of countries studied was illustrating the point about uncertain contexts. Another limitation is that we focus the analysis on the human capital involved in decision making. Ideally, we would have assessed the predictive information together with the indicators that we analyze.

In further research and future versions of this paper we intend to enrich our data to a higher degree with other information extracted from LinkedIn. More specifically, we would like to gain more detailed insights with regard to the technological and managerial experience by drawing on the specific endorsed skillsets of individuals in the entrepreneurial teams. Another important angle would be to derive and include attributes from the social networks in which the entrepreneurs are embedded.

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