Human Capital and Law in African Venture Capital and Private Equity Markets

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This dissertation is dedicated to Musa O. Adongo. Dad, I wish you were here for this.

ABBREVIATIONS

AMP	Advanced Management Program
AVCA	African Venture Capital Association
CEO	Chief Executive Officer
CFA	Chartered Financial Analyst
CPA	Certified Public Accountant
EMPEA	Emerging Markets Private Equity Association
GDP	Gross Domestic Product
GP	General Partner
ICSID	International Center for Settlement of Investment Disputes
IPO	Initial Public Offering
LP	Limited Partner
MBA	Masters in Business Administration
NAM	Negative Assortative Matching
NASDAQ	National Association of Securities Dealers Automated Quotations
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PAM	Positive Assortative Matching
PE	Private Equity
PhD	Doctor of Philosophy
R&D	Research and Development
SAVCA	South African Venture Capital Association
STEM	Science, Technology, Engineering, or Mathematics
UK	United Kingdom
USA	United States of America
VC	Venture Capital

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Abstract

The three articles in this dissertation investigate the effects of human capital and law on venture capital and private equity investments and exits in Africa. Using a novel panel dataset, I test the overall null hypotheses that these two factors have no influence on venture capital and private equity activity on the continent.

In the first article, evidence suggests that negative assortative matching occurs between general partners and private equity portfolio company teams in Africa by their work experience in the venture capital or private equity industry. Since portfolio company teams on the continent lack this human capital trait, the direction of matching suggests that the dissimilar agents they match to are general partner teams with more work experience in the venture capital or private equity industry.

In the second article, evidence suggests that relative to other-tech exits, an increase in the proportion of bachelor degrees and graduates from a top-ranked university in post-match general partner and portfolio company teams increases the probability of clean-tech initial public offering exits. An increase in the proportion of bachelor degrees also increases the probability of clean-tech trade sale exits. In addition, an increase in the proportion of masters or doctoral degrees in post-match teams increases the probability of clean-tech secondary sale exits.

In the third article, evidence shows that improving a country's legal environment has a significantly negative effect on seed, start-up, or early venture capital investment within its borders, in the short-run. Theory suggests this is because better domestic legal environments promote the use of debt by general partners, which is difficult for seed, start-up, or early stage portfolio companies to access due to inadequate assets that can be used as collateral.

Based on this evidence, I can reject the null hypothesis that human capital has no influence on private equity investments, and clean-tech exits in Africa. I can also reject the null hypothesis that law has no short-run influence on seed, startup, or early venture capital investments on the continent.

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Overall Introduction

In recent years, venture capital and private equity investors' sentiments on opportunities in Africa have been increasingly positive. However, current literature on venture capital and private equity for the continent is descriptive or limited to single-country studies. The three dissertation articles extend this literature by using more robust techniques to investigate the effects of human capital and law on multi-country venture capital and private equity activity in Africa. Using a novel panel dataset, I test the overall null hypothesis that these two factors have no influence on this activity.

In the first article titled "Does Work Experience in the Venture Capital or Private Equity Industry Matter?" I draw from the assortative matching concept to test the null hypothesis that a general partner (GP) team's work experience in the venture capital or private equity industry has no influence on its investments. Evidence indicates that negative assortative matching by this human capital trait occurs between GP and private equity portfolio company teams. Based on this finding I can reject the null hypothesis for the private equity stage.

In the second article titled "Does Education influence Clean-Tech Venture Capital and Private Equity Exits?" I test the null hypothesis that post-match education in GP and portfolio company teams has no influence on clean-tech, relative to other-tech, venture capital and private equity exits. Evidence suggests that an increase in the proportion of bachelor degrees and graduates from a top-ranked university in post-match teams increases the probability of clean-tech initial public offering exits. An increase in the proportion of bachelor degrees also increases the probability of clean-tech trade sale exits. In addition, an increase in the proportion of masters or doctoral degrees in post-match teams increases the probability of clean-tech secondary sale exits. Based on these findings, I can reject the null hypothesis. However, the education trait that matters depends on the type of exit.

Finally in the third article titled "Do Domestic Legal Environments influence Venture Capital Investments?" I rely on a theory that argues that better domestic legal environments promote the use of debt by GPs. Since portfolio companies at the seed, startup, or early stages, have not yet acquired adequate tangible assets that can be collateralized, they cannot access this financing instrument. Drawing from this theory, I test the null hypothesis that improving a country's legal environment has no influence on venture capital investments within its borders. Evidence shows that improving the domestic legal environment has a significantly negative effect on seed, start-up, or early venture capital investment. Based on this finding, I can reject the null hypothesis at this investment stage, for the short-run.

I

Does Work Experience in the Venture Capital or Private Equity Industry Matter?

Abstract

Using a novel panel dataset, I investigate whether assortative matching occurs between general partner and portfolio company teams in Africa by their work experience in the venture capital or private equity industry. Evidence indicates that negative assortative matching by this trait occurs between these agents only at the private equity stage. Since portfolio company teams on the continent lack venture capital or private equity work experience, the direction of matching suggests that the dissimilar agents they match to are general partner teams with more of this trait. The finding suggests that general partner teams with relatively more work experience in the venture capital or private industry have a higher likelihood of investing in private equity portfolio companies.

Keywords: private equity, venture capital, assortative matching, human capital, Africa

JELclassification: J24, G24, O55

1 Introduction

In a 2011 survey, Africa registered the largest annual increase in attractiveness to limited partners (LPs) relative to other emerging markets, except Russia (Coller Capital and EMPEA, 2011).[1] However, these investors perceived the lack of deal development, screening, structuring, and execution skills among general partners (GPs) on the continent as one constraint on their ability to exploit venture capital and private equity investment opportunities (Choi, 2011).[2]

The objective of this article is to determine if there is evidence to support this perception by determining if these skills, which are obtained through work experience in the venture capital or private equity industry, affect GPs' abilities to invest in portfolio companies on the continent. To achieve this objective, I test the null hypothesis that a GP team's work experience in the venture capital or private equity industry has no influence on the likelihood that it invests in a portfolio company team. I conduct the hypothesis test on a random sample of venture capital and private equity investments in Africa (excluding South Africa), over the period between 2004 and 2010.

The investments represent the joint outcome of individual, independent decisions by two sets of heterogeneous agents that result in a match where they "... combine to form entities with some common purpose that none can accomplish alone" (Mortensen, 1982). A key feature of the sample dataset is that I do not observe GP or portfolio company teams that do not enter a market or are in a market but do not receive an investment (unmatched agents). To identify the direction of matching in this case, I adopt a potential matches framework (Fox, 2010). It describes an equilibrium outcome assuming perfectly informed agents in a decentralized, frictionless setting.

[1] Emerging venture capital or private equity markets include Africa, Asia, Central and Eastern Europe, Latin America, the Middle East, Russia, and Turkey.

[2] Venture capital and private equity investments are made by GPs, who are intermediaries that directly invest in privately held portfolio companies through funds using equity or quasi-equity instruments. They actively manage these investments as advisors, directors or managers, with an explicit strategy to exit in the medium-term (Sahlman, 1990). GPs obtain the money to invest from LPs, who are institutional investors such as pension funds and university endowments. While wealthy individuals (angel investors) use their own money to directly finance privately held portfolio companies, they will not be included in this article due to lack of data on their activities.

I rely on the assortative matching concept, which is defined as a monotonic correlation that describes sorting patterns in a market equilibrium, to discuss the findings (Becker, 1973 and 1974). A coefficient's sign reflects the direction of matching, with positive assortative matching (PAM) observed when similar agents match and negative assortative matching (NAM) observed when dissimilar agents match.[3]

If portfolio companies in Africa rarely have team members with work experience in the venture capital or private equity industry, similar GP teams will have less of this trait while dissimilar GP teams have more of this trait. Since LPs perceive that GPs with more of this trait should have a great ability to exploit investment opportunities, the prediction that arises from their perception is that *NAM by work experience in the venture capital or private equity industry should occur between GP and portfolio company teams in Africa*.

To obtain the evidence that I rely on in my conclusion, I compare the results of a conditional logit (McFadden, 1974) to a rare events logit estimation (King and Zeng, 2001).[4] For identification in both these static, reduced form estimations, I adopt a two-way error component, panel fixed-effects specification. It relies on within variation in skill distributions as individuals with venture capital or private equity work experience join or leave GP or portfolio company teams, while controlling for time dependent factors that affect the overall environment where matches occur.

I include a comprehensive set of time varying controls intrinsic to GPs, portfolio companies, and the markets in which matches occur to mitigate omitted variable bias. I also include an instrumental variable to mitigate simultaneity bias that may arise between the number of investments and work experience in the venture capital or private equity industry, if there is a tendency for GPs to hire more individuals as they make more investments. The instrument I use is the local availability of venture capital or private equity industry work experience in a market (Bottazzi et al., 2008).

[3] I do not use the alternative terminology that refers to PAM as assortative matching and NAM as anti-assortative matching.

[4] These empirical estimations take into account two-sided, agent heterogeneity and differ from those that assume portfolio companies are homogeneous or unilaterally decide to select a GP.

In summary, I find evidence that NAM occurs between GP and portfolio company teams by their work experience in the venture capital or private equity industry at the private equity stage. Since portfolio companies in Africa rarely have team members with work experience in the venture capital or private equity industry, the direction of matching suggests that the dissimilar agents they match to are GP teams with more of this trait. The finding can be interpreted as an indication that, at the private equity stage, GP teams in Africa with relatively more work experience in the venture capital or private equity industry have a higher likelihood of investing in portfolio companies.

Following this introduction, the rest of the article is organized as follows. Section 2 reviews related literature. Section 3 discusses the data. Section 4 describes the method used to achieve the article's objective. Section 5 presents the results and a discussion. The last section summarizes and draws conclusions based on the results.

2 Literature Review

Venture capital and private equity markets are characterized by weak information where agents rely on signals to sort themselves into equilibrium outcomes (Spence, 1973). In this article, signals are represented by the human capital traits (education and work experience) of GP and portfolio company teams.[5] Preferences are formed over these human capital signals and agents rely on them to match with each other (Hoppe et al., 2009; Kushnir, 2010).[6]

The concept of matching between two distinct sets of heterogeneous agents in a market has a long history in economic literature (Koopmans and Beckman, 1957; Shapley and Shubik, 1972; Becker, 1973 and 1974). In this article, agents form coalitions in their individual sets and these coalitions then match to each other (Bloch and Dia-

[5]Education represents general human capital, which is defined as skills acquired through formal education that can be applied across most firms and settings. Work experience captures industry-specific human capital, which is defined as skills specific to a particular time or setting that are learned in prior jobs or industries and are transferable to future jobs (Zarutske, 2010).

[6]Tyebjee and Bruno (1984) describe how GPs obtain and select portfolio companies. Similarly, anecdotal evidence exists indicating that portfolio companies have preferences over which GP they agree to match to (Smith, 1999).

mantoudi, 2011).[7] The matches between GP and portfolio company teams occur in a decentralized (Diamantoudi et al. 2007; Satterthwaite and Shneyerov, 2007; Konishi and Sapozhnikov, 2008; Niederle and Yariv, 2009) as opposed to a centralized setting (Roth, 1984; Bulow and Levin, 2006).

The observed matching patterns represent an equilibrium that can be achieved by various underlying mechanisms e.g. deferred acceptance, top trading cycles, or random (Gale and Shapley, 1962; Shapley and Scarf, 1974; Roth and Vande Vate, 1991; Pais, 2008; Hoppe et al., 2011; Chen and Sönmez, 2006; Abraham, 2003).[8] Also, this equilibrium occurs in a transferable (Fox, 2009; Siow, 2009) as opposed to a non-transferable utility setting (Legros and Newman, 2007; Hsieh, 2011). Finally, it is the outcome of a static (Fox, 2009) as opposed to dynamic process (Satterthwaite and Shneyerov, 2007).

Becker (1973 and 1974) introduced the assortative matching concept to describe the matching equilibrium in a marriage market. In his theoretical model a spouse chooses between working in the household, in the market, or leisure (non-household and non-market activities). After a modification that eliminates agents' market participation options,[9] the theory demonstrates that NAM occurs regardless of whether or not the disutility from costs incurred from engaging in joint household activities, which is negative, exceeds the utility from reducing leisure to specialize in household activities when the trait of interest enters the production function as a gross substitute i.e. negatively. PAM occurs if the disutility from costs incurred in joint post-match production does not exceed utility from specializing in household activities when the trait of interest enters the production function as a gross complement i.e. positively.[10]

[7]Matches can occur be between one element in an agent's set with one element in the other set - one to one (Choo and Siow, 2006), one element in an agent's set with a group of elements in the other set - one to many (Kelso and Crawford, 1982; Roth and Sotomayor, 1989), or a group of elements in one set and a group of elements in the other set -many to many (Hatfield et al., 2011).

[8]While the article focuses on a matching equilibrium, other studies focus on a search equilibrium (McNamara and Collins, 1990; Shimer and Smith, 2000; Atakan, 2006; Silveira and Wright, 2007; Smith, 2009; Korok et al., 2009; Mendes et al., 2010; Lauermann, 2013).

[9]Lam (1998) also modified this theory restricting a spouse's choice to either working in the household or engaging in leisure.

[10]Behavioral (Winch, 1958), agency (Serfes, 2005; Li and Ueda, 2009), or monitored finance (Dam, 2007) theories also describe agents' assortative matching motivations.

Adapting this theory to venture capital or private equity markets, NAM between GP and portfolio company teams occurs if the trait of interest enters the production function as a gross substitute, which is the case if agents are dissimilar on that trait. It could also occur if the trait enters the production function as a gross complement, which is the case if agents are similar on that trait, but the utility from participating in joint, post-match production does not exceed the disutility of costs incurred in joint post-match production. PAM between GP and portfolio company teams occurs if the trait of interest enters the production function as a gross complement and the utility from participating in joint, post-match production exceeds the cost disutility of joint post-match production. There is no clear *a priori* conclusion on the direction of matching between agents because it depends on which of the two opposing effects outweighs the other.[11] Therefore, empirical evidence is required to determine assortative matching patterns.

In the venture capital setting,[12] empirical matching studies include Sorenson and Stuart (2001), Dimov et al. (2007), Sørensen (2007), Sunesson (2009), Bengtsson and Hsu (2010), Bottazzi et al. (2011), and Hegde and Tumlinson (2011).[13] Only three of these papers account for the role of work experience in the venture capital or private equity industry, to any extent.

First, Dimov et al., (2007) find that a GP team's public or private finance industry expertise is negatively related to matches with seed, start-up, or early venture capital portfolio companies as a proportion of their overall portfolio.[14] Second, Sørensen (2007) finds that experience, defined as the number of investment rounds a GP has participated in, is positively related to matches with expansion venture capital portfolio

[11] See Appendix A for a proof.

[12] Other settings where empirical studies on matching exist include marriage (Pencavel, 1998; Suen and Kwong, 1999; Jepsen and Jepsen, 2002; Choo and Siow, 2006), agriculture (Ackerberg and Botticini, 2002), banking (Akkus and Hortaçsu, 2006), automotive parts (Fox, 2009), professional sports (Yang et al. 2009), auditing services (Bills and Jensen, 2010), and labor (Zamudio, Wang and Haruvy, 2011).

[13] Studies such as Bhagwat (2011) that investigate how matches are formed between syndicating partners only focus on the GP's side i.e. one side of a two-sided problem.

[14] Dimov et al. (2007) find that this negative relationship is magnified by higher status but mitigated by higher reputation.

companies.[15] Finally, Bengtsson and Hsu (2010) find that NAM occurs between GP and venture capital portfolio company teams by their finance or operations expertise. They also find that PAM occurs between GP and venture capital portfolio company teams by their common ethnicity, top university affiliation, sales work experience, or a Doctor of Philosophy (PhD) degree.[16]

Although only Bengtsson and Hsu (2010) apply the assortative matching concept, their finance expertise measure does not distinguish between whether or not it was obtained in the venture capital and private equity industry. This distinction is important in this article because deal development, screening, structuring and execution skills are very unique to the industry and could only be obtained by prior work experience in another GP, until recently.[17] Using experience, defined as the number of investment rounds participated in, to measure the quality of a GP's team does not solve this shortcoming because it misses the fact that these rounds are conducted by individuals, who take the experience they gain from their participation with them to the next GP when they leave. Thus, at the time of an investment, Sørensen's (2007) measure attributes, to a GP team, venture capital or private equity industry work experience that may be long gone.

Also, the previous studies findings are limited to the United States of America (USA) venture capital market. Dimov et al. (2007) conducted their analysis on data covering initial, as opposed to follow-on, investments by 108 GP teams in venture capital portfolio companies in the USA between 1997 and 2002. Sørensen (2007) conducted

[15] Sørensen (2007) find that this sorting, which represents a selection effect, affects investment outcomes.

[16] Bengtsson and Hsu (2010) also find that GP teams with a MBA degree or with finance or operations experience are more likely to match with older portfolio companies and those in the later stages of their lifecycle. Those with more sales experience are more likely to match with portfolio companies that receive less financing. Also, portfolio company teams with a PhD degree receive more financing. Finally, they did not find any evidence that ethnicity or top-university affiliation had an effect on investment outcomes.

[17] Until recently, venture capital and private equity education was obtained through apprenticeships in existing firms e.g. African Venture Capital Fellows program (Harvard, 2013), Emerging Institutions Fellowship Program (Landmark Development Initiative Africa, 2012), Kauffman Program (Kauffman, 2013), and Toigo Program (Allen and Ullman, 2009). However, some universities have started including them as part of their curricula (*see* Chaplinsky and Marinescu, 2002; Andrews and Hyland, 2010; Bellamy, 2010). Also industry assocations e.g. AVCA, SAVCA and EMPEA offer training courses to industry practitioners.

their analysis on a potential matches dataset capturing initial investments by 75 GPs in venture capital portfolio companies located in California and Massachusetts between 1982 and 1995. Finally, Bengtsson and Hsu (2010) conducted their analysis on a potential matches dataset capturing GP teams' investments in venture capital portfolio companies in the USA from the late 1990s to 2007.

The key contribution of this article is to investigate assortative matching patterns using a more direct measure of work experience in the venture capital or private equity industry that distinguishes it from work experience in other finance industries, e.g. commercial banking, insurance, fixed income investment, and stock market (public equity) investment. I also add to the empirical literature on matching in this setting by including the private equity stage in the analysis. Finally, evidence from the sample of African investments contributes to the broader empirical literature on venture capital and private equity by providing insights from a region where current knowledge in this area is descriptive e.g survey summary statistics (AVCA, 2006; Jones and Mlambo, 2009; Sathyamurthy et al., 2009; KPMG and SAVCA, 2011), and case studies (Masum et al., 2010); or limited to single-country studies (Hassan, 2010; Hassan and Ibrahim, 2012).[18]

This article's empirical strategy is close to Bengtsson and Hsu (2010), who include multiple human capital traits simultaneously in their analysis.[19] However, in addition to the distinction between work experience in the venture capital and private industry and in other finance industries, the two studies also differ by how other human capital traits are measured.

First, contrary to the binary indicator used by Bengtsson and Hsu (2010) to identify the presence of a human capital trait in a GP or portfolio company team, I use Dimov et al.'s (2007) measure that captures the proportion of a trait in a GP or portfolio company team e.g. 0.35 indicates that 35% of a team's members have that trait.[20] This proportion

[18]So far, multi-continent venture capital and private equity studies have ignored Africa. Those that do not, only include South Africa (Cumming and Johan, 2009).

[19]The empirical strategy adopted in this paper is also closely related to Jepsen and Jepsen (2002).

[20]This mitigates one potential source of heteroskedasticity arising from teams' size differences.

represents the ranking of agents' traits into percentiles, which I further categorize into deciles.[21]

Second, I distinguish between chief executive officer (CEO) or upper level management experience and strategy experience in GP and portfolio company teams. Bengtsson and Hsu (2010) combine CEO, upper level management, strategy and operations experience in a single category. To measure strategy, I use consulting experience that represents strategy experience obtained even if one has never been a CEO or upper level manager.

Furthermore, I modify the education measure adopted by Bengtsson and Hsu (2010). Rather than only using the attainment of a Masters in Business Administration (MBA) or PhD degree and attendance at a USA ivy league university, I use a broader measure adopted in studies that explore the effect of human capital on investment outcomes (Dimov and Shepherd, 2005; Zarutskie, 2010). The measure includes disciplines majored in at university, Bachelors, Masters and Doctoral degrees, and post-graduation industry certifications e.g. Certified Public Accountant (CPA), Chartered Financial Analyst (CFA), Advanced Management Program (AMP), etc. In addition, I broaden Bengtsson's and Hsu's measure of attendance at an ivy league institution by including high-reputation universities on other continents while limiting it to *graduation* from these higher education institutions.

Finally, I account for the within country simultaneity bias between GP and portfolio company teams by using an instrumental variable. This potential source of bias is ignored by Bengtsson and Hsu (2010).

3 Data

Previous empirical studies that have investigated human capital effects in venture capital and private equity markets rely on information collected from various sources to create datasets that are suitable for analysis (Sunesson, 2009; Bengtsson and Hsu, 2010;

[21] *See* Hoppe et al. (2009) for a discussion of rank correlations in a matching structure.

Zarutskie, 2010; Bottazzi et al., 2011). This information is obtained from commercial sources e.g. CapitalIQ, VentureXpert, and SDC Platinum, that rely on websites, annual reports, press releases, and proprietary sources for their data. The commercial databases are complemented with additional information obtained from surveys, or on-line career networking sites such as LinkedIn where individuals voluntarily enter their career and education histories (Davis et al., 2008; Sunesson, 2009; Bottazzi et al., 2011). Due to the limited coverage of Africa in existing commercial databases,[22] I independently compile a dataset of the characteristics of GPs and the portfolio companies they invested in from various public, secondary sources including audited annual reports and unaudited sources e.g. website content, conference presentations, press releases, and newsletters.

I identify the GPs from member lists and publications of industry associations including the African Venture Capital Association (AVCA), Emerging Markets Private Equity Association (EMPEA), South African Venture Capital Association (SAVCA), and the Tunisian Venture Capital Association (AVCA, 2004; AVCA, 2006; EMPEA 2009; SAVCA, 2005; Mthombothi, 2008; ATIC, 2009). Relying on evidence from data restricted to these sources potentially suffers from selection issues because only the more successful GPs may subscribe to industry associations.

To mitigate this source of bias, I identified other GPs and their investments using additional secondary sources. These sources include the Venture Capital Funds Index (Rhijn, 2008), which is an industry directory listing, industry conference output and delegate lists, previous employers stated on team members' profiles posted on GPs' websites, and africa-assets.com and privateequityafrica.com, which are two online portals that began to report on venture capital and private equity transactions in Africa from January 2011.

[22]The VentureXpert database which contained information on 28,824 global venture capital transactions between 2000 and 2008, is heavily weighted towards North America - 41.6%, Western Europe - 27.5%, and East Asia - 22.6%. The rest of the data consist of Oceania - 3.2%, Eastern Europe - 1.7%, Latin America - 1.5%, the Middle East - 1.1%, and Africa - 0.8% (Brander et al. 2010).

From this comprehensive data collection effort, I identify investments in 8,523 portfolio companies by 862 GP firms across 54 African countries. However, coverage error could still bias results obtained if this overall dataset is used in the analysis because it does not represent the population of GPs in Africa, which is unknown. To account for this, I draw a random sample of 70% of this dataset clustered at the GP level. From this random sample, I eliminate observations that represent follow-on investments.[23] Where multiple GPs match to the same portfolio company as a syndicate, I restrict the match to the lead GP, defined as the one that purchases the highest stake in the portfolio company or provides the most financial capital, because they are the ones who negotiate terms with the portfolio company and interact with them.[24]

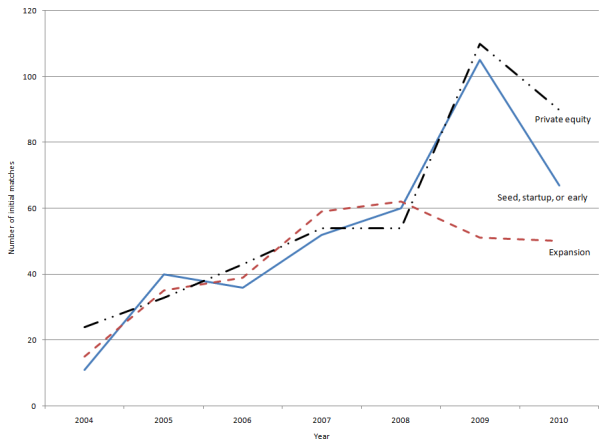
After these adjustments, I end up with 5,158 observations representing initial matches between one GP team and one or many portfolio company teams.[25] Due to the self-reported nature of the data, only 1,945 can be identified as matches occurring from 2004 to 2010. However, 185 of these matches cannot be linked to a specific investment stage. Therefore, the final sample consists of 1,760 observations which is approximately 24% of the overall dataset. This sample, which is illustrated in Figure 1, represents actual matches between 499 seed, start-up, or early venture capital, 474 expansion venture capital, or 787 private equity portfolio company teams and one of 257 GP teams across 43 African countries.

This sample represents the most comprehensive dataset used to analyze venture capital and private equity activity in Africa, to date. With only 43 GPs reporting to the 2005 survey by the AVCA (AVCA, 2006) and 65 GPs reporting to the 2010 survey by the SAVCA (KPMG and SAVCA, 2011), which was the highest number reporting to this survey in any year up to that year, relying on these datatsets would not be as comprehensive. Also, the VentureXpert database identifies 235 matches between GPs

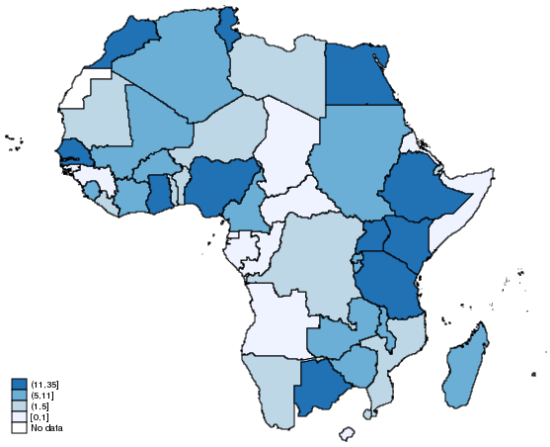
[23]The restriction to initial matches accounts more accurately for GPs' and portfolio companies' current decisions, as opposed to decisions made in prior periods when market conditions may have been different. In addition, it limits the interaction between these agents to one period where equilibrium matches are determined simultaneously.

[24]Fiet (1995) and Bottazzi et al. (2008) suggest that delegating the responsibility for interacting with the company to a syndicate leader is done to prevent duplication of effort and to mitigate free-riding.

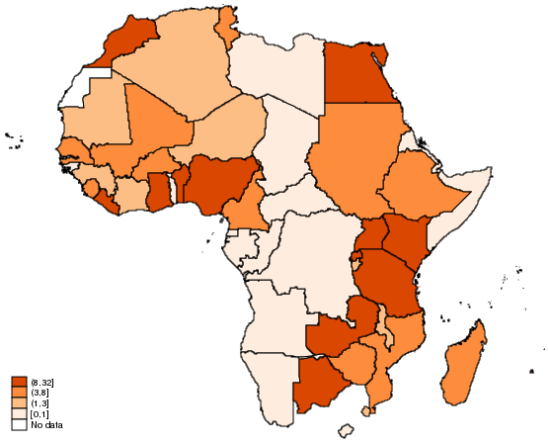
[25]Therefore, this article analyzes a one to many coalition matching structure.



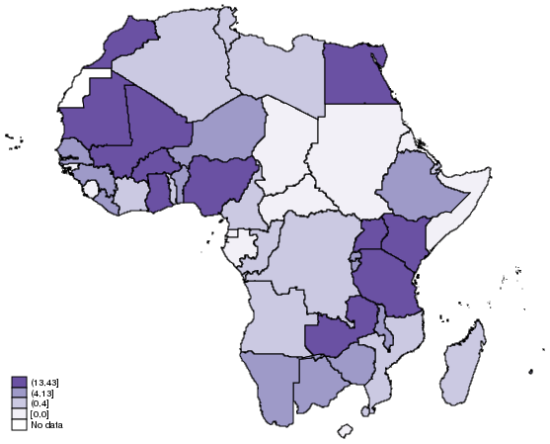
Annual flow of number of initial investments (by stage)



Note: Seed, startup, or early venture capital: n = 499



Note: Expansion venture capital: n = 474



Note: Private equity: n = 787

Figure 1: Number of initial investments in Africa, excluding South Africa (2004 to 2010)

and venture capital portfolio companies in Africa, between 2000 and 2008 (Brander et al., 2010). I identify 734 matches from 2004 to 2008 with 354 of these being in the seed, start-up, or early venture capital stages.

In addition, the EMPEA's dataset indicates that there were 87 matches between GPs and venture capital or private equity portfolio companies in sub-Saharan Africa between 2008 and 2009.[26] The dataset in this paper identifies 711 venture capital or private equity matches in the same sub-region between 2008 and 2009. Furthermore, Avanz Capital's database contains 115 fund managers, which is approximately half of

[26]I thank EMPEA for providing top-level figures on the number of deals in sub-Saharan Africa from their database for comparison.

the fund managers in this article's sample (Assaad et al., 2012). Finally, Cambridge Associates' African Private Equity and Venture Capital Index is based on information from approximately 40 funds' investments in 350 portfolio companies (Ventures, 2013), which is approximately 20% of the investments in this article's sample.

I obtain the data capturing market characteristics where matches occur from the publicly accessible, online data portal provided by the World Bank (2011). This portal includes information from the African Development Indicators, Doing Business, Governance Indicators, World Development Indicators, and Global Development Finance databases. The data are reported by government agencies, obtained through field surveys, or compiled from other agencies e.g. the International Monetary Fund, United Nations, and World Economic Forum. The Doing Business database contains variables that I consider crucial in controlling for market characteristics that affect portfolio companies' decisions. Since the compilation of data from this source only began in 2004, this determines the earliest cutoff date that I consider in the analysis.[27]

3.1 Human Capital Traits

The human capital characteristics in this article reflect the work experience and education traits shared by GP and portfolio company teams. The work experience variables I include are the proportion of a team's members with venture capital or private equity industry experience at another GP, non-venture capital or non-private equity finance experience, CEO or upper level managemenent experience that is not obtained from being a former entrepreneur, strategy or management consulting experience, start-up experience from being a former entrepreneur, and experience in science, technology, engineering, or mathematics (STEM) jobs.

The education variables I include are the proportion of a team's members with a bachelors, masters or doctoral degree. I also include the proportion of a team's members that have obtained post-graduation industry certifications e.g. CPA, CFA, AMP, etc.

[27]The self-reported nature of the data results in missing observations in some of the variables obtained from these sources.

In addition, I include the discipline(s) majored in at university by a team's members i.e. business, economics, law, STEM, and an other education category to capture other majors e.g. political science, sociology, languages, history, etc. Finally, I include the proportion of a team's members that graduated from a top-ranked university.

To determine the set of top-ranked universities, I rely on prior literature that has investigated human capital effects in venture capital markets (Sunesson, 2009; Bengtsson and Hsu, 2010; Zarutskie, 2010; Bottazzi et al., 2011). Since this literature restricts its choices to USA or United Kingdom (UK) education systems, I rely on the Top 200 global ranking of universities compiled by Quacquarelli Symonds (2004) to select other choices. For Africa, I selected the only universities that appear on the rankings in any year the index covers. The universities included in this article encompass the Top 10 engineering, economics, law, and MBA schools (Li and Ueda, 2006).[28]

I use job titles to determine the relevant GP team members to include i.e. those more directly involved in deal development, screening, structuring, and execution. These team members consist of those whose job title is CEO, director, investment or fund manager, investment officer, principal, partner, associate, analyst, or general counsel.[29] I exclude non-executive directors and chairpersons of a GP because they are more likely to be involved in board responsibilities to LPs. I also exclude team members responsible for investments on other continents because they are more likely to be developing, screening, structuring, and executing deals in those regions rather than in Africa. Finally, I exclude support staff because they are likely to be focused on in-house administration.

[28]The universities include Brown, Columbia, Cornell, Dartmouth, Duke, Harvard, Massachusetts Institute of Technology, University of California-Berkeley, University of Chicago, University of Pennsylvania, Princeton, Yale, and Stanford in the USA; McGill and University of Toronto in Canada; Cambridge, Oxford, Imperial College, London School of Economics, and London Business School in the UK; Sorbonne University in France; Bocconi University in Italy; Tilburg University in the Netherlands; University of New South Wales in Australia; Tsinghua University in China; and University of Cape Town, University of Witwatersrand, and University of Stellenbosch in South Africa.

[29]Since not all these team members interact with a specific portfolio company, the results can be interpreted as an upper bound if the focus was on investment outcomes. However, because the input of various GP team members may be required in the process of deal development, screening, and structuring the concern is mitigated in this article.

I define the start and departure dates of a GP's or portfolio company's team member as the year they joined or left a firm. These dates are explicitly indicated in annual reports, member profiles on GPs' or portfolio companies' websites, or issued in press releases. In cases where this information was not provided from these sources, I relied on LinkedIn, Bloomberg, or Zoominfo.[30] If the departure dates were unavailable even from these sources, I defined them as the last year they appeared in an annual report or the year prior to which they are announced to have joined a new GP or portfolio company.

3.2 Non-Human Capital Traits

I also include non-human capital traits shared between GP and portfolio company teams such as gender composition, age, information availability, and distance. In addition, I include unshared time varying traits that are specific to GPs, portfolio companies and markets where matches occur.

I measure gender composition as the proportion of females in a team. I measure the age of GPs and portfolio companies as the difference between the year a match occurs and their year of establishment. Information availability is measured by the proportion of team members that do not report their education and work experience.[31] Finally, I measure distance between a GP and a portfolio company using an ordinal indicator where one indicates that a GP has an office in the same country as the portfolio company (whose values are all zero) it matches to; two indicates a GP has an office in the same sub-region, but not in the same country as the portfolio company; three indicates a GP has an office on the continent, but not in the same sub-region as the portfolio company; and four indicates a GP has no office presence on the continent.

[30]Using these sources, I also identified past employees that were part of current team members' social networks. This allowed me to mitigate measurement error for the human capital traits of GP and portfolio company teams.

[31]The implicit assumption is that teams whose members report less education and work experience details also disclose less information on other dimensions.

The non-human capital traits specific to a GP include its cumulative stage-specific experience in a market, relative to that of all other GPs in that market. I measure this as the ratio of the number of seed, start-up, and early venture capital (or expansion venture capital, or private equity) matches a GP has realized in a market up to the year preceding the particular year in which a match occurs; to matches between portfolio companies and all GPs in that market, in the same stage, and over the same period. I also include the GP's size, which I measure by the number of funds per team member.[32]

The non-human capital traits specific to a portfolio company include its investment stage. This is measured by three separate binary indicators equal to one if a portfolio company is in the seed, start-up or early venture capital, expansion venture capital, or private equity stages, and zero otherwise.[33]

The non-human capital traits specific to a market where a match occurs include the real per capita gross domestic product (GDP) growth rate in purchasing power parity terms with a base year of 2005. I also include a measure of the quality of the legal system, which is measured as a score ranging between -2.68 and 1.02 where higher values of this measure indicate that "agents have more confidence in and abide by the rules of society, in particular the quality of contract enforcement, the police, and the courts and have lower perceptions on the likelihood of crime and violence" (Kauffman et al., 2011).

In addition, I include the per capita number of STEM journal articles published to proxy for the innovative structure of a market, which may influence the supply of suitable deals.[34] I also include measures that affect portfolio companies decisions to enter a matching market including the labor force participation rate of individuals aged

[32]This controls for the hypothesis that larger GPs may have more resource laxity, and are thus more inclined to match with venture capital portfolio companies that are thought to be more difficult to fund or experimental (Dimov et al., 2007). It also controls for potential monitoring costs that may affect a GP's decision to participate in an additional match.

[33]These are time invariant but are required for dataset restrictions that categorize portfolio companies by investment stage.

[34]Alternative measures such as research and development (R&D) expenditure as a percentage of GDP, or the number of patents per capita applied for by residents of a country suffer from relatively too few datapoints over the analysis period.

15 and over, and the cost of starting up a business as a proportion of income per capita.[35] Finally, I include the amount of domestic credit provided by the banking sector as a percentage of GDP, and the cost of closing a business measured as the recovery rate from declaring bankruptcy in terms of cents on the dollar.[36]

3.3 Potential Matches

The sample defined so far and summarized in Table 1 reflects actual matches representing the joint outcome of individual decisions by heterogeneous GP and portfolio company teams. It does not include unmatched agents. In cases where the available data is of this type, the potential matches framework is adopted to identify the direction of matching between agents (Fox, 2010).[37]

The framework is an empirical expression of the local product maximization condition based on single-agent responses under price-taking behaviour (Fox, 2008). This condition states that total production value from any two actual matches exceeds that of any counterfactual alternatives. It explains that the market equilibrium relies on pairwise stability, which posits that matches are stable if no currently matched agents are willing to exchange partners to form new matches (Yang et al., 2009).[38]

In a potential matches dataset, actual matches are represented by the ones in a binary indicator. The zeros represent counterfactual matches (matches that could have occurred but did not), which are constructed from the set of actual matches, assuming perfect information.

[35]Higher values of these measures should be a disincentive to potential entrepreneurs to start a portfolio company (Poschke, 2010).

[36]Higher values of the former measure and lower values of the latter should be a disincentive to opting for the financial, human and social capital offered by GPs as opposed to pure credit financing from banks. An attempt to include the real lending rate (*see* Romain and Potterie, 2003; Félix et al., 2007), measured by the lending interest rate minus the consumer price index inflation rate with a base year of 2005, instead of domestic banking credit suffered, from severe multicollinearity with the start-up costs measure i.e. linear collinearity > 0.8.

[37]For venture capital examples, see Sorenson and Stuart (2001), Sørensen (2007), Sunesson (2009), Bengtsson and Hsu (2010), Bottazzi et al. (2011), and Hegde and Tumlinson (2011). For examples in other settings e.g. marriage markets, see Jepsen and Jepsen (2002).

[38]See Appendix B for a proof adapted to the venture capital or private equity market setting from Yang et al., (2009).

Table 1: Summary statistics for actual and potential dataset

	Actual						Potential					
	general partner			portfolio company			general partner			portfolio company		
Variable	mean	std. dev.	obsv.	mean	std. dev.	obsv.	mean	std. dev.	obsv.	mean	std. dev.	obsv.
Y (=1 if actual match)	1	0	1,760	1	0	1,760	0.0963	0.2950	18,283	0.0963	0.2950	18,283
VC/PE experience	0.1464	0.2400	1,425	0.0296	0.1099	483	0.2733	0.3145	14,651	0.0384	0.1189	5,911
finance experience	0.1492	0.2060	1,396	0.1219	0.2472	494	0.2324	0.2280	14,329	0.1030	0.2027	5,999
ceo/upper mgmt. experience	0.0810	0.1208	1,379	0.3201	0.3408	503	0.0995	0.1533	14,176	0.3183	0.3197	6,164
consulting experience	0.1644	0.1864	1,378	0.1518	0.2548	494	0.2627	0.2431	14,059	0.1430	0.2306	6,060
start-up experience	0.0517	0.0945	1,379	0.1223	0.2554	490	0.0534	0.1207	14,053	0.0986	0.2270	5,996
STEM experience	0.0473	0.0765	1,374	0.2317	0.3385	496	0.0381	0.0878	14,055	0.2216	0.3271	6,073
bachelors	0.4672	0.2746	1,477	0.6771	0.3356	561	0.5614	0.3004	15,120	0.6311	0.3252	6,857
masters	0.2621	0.2139	1,459	0.3173	0.3495	554	0.2640	0.2219	14,752	0.2877	0.3281	6,744
PhD	0.0436	0.0851	1,445	0.0503	0.1762	551	0.0266	0.0762	14,704	0.0468	0.1709	6,734
certification	0.2029	0.2353	1,421	0.3108	0.3336	547	0.3556	0.2902	14,818	0.3804	0.3120	6,790
top-ranked university	0.1471	0.1959	1,374	0.1923	0.2979	477	0.2354	0.2569	13,811	0.2076	0.2744	5,908
business education	0.3210	0.3126	1,415	0.3985	0.3533	547	0.5132	0.3211	14,673	0.4262	0.3283	6,686
economics education	0.0846	0.1144	1,408	0.0655	0.1865	533	0.0659	0.1057	14,116	0.0491	0.1412	6,503
law education	0.0578	0.1092	1,395	0.0505	0.1403	531	0.0943	0.1396	14,371	0.0630	0.1432	6,501
STEM education	0.1195	0.1318	1,398	0.3547	0.3704	545	0.1010	0.1268	14,424	0.3224	0.3525	6,567
other education	0.1246	0.1385	1,400	0.1371	0.2536	535	0.1025	0.1425	14,171	0.1438	0.2276	6,520
female	0.2440	0.2089	1,674	0.1401	0.2715	864	0.1831	0.2181	16,441	0.1155	0.2403	10,010
information	0.4772	0.3334	1,705	0.5445	0.4531	978	0.6505	0.3418	16,666	0.5865	0.4375	10,937

Table 1 continued: Summary statistics for actual and potential dataset

	Actual						Potential					
	general partner			portfolio company			general partner			portfolio company		
Variable	mean	std. dev.	obsv	mean	std. dev.	obsv.	mean	std. dev.	obsv.	mean	std. dev.	obsv.
age (in years)	24.3676	22.7902	1,591	24.4522	32.157	1,160	14.2899	18.3110	16,138	31.3945	37.1139	12,732
distance (= 1 to 4)	2.1476	1.3780	1,755	1	0	1,760	1.4902	1.0665	18,055	1	0	18,283
cumulative seed, start-up, or early	0.0050	0.0072	954				0.0046	0.0070	3,781			
cumulative expansion	0.0051	0.0070	971				0.0044	0.0075	4,403			
cumulative private equity	0.0052	0.0067	953				0.0033	0.0054	10,281			
size	0.6012	0.8397	1,449				0.5137	0.8049	11,880			
local availability instrument	0.4653	0.1719	1,760				0.5151	0.0801	18,283			
seed, start-up, or early (=1 if in stage)				0.2835	0.4508	1,760				0.1483	0.3554	18,283
expansion (=1 if in stage)				0.2693	0.4437	1,760				0.1425	0.3496	18,283
private equity (=1 if in stage)				0.4472	0.4973	1,760				0.7138	0.4520	18,283
per capita GDP growth rate	0.0353	0.0202	1,753	0.0353	0.0202	1,753	0.0390	0.0112	18,272	0.0390	0.0112	18,272
rule of law	-0.2074	0.5117	1,760	-0.2074	0.5117	1,760	0.0713	0.2981	18,283	0.0713	0.2981	18,283
labor force participation rate	0.6176	0.1250	1,755	0.6176	0.1250	1,755	0.5547	0.0674	18,274	0.5547	0.0674	18,274
bank credit	0.9827	0.7893	1,720	0.9827	0.7893	1,720	1.6599	0.5331	18,213	1.6599	0.5331	18,213
startup cost	0.7246	2.0840	1,615	0.7246	2.0840	1,615	0.2091	0.8011	17,379	0.2091	0.8011	17,379
bankruptcy cost	0.2774	0.1189	1,615	0.2774	0.1189	1,615	0.3207	0.0569	17,379	0.3207	0.0569	17,379
STEM journal publications	0.00003	0.00003	1,756	0.00003	0.00003	1,756	0.0001	0.00002	18,275	0.0001	0.00002	18,275

Note: Actual n = 1,760; Potential n = 18,283.

For example, given two GPs i and j, and two portfolio companies a and b, where the actual matches are $[i,a]$ and $[j,b]$, the counterfactual matches will be $[i,b]$ and $[j,a]$ (Sørensen, 2007). In this case, the dataset of only actual matches includes two observations while that of all potential matches includes four observations.[39]

The construction of counterfactual matches can be handled in various ways. One way is not to impose any restrictions and assume that all portfolio companies (GPs) know all GPs (portfolio companies) that are seeking a match, regardless of geography or stage. While such a method is attractive because it lets the econometric model determine the likelihood of a match, it may result in systematic underestimation of standard errors from ignoring non-independence when GPs enter the dataset more than once (Sorenson and Stuart, 2001). It may also result in impossible counterfactual matches (Jepsen and Jepsen, 2002). Therefore, the literature recognizes that it is sensible to impose certain restrictions when constructing counterfactual matches.

I adopt Sorenson's and Stuart's (2001) approach to construct the counterfactual matches. They assume perfect information between GPs and portfolio companies is restricted to the same market and investment stage. The first restriction is reasonable because countries in Africa are highly segmented. Therefore, while GPs may be aware of potential portfolio companies in other countries, portfolio companies are rarely cognizant of GPs in other countries, if at all.[40]

The second restriction is also reasonable because GPs pursue matches as part of an explicit investment strategy that they communicate to LPs in the partnership agreements they distribute when raising funds. Ignoring this would result in imposing investment strategies on them. Therefore, a zero represents a portfolio company (GP) that could potentially have matched to a specific GP (portfolio company), but chose another in the same market and investment stage.[41] In addition, I restrict counterfactual matches to

[39]It differs from the job search model with a similar dataset issue, where each agents is assigned a single zero in the binary indicator that represents their market entry choice (Logan, 1998).

[40]While the market definition can be expanded to a region, Fox (2008) argues that it should be defined conservatively to maintain consistency where it is unclear.

[41]For example, if an actual match occurs between a GP and expansion venture capital portfolio company in Angola, the counterfactual matches will be between that GP and other expansion venture capital portfolio companies that matched to other GPs in that market.

those that occur between portfolio companies and GPs that had begun to operate at the time the match could occur in a market.

The potential matches dataset is also summarized in Table 1. It represents 18,283 observations represented by a binary indicator, where one reflects actual matches (n=1,760) and zero reflects counterfactual matches (n=16,523). With 86% of potential matches located in South Africa, this country overwhelmingly dominates this dataset. The potential matches dataset that excludes South Africa consists of 2,536 observations[42] with 1,020 actual matches and 1,516 counterfactual matches.[43]

4 Methods

To test the null hypothesis, I rely on a static, reduced form empirical model. It assumes matches in a market are the joint outcome of independent decisions by heterogeneous GPs and portfolio companies i.e. error terms are uncorrelated (Logan, 1998).[44]

4.1 Empirical Model

The estimated model is a discrete choice specification that assumes a linear additive form. It is specified in Equation 1.

$$\begin{aligned} U_{gpct} &= V^{\star}_{gpct} + \varepsilon_{gpct} \\ V^{\star}_{gpct} &= \alpha + X'_{gpct}\beta_1 + \Gamma'_{gpct}\beta_2 \\ \varepsilon_{gpct} &= \mu_{gpc} + \gamma_t + v_{gpct} \end{aligned} \tag{1}$$

Where U_{gpct} denotes the utility a portfolio company $(p = 1...P)$ obtains from selecting a GP $(g = 1...G)$, or vice versa, in a market that is represented by a country $(c = 1...C)$, in a certain time period $(t = 1...T)$. U_{gpct} is known to the GP and portfolio

[42] 1,067 is the suggested sample size for a 95% confidence level in the results when the population size is unknown.

[43] This captures matches between 731 seed, start-up or early stage, 764 expansion stage and 1,041 private equity portfolio companies and one of 186 GPs.

[44] Horowitz (1991) argues that focusing on better measurement of observables is preferred to adopting correlated error structures that lead to problems of comparing or transferring coefficient estimates between data sets.

company but I cannot observe it as the researcher. However, I can observe the choices made by the GP and portfolio company. These observed choices denote representative utility $V^{\star}_{gpct}$, which together with the random disturbance term ε_{gpct} make up U_{gpct}.

$V^{\star}_{gpct}$ represents the latent variable U_{gpctm}, where the subscript $m = 1,0$ is added to represent a binary indicator with one denoting an actual match that occurs because an agent provides its match partner with higher indirect utility than a counterfactual option, and zero otherwise. This relationship is specified in Equation 2.

$$V^{\star}_{gpct} = \begin{cases} 1 & if\, U_{gpct1} \geq U_{gpct0} \\ 0 & if\, U_{gpct1} < U_{gpct0} \end{cases} \tag{2}$$

$V^{\star}_{gpct}$ represents the dependent variable. α denotes the constant term. X_{gpct} is a matrix containing variables reflecting the absolute value of the distance between the decile rankings of human and non-human capital traits that are shared between GP and portfolio company teams.[45] I am interested in estimating the coefficient vector β_1, where the key variable is work experience in the venture capital or private equity industry. Γ_{gpct} is a matrix of control variables that includes unshared, time varying characteristics specific to the GP, portfolio company, and market in which matches occur.

The random disturbance term ε_{gpct} consists of μ_{gpc} denoting unobserved, time invariant terms specific to a GP, portfolio company, and the market in which a match occurs. It also consist of γ_t denoting the unobserved time effect. v_{gpct} denotes the remaining random error.

4.2 Estimation Strategy

I will start by describing the assortative matching pattern between GP and portfolio company teams for work experience in the venture capital or private equity industry. With South Africa dominating the potential matches dataset, I limit the discussion to

[45] This represents the Euclidean as opposed to Mahalnobis distance measure (Perese, 2002; Hegde and Tumlinson, 2011). Sorenson and Stuart (2001) used it to measure industry and geographic distance in their spatial analysis of network tie formation between GPs and portfolio companies. It was also used by Jepsen and Jepsen (2002) in their analysis of matching patterns in a marriage market.

results that exclude it because of its outlier status.[46] I then present pairwise correlations. Finally, I estimate specifications with only venture capital or private equity work experience as the independent variable, using estimations that separate portfolio companies by investment stage. These descriptive and univariate analyses provide a good starting point to describe sorting patterns in venture capital and private equity markets.

I then proceed to multivariate estimations that include all traits simultaneously. I compare results from a conditional logit estimation (McFadden, 1974)[47] to those obtained from a rare events logit estimation, which was also used by Bengtsson and Hsu (2010).[48] In these estimations, I adjust the standard errors for clustering at the country level.[49] I compare the results of a specification that includes all human capital traits to one that excludes discipline(s) majored in at university. This alleviates concerns that this concept is already captured by work experience.[50]

Measuring the human and non-human capital traits that are shared between GP and portfolio company teams as the absolute value of the distance between their decile rankings determines how one interprets the results on the direction of the matching pattern.[51] A negative sign for a coefficient represents PAM, which reflects that the distance between traits in an actual match is closer than in counterfactual matches. A positive

[46]Before its independence, foreign companies used private equity to cut ties with their subsidiaries in South Africa in the mid 1980s (Financial Mail, 1997). Following its independence from the apartheid regime, South Africa decided to pursue ways in which to integrate previously disadvantaged societal groups back into the economy. The purchasing of stakes in new and existing business using venture capital and private equity was one method chosen to achieve this objective. This public policy can explain the relatively higher volume of matches in this market resulting from GPs' investment motives that are different from their motives in other African countries, or anywhere else in the world.

[47]Dimov et al. (2007) relied on an ordinary least squares (OLS) estimation technique. Sørensen (2007) relied on a Bayesian estimation technique using Gibbs sampling (Geweke, 1999).

[48]King and Zeng (2001) find that it corrects for the bias arising from underestimating the factors that predict a match. This occurs when using the potential matches framework because the proportion of ones in the sample do not reflect the proportion of ones in the population (*see* Sorenson and Stuart, 2001 for another empirical application of this technique).

[49]With the data representing a sample of some of the matches in a market, the logic of the asymptotics is that I expect to observe more and more matches from this market (Santiago & Fox, 2008). Clustering matches at the GP level, which is done by Sørensen (2007) and Bottazzi et al. (2011), would suggest that I observe all GPs but do not capture all matches they made.

[50]The concern relies on assuming that no structural labor issues exist in the market, so that individuals end up working in fields they studied at university.

[51]If my objective was to estimate the potential payoff from each match, I would measure the shared traits by the interaction between their percentile rankings (Fox, 2010). I would then estimate such a model using maximum score, tobit or non-linear least squares techniques (Manski, 1974; Horowitz, 1992; Fox, 2008; Choo and Siow, 2006; Blevins and Kahn, 2011).

coefficient sign represents NAM, which reflects that the distance between traits in a counterfactual match is closer than in actual matches (Jepsen and Jepsen, 2002).[52]

I account for potential omitted variable bias using a comprehensive set of control variables to mitigate selection on observables. To account for potential endogeneity bias, I use a two-way error components panel fixed-effects specification that eliminates agents' or markets' unobserved time invariant characteristics.[53] Identification relies on variation within GP or portfolio company teams as individuals with work experience in the venture capital or private equity industry join or leave. I use year dummies to account for the time component in the error term that captures factors that affect the overall environment where matches occur e.g. the 2007/8 global financial crisis.[54]

To account for within market simultaneity bias, which may arise between the number of investments and work experience in the venture capital or private equity industry from the tendency of GPs to hire more individuals as they make more investments, I include an instrumental variable.[55] The instrument I use is local availability of venture capital or private equity industry work experience in a market.[56] It is measured by the ratio of the number of investments made in a market by other GPs with venture capital or private equity work experience to the number of all investments made by other GPs in that market.[57]

[52]Using the distance between traits assumes that the direction of the difference (who has a more education or experience, either the GP or portfolio company) does not matter (Jepsen and Jepsen, 2002). However, if few or no portfolio companies have a team member with venture capital or private equity experience (which is the case in this article), the issue does not raise significant concerns.

[53]This approach was adopted by Ackerberg and Botticini (2002) to control for the endogenous process that resulted in matches between landlords and tenants in 14th century Tuscany.

[54]It is equivalent to a difference in difference identification technique applied to a dataset with unmatched agents that would use GP and portfolio company pairs that did not experience within variation in their skill distributions from individuals with venture capital or private equity work experience joining or exiting them as the control group.

[55]See Angrist et al. (1996) for a discussion of how instrumental variables can be embedded within the potential matches framework.

[56]The use of parents' education and family characteristics of a team's members, which are popular instruments in the traditional labor literature, could be used. However, these variables are unavailable in the sources used to compile this article's dataset.

[57]Bottazzi et al. (2008) motivate the suitability of this instrument by arguing that while a portfolio company's actual choice may be endogeneous the local availability of venture capital or private equity industry experience is exogeneous and becomes irrelevant once a choice is made.

To account for potential bias from reverse causality between matches and the time-varying characteristics of the market in which they occur, I lagged the market characteristics by one year.[58] For example, where the dependent variable represents a match occurring in 2007, the market characteristics represent conditions that existed in those countries in 2006.[59]

I adopt a multiple imputation by chained equations technique to account for missing observations in the unshared control variables.[60] The approach imputes missing values by drawing possible values from a non-parametric distribution and generating various plausible datasets, whose combined results are used to arrive at coefficient estimates with standard errors that reflect the uncertainty from imputation (Rubin, 1987). It is contrary to a mean subsitution technique that imputes a single value for missing observations, which may bias parameter estimates towards zero (Acock, 2005).[61]

5 Results & Discussion

Table 2 illustrates that the mean value of the distance between agents' work experience in the venture capital or private equity industry for actual matches is 4.026 compared to 3.595 for counterfactual matches, in the sample excluding South Africa. The relatively larger value for actual matches suggests that NAM occurs between GP and portfolio company teams for this trait. In the sample, I identify only 29 portfolio companies that have a team member with work experience in the venture capital or pri-

[58]For example, it can be argued that higher per capita GDP growth rates attract GPs to a market because this reflects a more vibrant economy that has increased market opportunities. The resulting higher level of matches in these countries may simultaneously affect GDP. This could occur because venture capitalists push entrepreneurs to begin production or produce more, which shows up as higher GDP growth; or private equity teams push them to slow down or switch production lines which shows up as slower GDP growth (Engel, 2002; Davis et al., 2008).

[59]Under this specification, one cannot argue that matches in 2007 cause an increase in GDP, or other market characteristics, in 2006 i.e. the lagged value of the independent variable is uncorrelated with the current value of the dependent variable's residual. See Cawley (2004) for the use of this approach in his analysis on the effect of obesity on wages.

[60]This restricts the dataset to include only observations where information on shared traits is available for the GP and portfolio company.

[61]Rubin (1987) recommends that 5 imputed datasets are enough for 95% confidence in results with 50% of observations missing. I use 10 imputed datasets.

Table 2: Summary statistics of shared traits for actual versus counterfactual dataset

	Full Sample				Excluding South Africa			
	Actual		Counterfactual		Actual		Counterfactual	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
vcap/pequity experience	3.5340	3.0585	4.4044	3.0842	4.0260	2.6334	3.5952	2.7953
finance experience	3.7101	2.5762	3.4976	2.4623	3.7304	2.5270	3.5256	2.4875
ceo/upper mgmt. experience	3.7317	2.7225	3.9134	2.7787	3.6183	2.5849	3.7710	2.6825
consulting experience	3.3931	2.4086	3.4025	2.4455	3.5391	2.5187	3.4530	2.5540
start-up experience	3.6718	3.9085	3.2117	3.9056	4.2119	3.8655	3.7013	3.9565
STEM experience	3.8218	2.8725	4.0942	2.9724	3.9143	2.9247	4.0592	2.9690
bachelors	3.1484	2.3349	3.1911	2.2746	3.2307	2.4243	3.3901	2.4849
masters	3.1669	2.2620	3.3274	2.3861	3.2432	2.3664	3.4667	2.5186
PhD	3.6491	4.0843	2.7936	3.9260	3.4328	4.1029	3.8167	4.0956
certification	3.2452	2.5154	3.1807	2.2988	3.4696	2.7877	3.5382	2.6868
top-ranked university	3.3802	2.4178	3.5716	2.5207	3.4560	2.5250	3.5778	2.5108
business education	3.2890	2.5514	3.2213	2.3273	3.4967	2.7311	3.3304	2.5457
economics education	4.6306	3.2569	3.6273	3.7106	5.0437	3.2896	5.0538	3.4464
law education	3.3509	3.4140	3.8733	3.6027	2.7050	3.5480	3.1373	3.5366
STEM education	3.3850	2.4566	3.7056	2.6136	3.3916	2.5013	3.6209	2.6345
other education	3.6053	2.5223	3.7611	2.6581	3.7228	2.6468	3.7853	2.5763
female	3.6173	2.8761	3.7741	2.7672	3.5005	2.8942	3.8157	2.8145
information	2.8179	2.2540	2.8226	2.1855	2.8945	2.3639	3.0113	2.3832
age	3.9582	2.6958	3.4159	2.4374	3.7780	2.5781	3.4817	2.4471
distance	1.1472	1.3776	0.4245	1.0075	1.8585	1.3188	1.5594	1.3060

Note: n = 18,283 for full sample; n = 2,536 for sample excluding South Africa; all observations range between 0 and 9 representing deciles except distance, which ranges between 1 and 4.

vate equity industry. Its almost complete absence among portfolio companies suggests that the dissimilar agents they select are GP teams with relatively higher levels of this trait.

5.1 Univariate analysis

Table 3 indicates that the pairwise correlation for work experience in the venture capital or private equity industry at the seed, startup, or early stages is 0.0654. The

Table 3: Univariate results for dataset excluding South Africa

work experience in VC/PE industry	Pairwise Correlations coefficient	Conditional Logit marginal effect	Rare Events Logit first difference
Seed, startup, or early	0.0654**	0.0079	0.0090
		(0.0212)	
Expansion	0.0503**	0.0207	0.0116*
		(0.01735)	
Private equity	0.1147***	0.0411***	0.0206
		(0.0120)	

Note: n = 2,536 for sample excluding South Africa; Except for pairwise correlations all models include time dummies; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

marginal effect of this trait from a conditional logit estimation is 0.0079.[62] Finally, the first difference from a rare events conditional logit estimation is 0.009.

At the expansion stage, the pairwise correlation for work experience in the venture capital or private equity industry is 0.0503. The marginal effect of this trait from a conditional logit estimation is 0.0207. Finally, the first difference from a rare events conditional logit estimation is 0.0116.

At the private equity stage, the pairwise correlation for venture capital or private equity experience is 0.1147. The marginal effect of this trait from a conditional logit estimation is 0.0411. Finally, the first difference of this trait from a rare events conditional logit estimation is 0.0206.

These positive parameter estimate suggest that NAM should occur between agents for work experience in the venture capital or private equity industry at all investment stages.

5.2 Multivariate analysis

In this section I discuss the results of estimations that include all traits simultaneously. I distinguish portfolio companies by investment stage.

[62] Although studies recognize that marginal effects in a panel fixed-effects, logit model are not consistently estimated (Corts and Singh, 2002; Richter and Taylor, 2008; Chernozhukov et al., 2009), I present them to confirm the direction of matching.

5.2.1 Seed, Startup, or Early

I begin by testing the null hypothesis that NAM by venture capital or private equity industry experience does not occur between GP and seed, startup, or early venture capital portfolio company teams.

The first and second columns in Table 4 present the results of a baseline specification that does not include the instrument. For conditional logit estimations that include disciplines majored in at university, a one unit (decile) increase in the distance of venture capital or private equity industry work experience between GP and seed, startup, or early venture capital portfolio company teams corresponds to a -16.13 percentage change in the odds that they realize a match.[63] The marginal effect of a small increase in this distance is -0.000002. In the estimation that excludes the disciplines, a one unit increase in the distance of this human capital trait between GP and seed, startup, or early venture capital portfolio company teams corresponds to a -11.06 percentage change in the odds that they realize a match. The marginal effect of a small increase in this distance is -0.0024. However, none of these conditional logit, baseline estimation results are significant at even the 10% level.

The first and second columns in Table 4 also present rare events logit estimation results for a baseline specification that does not include the instrument. In the estimation including disciplines majored in at university, a one unit increase in the distance of venture capital or private equity industry work experience between GP and seed, startup, or early venture capital portfolio company teams corresponds to a 1.96 percentage change in the odds that they realize a match, or a marginal effect for a small increase in this distance of 0.0049. In the estimation excluding the disciplines, a one unit increase in the distance of this human capital trait between GP and seed, start-up, or early venture capital portfolio company teams corresponds to a 1.24 percentage change in the odds that they realize a match, or a marginal effect for a small increase in this distance of 0.0031. However, none of these results are significant even at the 10% level.

[63] I calculate this value from the coefficient, which represents log odds. In this case, the coefficient of -0.1759 results in a percentage change in odds of $\left(100 \times \left[e^{-0.1759 \times 1} - 1\right]\right) = -16.13$

Table 4: Multivariate results for dataset excluding South Africa

	Baseline						Instrumental Variable					
	Seed, Startup & Early		Expansion		Private Equity		Seed, Startup & Early		Expansion		Private Equity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Work experience in VC/PE industry	coefficient	marginal effect	coefficient	marginal effect	coefficient	marginal effect	coefficient	marginal effect	coefficient	marginal effect	coefficient	marginal effect
Conditional Logit:												
including disciplines	-0.1759	-0.000002	0.1211	2.4E-17	0.1829**	0.0081	-0.1182	-0.00001	0.1180	1.427E-19	0.1877**	0.0065
	(0.2108)	(0.0003)	(0.1142)	(0.0000)	(0.0920)	(0.0868)	(0.2352)	(0.0020)	(0.1153)	(0.0000)	(0.0932)	(0.0936)
excluding disciplines	-0.1172	-0.0024	0.0766	1.648E-20	0.1818**	0.0071	-0.0838	-0.0005	0.0755	3.012E-21	0.1875**	0.0077
	(0.1701)	(0.3279)	(0.0976)	(0.0000)	(0.0885)	(0.0922)	(0.1743)	(0.0484)	(0.1013)	(0.0000)	(0.0896)	(0.0773)
Rare Events Logit:												
including disciplines	0.0194	0.0049	0.0855*	0.0214	0.1283**	0.0321	-0.0024	-0.0006	0.0772	0.0193	0.1268**	0.0317
	(0.0900)		(0.0454)		(0.0615)		(0.0988)		(0.0461)		(0.0616)	
excluding disciplines	0.0123	0.0031	0.0617	0.0154	0.1327**	0.0332	-0.0092	-0.0023	0.0598	0.0150	0.1312**	0.0328
	(0.0850)		(0.0450)		(0.0595)		(0.0954)		(0.0459)		(0.0593)	

Note: Imputations = 10; Standard errors clustered at the country level are in parentheses; Human and non-human capital controls and time dummies are included in all specifications;
Conditional logit - Seed, startup, or early: n = 121, countries=6; Expansion: n = 220, countries=12; Private equity: n = 189, countries=8;
Rare events logit - Seed, startup, or early stages: n = 128; Expansion stage: n = 236; Private equity stage: n = 201;
Observations in each specification differ because of variance in the dependent variable, which is the potential match indicator;
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

The seventh and eighth columns of Table 4 present conditional logit estimation results for an instrumental variable specification. For the estimation that includes disciplines majored in at university, a one unit increase in the distance of venture capital or private equity industry work experience between GP and seed, start-up, or early venture capital portfolio company teams corresponds to a -11.15 percentage change in the odds that they realize a match, or a marginal effect of -0.00001. In the estimation excluding the disciplines, a one unit increase in the distance of this human capital trait between GP and portfolio company teams corresponds to a -8.04 percentage change in the odds that they realize a match, or a marginal effect of a -0.0005. However, none of these conditional logit, instrumental variable estimation results are signficant at even the 10% level.

The seventh and eighth columns of Table 4 also present rare events logit estimation results for an instrumental variable specification. For the estimation that includes disciplines majored in at university, a one unit increase in the distance of venture capital or private equity industry work experience between GP and seed, start-up, or early venture capital portfolio company teams corresponds to a -0.24 percentage change in the odds that they realize a match, or a first difference of -0.0006. In the estimation excluding the disciplines, a one unit increase in the distance of this human capital trait between GP and portfolio company teams corresponds to a -0.916 percentage change in the odds that they realize a match. The marginal effect of a small increase in this distance is -0.0023. However, none of these rare events logit instrumental variable estimation results are signficant at even the 10% level.

The negative coefficient signs for the conditional logit estimations, whether or not I include the instrument, and for the rare events logit instrumental variable estimation suggest that PAM occurs between GP and seed, startup, or early venture capital portfolio company teams by their work experience in the venture capital or private equity industry. However, the rare events logit baseline estimation result is a positive coefficient, which indicates NAM by this trait. From the mixed results I cannot predict the

direction of matching for this stage. Furthermore, with none of the results for either of the estimations being significant even at the 10% level, there is no evidence to suggest that NAM by this trait is occuring between GP and portfolio company teams. Therefore, I cannot reject the null hypothesis that NAM by work experience in the venture capital or private equity industry does not occur between GP and seed, startup, or early venture capital portfolio company teams in Africa.

5.2.2 Expansion stage

I then test the null hypothesis that NAM by work experience in the venture capital or private equity industry does not occur between GP and expansion venture capital portfolio company teams in Africa.

The third and fourth columns in Table 4 present the results of a baseline specification that does not include the instrument. For conditional logit estimations that include disciplines majored in at university, a one unit (decile) increase in the distance of venture capital or private equity industry work experience between GP and expansion venture capital portfolio company teams corresponds to a 12.87 percentage change in the odds that they realize a match. The marginal effect of a small increase in this distance is 2.4E-17. In the estimation that excludes the disciplines, a one unit increase in the distance of this trait between GP and expansion venture capital portfolio company teams corresponds to a 7.96 percentage change in the odds that they realize a match. The marginal effect of a small increase in this distance is 1.648E-20. However, none of these conditional logit, baseline estimation results are signficant at even the 10% level.

The third and fourth columns in Table 4 also present rare events logit estimation results for a baseline specification that does not include the instrument. In the estimation including disciplines majored in at university, a one unit increase in the distance of venture capital or private equity industry work experience between GP and expansion venture capital portfolio company teams corresponds to a 8.93 percentage change in the odds that they realize a match, which is significant at the 10% level, or a marginal

effect for a small increase in this distance of 0.0214. In the estimation excluding the disciplines, a one unit increase in the distance of this trait between GP and expansion venture capital portfolio company teams corresponds to a 6.36 percentage change in the odds that they realize a match, or a marginal effect for a small increase in this distance of 0.0154. However, none of these rare events logit, instrumental variable estimation results are signficant below the 10% level.

The ninth and tenth columns of Table 4 present conditional logit estimation results, for an instrumental variable specification. For the estimation that includes disciplines majored in at university, a one unit increase in the distance of venture capital or private equity industry work experience between GP and expansion venture capital portfolio company teams corresponds to a 12.52 percentage change in the odds that they realize a match, or a marginal effect for a small increase in this distance of 1.427E-19. In the estimation excluding the disciplines, a one unit increase in the distance of this trait between GP and expansion venture capital portfolio company teams corresponds to a 7.84 percentage change in the odds that they realize a match, or a marginal effect for a small increase in this distance of 3.012E-21. However, none of these conditional logit, instrumental variable estimation results are signficant even at the 10% level.

The ninth and tenth columns of Table 4 also present rare events logit estimation results for an instrumental variable specification. For the estimation that includes disciplines majored in at university, a one unit increase in the distance of venture capital or private equity industry work experience between GP and expansion venture capital portfolio company teams corresponds to a 8.03 percentage change in the odds that they realize a match, which is significant at the 10% level, or a marginal effect for a small increase in this distance of 0.0193. In the estimation excluding the disciplines, a one unit increase in the distance of this trait between GP and expansion venture capital portfolio company teams corresponds to a 6.16 percentage change in the odds that they realize a match, or a marginal effect for a small increase in this distance of 0.015. However, none

of these rare events logit, instrumental variable estimation results are signficant below the 10% level.

The positive coefficient signs for the conditional and rare events logit estimations, whether or not I include the instrument, suggest that NAM occurs between GP and expansion venture capital portfolio company teams by their work experience in the venture capital or private equity industry. However, with none of the results for either the conditional or rare events logit estimations being significant below the 10% level, there is no evidence to suggest that NAM by this trait is occurring for GP and portfolio company teams. Therefore, I cannot reject the null hypothesis that NAM by work experience in the venture capital or private equity industry does not occur between GP and expansion venture capital portfolio company teams in Africa.

5.2.3 Private equity stage

Finally, I test the null hypothesis that NAM by work experience in the venture capital or private equity industry does not occur between GP and private equity portfolio company teams in Africa.

The fifth and sixth columns in Table 4 present the results of a baseline specification that does not include the instrument. For conditional logit estimations that include disciplines majored in at university, a one unit (decile) increase in the distance of venture capital or private equity industry work experience between GP and private equity portfolio company teams corresponds to a 20.069 percentage change in the odds that they realize a match, which is significant at the 5% level. The marginal effect of a small increase in this distance is 0.0081. In the estimation that excludes the disciplines, a one unit increase in the distance of this trait between GP and private equity portfolio company teams corresponds to a 19.937 percentage change in the odds that they realize a match, which is significant at the 5% level. The marginal effect of a small increase in this distance is 0.0071.

The fifth and sixth columns in Table 4 also present rare events logit estimation results for a baseline specification that does not include the instrument. In the estimation including disciplines majored in at university, a one unit increase in the distance of venture capital or private equity industry work experience between GP and private equity portfolio company teams corresponds to a 13.689 percentage change in the odds that they realize a match, which is significant at the 5% level, or a marginal effect for a small increase in this distance of 0.0321. In the estimation excluding the disciplines, a one unit increase in the distance of this trait between GP and private equity portfolio company teams corresponds to a 14.191 percentage change in the odds that they realize a match, which is significant at the 5% level, or a marginal effect for a small increase in this distance of 0.0332.

The eleventh and twelfth columns of Table 4 present conditional logit estimation results for an instrumental variable specification. For the estimation that includes disciplines majored in at university, a one unit increase in the distance of venture capital or private equity industry work experience between GP and private equity portfolio company teams corresponds to a 20.647 percentage change in the odds that they realize a match, which is significant at the 5% level, or a marginal effect for a small increase in this distance of 0.0065. In the estimation excluding the disciplines, a one unit increase in the distance of this trait between GP and private equity portfolio company teams corresponds to a 20.623 percentage change in the odds that they realize a match, which is significant at the 5% level, or a marginal effect for a small increase in this distance of 0.0077.

The eleventh and twelfth columns of Table 4 also present rare events logit estimation results for an instrumental variable specification. For the estimation that includes disciplines majored in at university, a one unit increase in the distance of venture capital or private equity industry work experience between GP and private equity portfolio company teams corresponds to a 13.519 percentage change in the odds that they realize a match, which is significant at the 5% level, or a marginal effect for a small increase in

this distance of 0.0317. In the estimation excluding the disciplines, a one unit increase in the distance of this trait between GP and private equity portfolio company teams corresponds to a 14.02 percentage change in the odds that they realize a match, which is significant at the 5% level, or a marginal effect for a small increase in this distance of 0.0328.

The positive coefficient signs for the conditional and rare events logit estimations, whether or not I include the instrument, suggest that NAM by work experience in the venture capital or private equity industry occurs between GP and private equity portfolio company teams. With all the results significant at the 5% level, there is evidence to suggest that NAM by this trait is occuring for GP and portfolio company teams at this stage. Therefore, I can reject the null hypothesis that NAM by work experience in the venture capital or private equity industry does not occur between GP and private equity portfolio company teams in Africa.

6 Summary & Conclusion

The objective of this paper is to empirically determine whether a GP team's work experience in the venture capital or private equity industry influences the likelihood that it invests in a portfolio company team in Africa (excluding South Africa). The descriptive and univariate results predict that I should observe NAM by this human capital trait occurring between GP and portfolio company teams on the continent.

The evidence of NAM by venture capital or private equity industry work experience is only significant at the private equity stage. Based on these findings, I can reject the null hypothesis that a GP team's work experience in the venture capital or private equity industry has no influence on the likelihood that it invests in a portfolio company team in Africa (excluding South Africa) at the private equity stage. However, I cannot reject this null hypothesis at either of the venture capital stages.

Since portfolio company teams in Africa rarely have venture capital or private equity experience, if at all, the findings suggest that at the private equity stage, they have

a higher likelihood of matching to GP teams with more venture capital or private equity industry work experience (dissimilar agents). Therefore, LPs interested in exploiting private equity investment opportunities are correct to be concerned about a shortage of deal development, screening, and structuring skills among GP teams in Africa (excluding South Africa) because evidence supports their perception that it is a constraint.

This article describes the assortative matching pattern between agents in a market based on signalling of human capital traits. The results reflect a matching equilibrium that could be the result of various underlying mechanisms e.g. deferred acceptance, top trading cycles, random, etc. Future research could use the same dataset to explore which of these mechanisms would result in the greatest efficiency.

The article assumes a frictionless, perfect information setting where agents' decisions to realize a match are independent. Future research can investigate if the findings are sensitive to these assumptions. They can be tested by comparing how well competing theoretical models fit the data on matching in African venture capital and private equity markets.

Also, future research can compare the results in this article to those obtained using alternative identification methods such as difference in difference techniques. This would require a dataset that includes unmatched agents.[64] Such a dataset would also allow bivariate probit estimation that assumes agents' decisions to realize a match are interrelated (Poirier, 1980; Przeworski and Vreeland, 2002).

[64]Davis et al. (2008) use the Longitudinal Business Database at the U.S. Bureau of the Census linked to CapitalIQ data to construct a representative sample of matched and unmatched agents at the private equity stage.

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APPENDICES

Appendix A

Becker (1973) describes NAM in the marriage market based on wage rates between spouses. In this setting, matching is motivated by the desire to maximize post-match output over all realized matches. This section summarizes his theoretical model with slight modifications to fit the context of this article.

There is a finite set of GPs, $GP = \{1, 2, \ldots G\}$, and portfolio companies, $P = \{1, 2, \ldots P\}$ where $G \leq P$. Assume all GPs differ only in trait A_G, and all portfolio companies only in A_P, that each trait has a monotonic effect on the output of any match Z, and that higher values have a larger effect when added separately:

$$\frac{\partial Z_{G,P}(A_G, A_P)}{\partial A_G} > 0 \; and \; \frac{\partial Z_{G,P}(A_G, A_P)}{\partial A_P} > 0 \tag{3}$$

If increasing A_G and A_P, together, adds the same amount to output as the sum of the additions when each is increased separately, all sortings of G and P would give the same total output. If increasing both adds less to output than the sum of the separate additions, a sorting of large A_G with small A_P, or vice versa, would give the greatest total output since an increase in A_G offsets the effect of a decrease in A_P. In this case, NAM is optimal:

$$\frac{\partial^2 Z(A_G, A_P)}{\partial A_G \partial A_P} < 0 \tag{4}$$

To describe this prediction, consider the individual match between GP i and portfolio company a, who differ only in their venture capital or private equity industry work experience, $vcpe$, but are identical in all other traits. In this case the optimal output between i and a can be written as:

$$Z_{i,a} \equiv \frac{S_{i,a}}{C_{i,a}(vcpe_i, vcpe_a, t_{i,a})} \equiv \frac{S_i + S_a}{C_{i,a}} \tag{5}$$

Where:

$Z_{i,a}$ is the post-match, output between i and a and is defined by a production function that relates $Z_{i,a}$ to different inputs as follows:

$$Z = f(b_n, t_k, X) \tag{6}$$

With b_n representing various bundles that provide utility from leisure i.e. the time an agent spends on other activities not related to increasing post-match output, where $n = [0, 1, 2 \ldots, r]$; t representing time inputs of the k^{th} agent, i and a respectively, that contribute to post-match output; and X representing exogenous environmental variables.

$S_{i,a}$ is the full income constraint that combines the leisure bundles and time constraints. It can be defined by a budget constraint as follows:

$$\sum^{n} p_n b_n = \sum^{k} vcpe_k l_k + w \tag{7}$$

With p representing the price of a leisure bundle; $vcpe_k$ representing venture capital or private equity industry work experience of the k^{th}agent; l_k representing leisure of the k^{th}agent; and w representing the agent's pre-existing wealth.

The time constraint T, which represents the total time available to each agent, relates l_k and t_k as follows:

$$l_k + t_k = T \tag{8}$$

This can be substituted into the budget constraint as follows:

$$\sum^{n} p_n b_n = \sum^{k} vcpe_k (T - t_k) + w \tag{9}$$

$$\sum^{n} p_n b_n + \sum^{k} vcpe_k t_k = \sum^{k} vcpe_k T + w = S_{i,a} \tag{10}$$

It represents the full income if $vcpe_k$ are constants.

$C_{i,a}$ is the average cost of production, which depends on $vcpe_i$ and $vcpe_a$ and t_k, which captures all other time dependent inputs.

If we re-write equation (5) as:

$$Z_{i,a} \equiv \frac{S_{i,a}}{C_{i,a}(vcpe_i, vcpe_a, t_{i,a})} \equiv \frac{\sum^{k} vcpe_k T + w}{C_{i,a}(vcpe_i, vcpe_a, t_{i,a})} \tag{11}$$

and differentiate by $vcpe_i$ we obtain:

$$Z_{i,a}^{vcpe_i} = \frac{TC_{i,a} - \left(\sum^{k} vcpe_k T + w\right) C_{i,a}^{vcpe_i}}{C_{i,a}^2} = \frac{T}{C_{i,a}} - \frac{S_{i,a}}{C_{i,a}^2} C_{i,a}^{vcpe_i} \tag{12}$$

From equation (11):

$$\begin{aligned} C_{i,a}(vcpe_i, vcpe_a, t_{i,a}) = S_{i,a} Z_{i,a}^{-1} &= \left(\sum^{k} vcpe_k T + w\right) Z_{i,a}^{-1} \\ &= \left(\sum^{k} vcpe_k [l_k + t_k] + w\right) Z_{i,a}^{-1} \end{aligned} \tag{13}$$

Since differentiating by $vcpe_i$ I obtain:

$$C_{i,a}^{vcpe_i} = t_i Z_{i,a}^{-1} \tag{14}$$

where t_i is the time spent by GP, i, on creating match output,

$$Z_{i,a}^{vcpe_i} = l_i C_{i,a}^{-1} > 0 \tag{15}$$

if l_i is greater than zero.

Similarly,

$$Z_{i,a}^{vcpe_a} = \frac{T}{C_{i,a}} - \frac{S_{i,a}}{C_{i,a}^2} C_{i,a}^{vcpe_a} = l_a C_{i,a}^{-1} > 0 \tag{16}$$

Differentiating $Z_{i,a}^{vcpe_a}$ with respect to $vcpe_i$ I get:

$$Z_{i,a}^{vcpe_a vcpe_i} = C_{i,a}^{-1} \frac{\partial l_a}{\partial vcpe_i} - C_{i,a}^{-2} C^{vcpe_i} l_a = -C_{i,a}^{-2} C^{vcpe_i} l_a + C_{i,a}^{-1} \frac{\partial l_a}{\partial vcpe_i} \tag{17}$$

The first term on the right of equation (17) is negative, so $Z_{i,a}^{vcpe_i vcpe_a}$ will be negative if the second term, $\frac{\partial l_a}{\partial vcpe_i}$, is nonpositive. This occurs if t_i and t_a are gross substitutes.[65] In this case, NAM by venture capital or private equity industry work experience is optimal i.e. a perfectly negative, rank correlation between $vcpe_i$ and $vcpe_a$ would maximize total match output.

$$\frac{\partial^2 Z_{i,a}}{\partial vcpe_i \partial vcpe_a} \equiv Z^{vcpe_i vcpe_a} \equiv Z^{vcpe_i vcpe_a} < 0 \tag{18}$$

If t_i and t_a are gross complements, the second term in equation $(17)$is positive and could be of such a magnitude that it swamps the first term such that $Z_{i,a}^{vcpe_a vcpe_i}$ is positive. To the extent that t_i and t_a could be complements or substitutes in production, the direction of the assortive matching pattern is not clear *a priori*.

[65]Gross complements or substitutes, as opposed to their net counterparts, include both income and substitution effects.

Appendix B

Actual matches observed by the researcher are assumed to represent an equilibrium where the theory of preferences can be applied because agents compete to match voluntarily, with the aim of raising their utility above the level that would exist if they chose not to pursue a match (Becker, 1973).[66]

Suppose the actual matches are between GP i and portfolio company a and GP j with portfolio company b.[67] Let the function $\triangle G(i,a)$ be the value that GP i contributes to an initiative when matched with portfolio company a, and $\triangle P(i,a)$ be the value that portfolio company a contributes to an initiative when matched with GP i. Let $s_{i,a}$ be the equity stake GP i purchases from portfolio company a. Then, the payoff functions for GP i, $\left(\pi^i\right)$, and for portfolio company a, (π^a), can be defined as:

$$\pi^i(i,a) = \triangle P(i,a) + s_{i,a} \tag{19}$$

$$\pi^a(i,a) = \triangle G(i,a) - s_{i,a} \tag{20}$$

Assume that $\tilde{s}_{j,a}$ is the equity stake from portfolio company a to GP j that makes GP j indifferent between portfolio company a and portfolio company b. The equation for GP j is then derived as follows:

$$\triangle P(j,a) + \tilde{s}_{j,a} = \triangle P(j,b) + s_{j,b} \tag{21}$$

Since portfolio company a matches with GP i instead of GP j, its payoff from matching with GP i exceeds the payoff from matching with GP j. We can assume that the equity stakes offered by portfolio company a and b do not influence those that have been previously negotiated in other actual matches because contracts are fixed for the

[66] Roth and Sotomayor (1989) illustrate that in a coalition level analysis, preferences over matches are complete and transitive

[67] This proof is adapted from Yang et al. (2009)

duration of an investment stage and are only reviewed at the end of the stage. Thus, we can derive the following inequality.

$$\pi^a(i,a) \geq \pi^a(j,a) \Rightarrow \triangle G(i,a) - s_{i,a} \geq \triangle G(j,a) - \tilde{s}_{j,a} \tag{22}$$

Substituting $\tilde{s}_{j,a}$ of Equation(21) into inequality(22) I get:

$$\triangle G(i,a) - s_{i,a} \geq \triangle G(j,a) - \left[\triangle P(j,b) + s_{j,b} - \triangle P(j,a)\right] \tag{23}$$

Similarly, the following inequality is derived for portfolio company b matching with GP j instead of GP i.

$$\triangle G(j,b) - s_{j,b} \geq \triangle G(i,b) - [\triangle P(i,a) + s_{i,a} - \triangle P(i,b)] \tag{24}$$

After combining inequalities (23) and (24) and rearranging, cancelling and grouping terms I get:

$$[\triangle G(i,a) + \triangle P(i,a)] + [\triangle G(j,b) + \triangle P(j,b)] \geq [\triangle G(j,a) + \triangle P(j,a)] + [\triangle G(i,b) + \triangle P(i,b)] \tag{25}$$

If the sum of payoffs from an actual match between GP i and portfolio company a is defined as:

$$f(i,a) = \triangle G(i,a) + \triangle P(i,a) \tag{26}$$

Then inequality (25) can be expressed as:

$$f(i,a) + f(j,b) \geq f(j,a) + f(i,b) \tag{27}$$

Inequality (27) expresses the local product maximization condition that defines a match equilibrium in venture capital and private equity markets. The total payoff from any two actual matches exceeds that of any counterfactual alternatives.

II

Does Education Influence Clean Tech Venture Capital and Private Equity Exits?

Abstract

Using a panel dataset, I investigate whether education in post-match general partner and portfolio company teams influences clean-tech venture capital and private equity exits in Africa. The evidence suggests that, relative to other-tech exits, an increase in the proportion of bachelor degrees and graduates from a top-ranked university in post-match teams increases the probability of clean-tech initial public offerings. An increase in the proportion of bachelor degrees also increases the probability of clean-tech trade sale exits. Finally, an increase in the proportion of masters or doctoral degrees increases the probability of a clean-tech secondary sale exits.

Keywords: private equity; venture capital; clean-tech; renewable energy; human capital; Africa

JEL classification: J24, G24, O55, Q42

1 Introduction

In 2010, the clean technology (clean-tech) energy industry comprising of biofuels, wind power, solar and fuel cell industries generated $188.1 billion in global revenues. This represented a 30.2 percent increase compared to 2009 (Pernick et al., 2011). Responding to this opportunity, limited partners (LPs) increased their portfolio allocations to venture capital and private equity investments, not only in clean energy but in other clean-tech[68] industries as well (Satyamurthy et al., 2010).[69] Beyond LPs' private benefits, positive externalities arise from increased energy access and security, as well as health benefits from a cleaner environment.[70] Therefore, successful outcomes from these investments are desired.

The main objective of this article is to investigate whether post-match education in general partner (GP) and portfolio company teams influences clean-tech venture capital and private equity outcomes. According to Spence (1973), education is a signal of a team's underlying ability. Assuming that teams with more ability have better outcomes, I expect that education in post-match GP and portfolio company teams should be positively related to better clean-tech outcomes, where these outcomes are measured by the probability of exit via initial public offering (IPO), trade sale, or secondary sale, relative to a write off.[71] I use a novel dataset of venture capital or private equity exits across 20 African countries from 1995 to 2012 to investigate whether this relationship occurs.

[68]Clean-tech investments occur in the agriculture, air and environment, materials, energy, recycling and waste, manufacturing and industry, transportation, water, and wastewater industries (*see* National Advisory Council for Environmental Policy and Technology (2008) for examples in each industry.)

[69]Venture capital and private equity investments are made by GPs, who are intermediaries that directly invest in privately held portfolio companies through funds using equity or quasi-equity instruments. They actively manage these investments as advisors, directors, or managers; with an explicit strategy to exit in the medium term (Sahlman, 1990). GPs obtain the money to invest from LPs, who are institutional investors such as pension funds and university endowments. While wealthy individuals (angel investors) use their own money to directly finance privately held portfolio companies, they will not be included in this article due to lack of data on their activities.

[70]These issues have increased scholarly interest in the clean-tech research agenda (Edenhofer et al., 2012; Wüstenhagen and Menichetti, 2012).

[71]Types of exit include: IPOs through new listings on stock exchanges; trade sales involving acquisitions by a larger firm or portfolio companies repurchasing stakes, secondary sales where GPs sell their stakes to another GP, but the portfolio company does not sell; and write-offs involving liquidations (Cumming and Johan, 2008)

To determine the effect, I compare clean-tech to other technology (other-tech)[72] exits, with non-innovative (traditional) sector exits as the reference category. The choice to invest in clean-tech requires GPs to forgo venture capital and private equity opportunities in other-tech and traditional sectors. These foregone opportunities should have relatively higher chances of exit because they are more familiar and have a higher level of market acceptance compared to clean-tech initiatives (Wüstenhagen et al, 2007).[73] Compared to the traditional sector exits, which face the lowest acceptance barriers and have the highest level of familiarity, we can expect the probability of clean-tech exits to be lower than other-tech exits because they have a relatively lower level of acceptance and familiarity.

In summary, the evidence suggests that relative to exits from traditional investments and write-offs, an increase in the proportion of bachelor (masters) degrees and graduates from a top-ranked university in a post-match GP and portfolio company team increases (decreases) the probability of clean-tech, relative to other-tech, IPO exits. It also suggests that an increase in the proportion of bachelor degrees (doctoral degrees or graduates from a top-ranked university) in a post-match GP and portfolio company team increases (decreases) the probability of clean-tech, relative to other-tech, trade sale exits. Finally, the evidence suggests that an increase in the proportion of masters or doctoral degrees in a post-match team increases the probability of clean-tech, relative to other-tech, secondary sale exits.

The rest of the article is organized as follows. Section 2 reviews related literature. Section 3 discusses the method and data used to achieve the article's objective. Section 4 presents the results and a discussion. The last section summarizes and draws conclusions based on the results.

[72]Other-tech includes biotechnology, information and communication technology, and microfinance sectors, or in activities that involve cutting edge manufacturing techniques.

[73]Acceptance is distinguished as socio-political, community, or market acceptance (Wüstenhagen, 2007)

2 Literature Review

Venture capital and private equity markets are characterized by weak information where GP and portfolio company teams rely on signals e.g. education, to attain an equilibrium (Spence, 1973; Hoppe et al., 2009; Kushnir, 2010).[74] To the extent that these education signals reflect agents' underlying abilities, they represent the pre-match potential that each agent has to contribute to post-match success. Defining education in post-match teams as the treatment effect, a better quality treatment should result in better outcomes. Therefore, the predicted relationship is that *post-match GP and portfolio company teams with more education should achieve better outcomes (exits).*

Among previous empirical studies that have investigated the effect of human capital on venture capital and private equity outcomes, Dimov and Shepherd (2005) find that while a GP team's education is positively related to venture capital IPO exits, its work experience is negatively related to the proportion of write-offs.[75] Zarutskie (2010) finds that while a GP team's venture capital or private equity industry work experience and start-up experience are positively related to the proportion of a portfolio exited via IPO or trade sale, teams with more MBA degrees have a lower proportion of exits.

While these previous empirical studies indicate that human capital is important, they do not focus on clean-tech outcomes. Those that do find that other-tech companies outperform clean-tech companies (Boulatoff and Boyer, 2009). However, they also find that clean tech companies perform no worse than their conventional (non clean-tech) energy counterparts (Ng and Olowojolu, 2010). In addition, they find that investors' experience, defined as the number of years they state that they have in the renewable energy sector, is positively related to the share of these investments in a portfolio, but negatively related to investment performance, defined as investors' perceptions of whether

[74] Education represents general human capital that is defined as skills acquired through formal education, which can be applied across most firms and settings (Zarutske, 2010).

[75] Work experience captures industry-specific human capital that is defined as skills specific to a particular time or setting, which is learned in prior jobs or industries and are transferable to future jobs (Zarutske, 2010).

their portfolio performance is above, equal to, or below a competitor's performance (Mansini and Menichetti, 2012).

However, the previous studies that focus on clean-tech outcomes only provide evidence from publicly held firms. Boulatoff and Boyer (2009) compare the financial performance of 310 public, clean-tech companies to their other-tech counterparts listed on the NASDAQ financial market. Ng and Olowojolu (2010) compare the operational performance, stock performance and the ability to raise finance by 99 public clean-tech energy companies to their conventional energy counterparts between 2004 and 2009.[76] In addition to not distinguishing between publicly or privately held portfolio companies, Mansini and Menichetti's (2012) definition of investors is not limited to GPs, but also includes banks, utilities, pension funds, hedge funds, insurance companies, private engineering companies, etc.

Finally, the datasets used in the empirical studies outlined above are limited to North America or Europe. Dimov and Shepherd's (2005) dataset consists of venture capital exits in the wireless communication industry in 2002 for 112 independent US GPs.[77] Zarutskie's (2010) dataset consists of venture capital exits by 318 first-time funds of independent GPs established in the USA between 1980 and 1998 (regardless of industry). Mansini's and Menichetti's (2012) dataset consists of clean-tech energy investments by 96 European investors in 2009.

The key contribution of this article will be to determine whether education in post-match GP or portfolio company teams influences clean-tech exits for privately held firms. Evidence from a sample of exits in Africa contributes to the broader empirical literature on venture capital and private equity by providing insights from a region where current knowledge is descriptive e.g summary statistics (Jones and Mlambo,

[76]They measure operational performance by gross margin, return on assets and return on equity; stock performance by average five-year stock return, standard deviation of average five-year stock return and average five-year stock return versus the average five-year NASDAQ composite index return; and ability to raise finance by five-year growth in equity, five-year growth in cash flow from financing activities and five-year growth in total liabilities.

[77]Independent GPs are not majority-owned by governments or multilateral agencies acting on their behalf (public), banks or insurance companies (finance), or corporations. However, they raise funds from these institutions.

2009; Sathyamurthy et al., 2010), case studies (Masum et al., 2010), or limited to single-country studies (Hassan, 2010; Hassan and Ibrahim, 2012).[78]

3 Methods & Data

To determine whether education influences clean-tech venture capital or private equity outcomes, I rely on a static reduced form empirical model. This section discusses the model, the data it relies on, and the strategy used to estimate it.

3.1 Empirical Model

The model used to investigate the predicted relationship stated in the previous section adopts the linear additive form specified in Equation 1.

$$y_{gpct} = \alpha + X'_{gpct}\beta_1 + \Gamma'_{gpct}\beta_2 + \varepsilon_{gpct} \tag{1}$$

Where y_{gpct} is the dependent variable. α denotes the constant term. X_{gpct} is a matrix containing variables reflecting the average of the proportion of post match education traits that are shared between GP $(g = 1...G)$, and portfolio company $(p = 1...P)$ teams, in a market that is represented by a country $(c = 1...C)$, in a certain year $(t = 1...T)$.[79] I am interested in estimating the coefficient vector β_1. Γ_{gpct} is a matrix of control variables that includes post-match shared non-human capital, and unshared time varying characteristics specific to the country in which exits occur. ε_{gpct} denotes the remaining random error term.

[78] So far, multi-continent venture capital and private equity studies have ignored Africa. Those that do not, only include South Africa (Cumming and Johan, 2009).

[79] I use the average as opposed to the product of their traits to prevent eliminating the presence of a trait in a matched pair if one agent has it while the other agent doesn't. For example, if 0.35 of a GP's team has a masters degree while none of a portfolio company's team has this education trait, the average of their shared trait will be 0.175 $[(0.35+0) \div 2]$ while the product would be 0 (0.35×0).

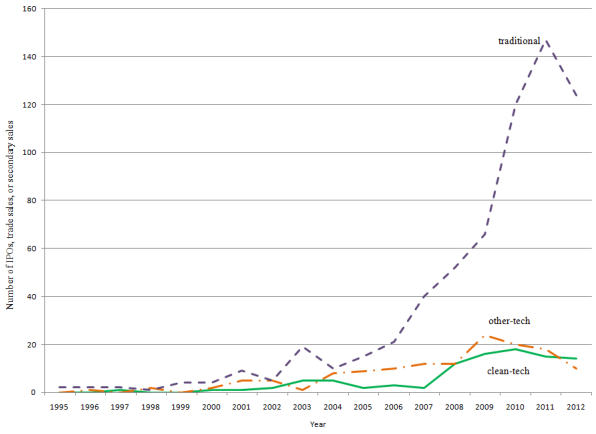
Table 1: Summary statistics

Variable	mean	standard deviation	minimum	maximum	observations
y (= 1 to 4)	2.8513	0.8973	1	4	3114
bachelors	0.6158	0.2400	0.0095	1	719
masters	0.2692	0.1999	0	0.9649	698
doctorate	0.0311	0.0688	0	0.5	696
certification	0.3583	0.1760	0	0.8	619
top-ranked university	0.2075	0.1711	0	0.8214	453
age (in years)	20.1480	18.4998	0	118.5	1781
Portfolio company:					
clean-tech (=1 if yes)	0.0556	0.2291	0	1	3077
other-tech (=1 if yes)	0.2158	0.4114	0	1	3077
traditional (=1 if yes)	0.7286	0.4447	0	1	3077
Market:					
GDP growth rate per capita	0.0294	0.0183	-0.0414	0.1084	3083
clean-tech usage	0.0266	0.0089	0	0.1161	3074
kyoto (= 1 if ratified)	0.8099	0.3925	0	1	3114
country_id	43.7322	5.8343	3	53	3114
year_exit	2007.64	2.6825	1995	2012	2848

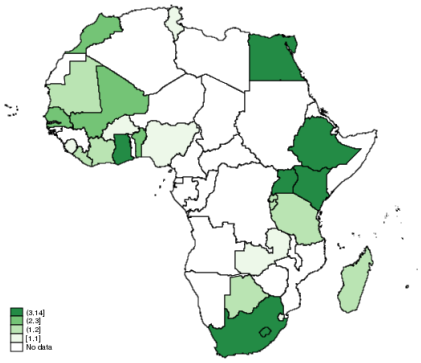
3.2 Data

The data on venture capital and private equity exits and the education traits of GP and portfolio company teams are obtained from various public, secondary sources including audited annual reports and unaudited sources e.g. website content, conference presentations, press releases, and newsletters. This data is summarized in Table 1.

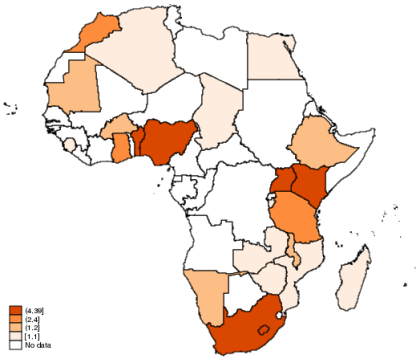
The data capturing the characteristics of countries where exits occur are obtained from the publicly accessible, online data portal provided by the World Bank (2013). This portal includes information from the African Development Indicators, Doing Business, Governance Indicators, World Development Indicators, and Global Development Finance databases. The data are reported by government agencies, obtained through field surveys, or compiled from other agencies e.g. the International Monetary Fund, United Nations, and World Economic Forum. These data are also summarized in Table 1. I discuss them in more detail in the rest of this sub-section.



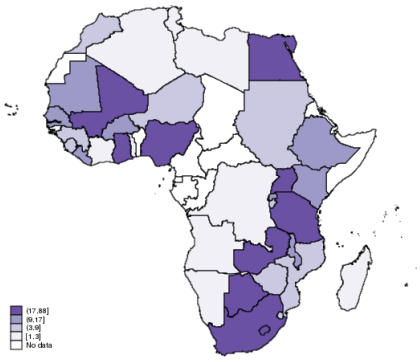
Number of IPO, trade sale, or secondary sale exits



Note: Clean-tech exits = 81



Note: Other-tech exits; n = 104



Note: Traditional exits; n = 556

Figure 1: Venture capital and private equity exits in Africa (1995 - 2012)

3.2.1 Dependent variable

The dependent variable is a categorical indicator equal to one if the exit from a match is a write-off (the baseline category), two if it is a secondary sale, three if it is a trade sale, and four if it is an IPO.[80] It represents a random sample of exits by 194 GPs from 741 portfolio companies across 45 countries, which are illustrated in Figure 1.[81] 26 of these GPs exited from 81 clean-tech portfolio companies over the sample period.

[80] I cannot assess outcomes using the internal rate of return (IRR) because the data on this metric result in a sample size that is inadequate for analysis.

[81] The top-left panel of Figure 1 illustrates that although the overwhelming majority of venture capital and private equity exits in Africa occur in the non-innovative traditional sector, clean-tech exits on the continent have risen since 2007 and had caught up with other-tech investments by 2010.

3.2.2 Key independent variable

The variable of interest is the average proportion of education in post-match GP and portfolio company teams. It includes the proportion of a team's members with a bachelor, masters or doctoral degree. It also includes the proportion of a team's members that have obtained post-graduation industry certifications e.g. certified public accountant, certified financial analyst, executive education, etc. Finally, it includes the proportion of a team's members that graduated from a top-ranked university.[82]

For the GP, I only include team members whose job title is chief executive officer, director, investment or fund manager, investment officer, principal, partner, associate, or analyst.[83] I exclude non-executive directors and chairpersons of a GP because they are more likely to be involved in board responsibilities to LPs. I also exclude team members responsible for executing deals on other continents rather than in Africa. Finally, I exclude support staff because they are likely to be focused on in-house administration.

I define the start and departure dates of a GP's or portfolio company's team member as the year they joined or left the team. These dates are explicitly indicated in the annual reports, member profiles on a GP's or company's website, or are issued in press releases. In cases where this information was not provided from these sources, I relied on LinkedIn, Bloomberg, or Zoominfo.[84] If the departure dates were unavailable even from these sources, I defined it as the last year they appeared in an annual report or the year prior to which they are announced to have joined a new GP or portfolio company.

[82]The universities include Brown, Columbia, Cornell, Dartmouth, Duke, Harvard, Massachusetts Institute of Technology, University of California-Berkeley, University of Chicago, University of Pennsylvania, Princeton, Yale, and Stanford in the USA; McGill and University of Toronto in Canada; Cambridge, Oxford, Imperial College, London School of Economics and London Business School in the UK; Sorbonne University in France; Bocconi University in Italy; Tilburg University in the Netherlands; University of New South Wales in Australia; Tsinghua University in China; and University of Cape Town, University of Witwatersrand, and University of Stellenbosch in South Africa.

[83]Since not all these team members interact with a specific portfolio company, the results can be interpreted as an upper bound.

[84]Using these sources, I also identified past employees that were part of current team members' social networks. This allowed me to mitigate measurement error for the education traits of GP and portfolio company teams.

3.2.3 Controls

I include age as a non-human capital trait shared between GP and portfolio company teams. I measure it using the difference between the year an exit occurs and their year of establishment.

The non-human capital traits specific to a portfolio company include three separate binary indicators equal to one if a portfolio company is clean-tech, other-tech, or traditional, and zero otherwise.[85]

The country characteristics that I include are real GDP per capita growth rate in purchasing power parity terms with a base year of 2005. I also include the percentage of alternative and nuclear energy in total energy use in each country. A higher value of this measure should reflect higher market acceptance that should have a positive influence on clean-tech exits. Furthermore, I include a binary indicator equal to one if a country has ratified the Kyoto Protocol, and zero otherwise (United Nations, 2012).[86]

3.3 Estimation Strategy

I adopt a multinomial logit estimation strategy where I include clean-tech and other-tech exits separately (with traditional exits as the reference category), without distinguishing portfolio companies by investment stage. This multinomial logit determines whether education in a post-match GP and portfolio company teams' influences IPOs, trade sales, and secondary sales, respectively (with write-offs as the baseline category).

I then calculate the difference between the results of clean-tech and other-tech estimations. To determine whether these differences are significant, I estimate a single regression that includes both types of portfolio companies. Its independent variables include the education traits and their controls interacted with the clean-tech or other-tech binary indicator.

[85]These are required for dataset restrictions that categorize portfolio companies by type.

[86]Using a panel dataset covering 26 OECD countries from 1991–2004, Popp et al. (2011) find that ratification of the Kyoto Protocol plays an important role for clean-tech energy adoption.

4 Results & Discussion

In this section I present multinomial logit estimation results and discuss them by exit type. While write-offs are not a desired exit for GPs and portfolio companies, I also present and discuss the results of this type of exit for completeness. I will limit the discussion to the marginal effects.

4.1 Initial Public Offering

The first row in Table 2 illustrates the effect of bachelor degrees on IPO exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of bachelor degrees in a post-match GP and portfolio company team increases the probability of a clean-tech IPO exit by 0.9314 and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of bachelor degrees in the post-match team increases the probability of an other-tech IPO exit by 0.6479 and is also significant at the 1% level. Finally, column 6 illustrates that a one unit increase in the proportion of bachelor degrees in a post-match GP and portfolio company team increases the probability of a clean-tech, relative to other-tech, IPO exit by 0.2385 (0.9314 - 0.6479).[87]

The third row in Table 2 illustrates the effect of masters degrees on IPO exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of masters degrees in a post-match GP and portfolio company team decreases the probability of a clean-tech IPO exit by 0.8587 and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of masters degrees in the post-match team decreases the probability of an other-tech IPO exit by 0.399 and is also significant at the 1% level. Finally, column 6 illustrates that a one unit increase in the proportion of masters degrees in a post-match GP and portfolio company team decreases the probability of a clean-tech, relative to other-tech, IPO exit by 0.4597 (-0.8587 - -0.399).

[87]While this difference is not significant even at the 10% level, I attribute this to the sample size not being large enough to estimate clean-tech and other-tech in a single regression with all their interaction terms.

Table 2: Multinomial logit results for Education: Initial Public Offerings

	Clean-Tech		Other-Tech		(1) - (3)	(2) - (4)
	(1)	(2)	(3)	(4)	(5)	(6)
		Marginal		Marginal		Marginal
Variable	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect
bachelors	21.4644	0.9314***	16.7700***	0.6479***	4.6944	0.2835
	(13.8603)	(0.1109)	(5.2411)	(0.1016)		
masters	26.3606	-0.8587***	6.3042	-0.3990***	20.0564	-0.4597
	(20.0157)	(0.1758)	(5.8128)	(0.1492)		
doctorate	-62.9976**	-0.7982*	-48.4955***	-1.6294***	-14.5021	0.8312
	(28.0862)	(0.4370)	(9.2294)	(0.4292)		
certification	17.3209	0.1559	11.5459**	-0.0222	5.775	0.1781
	(10.6309)	(0.1089)	(5.6220)	(0.1179)		
top-ranked university	-40.4060*	-0.8489***	-24.2076***	-0.8881***	-16.1984	0.0392
	(24.3279)	(0.1664)	(5.3059)	(0.1484)		
Observations	375		399		430	
Prob > chi2	0.0000		0.0000		0.0000	
Pseudo R^2	0.5744		0.4286		0.6448	

Note: Controls for clean-tech exits include age, clean-tech, GDP growth per capita, clean-energy use, and kyoto;
Controls for other-tech exits include age, other-tech, and GDP growth per capita;
Delta standard errors are in parentheses; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

The fifth row in Table 2 illustrates the effect of doctoral degrees on IPO exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of doctoral degrees in a post-match GP and portfolio company team decreases the probability of a clean-tech IPO exit by 0.7982 and is significant at the 10% level. Since this is not significantly different from a write-off, I do not discuss how it differs from other-tech IPO exits. Column 4 illustrates that a one unit increase in the proportion of doctoral degrees in the post-match team decreases the probability of an other-tech IPO exit by 1.6294 and is significant at the 1% level.[88]

The seventh row in Table 2 illustrates the effect of post-degree certifications on IPO exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of certifications in a post-match GP and portfolio company team increases the probability of a clean-tech IPO exit by 0.1559 but is not significant even at the 10%

[88] Across all exit types, except write-offs, the marginal effect for this education trait is greater than 1. This could be due to the low prevalence of doctoral degrees among GP or portfolio company teams in Africa.

level. Column 4 illustrates that a one unit increase in the proportion of certifications in the post-match team decreases the probability of an other-tech IPO exit by 0.0222 but is also not significant even at the 10% level. Since the effect of an increase in the proportion of certifications is not significantly different between IPOs and write-offs for both clean-tech and other-tech, I do not discuss how they differ.

The ninth row in Table 2 illustrates the effect of graduation from a top-ranked university on IPO exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in a post-match GP and portfolio company team decreases the probability of a clean-tech IPO exit by 0.8489 and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in the post-match team decreases the probability of an other-tech IPO exit by 0.8881 and is also significant at the 1% level. Finally, column 6 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in a post-match GP and portfolio company team increases the probability of a clean-tech, relative to other-tech, IPO exit by 0.0392 (-0.8489 - -0.8881).

In summary the findings suggest that an increase in the proportion of bachelor (masters) degrees and graduates from a top-ranked university in a post-match GP and portfolio company team increases (decreases) the probability of a clean-tech, relative to other-tech, IPO exit.

4.2 Trade sale

The first row in Table 3 illustrates the effect of bachelor degrees on trade sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of bachelor degrees in a post-match GP and portfolio company team decreases the probability of a clean-tech trade sale exit by 0.4803 and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of bachelor degrees in the post-match team decreases the probability of an other-tech trade sale exit by 0.5260 and is

Table 3: Multinomial logit results for Education: Trade Sale

	Clean-Tech		Other-Tech		(1) - (3)	(2) - (4)
	(1)	(2)	(3)	(4)	(5)	(6)
		Marginal		Marginal		Marginal
Variable	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect
bachelors	11.2980	-0.4803***	10.2059**	-0.5260***	1.0921	0.0457
	(13.8916)	(0.0962)	(5.1954)	(0.1019)		
masters	35.0408*	0.2984**	6.3986	-0.2448*	28.6422	0.5432
	(20.0809)	(0.1373)	(5.7127)	(0.1275)		
doctorate	-41.0904	1.9438***	-20.8277**	3.0907***	-20.2627	-1.1469
	(27.7438)	(0.2658)	(8.3713)	(0.2622)		
certification	16.2256	-0.0331	12.6307**	0.2038*	3.5949	-0.2369
	(10.6998)	(0.1052)	(5.6124)	(0.1094)		
top-ranked university	-32.1224	0.3590***	-16.0853***	0.5757***	-16.0371	-0.2167
	(24.3500)	(0.1368)	(5.1189)	(0.1319)		
Observations	375		399		430	
Prob > chi2	0.0000		0.0000		0.0000	
Pseudo R^2	0.5744		0.4286		0.6448	

Note: Controls for clean-tech exits include age, clean-tech, GDP growth per capita, clean-energy use, and kyoto; Controls for other-tech exits include age, other-tech, and GDP growth per capita;
Delta standard errors are in parentheses;$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

also significant at the 1% level. Finally, column 6 illustrates that a one unit increase in the proportion of bachelor degrees in a post-match GP and portfolio company team increases the probability of a clean-tech, relative to other-tech, trade sale exit by 0.0457 (-0.4803 - -0.5260).

The third row in Table 3 illustrates the effect of masters degree on trade sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of masters degrees in a post-match GP and portfolio company team increases the probability of a clean-tech trade sale exit by 0.2984 and is significant at the 5% level. Column 4 illustrates that a one unit increase in the proportion of masters degrees in the post-match team decreases the probability of an other-tech trade sale exit by 0.2448 but is only is significant at the 10% level. Since this is not significantly different from write offs, I do not discuss how it differs from clean-tech trade sale exits.

The fifth row in Table 3 illustrates the effect of doctoral degrees on trade sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of doctoral degrees in a post-match GP and portfolio company team increases the probability of a clean-tech trade sale exit by 1.9438 and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of doctoral degrees in the post-match team increases the probability of an other-tech trade sale exit by 3.0907 and is also significant at the 1% level. Finally, column 6 illustrates that a one unit increase in the proportion of doctoral degrees in a post-match GP and portfolio company team decreases the probability of a clean-tech, relative to other-tech, trade sale exit by 1.1469 (1.9438 - 3.0907).

The seventh row in Table 3 illustrates the effect of post-degree certifications on trade sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of certifications in a post-match GP and portfolio company team decreases the probability of a clean-tech trade sale exit by 0.0331 but is not significant even at the 10% level. Column 4 illustrates that a one unit increase in the proportion of certifications in the post-match team increases the probability of an other-tech trade sale exit by 0.2038 but is only significant at the 10% level. Since the effect of an increase in the proportion of certifications is not significantly different between trade sales and write-offs for both clean-tech and other-tech, I do not discuss how they differ.

The ninth row in Table 3 illustrates the effect of graduation from a top-ranked university on trade sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in a post-match GP and portfolio company team increases the probability of a clean-tech trade sale exit by 0.3590 and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in the post-match team increases the probability of an other-tech trade sale exit by 0.5757 and is also significant at the 1% level. Finally, column 6 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in a post-match GP and portfolio company

team decreases the probability of a clean-tech, relative to other-tech, trade sale exit by 0.2167 (0.3590 - 0.5757).

In summary the evidence indicates that an increase in the proportion of doctoral (bachelor) degrees and graduates from a top-ranked university in a post-match GP and portfolio company team decreases (increases) the probability of a clean-tech, relative to other-tech, trade sale exit.

4.3 Secondary sale

The first row in Table 4 illustrates the effect of bachelor degrees on secondary sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of bachelor degrees in a post-match GP and portfolio company team decreases the probability of a clean-tech secondary sale exit by 0.3477 and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of bachelors degrees in the post-match team decreases the probability of an other-tech secondary sale exit by 0.0034 but is not significant even at the 10% level. Since this is not significantly different from write offs I do not discuss how an increase in bachelor degrees affects clean-tech, versus other tech, secondary sale exits.

The third row in Table 4 illustrates the effect of masters degrees on secondary sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of masters degrees in a post-match GP and portfolio company team increases the probability of a clean-tech secondary sale exit by 0.729, and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of masters degrees in the post-match team increases the probability of an other-tech secondary sale exit by 0.7105 and is also significant at the 1% level. Finally, column 6 illustrates that a one unit increase in the proportion of masters degrees in a post-match GP and portfolio company team increases the probability of a clean-tech, relative to other-tech, secondary sale exit by 0.0185 (0.729 - 0.7105).

Table 4: Multinomial logit results for Education: Secondary Sale

	Clean-Tech		Other-Tech		(1) - (3)	(2) - (4)
	(1)	(2)	(3)	(4)	(5)	(6)
		Marginal		Marginal		Marginal
Variable	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect
bachelors	12.2548	-0.3477***	13.8854***	-0.0034	-1.6306	-0.3443
	(13.9258)	(0.1027)	(5.2659)	(0.0971)		
masters	39.8290**	0.7290***	12.9395**	0.7105***	26.8895	0.0185
	(20.1100)	(0.1341)	(5.8257)	(0.1183)		
doctorate	-73.7033**	-1.4805***	-53.1774***	-1.7648***	-20.5259	0.2843
	(28.4897)	(0.4358)	(9.7908)	(0.4318)		
certification	16.3671	-0.0264	11.2832**	-0.0655	5.0839	0.0391
	(10.6991)	(0.0913)	(5.6558)	(0.1039)		
top-ranked university	-32.8350	0.2755**	-19.3944***	0.1339	-13.4406	0.1416
	(24.3765)	(0.1269)	(5.2979)	(0.1231)		
Observations	375		399		430	
Prob > chi2	0.0000		0.0000		0.0000	
Pseudo R^2	0.5744		0.4286		0.6448	

Note: Controls for clean-tech exits include age, clean-tech, GDP growth per capita, clean-energy use, and kyoto;
Controls for other-tech exits include age, other-tech, and GDP growth per capita;
Delta standard errors are in parentheses; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

The fifth row in Table 4 illustrates the effect of doctoral degrees on secondary sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of doctoral degrees in a post-match GP and portfolio company team decreases the probability of a clean-tech secondary sale exit by 1.4805 and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of doctoral degrees in the post-match team decreases the probability of an other-tech secondary sale exit by 1.7648 and is also significant at the 1% level. Finally, column 6 illustrates that a one unit increase in the proportion of doctoral degrees in a post-match GP and portfolio company team increases the probability of a clean-tech, relative to other-tech, secondary sale exit by 0.2843 (1.4805 -1.7648).

The seventh row in Table 4 illustrates the effect of post-degree certifications on secondary sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of certifications in a post-match GP and portfolio company team de-

creases the probability of a clean-tech secondary sale exit by 0.0264 but is not significant even at the 10% level. Column 4 illustrates that a one unit increase in the proportion of certifications in the post-match team decreases the probability of an other-tech secondary sale exit by 0.0655 but is also not significant even at the 10% level. Since the effect of an increase in the proportion of certifications on clean-tech or other-tech secondary sale exits is not significantly different from write-offs, I do not discuss how they differ.

The ninth row in Table 4 illustrates the effect of graduation from a top-ranked university on secondary sale exits, relative to writeoffs. Column 2 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in a post-match GP and portfolio company team increases the probability of a clean-tech secondary sale exit by 0.2755 and is significant at the 1% level. Column 4 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in the post-match team increases the probability of an other-tech secondary sale exit by 0.1339 but is not significant even at the 10% level. Since this is not significantly different from write-offs I do not discuss how it differs from clean-tech secondary sale exits.

In summary the evidence indicates that an increase in the proportion of masters or doctoral degrees in a post-match GP and portfolio company team increases the probability of a clean-tech, relative to other-tech, secondary sale exit.

4.4 Write-offs

The first row in Table 5 illustrates the effect of bachelor degrees on write-offs. Column 1 illustrates that a one unit increase in the proportion of bachelor degrees in a post-match GP and portfolio company team decreases the probability of a clean-tech write-off by 0.1034 but is not significant even at the 10% level. Therefore, I do not discuss how an increase in this education trait affects clean-tech, versus other tech, write-offs. Column 2 illustrates that a one unit increase in the proportion of bachelors

Table 5: Multinomial logit results for Education: Write-offs

Variable	Clean-Tech (1) Marginal Effect	Other-Tech (2) Marginal Effect	(1) - (2) (3) Marginal Effect
bachelors	-0.1034	-0.1185***	0.0151
	(0.0729)	(0.0486)	
masters	-0.1687	-0.066	0.1027
	(0.1176)	(0.0548)	
doctorate	0.3349*	0.3035***	0.0314
	(0.1720)	(0.1000)	
certification	-0.0964	-0.1161**	0.0197
	(0.0602)	(0.0580)	
top-ranked university	0.2144	0.1785***	0.0359
	(0.1388)	(0.0543)	
Observations	375	399	430
Prob > chi2	0.0000	0.0000	0.0000
Pseudo R^2	0.5744	0.4286	0.6448

Note: Controls for clean-tech exits include age, clean-tech, GDP growth per capita, clean-energy use, and kyoto; Controls for other-tech exits include age, other-tech, and GDP growth per capita; Delta standard errors are in parentheses; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

degrees in the post-match team decreases the probability of an other-tech write-off by 0.1185 and is significant at the 1% level.

The third row in Table 5 illustrates the effect of masters degrees on writeoffs. Column 1 illustrates that a one unit increase in the proportion of masters degrees in a post-match GP and portfolio company team decreases the probability of a clean-tech write off by 0.1687 but is not significant even at the 10% level. Column 2 illustrates that a one unit increase in the proportion of masters degrees in the post-match team decreases the probability of an other-tech write-off by 0.066 but is also not significant even at the 10% level. Since the effect of an increase in the proportion of this education trait on clean-tech or other-tech write-offs is not significant, I do not discuss how they differ.

The fifth row in Table 5 illustrates the effect of doctoral degrees on writeoffs. Column 1 illustrates that a one unit increase in the proportion of doctoral degrees in a post-match GP and portfolio company team increases the probability of a clean-tech

write-off by 0.3349 and is significant at the 10% level. Since I cannot rely on this level of significance as evidence, I do not discuss how an increase in this education trait affects clean-tech, versus other tech, write-offs. Column 2 illustrates that a one unit increase in the proportion of doctoral degrees in the post-match team increases the probability of an other-tech write-off by 0.3035 and is significant at the 1% level.

The seventh row in Table 4 illustrates the effect of post-degree certifications on writeoffs. Column 1 illustrates that a one unit increase in the proportion of certifications in a post-match GP and portfolio company team decreases the probability of a clean-tech write-off by 0.0964 but is not significant even at the 10% level. Therefore, I do not discuss how an increase in this education trait affects clean-tech, versus other tech, write-offs. Column 2 illustrates that a one unit increase in the proportion of certifications in the post-match team decreases the probability of an other-tech write-off by 0.1161 and is significant at the 5% level.

The ninth row in Table 4 illustrates the effect of graduation from a top-ranked university on writeoffs. Column 1 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in a post-match GP and portfolio company team increases the probability of a clean-tech write-off by 0.2144 but is not significant even at the 10% level. Therefore, I do not discuss how an increase in this education trait affects clean-tech, versus other tech, write-offs. Column 2 illustrates that a one unit increase in the proportion of graduates from a top-ranked university in the post-match team increases the probability of an other-tech write-off by 0.1785 and is significant at the 1% level.

5 Summary & Conclusion

This article aims to determine whether education in post-match GP and portfolio company teams influences clean-tech, relative to other-tech, venture capital and private equity exits in Africa.

The evidence suggests that, relative to exits from traditional investments and write-offs, an increase in the proportion of bachelor (masters) degrees and graduates from a top-ranked university in a post-match GP and portfolio company team increases (decreases) the probability of a clean-tech, relative to other-tech, IPO exit. It also suggests that an increase in the proportion of bachelor degrees (doctoral degrees or graduates from a top-ranked university) in a post-match GP and portfolio company team increases (decreases) the probability of a clean-tech, relative to other-tech, trade sale exit. Finally, the evidence suggests that an increase in the proportion of masters or doctoral degrees in a post-match pair increases the probability of a clean-tech, relative to other-tech, secondary sale exit.

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III

Do Domestic Legal Environments Influence Venture Capital Investment?

Abstract

Using an African panel dataset, I investigate whether a country's legal environment influences venture capital investment within its borders. Evidence shows that improving the domestic legal environment has a significantly negative effect on venture capital investment at the seed, start-up, or early stages, in the short-run. Theory suggests this occurs because better domestic legal environments promote the use of debt by general partners. Since portfolio companies at the seed, startup, or early stages have not yet acquired adequate tangible assets that can be collateralized, they cannot access this financing instrument.

Keywords: law; venture capital; private equity, Africa

JEL classification: K4, G3, O55

1 Introduction

Venture capital affects innovation, firm productivity, and together with private equity influences employment dynamics (Kortum and Lerner, 2000; Engel, 2002; Davis et al. 2008). The implications for economic growth and individual welfare justify policy aimed at stimulating investments in this area.[89] One policy advocacy area that has been identified by practitioners through industry associations such as the Emerging Markets Private Equity Association is improving the legal environment (EMPEA, 2012). Since legal environments are pure public goods, improvements occur through state actors. These policy makers only have sole control over their domestic legal environment.

The domestic legal environment reflects legitimate enforcement mechanisms within the borders of the country where a portfolio company is located.[90] It consists of rules on investor protection and intellectual property rights, as well as the quality of their enforcement (La Porta et al., 1998; Smith and Ueda, 2006). These influence "... the nature of legal obligations that [parties to an agreement have to each other], as well as... how courts interpret and enforce these obligations..." (Shleifer and Vishny, 1997, p.750). The obligations arise from the rights intrinsic to the equity stakes that general partners (GPs) purchase from portfolio companies (Hart, 1995).[91]

A strong domestic legal environment mitigates moral hazard between GPs and portfolio companies. One branch of theory relies on this link as the basis of arguments that demonstrate domestic legal environment effects on venture capital investments. An-

[89] Venture capital and private equity investments are made by GPs, who are intermediaries that directly invest in privately held portfolio companies through funds using equity or quasi-equity instruments. They actively manage these investments as advisors, directors or managers, with an explicit strategy to exit in the medium term (Sahlman, 1990). GPs obtain the money to invest from limited partners (LPs), who are institutional investors such as pension funds and university endowments. While wealthy individuals (angel investors) use their own money to directly finance privately held portfolio companies, they will not be included in this article due to lack of data on their activities.

[90] It relies on legitimate, as opposed to illegitimate, coercion to provide credibility to implicit or explicit threats because an offending party is convinced that an aggrieved party can go to court to enforce contracts in case of a breach in its terms. Other enforcement mechanisms rely on guilt or repeated interactions (Fafchamps et al., 1995).

[91] These rights stipulate conditions for staged financing, cash flow distribution, "[inspecting] portfolio companies' facilities, books, and records; [receiving] timely financial reports and operating statements ... [and ... intervening] quickly, should company performance suffer, through [board] positions ... and, ... voting control'' (Sahlman, 1990, p. 508; Fenn et al., 1996, p. 33 and p. 43).

other branch argues that the domestic legal environment should have no effect on these investments. The objective of this article is to determine which of these competing views is supported by evidence. The main null hypothesis I test to achieve this objective is that domestic legal environments have no influence on venture capital investments.

Testing the hypothesis requires data from a sample of countries with diverse legal environments (La Porta et al., 1998). In this article, I rely on a dataset that captures the number of initial, as opposed to follow on, investments by a sample of GPs in venture capital and private equity portfolio companies across countries in Africa where an aggregate measure of the legal environment for each country is available from 1996 and measures of its components are available from 2004.

I apply a macro analysis to this dataset, with countries as the units of observation. In a specification that uses the aggregate legal environment measure, I adopt a panel fixed-effects estimation for identification. In a specification that uses its components, I compare the results of a panel fixed-effects estimation to a pooled estimation where the variables are first-differenced. In both specifications, the key investment category is seed, startup, or early venture capital. In counterfactual analyses, I investigate domestic legal environment effects on expansion venture capital and private equity investments. I then conduct additional analysis that investigates whether the results differ across legal jurisdictions, also with panel fixed-effects estimations. One source of concern in these estimations is simultaneity bias. To mitigate this, I lag the independent variables by one year.

In summary, I find that an increase in the aggregate measure of a country's legal environment has a significantly negative effect on seed, start-up, or early venture capital investment. Specifically, a one percentage point increase in a country's rule of law score should result in a 2.85 percentage point decrease in the number of seed, startup, or early venture capital investments. Therefore, I can reject the null hypothesis that the domestic legal environment has no influence on seed, startup, or early venture capital investment. Theory suggests this is because better domestic legal environments promote the use of

debt by GPs. Since portfolio companies at the seed, startup, or early stages have not yet acquired adequate tangible assets that can be collateralized, they cannot access this financing instrument.

Following this introduction, the rest of the article is organized as follows. Section 2 outlines the predictions arising from theoretical literature and summarizes related empirical literature. Section 3 discusses the methods and data that I use to achieve the article's objective. Section 4 presents the results of applying the methods and discusses the findings. Finally, Section 5 summarizes the article and concludes.

2 Literature Review

Some theories argue that domestic legal environments should not have an effect on venture capital investment. First, if labor and capital are rented every minute on the spot market, at a competitive price, no resources are left over to divert to GPs' or portfolio companies' own uses. This product market competition ensures that no moral hazard occurs between these agents (Alchian, 1950; Stigler, 1958). Second, if certain pre-conditions are met, privately negotiated contracts between GPs and portfolio companies ensure both agents' have incentives to act in their mutual interest by not engaging in moral hazard (Coase, 1960; Bergman and Nicolaievsky, 2007).[92]

With competition or private contracts eliminating moral hazard between agents, the theoretical channel through which domestic legal environments impact venture capital and private equity activity does not exist. The prediction from these theories is that *domestic legal environments should have no effect on venture capital or private equity investments*.

However, Bottazzi et al. (2009) rely on the effect a better domestic legal environment has on limiting both GPs' and portfolio companies' opportunities to engage in moral hazard as the basis of their argument that it has an impact on venture capital in-

[92]These pre-conditions include low transaction costs, adequate information, existence of property rights, and reasonable agents. They ensure the efficient level of protection is attained (Coase, 1960).

vestment.[93] In their double moral hazard principal-agent model, which they augment with a legal environment component,[94] they theoretically demonstrate that the reduction in moral hazard allows GPs to use more debt or quasi-equity instruments and still fulfil the reservation utility of portfolio companies.[95]

The increasing preference by GPs to use debt or quasi-equity instruments in better legal environments should have negative implications on the ability of portfolio companies at the seed, start-up, or early stages to access venture capital because they lack adequate tangible assets that can be collateralized. However, it should have positive implications on the ability of portfolio companies at the expansion or private equity stages to access debt instruments, respectively, because they have begun to acquire adequate, or have significant tangible assets that can be collateralized (Sahlman, 1990).[96] The prediction that arises from this theoretical argument is that *better domestic legal environments should have less seed, startup, or early venture capital investment, but more expansion venture capital, and private equity investment*.

This predicted relationship between the domestic legal environment and venture capital activity occurs beyond a certain minimum threshold in the quality of this legal environment required for efficient contracting because agreements between GPs and portfolio companies are state-contingent contracts (Bottazzi et al., 2009).[97] This implies that the hypothesis test should be conducted using a non-linear specification that accounts for threshold effects.

[93]Moral hazard can occur between a GP and portfolio company, between the GP and LP, or between a syndicate of GPs, who invest in a single portfolio company. This article focuses on the first category.

[94]Some theoretical models that focus on how agency issues (moral hazard and adverse selection) are solved by an intermediary assume that a reliable legal environment ensuring threat credibility exists (Chan, 1983; Amit et al. 1990; Trester, 1994; Cable and Shane, 1997; Bergemann and Hege, 1998; Elitzura and Gavious, 2003). Therefore, while they do not assume it is non-existent, they do not explicitly account for it in their arguments.

[95]Evidence exists that better legal environments are associated with more use of debt instruments for downside protection (Bottazzi et al., 2009).

[96]Portfolio companies at the seed, start-up, or early stages are involved in proof of concept and incipient activities. Those at the expansion stage are involved in high-growth activities. Finally, those in the private equity stage are mature companies involved in restructuring, or buyouts (Sahlman, 1990; Fenn et al., 1996).

[97]The predicted relationship also depends on GPs' bargaining power being above a minimum threshold level, in other words, they are not in a competitive setting. Bottazzi et al. (2009) use a generalized Nash bargaining solution to demonstrate that below a certain level for the GP's bargaining power there is a negative relationship between the quality of the legal environment and the optimal amount of debt.

Empirical studies investigating the link between domestic legal environments and venture capital or private equity investment were undertaken in the early part of the last decade. Allen and Song (2002) found that better domestic legal environments are negatively related to seed, startup, or early venture capital investments and positively related to expansion venture capital investments. Contrary to the theoretical prediction, these authors found that a negative relationship exists between better domestic legal environments and private equity investments.

However, none of Allen and Song's (2002) results were significant even at the 10% level. This indicates a lack of evidence that domestic legal environments have an effect on venture capital or private equity investment. In fact, the absence of an effect was exploited by Jeng and Wells (2000), who adopted a rule of law measure of the domestic legal environment as an instrument in their study on the link between initial public offerings and venture capital investment.[98]

Although the previous empirical studies support the conclusion that there is no link between the domestic legal environment and venture capital investment, a common weakness in their findings is they use estimation techniques that cannot identify causal links.[99] Therefore, current knowledge on the effect of domestic legal environments on venture capital or private equity investment is limited to correlations. In addition, they measure investment by the amount of finances directed by GPs to venture capital as a percentage of GDP (Allen and Song, 2002), or invested by LPs (Jeng and Wells, 2000). Furthermore, their analysis is conducted using a sample of countries that may not greatly differ in the quality of their legal systems.[100]

The key contribution of this article is to identify if a causal link exists between the domestic legal environment and venture capital or private equity investment by adopting

[98]Bottazzi et al. (2009) also find that the domestic legal environment has no effect on whether GPs use debt or quasi-equity instruments, or the intensity of interaction with their venture capital portfolio companies.

[99]Allen and Song (2002) use vanilla ordinary least squares and Jeng and Wells (2000) use between regressions.

[100]Jeng and Wells (2000) used data covering 15 OECD countries including Australia, New Zealand, Japan and Israel as well as countries in North America and Europe over the period between 1986 and 1995. Allen and Song (2002) used data covering 16 Asian countries, 16 European countries and the USA in the 1990s.

a panel fixed-effects technique. In addition, I measure investments by the *number* of venture capital or private equity portfolio companies receiving initial, as opposed to follow on, equity or quasi-equity funding from GPs.[101] This is important because, while the amount of finances invested is a useful indicator it may be confounded by portfolio company size effects. For example, if $100 million is invested in one portfolio company in country A and $10 million dollars is invested in 10 portfolio companies in country B, the amount of finances invested in both countries will be equivalent even though more investments occur in country B. Furthermore, using African countries to test the hypothesis in this article provides evidence from a region that is missing in the literature and where domestic legal environments vary.

The use of a dataset consisting of GPs' investments in Africa also allows this article to investigate the effect on venture capital investment of components of a rule of law score. Bottazzi et al. (2009) are only able to use this aggregate measure because the results obtained from investigating its components would suffer from the severe multi-collinearity that exists in a sample consisting only of European countries (Berkowitz et al., 2003).[102] This article's dataset does not suffer from this shortcoming.

Finally, I include a more comprehensive set of time varying control variables than previous studies in the specification that includes components of the aggregate rule of law measure. These include start-up and bankruptcy costs, which were recognized as important but could not be included in previous studies due to lack of data (Jeng and Wells, 2000). These and other additional variables mitigate omitted variable bias.

Studies also find that legal rules and the quality of their enforcement vary systematically by legal jurisdictions (Hart, 1995; La Porta et al., 1997; Parker, 2007). Legal jurisdictions in Africa fall into the categories illustrated in Table 1.

[101]The restriction to initial investment accounts more accurately for GPs' and portfolio companies' current decisions, as opposed to decisions made in prior periods when the legal environment and other country conditions may have been different.

[102]Bottazzi et al. (2009) used a sample of 17 European countries over the period from 1998 to 2001 to investigate the effect of the legal environment on the use of debt, and the provision of value-added support.

Table 1: African countries (by legal jurisdiction)

Legal jurisdiction	Countries
Common	Ghana, Kenya, Liberia, Malawi, Mauritius, Sierra Leone, Tanzania, Uganda, Zambia
Civil:	
German	Benin, Guinea
Dutch	Botswana, Lesotho, Namibia, South Africa, Swaziland, Zimbabwe
Belgian	Burundi, Democratic Republic of Congo
Portuguese	Angola, Cape Verde, Guinea-Bissau, Mozambique
Spanish	Equatorial Guinea
French	Burkina Faso, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Gabon, Madagascar, Mali, Niger, Senegal
Pluralistic:	
Belgian-German	Rwanda
Common-Islamic	Nigeria, Sudan
Common-Italian-Islamic	Ethiopia, Eritrea, Somalia
Common-French	Cameroon, Seychelles
French-Islamic	Algeria, Egypt, Libya, Mauritania, Morocco, Tunisia
French-German	Togo

Note: Countries are allocated to legal jurisdictions based on Kritzer (2002).

Common law countries include those colonized by the United Kingdom. While German civil law countries include those colonized by Germany, French civil law countries include those colonized by Belgium, France, Italy, Netherlands, Portugal, and Spain.[103] Pluralistic legal systems are a combination of these with some countries also having Islamic law.[104]

These legal jurisdictions are exogenous because "... countr[ies in Africa] involuntarily adopted them through colonization or conquest [by one of the European countries to which they owe the origin of their laws] and even in the case where countries adopted legal jurisdiction freely as in former Spanish colonies, the crucial consideration was language and the broad political stance of the law rather than the treatment of investor protections" (La Porta et al., 1998 p. 1126; Siems, 2006).

[103]La Porta et al. (1998) combine Italian, Portuguese, Spanish, Dutch, and Belgian civil law categories into one French civil law category. They also include South Africa in the common law category.

[104]While La Porta et al. (1998) argue that Islamic law has limited influence on investor protection, which is governed by commercial law and the law of contract and tort, this article is of the opinion that it has an effect on whether or not portfolio companies engage in moral hazard. Therefore, I include it.

Smith and Ueda (2006) argue that common law systems are more adaptable (better) than civil law systems.[105] Using the same argument that GPs prefer using debt instruments in better legal environments,[106] the predicted relationship that arises is *common law systems should have relatively less seed, startup, or early venture capital investment, but more expansion venture capital and private equity investment than civil and pluralistic legal systems.* I test this prediction in additional analysis.

Empirical studies investigating the link between legal jurisdictions and venture capital or private equity investments have been undertaken over the last decade. They find that relative to a common law system, all civil law systems are negatively related to venture capital investment, regardless of stage, and to seed, startup, or early stage venture capital investment (Jeng and Wells, 2000; Allen and Song, 2002; Bonini and Alkan, 2011). While they also find that all civil law systems are positively related to private equity investment, the French civil law system is positively related to expansion venture capital investment as well (Allen and Song, 2002).

3 Methods & Data

In this section I present the empirical model, data, and empirical strategy I use to test the predictions outlined in the previous section.

3.1 Empirical Model

The empirical model I adopt is presented in Equation 1 below. It is in log-linear additive form to represent a non-linear relationship between the domestic legal environment and venture capital or private equity investment.

[105]This is because in common law systems, law is made by judges and subsequently incorporated into legislature, and company and bankruptcy or reorganization laws exist separately, mainly in the form of acts. Civil law systems rely heavily on legal scholars to ascertain and monitor its rules, and use statutes and comprehensive codes to order legal material, and company and bankruptcy laws are part of commercial codes (La Porta et al., 1998).

[106]Evidence exists that the use of debt instruments is more prevalent in common law relative to civil law systems (Lerner and Schoar, 2005).

$$\begin{aligned} ln\, y_{ct} &= \alpha + ln X_{ct}\beta_1' + ln \Gamma_{ct}\beta_2' + \upsilon_{ct} \\ \upsilon_{ct} &= \mu_c + \gamma_t + \varepsilon_{ct} \end{aligned} \tag{1}$$

Where y_{ct} is a vector representing the dependent variable. α denotes the constant term. X_{ct} is a matrix that consists of key independent variables representing the domestic legal environment, where I am interested in estimating the coefficient vector β_1. Γ_{ct} is a matrix that consists of control variables representing countries' other legal and non-legal, time-varying characteristics. c represents a specific country and t represents a specific year. The random disturbance term υ consists of μ denoting the unobserved time invariant, country characteristics. It also consists of γ denoting the unobserved time effect. ε denotes the remaining random error.

3.2 Data

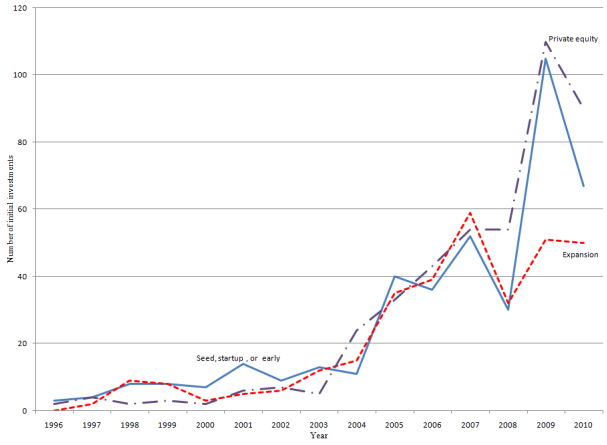
In this sub-section, I describe the variables used to estimate the empirical specification. I also describe the sources of data from which they are obtained.

3.2.1 Dependent variable

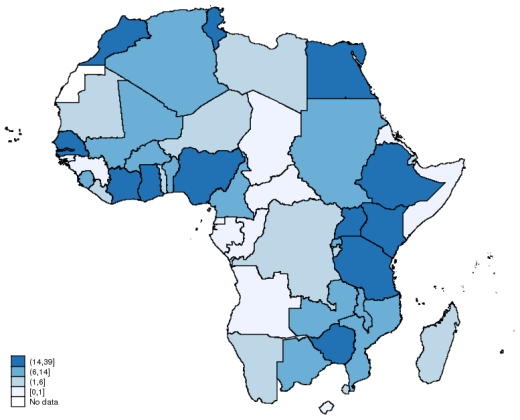
For the main analysis, the dependent variable represents the annual number of seed, startup, or early venture capital portfolio companies in African countries that receive initial investments, excluding South Africa.[107] In the counterfactual analyses it represents the annual number of expansion venture capital and private equity portfolio companies, respectively.

Figure 1 illustrates the flow and distribution of these investments on the continent (437 seed, start-up, or early venture capital, 356 expansion venture capital, and 439 private equity portfolio companies) between 1996 and 2010 by a random sample of 451 GPs. The random sample of GPs is drawn from a hand-collected dataset that contains

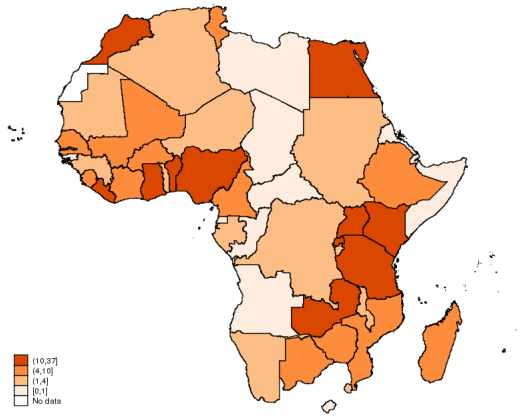
[107] With a much higher number of venture capital and private equity investments in South Africa relative to other African countries, I exclude it from the analysis because it is an outlier.



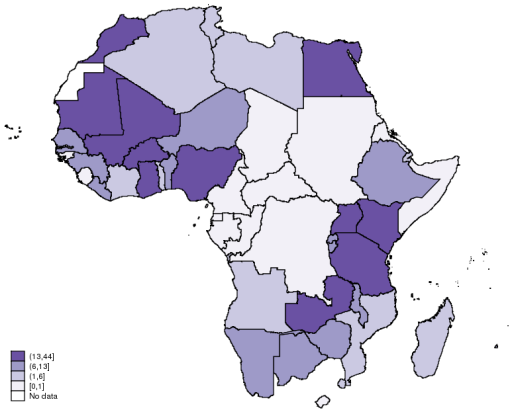
Annual flow of number of initial investments (by stage)



Note: Seed, startup, early venture capital: n = 437



Note: Expansion venture capital: n = 356



Note: Private equity: n = 439

Figure 1: Number of initial investments in Africa, excluding South Africa (1996 to 2010)

information on 862 GPs and the 8,523 portfolio companies they invested in across 54 African countries from 1948.

I compile the overall dataset from various publicly available secondary sources, including audited annual reports and unaudited sources such as website content, conference presentations, press releases, and newsletters, due to the limited coverage of Africa in existing commercial databases.[108] The GPs in this overall dataset are identified from member lists and publications of industry associations including the African Venture Capital Association (AVCA), Emerging Market Private Equity Association (EMPEA),

[108]The VentureXpert database, which contained information on 28,824 global venture capital transactions between 2000 and 2008, is heavily weighted towards North America - 41.6%, Western Europe - 27.5%, and East Asia - 22.6%. The rest of the data consist of Oceania - 3.2%, Eastern Europe - 1.7%, Latin America - 1.5%, the Middle East - 1.1%, and Africa - 0.8% (Brander et al. 2010).

South African Venture Capital Association (SAVCA), and the Tunisian Venture Capital Association (AVCA, 2004; AVCA, 2006; EMPEA 2009; SAVCA, 2005; Mthombothi, 2008; ATIC, 2009). However, relying on evidence from data restricted to these sources potentially suffers from selection bias because only the most successful GPs may subscribe to industry associations.

To mitigate this source of bias, I identified other GPs and their investments using other secondary sources. The additional sources include the Venture Capital Funds Index (Rhijn, 2008), which is an industry directory listing, delegate lists and output from industry conferences, previous employers stated on team members' profiles posted on GPs' websites, and africa-assets.com and privateequityafrica.com, which are two online portals that began to provide data on venture capital and private equity transactions in Africa from January 2011.

Since the overall dataset does not represent the population of GPs in Africa (which is unknown) randomly sampling from it mitigates bias arising from coverage error. The random sample used in this article represents the most comprehensive dataset used to analyze venture capital or private equity investments in Africa, to date. With only 43 GPs reporting to the 2005 survey by the AVCA (AVCA, 2006) and 65 GPs reporting to the 2010 survey by the SAVCA (KPMG and SAVCA, 2011), which was the highest number reporting to this survey in any year up to that year, relying on these datatsets would not be as comprehensive. Also, the VentureXpert database identifies 235 venture capital investments in Africa between 2000 and 2008 (Brander et al., 2010). The sample I use contains 868 venture capital investments over the same period with 207 of these being at the seed, start-up or early stages. In addition, Avanz Capital's database contains 115 fund managers, which is approximately one quarter of the fund managers in this article's sample (Assaad et al., 2012). Finally, the EMPEA's dataset indicates that there were 87 venture capital or private equity investments by GPs in sub-Saharan Africa between 2008 and 2009.[109] The sample I use contains 397 venture capital or private equity investments in the same sub-region in these two years.

[109]I am grateful to the EMPEA for providing these top-level figures.

3.2.2 Key independent variables

In the first set of estimations, the key variable is a rule of law score that was also used by Bottazzi et al. (2009). It is an aggregate measure of the quality of a country's domestic legal environment that has been collected bi-annually from 1996 and annually from 2002 by the World Bank, and is available in its Governance indicators database. Rule of law scores for African countries range between -2.68 and 1.02, where higher values represent more favorable "perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence" (Kauffman et al., 2011). I adjust the scale of the measure by adding 2.681 to each country's rule of law measure to prevent any loss of data from logarithmic transformations.

In the second set of estimations, the key variables consist of the individual components of the rule of law score. First, I include a director liability measure that has been collected annually from 2004, by the World Bank and is available in its Doing Business database. This measure ranges between 0 and 10, where higher values represent greater liability of directors for self-dealing. It is one component of an investor protection index that measures the strength of minority shareholder protections against directors' misuse of corporate assets for personal gain. Director liablity is itself an index consisting of seven components.[110]

Second, I include a measure of shareholder suits that has also been collected annually from 2004, by the World Bank and is available in its Doing Business database. It ranges between 0 and 10, where higher values represent greater powers of shareholders

[110]The first and second capture whether a shareholder plaintiff is able to hold corporate bodies (CEO or managing director, board of directors, the supervisory board, controlling shareholder, or minority shareholders holding 10% or less of a company's share capital) liable for the damage a transaction causes to the company. The third captures whether a court can void the transaction upon a successful claim by a shareholder plaintiff. The fourth captures whether the controlling shareholder pays damages for the harm caused to the company upon a successful claim by the shareholder plaintiff. The fifth captures whether the controlling shareholder repays profits made from the transaction upon a successful claim by the shareholder plaintiff. The sixth captures whether both fines and imprisonment can be applied against the controlling shareholder. Finally, the seventh captures whether shareholder plaintiffs are able to sue directly or derivatively for the damage the transaction causes to the company (Djankov et al., 2008).

to challenge a transaction by suing officers and directors for misconduct. Shareholder suits is itself an index consisting of six components.[111] It is another component of the investor protection index.

Third, I include a measure of the extent of disclosure that has also been collected annually from 2004, by the World Bank and is available in its Doing Business database. It ranges between 0 and 10 where higher values represent higher transparency of related-party transactions. Extent of disclosure is itself an index consisting of five components.[112] It is the final component of the investor protection index.

I also include a measure of intellectual property rights. It captures the strength of a country's policies protecting intellectual property, patents, copyrights, and trademarks (Horst, 2006). This measure has been collected annually from 2007 by the Property Rights Alliance as a component of their International Property Rights Index.

To measure the quality of contract enforcement, I include the cost of enforcing a contract per procedure and the time to enforce a contract per procedure. They are obtained from the individual components of the aggregate legal procedural complexity measure used by Bottazzi et al. (2009). These variables have been collected annually from 2004, by the World Bank and are available in its Doing Business database.

Time variation for the components of the rule of law score only began to occur for the countries illustrated in Table 2 from 2006. Therefore, it is only from 2006 to 2010 that the effect of any of the components of rule of law on venture capital or private equity investments can be identified.

[111]The first captures the range of documents available to the shareholder plaintiff from the defendant and witnesses during trial. The second captures whether the plaintiff can directly examine the defendant and witnesses during trial. The third captures whether the plaintiff can obtain categories of relevant documents from the defendant without identifying each document specifically. The fourth captures whether minority shareholders can request that a government inspector investigate the transaction without filing suit in court. The fifth captures whether minority shareholders have the right to inspect the transaction documents before filing suit. The sixth captures whether the standard of proof for civil suits is lower than that for a criminal case (Djankov et al., 2008).

[112]The first captures which corporate body can provide legally sufficient approval for a transaction. The second captures whether immediate disclosure of the transaction to the public, the regulator or the shareholders is required. The third captures whether disclosure in the annual report is required. The fourth captures whether disclosure by a controlling shareholder to the board of directors or the supervisory board is required. The fifth captures whether it is required that an external body, for example, an external auditor, review the transaction before it takes place (Djankov et al., 2008).

Table 2: Countries that experienced index measure variation (by year)

	Investor protection			Quality of enforcement per procedure	
Year	Director liability	Shareholder suits	Disclosure	Cost to enforce contract	Time to enforce contract
2006	-	-	-	Burkina Faso, Burundi, Rwanda	Burkina Faso, Burundi, Rwanda
2007	Tanzania	Tanzania	-	Nigeria, Sudan	Nigeria, Sudan, Gambia,
2008	Mozambique	Mozambique	-	Burkina Faso, Ghana, Malawi, Mauritania, Mozambique	Burkina Faso, DR Congo, Ghana, Malawi, Mauritania, Mozambique
2009	Botswana, Tunisia	-	Botswana, Egypt	Mozambique	Burundi, DR Congo, Mauritania, Mozambique
2010	Rwanda, Sierra Leone, Tunisia	Rwanda, Sierra Leone, Mali	Rwanda, Sierra Leone, Tunisia	Algeria, Burkina Faso, Ethiopia, Kenya, Mali, Mauritius,	Algeria, Botswana, DR Congo, Ethiopia, Mali, Mauritius, Rwanda, Uganda

Note: DR Congo is the Democratic Republic of Congo

In additional analysis, I investigate whether domestic legal environment effects differ by legal jurisdictions. In this specification, the legal jurisdictions are represented by binary indicators that equal one if a country's legal jurisdiction is common (the reference category), civil, or pluralistic and zero, otherwise. I interact these binary indicators with the rule of law score.

3.2.3 Control variables

The first set of control variables consist of measures of the domestic legal environment that are unrelated to protecting investors or intellectual property rights, and the quality of contract enforcement. First, I include a control of corruption score in the specification that uses the individual components of the rule of law score. It has been collected bi-annually from 1996 and annually from 2002 by the World Bank and is available in its Governance indicators database.

For African countries, this score ranges between -2.06 and 1.26 where higher values reflect a lower "perception of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests" (Kauffman, 2011) i.e. less corruption. I adjust the scale of the measure by adding 2.061 to each country's control of corruption measure to prevent any loss of data from logarithmic transformations.

Second, I include a strength of legal rights measure that has been collected annually from 2004, by the World Bank and is available in its Doing Business database. It ranges between 0 and 10 where higher values reflect the "degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending" (Djankov et al., 2007). This measure captures the strength of laws affecting debt, which is one option in the tradeoff portfolio companies face when seeking external finance.

Third, I include an aggregate index reflecting the rigidity of employment regulation that has been collected annually from 2004, by the World Bank and is available in its Doing Business database. This index ranges between 0 and 100, where higher values

are an average of the flexibility employers have to hire, fire or determine the hours their employees work. This employment regulation measure captures one factor influencing the incentives of individuals to start potential portfolio companies.

In addition, I include a binary indicator that equals one if a country is a member of the International Center of the Settlement of Investment Disputes (ICSID) and zero, otherwise. This measure of the foreign or external legal environment, over which policy makers do not have sole control, is available from the World Bank (ICSID, 2012).[113]

The second set of control variables capture the non-legal, time-varying characteristics of the country in which the portfolio company is located. These variables are collected annually by the World Bank and are available in its World Development Indicators database.[114] The rest are available in its Doing Business Database.

First, I include the real per capita gross domestic product (GDP) growth rate in purchasing power parity terms with a base year of 2005. This controls for the finding that macroeconomic expansions lead to an increase in the number of start-ups, which is related to an increase in demand for venture capital that should result in a higher number of venture capital investments (Achs and Audretsch, 1994).

Second, I include the number of scientific and technical journal articles published in the fields of physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences per 1000 people to proxy for the innovative structure of a market.[115] This may affect a GP's decision to enter into a market because it influences the supply of suitable venture capital investments. Third, I include the highest marginal corporate tax rate.[116]

[113]Bottazzi et al. (2009) use a GP's legal environment as their external legal environment. To keep the focus on the domestic legal environment, I do not.

[114]The data are reported by government agencies, obtained through field surveys, or compiled from other agencies such as the International Monetary Fund, United Nations, and World Economic Forum. Due to their self-reported nature, some of these control variables have missing observations.

[115]Alternative measures such as research and development (R&D) expenditure as a percentage of GDP or the number of patents per capita applied for by residents of a country suffer from relatively fewer data points over the analysis period.

[116]Porteba (1989) argues that capital gains taxes affect venture capital portfolio companies' decisions to enter a market. However, there are few datapoints for this measure in the data.

Table 3: Summary statistics for full sample versus dataset excluding South Africa: 1996 to 2010

	Full sample					Excluding South Africa				
Variables (logarithms)	mean	standard deviation[a]	minimum	maximum	observations	mean	standard deviation[a]	minimum	maximum	observations
Seed,startup,early	0.7052	0.5800	0	4.0073	212	0.5602	0.5388	0	2.4849	198
Expansion	0.6301	0.5325	0	3.7136	189	0.4966	0.4872	0	2.3026	174
Private equity	0.8735	0.6198	0	4.4188	185	0.6565	0.6014	0	2.7726	170
Rule of Law	0.5969	0.2797	-6.9077	1.3086	572	0.5886	0.2824	-6.9078	1.3086	561
ICSID member	0.8064	0.0346	0	1	780	0.8222	0.0350	0	1	765
GDP growth per capita	-1.0906	0.4691	-12.7164	0.2217	668	-1.0908	0.4740	-12.7164	0.2217	654
Laborforce participation	-0.4067	0.0217	-0.8440	-0.1098	735	-0.4018	0.0217	-0.8440	-0.1098	720
STEM articles	-5.8932	0.4220	-11.3989	-2.3235	732	-5.9554	0.4263	-11.3989	-2.3235	717
Bank credit	-0.0687	0.2284	-3.9622	1.1423	706	-0.0882	0.2305	-3.9622	1.1423	691
Real interest rate	0.0731	0.1255	-0.372	1.9018	493	0.0743	0.1274	-0.372	1.9018	478
GP firms in market	0.9399	0.6514	0	4.5109	408	0.8382	0.6509	0	2.9444	393
CountryID	26.75	0	1	53	780	26.3922	0	1	53	765
Year	2003	4.3233	1996	2010	780	2003	4.3233	1996	2010	765

Note:[a]within standard deviations are presented; All variables except ICSID member, CountryID and Year, are in logarithmic form.

Table 4: Summary statistics for full sample versus dataset excluding South Africa: 2006 to 2010

	Full sample					Excluding South Africa				
Variables (logarithms)	mean	standard deviation[a]	minimum	maximum	observations	mean	standard deviation[a]	minimum	maximum	observations
Seed,startup,early	0.8660	0.4684	0	4.0073	125	0.7481	0.4763	0	2.4849	120
Expansion	0.7505	0.4766	0	3.7136	114	0.6332	0.4789	0	2.3026	109
Private equity	0.9949	0.5561	0	4.4188	116	0.8622	0.5600	0	2.7726	111
Director liability	-1.4383	0.1021	-2.3026	-0.2231	195	-1.4637	0.1031	-2.3026	-0.2231	191
Shareholder suits	-0.8268	0.0257	-2.3026	0	191	-0.8397	0.0260	-2.3026	0	187
Disclosure	-0.7694	0.0120	-2.3026	-0.2231	187	-0.7813	0.0121	-2.3026	-0.2231	183
Cost to enforce contract	-0.0098	0.0061	-1.0033	1.5582	239	-0.0122	0.0061	-1.0033	1.5582	234
Time to enforce contract	2.7657	0.0603	1.7286	3.7336	239	2.7607	0.0610	1.7286	3.7336	234
Intellectual property rights	-0.8808	0.0861	-1.5141	-0.3011	60	-0.9088	0.0880	-1.5141	-0.4943	57
Control of corruption	0.0831	0.8298	-16.9640	1.1217	260	0.0691	0.8378	-16.9640	1.1217	255
Creditor rights	-0.9496	0.0308	-2.3026	0	239	-0.9699	0.0311	-2.3026	0	234
ICSID member	0.8077	0	0	1	260	0.8235	0	0	1	255

Table 4 continued: Summary statistics for full sample versus dataset excluding South Africa: : 2006 to 2010

	Full sample					Excluding South Africa				
Variables (logarithms)	mean	standard deviation[a]	minimum	maximum	observations	mean	standard deviation[a]	minimum	maximum	observations
GDP growth per capita	-1.9209	0.1782	-2.9582	-1.1866	239	-1.9211	0.1774	-2.9582	-1.1866	234
Laborforce participation	-0.4008	0.0056	-0.8440	-0.1098	245	-0.3963	0.0054	-0.8440	-0.1098	240
Rigidity of employment	-1.1180	0.0960	-2.6593	-0.3147	237	-1.1199	0.0968	-2.6593	-0.3147	232
STEM articles	-5.8047	0.3244	-11.3989	-2.3235	243	-5.8663	0.3277	-11.3989	-2.3235	238
Startup cost	-2.4454	0.4037	-6.0749	1.9578	239	-2.3977	0.4076	-6.0749	1.9578	234
Closing cost	-1.6952	0.0233	-2.6593	-0.2744	217	-1.6947	0.0236	-2.6593	-0.2744	212
Bankruptcy recovery rate	-1.7611	0.3778	-6.9078	-0.5058	206	-1.7774	0.3824	-6.9078	-0.5058	201
Bank credit	-0.0993	0.0881	-2.7165	0.9606	236	-0.1213	0.0889	-2.7165	0.9606	231
Real interest rate	-1.2567	0.2972	-3.2463	1.7823	161	-1.2540	0.3020	-3.2463	1.7823	156
Corporate tax rate	-1.1935	0.1287	-2.3026	-0.6932	147	-1.1980	0.1298	-2.3026	-0.6932	142
GP firms in market	1.2475	0.3681	0	4.5109	190	1.1666	0.3719	0	2.9444	185
CountryID	26.75	0	1	53	260	26.3922	0	1	53	255
Year	2008	1.4169	2006	2010	260	2008	1.4170	2006	2010	255

Note:[a]within standard deviations are presented; All variables except ICSID member, CountryID and Year, are in logarithmic form.

Fourth, I include variables that affect an individuals' occupational choice between working in the conventional labor market versus starting a potential portfolio company (Poschke, 2010). These variables include the labor force participation rate of individuals aged 15 and over, the cost of starting a business as a proportion of income per capita, and the cost of closing a business measured by the recovery rate from declaring bankruptcy in terms of cents on the dollar.[117]

Fifth, I include variables that affect a potential portfolio companies decision to opt for the financial, human and social capital offered by GPs as opposed to pure credit financing from banks i.e. a potential portfolio companies' choice to enter a market. These variables include the amount of domestic credit provided by the banking sector as a percentage of GDP, and the real interest rate (Romain and Potterie, 2003; Félix et al., 2007).[118]

Finally, I include the number of GPs in a country each year. It controls for the level of market competition, which may affect a GP's decision to enter a market. This variable is obtained from the same overall dataset that I obtained the dependent variable.

The variables included in the specification that uses the rule of law score and that which uses its individual components are summarized in Table 3 and 4, respectively. I convert the variables to decimal format before logarithmic transformation.[119]

3.3 Estimation Strategy

The estimation strategy I adopt to test the hypothesis is based on the country of destination paradigm that is used to record where funds are invested, in other words, the countries they go to.[120] I conduct a macro analysis with these countries as the units of observation, where I present and discuss results that exclude South Africa because

[117]Higher values of the first two measures should be a disincentive for individuals to start potential portfolio companies. A higher value of the last measure should have the opposite effect.

[118]While higher values of the former measures should be an incentive to the portfolio company to opt for credit financing from banks, higher values of the latter should be a disincentive.

[119]While I also present summary statistics for the dataset that includes South Africa, the analysis will be focused on the dataset that excludes it.

[120]The alternative is the country of management paradigm that is used to record where funds are raised, in other words, the country where the GP is headquartered (EVCA, 2001).

its relatively higher number of investments make it an outlier.[121] The main analysis investigates domestic legal environment effects on seed, startup, or early venture capital investments. I then conduct counterfactual analyses that investigate domestic legal environment effects on expansion venture capital and private equity investments, respectively.

For each set of estimations, I begin by investigating whether a causal link exists between the rule of law score and venture capital or private equity investments. These estimations are conducted over a sample period ranging between 1996 and 2010. In this estimation, I exclude all the variables obtained from the Doing Business database because they are only available from 2004. I then investigate which components of the rule of law score are causally linked to venture capital or private equity investment. These estimations are conducted over a sample period ranging between 2006 and 2010 and use all the variables described in the previous section, except the rule of law score.

In additional analysis, I investigate whether the results differ across legal jurisdictions. These estimations are conducted over the sample period ranging between 1996 and 2010.

To achieve the article's objective. I begin by describing the linear relationship between the domestic legal environment and venture capital or private equity investment using pairwise correlations. I then proceed to discuss the results of various multivariate estimations.

In the estimation of the link between the rule of law score and venture capital or private equity investments and in the additional analyses, I use a panel fixed-effects technique to establish causal identification. This relies on within country variation in the domestic legal environment measure and the number of investments. I use year dummies in this estimation to account for the time component in the error term, which captures factors that affect the overall environment such as the 2007/8 global financial crisis.

[121]The results for the full sample including South Africa are available from the author, on request.

In investigating the link between components of the rule of law score and venture capital or private equity investments, I also estimate a pooled ordinary least squares (OLS) regression where the variables are first differenced and standard errors are adjusted for clustering by country. However, I limit my discussion to the results obtained from panel fixed-effects estimations. I also adopt a multiple imputation by chained equations technique to account for missing observations in the control variables in this estimation.[122] This approach imputes missing values by drawing possible values from a non-parametric distribution and generating various plausible datasets, whose combined results are used to arrive at coefficient estimates with standard errors that reflect the uncertainty from imputation (Rubin, 1987).[123] It is contrary to a mean substitution technique that imputes a single value for missing observations, which may bias parameter estimates towards zero (Acock, 2005).

To mitigate omitted variable bias, both specifications rely on a comprehensive set of time varying controls that capture the characteristics of the countries where portfolio companies are located. The use of panel fixed-effects, or first-differenced variables in the pooled estimations, eliminates time invariant characteristics based on the assumption that all unobserved heterogeneity is constant across countries and is differenced away. This mitigates potential bias from selection on unobservables.

Simultaneity bias may arise between venture capital or private equity investments and the domestic legal environment if there are more frequent actions by GP firms and portfolio companies to clarify or settle contract disputes in countries with relatively higher investments. This could lead to the changes in legal rules and procedures that make a local court system more conducive for these investments (Smith and Ueda, 2006). To mitigate this source of bias, I lag all the independent variables by one year i.e. where the dependent variable represents an investment occurring in 2007, the independent variables represent conditions that existed in those countries in 2006.[124] This

[122] I do not impute values for missing observations in the key independent variables.

[123] I use 10 imputed datasets, which are more than the 5 needed for 95% confidence in results with 50% of observations missing (Rubin, 1987).

[124] The analysis captures short-run effects of a change in the domestic legal environment on venture capital or private equity investment, as opposed to long term effects.

approach assumes that the lagged value is uncorrelated with the current venture capital or private equity investment residual.[125]

4 Results & Discussion

I begin by testing the null hypothesis that better domestic legal environments should not have less seed, startup or early venture capital investments. I will first discuss the effect of the rule of law score and then try to identify whether its components influence venture capital investment. The first column of Table 5 indicates that the pairwise correlation between the rule of law score and seed, startup, or early venture capital investments is 0.0446. However, the marginal effect from the fixed effects estimation in column 2 suggests that the causal direction of an increase in the rule of law score on seed, startup, or early venture investments is negative. Its 5% significance level provides evidence that a one percentage point increase in the rule of law score should result in a 2.85 percentage point decrease in the number of seed, startup, or early venture capital investments Therefore, I can reject the null hypothesis that better domestic legal environments should not have less seed, startup, or early stage venture capital investments.

Table 6 presents the results of estimations to determine the effect of components of the rule of law score on seed, startup, or early venture capital investments. The first column of Table 6 indicates a positive pairwise correlation of 0.0492 and 0.0148, respectively, between director liability and disclosure and seed, startup, or early venture capital investment. It indicates a negative pairwise correlation of -0.0206 between shareholder suits and this stage of venture capital investment. In the fixed effects estimation in column 3 of Table 6, the marginal effect of a one percentage point increase in disclosure on seed, startup, or early venture capital investments is -7.1237 but is not significant even at the 10% level.[126]

[125]This was one approach used by Cawley (2004) to deal with a similar issue in a study on the link between obesity and wages. However, he lagged his independent variables by 7 years.

[126]Director liability and shareholder suits were not included in the fixed-effects estimation because they did not vary over time for this specification.

Table 5: Marginal effects for panel fixed effects estimation

	Seed, startup, or early		Expansion		Private equity	
	(1)	(2)	(3)	(4)	(5)	(6)
	Pairwise		Pairwise		Pairwise	
Variable	Correlation	Fixed effects	Correlation	Fixed effects	Correlation	Fixed effects
Rule of law	0.0446	-2.8456**	-0.1486*	-0.7635	0.0653	0.5649
		(1.1347)		(1.1384)		(1.1833)
Observations		99		83		89
Countries		24		20		21
Prob > F		0.0009		0.1551		0.0013
within R^2		0.4697		0.3324		0.4831
y = Xb (predict)		0.6409		0.6421		0.7456

Note: Sample period is from 1996 to 2010 and excludes South Africa; Controls include GDP growth, labor force participation, STEM articles, domestic bank credit, real interest rate, and number of GPs in a market;
Year dummies are included; Delta standard errors are in parentheses; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

The first column of Table 6 also illustrates that the pairwise correlation between intellectual property rights and seed, startup, or early venture capital investments is -0.1808. In the fixed-effects estimation in column 3, the marginal effect of a one percentage point increase in intellectual property rights on this stage of venture capital investments is 3.5345, which is not significant even at the 10% level.

The first column of Table 6 further illustrates negative pairwise correlations of -0.1914 and -0.2082, respectively, between both cost and time to enforce a contract per procedure and seed, startup, or early venture capital investment. In the fixed-effects estimation in column 3, the marginal effects of a one percentage point increase in cost and time to enforce a contract per procedure on this stage of venture capital investment are 5.064 and -4.2476, respectively. However, they are both not significant even at the 10% level.

The fixed-effects results of components of the rule of law score are mixed. While intellectual property rights and cost to enforce a contract per procedure are positively related to seed, startup, or early venture capital investment, disclosure and time to enforce a contract per procedure are negatively related to this venture capital stage.

Table 6: Marginal effects for pooled versus panel fixed-effects estimation

	Seed, startup, or early			Expansion			Private Equity		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Pairwise			Pairwise			Pairwise		
Variables	Correlation	Pooled	Fixed Effects	Correlation	Pooled	Fixed Effects	Correlation	Pooled	Fixed Effects
Director liability	0.0492	-1.227	-	-0.0097	-2.3864	-	0.0542	-	-
		(2.2238)			(1.6217)				
Shareholder suits	-0.0206	-	-	0.0461	-	-	-0.0471	-	-
Disclosure	0.0148	-10.4487	-7.1237	-0.1340	11.1603	-4.3594	-0.0974	-5.8906	-11.8224
		(14.412)	(33.917)		(7.946)	(31.061)		(7.3594)	(21.241)
Intellectual	-0.1808	-0.5049	3.5345	-0.3293**	4.2495	2.4471	-0.0245	-3.0387	1.3083
property rights		(2.1434)	(18.716)		(2.8046)	(11.698)		(2.017)	(9.2218)
Cost to	-0.1914**	-0.2352	5.064	0.0698	-0.0222	-	-0.0100	3.2718	51.0338
enforce contract		(7.4104)	(313.93)		(4.1627)			(3.2862)	(169.88)
Time to	-0.2082**	2.8039*	-4.2476	-0.0596	14.6386	-	-0.1877*	2.1575	1.1842
enforce contract		(1.4834)	(13.398)		(33.373)			(1.4586)	(7.1586)
Observations		31	39		29	38		29	37
y = Xb (predict)		0.1152	0.8543		-0.1850	0.6876		0.1369	1.0539

Note: Sample period is from 2006 to 2010 and excludes South Africa; Imputations = 10; Controls include GDP growth, labor force participation, rigidity of employment regulation, startup costs, bankruptcy recovery rate, STEM articles, domestic bank credit, real interest rate, corporate tax rate, and number of GPs in a market; Year dummies are included; Delta standard errors are in parentheses; Standard errors are adjusted for clustering by country in the pooled regression; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

However, none of these results are significant at the 10% level. Therefore, there is no evidence that any individual component influences seed, startup, or early stage investments.

4.1 Counterfactuals

Bottazzi et al. (2009) argue that a negative relationship between the domestic legal environment and seed, startup, or early venture capital investments arises because portfolio companies cannot access debt financing due to inadequate tangible assets that can be collateralized. Since portfolio companies at the expansion stage have began to acquire tangible assets that can be collateralized and those at the private equity stages have significant tangible assets, these investments should increase with improvements in the domestic legal environment. The counterfactual analyses test these predictions.

4.1.1 Expansion venture capital

I test the null hypothesis that better domestic legal environments should not have more expansion venture capital investments. The third column of Table 5 illustrates that the pairwise correlation between the rule of law score and expansion venture capital investments is -0.1486. In the fixed-effects estimation in column 4, the marginal effect of a one percentage point increase in this rule of law measure on expansion venture capital investments is -0.7635, which is not significant even at the 10% level.

The negative causal link between the rule of law score and expansion venture capital investments from the fixed-effects estimation is contrary to expectations. This could be because portfolio companies at the lower end of the expansion venture capital spectrum have still not acquired adequate tangible assets relative to those at the higher end (Sahlman, 1990; Fenn et al., 1996). While investments at the former stage may react to an improvement in the domestic legal environment in the same way as seed, startup, or early venture capital investments, those in the latter stage may react according to the predicted relationship. The combined, but opposing effects, may explain the lack of

significance for the results at even the 10% level. Therefore, I cannot reject the null hypothesis that better domestic legal environments should not have more expansion venture capital investments.

Table 6 also presents the results of estimations to determine the effect of components of the rule of law score on expansion venture capital investments. While the fourth column illustrates negative pairwise correlations of -0.0097 and -0.1340, respectively, between director liability and disclosure and expansion venture capital investment, it illustrates a positive pairwise correlation of 0.0461 between shareholder suits and this stage of venture capital investments. In the fixed-effects estimation in column 6, the marginal effect of a one percentage point increase in disclosure on expansion venture capital investment is -4.3594 but is not significant at even the 10% level.[127]

The fourth column of Table 6 illustrates that the pairwise correlation between intellectual property rights and expansion venture capital investments is -0.3293. In the fixed-effects estimation in column 6, the marginal effect of a one percentage point increase in intellectual property rights on this stage of venture capital investments is 2.4471, but is not significant at even the 10% level.

The fixed-effects results of components of the rule of law score are mixed. While intellectual property rights is positively related to expansion venture capital investment, disclosure is negatively related to this stage of venture capital investment. However, with none of the marginal effects significant even at the 10% level, there is no evidence that any individual component influences expansion venture capital investments.

4.1.2 Private equity

I then test the null hypothesis that better domestic legal environments should not have more private equity investments. The fifth column of Table 5 illustrates that the pairwise correlation between the rule of law score and private equity investments is 0.0653. In the fixed-effects estimation in column 6, the marginal effect of a one percentage point

[127]Director liability, shareholder suits, and quality of contract enforcement measures were not included in the fixed-effects estimation because they do not vary over time for this specification.

increase in this rule of law measure on private equity investments is 0.5649 but is not significant even at the 10% level.

While these fixed-effects results suggest that the causal direction of an increase in the rule of law score on private equity investments is positive, which conforms to our expectation, it is not significant at even the 10% level. Therefore, I cannot reject the null hypothesis that better domestic legal environments should not have more private equity investments.

Table 6 also presents the results of estimations to determine the effect of components of the rule of law score on private equity investments. While the seventh column indicates negative pairwise correlations of -0.0471 and -0.0974, respectively, between shareholder suits and disclosure and private equity investments, it indicates a positive pairwise correlation of 0.0542 between director liability and this stage of investment. In the fixed-effects estimation in column 9, the marginal effect of a one percentage point increase in disclosure on private equity investment is -11.8224, but is not significant even at the 10% level.[128]

The seventh column of Table 6 illustrates that the pairwise correlation between intellectual property rights and private equity investments is -0.0245. In the fixed-effects estimation in column 9, the marginal effect of a one percentage point increase in intellectual property rights on this stage of investment is 1.3083, which is not significant even at the 10% level.

The seventh column of Table 6 further illustrates that the pairwise correlations between cost and time to enforce a contract per procedure and private equity investments are -0.01 and -0.1877, respectively. The fixed-effects estimation in column 9 indicates that the marginal effects of a one percentage point increase in cost and time to enforce a contract per procedure on this stage of investment are 51.0338 and 1.1842, respectively. However, they are both not significant even at the 10% level.

[128]Director liability and shareholder suits were not included in the fixed-effects estimation because they did not vary over time for this specification.

The fixed-effects results of the components of the rule of law score are mixed. While disclosure is negatively related to private equity investments, intellectual property rights, and cost and time to enforce a contract per procedure are positively related to private equity investments. With none of the marginal effects being significant even at the 10% level, there is no evidence that any of these components influence the number of private equity investments Therefore, I cannot reject the null hypothesis that better domestic legal environments should not have more private equity investments.

4.2 Additional Analysis

I also investigate whether domestic legal environments effects on venture capital or private equity investment differ across legal jurisdictions.

4.2.1 Legal Jurisdictions

I test the null hypothesis that common law systems should not have less seed, startup, or early venture capital investments than civil and pluralistic law systems. The first column in Table 7 illustrates that relative to common law systems, all other civil and pluralistic law systems have more seed, startup, or early venture capital investments, except for those with a Common-French pluralistic system. However, none of the results are significant even at the 10% level. Therefore, I cannot reject the null hypothesis that common law systems should not have less seed, startup, or early venture capital investments than civil and pluralistic legal systems.

I then test the null hypothesis that common law systems should not have more expansion venture capital investments than civil and pluralistic law systems. The second column of Table 7 illustrates that relative to common law systems, all other civil and pluralistic law systems have less expansion venture capital investments, except for those with Dutch and French civil law, and Common-Italian-Islamic pluralistic systems. However, only the Dutch civil law system's coefficient of 80.5108 significantly differs from the common law system at a 5% level.

Table 7: Marginal effects for panel fixed effects estimation

Variable	(1) Seed, Startup, or Early	(2) Expansion	(3) Private Equity
Rule of Law	-5.0685**	-0.3415	2.0169
	(2.4952)	(2.4909)	(2.8568)
Rule of Law×Common	*reference*	*reference*	*reference*
Rule of Law×Common-Islamic	1.8245	-0.0547	-2.4517
	(3.1083)	(3.0565)	(3.4480)
Rule of Law×German	-	-	-
Rule of Law×Dutch	0.1364	80.5108**	-9.8900*
	(13.4187)	(31.9931)	(5.6943)
Rule of Law×Belgian-German	-	-	-
Rule of Law×Belgian	14.8592	-	2.5714
	(10.7583)		(11.6918)
Rule of Law×Common-French	-4.5697	-9.3834	-
	(7.6898)	(8.1309)	
Rule of Law×Common-Italian-Islamic	7.9770	0.0866	-5.2754
	(5.6073)	(5.6325)	(12.3747)
Rule of Law×Portuguese	5.2367	-12.7079	-20.4677**
	(9.1047)	(10.5416)	(8.6007)
Rule of Law×Spanish	-	-	-
Rule of Law×French-Islamic	8.0519	-1.8266	2.5831
	(5.1257)	(4.6081)	(4.3471)
Rule of Law×German-French	-	-	-
Rule of Law×French	5.2600	1.4414	31.5940
	(12.0089)	(13.7573)	(21.4685)
Observations	99	83	89
Countries	24	20	21
Prob > F	0.0071	0.1254	0.0016
within R^2	0.5304	0.4641	0.5878

Note: Sample is from 1996 to 2010 and excludes South Africa; Controls include GDP growth, labor force participation, STEM articles, Domestic bank credit, real interest rate, and number of GPs in market; Year dummies are included; German, Belgian-German, French-German, and Spanish jurisdictions drop out of all estimations; Belgian jurisdictions drop out of expansion stage estimations; French-Common jurisdictions drop out of private equity estimations; Delta standard errors are in parentheses;
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Based on this finding, I can reject the null hypothesis that common law systems should not have less expansion venture capital investments than Dutch civil law systems. This result supports the alternative hypothesis that common law systems should have less expansion venture capital investments than Dutch civil law systems. It is contrary to the expectation that better law systems should have more expansion venture capital investments because GP firms have a preference for offering debt instruments to their portfolio companies.

Relying on a similar explanation as in the counterfactual analysis that focused on this stage of venture capital investment, I argue that this unexpected result is because portfolio companies at the lower end of the expansion venture capital spectrum have still not acquired adequate tangible assets relative to those at the higher end (Sahlman, 1990; Fenn et al., 1996). Therefore, they react to a better domestic legal environment in the same way as seed, startup, or early venture capital investments.

Finally, I test the null hypothesis that common law systems should not have more private equity investments than civil and pluralistic law systems. The third column of Table 7 illustrates that relative to common law systems, all other civil and pluralistic law systems have less private equity investments, except for those with Belgian and French civil law, and those with a French-Islamic pluralistic law system. However, only the Dutch and Portuguese civil law systems coefficients of -9.89 and -20.4677 differ from the common law system at a 10% and 5% significance level, respectively. With only the latter category achieving a 5% sigificance level, I can reject the null hypothesis that common law systems should not have less private equity investments than Portuguese civil law systems.

Overall, these fixed-effects results suggest that seed, startup, or early venture capital investments do not differ across legal jurisdictions in Africa. However, there is evidence that relative to common law systems more expansion venture capital investments occur in Dutch civil law systems and fewer private equity investments occur in Portuguese civil law systems.

5 Summary & Conclusion

One branch of theory argues that domestic legal environments influence venture capital investments. Another branch argues that it should not. The objective of this article is to determine which of these competing views is supported by evidence. The main null hypothesis I tested to achieve this objective is that domestic legal environments have no influence on venture capital investments.

Using a dataset that captures the number of initial investments by a sample of GPs in venture capital and private equity portfolio companies across countries in Africa I find evidence that domestic legal environments influence seed, startup, or early venture capital investments. Specifically, a fixed-effects estimation conducted for a sample covering the period from 1996 to 2010 indicates that a one percentage point increase in a country's rule of law score should result in a 2.85 percentage point decrease in the number of seed, startup, or early venture capital investments. At a significance level of 5%, I can reject the main null hypothesis that domestic legal environments have no influence on seed, startup or early stage venture capital investments. Since I lag the legal environment measure by 1 year, this finding is applicable to the short-run.

The evidence supports the theoretical argument that a better legal environment promotes the use of debt by GPs, which requires portfolio companies to have tangible assets that can be collateralized. The number of investments in portfolio companies at the seed, startup, or early venture capital stages falls because they do not have an adequate amount of these assets, if they have any at all (Sahlman 1990; Fenn et al., 1996).

This article does not focus on external legal environments e.g. for the GP or fund. It would be of interest to determine whether these influence expansion venture capital or private equity investments before we attribute the absence of an influence of the legal environment on these stages to the coasian (Coase, 1960) or product market competition theories (Alchian, 1950; Stigler, 1958). In addition, it would be of interest to determine whether the domestic legal environment influences exits from investments.

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Overall Conclusion

The three articles in this dissertation use a novel panel dataset to test the overall null hypotheses that human capital and law have no influence on venture capital and private equity activity in Africa. Each article goes beyond descriptive analysis or single-country studies to more robust, multi-country analyses of investors' and portfolio companies' venture capital and private equity activities on the continent.

In the first article titled "Does Work Experience in the Venture Capital or Private Equity Industry Matter?" I rely on the assortative matching theoretical concept to test the null hypothesis that a GP team's work experience in the venture capital or private equity industry has no influence on its investments. Evidence indicates that negative assortative matching by this human capital trait occurs between GP and private equity portfolio company teams. Based on this finding, I can reject the null hypothesis for the private equity stage. The finding suggests that GP teams with relatively more work experience in the venture capital or private industry have a higher likelihood of investing in private equity portfolio companies.

In the second article titled "Does Education influence Clean-Tech Venture Capital and Private Equity Exits?" I test the null hypothesis that post-match education in GP and portfolio company teams, which signals their ability, has no influence on clean-tech, relative to other-tech, venture capital and private equity exits. Evidence suggests that an increase in the proportion of bachelor degrees and graduates from a top-ranked university in post-match teams increases the probability of clean-tech initial public offering exits. An increase in the proportion of bachelor degrees also increases the probability of clean-tech trade sale exits. In addition, an increase in the proportion of masters or doctoral degrees in post-match teams increases the probability of clean-tech secondary sale exits. Based on these findings, I can reject the null hypothesis. However, the education trait that matters depends on the type of exit. These findings suggest that team ability, signalled by their educational attainment, influences exits on the continent.

Finally, in the third article titled "Do Domestic Legal Environments influence Venture Capital Investments?" I rely on a theory that argues that better domestic legal environments promote the use of debt by GPs. Since portfolio companies at the seed, startup, or early stages, have not yet acquired adequate tangible assets that can be collateralized, they cannot access this financing instrument. Drawing from this theory, I test the null hypothesis that improving a country's legal environment should increase venture capital investments within its borders. Evidence shows that improving the domestic legal environment has a significantly negative effect on seed, start-up, or early venture capital investment in the short run. Based on this finding, I can reject the null hypothesis for the seed, start-up, or early venture capital stage. This finding suggests that legal environment changes can have unintended effects.