

THE IMPACT OF NETWORKS ON ENTREPRENEURS AND STARTUPS

ESSAYS ON INVESTOR CENTRALITY, ENTREPRENEUR RELATIONSHIP AND STARTUP PERFORMANCE

Thèse présentée à la Faculté des sciences économiques

Institut de Management

Université de Neuchâtel

Pour l'obtention du grade de docteur en Management

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Soutenue le 29 Novembre 2023



IMPRIMATUR POUR LA THÈSE

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Résumé

Dans cette étude en trois chapitres, nous explorons tout d'abord le rôle critique de la centralité du réseau d'investisseurs dans la réussite de l'entreprise, en soulignant comment les positions centrales des investisseurs stimulent la performance à long terme, le succès de l'introduction en bourse et le financement ultérieur. Le deuxième chapitre met en évidence l'importance de la confiance au sein des réseaux d'investisseurs, en soulignant le rôle des expériences partagées et de la similarité relative dans le choix des investisseurs. Dans le troisième chapitre, l'étude examine la dynamique des réseaux d'entrepreneurs dans l'industrie biotechnologique française, en mettant en évidence l'impact des liens interpersonnels, de la diversité et des paramètres du réseau sur les performances de l'entreprise et la collecte de fonds. Dans l'ensemble, ces chapitres donnent un aperçu complet de l'interaction entre les réseaux d'investisseurs, la transmission d'informations et les liens interpersonnels, et mettent en lumière les principaux moteurs de la réussite et de la croissance des entreprises.

Mots-clés : startup, réseau, quantitatif, investisseur, liens multiplexes, capital social, biotechnologies, centralité, similarité, confiance, VC, SPAC

Abstract

In this three-chapter study, we first explore the critical role of investor network centrality in shaping entrepreneurial success, emphasizing how central investor positions boost long-term performance, IPO success, and subsequent funding. The second chapter highlights the importance of trust within investor networks, emphasizing the role of shared experiences and relative similarity in shaping investor choices. In the third chapter, the study examines the dynamics of entrepreneurial networks in the French biotechnology industry, showcasing the impact of interpersonal ties, diversity, and network metrics on company performance and fundraising. Overall, these chapters provide comprehensive insights into the interplay of investor networks, information transmission, and interpersonal ties, illuminating key drivers of entrepreneurial success and growth.

Keywords: startup, network, quantitative, investor, multiplex ties, social capital, biotechs, centrality, similarity, trust, VC, SPAC

Acknowledgments

I want to express my deepest gratitude to all those who have contributed to the completion of this thesis. This journey has been challenging and rewarding, and I am sincerely thankful for the support and guidance I have received.

First and foremost, I extend my heartfelt appreciation to my thesis advisor, Prof. Claudia Joncczyk-Sédès, for her unwavering support, invaluable insights, and constant encouragement throughout the research process. Her expertise and commitment played a pivotal role in shaping this work.

I am grateful to the members of my thesis committee, Prof. Florian Weigert, Prof. Emmanuel Lazega, and Prof. Thomas Straub, for their constructive feedback and valuable suggestions that significantly improved the quality of this thesis. Their diverse perspectives enriched my understanding of the subject matter. I would like to thank the Management Institute at the University of Neuchâtel for providing the necessary resources and facilities to complete this research successfully. The academic environment fostered a culture of learning and exploration that greatly contributed to the development of this thesis.

I owe my parents, family, and friends a debt of gratitude for their unwavering support and understanding throughout this academic journey. Their encouragement provided the motivation needed to overcome challenges and persevere in the pursuit of knowledge.

In a special note of personal thanks, I want to express my appreciation to Prof. Francis Bloch, Dr. Benjamin Blumenthal, Prof. Olivier Compte, Camille Constant, Prof. Emmanuelle Fauchart and Prof. Bruno Lanz. Their insights and encouragement were instrumental in navigating the complexities of this research. I also extend my appreciation to all the participants and staff of the Sunbelt Con-

ference, the Academy of Management Conference, and the NSF Network Science in Economics Conference. The valuable feedback and discussions with fellow researchers significantly contributed to the refinement of my ideas and the overall quality of this thesis.

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Nul ne peut atteindre l'aube sans passer par le chemin de la nuit.

Khalil Gibran, 1926

À mon père.

Introduction

In the multifaceted landscape of entrepreneurship and investment, this thesis delves into a nuanced exploration of pivotal factors underpinning entrepreneurial success. We first introduce the motivations that lead to the making of this thesis. Then, we propose a series of definitions that should help to a better understanding of some of the notions and terms covered in the thesis. We conclude this introduction with short summaries of our research chapters.

After this brief introduction, we proceed with our investigations as the thesis unfolds across three chapters on the intricate interplay between investor networks, trust dynamics, and interpersonal relationships. Finally, we conclude this work of research with a summary of the contributions that we bring to the field, we cover the limitations encountered while carrying out this work, and we suggest areas for future research.

Motivations

Network-based research on entrepreneurship is an active field of research. However, the focus is often solely on investor success or entrepreneur performance (Hoang and Antoncic, 2003). We develop in the following chapters an argument based on the intertwined role of network effects between those two actors.

We first take a general view of the topic. Indeed, in the first chapter, we study the effect of networks on investors and startups. More precisely, we look at a network of investors and focus on the impact that connection at the investor's level may have on their investees. This macro-level study is carried out across industries

and covers a wide range of actors using a longitudinal data set.

Subsequently, we want to extend those results and dig into investors' dyadic level of relationship. We focus in chapter 2 on trust between investors and the lasting effects that the previous interaction may carry. Thus, we go from a macro-level study on the network (in Chapter 1) to a fine-grained modelization of investors' trust-building and decision-making.

Finally, we focus on a specific industry (biotechnologies) and highlight the role of the dynamic evolution of relationships between stakeholders. In Chapter 3, we, therefore, are able to rely on a unique dataset built in two waves, which allows us to tie entrepreneur networking choices and their startup relative level of performance.

Hence, this thesis follows a natural evolution as we break down the building block of network impact at all the principal axes of performance in the startup ecosystem. By first taking a macro stance, we can isolate the effects of centrality on startup performance in a global study. Then, we orient our research toward previously hidden aspects of relationship building, namely, trust. In this second part, we take a micro view of the network and uncover how some previous static data can impact the network evolution and subsequent effects. We conclude this work of research with a third part dedicated to dynamic relationships among agents.

Definitions

Definition 0.0.1 (Startup) *A small business that has just been started.*

Cambridge dictionary

The rise in the number of startups is a major topic. According to the Bureau of Labor Statistics, the number of new establishments in the United States rose from 608,769 in 2009 to 679,072 in 2016. According to OECD's numbers, new enterprise creations in France have more than doubled between 2007 and 2018. Thus, it makes for an important area for research. Indeed, startup creation significantly affects productivity and the real GDP (Gourio, Messer, and Siemer (2016)). They also have a direct, persistent, effect on the fluctuations in employment (Sedláček and Sterk (2017)).

Now, while this definition is correct, there is more to it. Maybe more pertinent to our study, a pragmatic definition is that:

"A startup is a human institution designed to create a new product or service under conditions of extreme uncertainty."

Ries (2011)

Indeed, to create value, a company must raise capital to develop its activities. The low success rate related to this kind of development makes investing in a startup a risky activity. Entrepreneurs, in which investors put their capital, have to take those risks, as pointed out by Hall and Woodward (2010), who reports that "it would be hard to find a more serious violation of the Borch-Arrow optimality condition than in the case of entrepreneurs." Hence, people investing in startups

at different stages are not the same. As founders are constantly looking for new capital to help their startups grow, they have to keep this in mind.

The first stage is commonly referred to as "seed." It involves various sources of funding, among which the owners ¹ Yet, this has limitations and can't be applied to all business opportunities. The following stage, often referred to as "early," involves investors who are called "angels" (or "business angels").

Definition 0.0.2 (Business Angel) *A high net-worth individual, acting alone or in a formal or informal syndicate, who invests his or her own money directly in an unquoted business in which there is no family connection and who, after making the investment, generally takes an active involvement in the business, for example, as an advisor or member of the board of directors.*

Mason and Harrison (2008)

In addition to the capital they bring, business angels also bring their connections to their own network of people. At this point in that scenario, investors in the startup are mainly (wealthy) individuals. This changes at the next stage. As we can have more powerful angels joining (also referred to as "super angels"), companies start to invest in the startup. Those companies are called Venture Capital firms (called "VCs"). They are corporations specializing in investing funds within startups to gain from an eventual increase in the company's value.

The mission of venture capital is defined as:

Definition 0.0.3 (Venture Capital) *Equity or equity-linked investments in young,*

¹A technique, sometimes called "bootstrapping," indicates that owners may/should as much as possible rely on personal funding to make their project organically grow.

privately held companies, where the investor is a financial intermediary who is typically active as a director, an advisor, or even a manager of the firm.

Lerner (2000)

At this stage, the company can receive cash from investors in several funding rounds. Named "series," those flows of invested capital are associated with a letter (A, B, C, ...). They are usually growing in size as time goes by, given the company's increasing need for new capital as it develops. Such a mode of operation is made possible by contracts set by VCs that allow control of the next round of funding while protecting the investor's interests, as per Kaplan and Strömberg (2003).

If VCs are a major part of this funding scheme ², other actors may intervene at later stages, such as banks or other forms of funds. Upon reaching this point, the company should be well developed and start to build its exit strategy, given that it has become profitable and could grow through all the steps.

The first-best exit option for a company is an Initial Public Offering (or IPO) :

Definition 0.0.4 (Initial Public Offering (IPO)) *A company's first sale of stock to the public. Securities offered in an IPO are often, but not always, those of young, small companies seeking outside equity capital and a public market for their stock. Investors purchasing stock in IPOs generally must be prepared to accept considerable risks for the possibility of large gains. IPOs by investment companies (closed-end funds) usually include underwriting fees that represent a load to buyers.*³

IPO is the preferred route for an investor, as it allows them to maximize the return on their investment; it is as well for entrepreneurs given that it allows them

²There is also the possibility of micro-VC investing earlier in the company but on a smaller monetary scale.

³nasdaq.com/investing/glossary/i/initial-public-offering

to raise more capital in the future (Ritter and Welch, 2002). Another favored option is the acquisition of the startup by a more powerful/larger company. Of course, besides those two positive options, the risk of a company closing remains for various reasons.

Later in the thesis, we also study the question of Special Purpose Acquisition Company (or SPAC, as defined below.) We introduce this element in particular because SPACs represent, like IPOS, a way to go public for companies, except that they are not carrying the same risk of freely floating on public markets. We will see those characteristics in more detail later as they offer quite an interesting framework in terms of economic impact and secrecy.

Definition 0.0.5 (Special Purpose Acquisition Company (SPAC)) *A type of blank check company is a “special purpose acquisition company,” or SPAC for short. A SPAC is created specifically to pool funds in order to finance a merger or acquisition opportunity within a set timeframe.*⁴

A particular characteristic on which we want to focus is the matter of "syndication." A broad definition of the term would be that:

Definition 0.0.6 (Venture Syndication) *A syndicate is defined to be a group of individuals who must make a common decision under uncertainty that will result in a payoff to be shared jointly among them.*

Wilson (1968)

⁴<https://www.investor.gov/introduction-investing/investing-basics/glossary/blank-check-company>

Hence, this directly implies the cooperation of several investors making a joint capital injection in a startup, allowing them to invest more than they could on their own. While there exist many reasons explaining the choice made by investors to syndicate, we can keep three main factors in mind (Lerner, 1994), which would explain the persistence of common investments. It is a way for investors to improve decision-making, as a larger pool of actors can judge the decisions. Benefits, therefore, arise from this synergy of investors, in line with results from Sah and Stiglitz (1986).

In this thesis, we emphasize the network of connections made through all those types of syndication to analyze the network of past investments. This allows us to determine the most prominent actors in the investment scene and its impact on their investees.

Summary of essays

The first chapter analyzes the effect of investor network centrality on the company they are investing in. Our longitudinal (1968-2018, across industries) study shows that an investor with a central network position benefits the entrepreneur pre-IPO and post-IPO. We find that a central network position increases the likelihood that the investee will obtain subsequent funding, go public, and perform well in the long term. We show that going public typically is linked to initial funding from a central investor - and even at the expense of a higher amount from a less central investor – to enable the accumulation of a broader investor base as it moves toward exit via an IPO. We also examine the effect of investor centrality on startup valuation at the time of the IPO and on the firm's short and long-term success. We find no direct impact in the short term but a positive impact in the long term.

In the second chapter, we analyze the transmission of information through the network by an investor to another investor. The signal quality is determined by the judgment each investor emits on other investors that transmit the information beforehand through the network. We propose an application of this model to the deal-making activities of venture capital (VC) and Special Purpose Acquisition Company (SPAC) investors and sponsors. We construct a composite trust index to study the impact of trust and its components under the form of demographic variables (career, education) on subsequent deal connections. A key finding is that trust results from a relative dyadic-level interaction of each node (investor) to estimate its counterparts' quality (and therefore trustability) and not solely from absolute variables (i.e., centrality, similarity.) Furthermore, we find that similarity in terms of structural-context similarity (Jeh and Widom, 2002), more than centrality, is an es-

sential driver of trust. The strength of this variable appears to originate from shared experiences (i.e., connections made during studies or career as an employee.)

Finally, in the third chapter, we focus on the formation of relationships built by entrepreneurs in the biotechnology industry in France, where we study two kinds of relationships: advice ties and friendship ties. The paper draws on data obtained in two waves in 2008 and 2013, investigates the changing power of interpersonal ties among entrepreneurs, and inspects their company's performance. We find that entrepreneurs' backgrounds and origins impact their networks, and we explore the relevance of interpersonal ties within this sector regarding subsequent link creation. We gain insights into the configuration of the entrepreneur's network onto the company they are building. We focus on the evolution and the composition of the entrepreneur's network, which leads to evidence of strong social ties and carrying links over time. We exhibit the outstanding value of diversity (gender, background). We follow their trajectory, which allows us to highlight a clear relationship between network metrics (churn, ties evolution, and centrality) and their relative level of performance (fundraising).

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CHAPTER 1

Money Talks

Money Talks:
The impact of investors' networks on entrepreneurs' success

INTRODUCTION

*"The best assumption to make is that your VC's primary value add is the cash they are investing. Then you'll always be surprised on the upside."*¹

One of the essential benefits investors provide is connections through a network of resources and personal contacts (Lockett, Ucbasaran, and Butler, 2006). Startups need to contract deals with investors to get the capital they need. They can reclaim more cash through syndicated deals. Wilson (1968) defines in its introduction a syndicate as: "a group of individuals who must make a common decision under uncertainty, and who, as a result, will receive a payoff jointly to be shared among them." Hence, "syndication" defines a portion of VC financing that involves cooperation among several investors to allow joint capital investment in a startup at a precise moment or over some time (Wang, 2020).

Syndicated deals tend to allow a more considerable investment than could be provided by a single investor. Those deals are the base of a net of connections between different investors (Bygrave, 1987). Network studies show that these contacts can be vital for delivering informational advantages, as an inside investor's presence will alleviate the risk of mispricing (Admati and Pfleiderer, 1994). Investors can enhance their balance sheet diversification by making smaller investments with lower risks and thus provide liquidity for developing innovation in complex fields (Ewens, Nanda, and Rhodes-Kropf, 2018). Overall, this form of stage investments allows for maximizing returns to network members while providing for a less costly way out of investment and thus encouraging risk-taking by investors (Gompers et al., 1995).

Well-connected VCs can contribute in a non-monetary way to the development of the said startup. Thanks to its connections, the VC can foster the startup structuration (i.e., implement new policies) and drive the growth of its human capital (Hellmann and Puri, 2002). Investors can have an impact in terms of certification, resulting in a lower cost of going public and subsequently in

¹Quote from Marc Andreessen, <http://blog.pmarca.com/>, who, among other roles, was cofounder of the venture capital firm Andreessen Horowitz which is headquartered in Silicon Valley, and was an early investor in firms such as Airbnb, Facebook, Twitter, and Skype.

the maximization of proceeds to the offering firm (Megginson and Weiss, 1991). They also can contribute to the long-term performance of the startup. Indeed, looking at VCs' reputation, Krishnan, Ivanov, Masulis, and Singh (2011) find that VCs with a higher reputation tend to exhibit more activity regarding their portfolio companies' governance, resulting in positive post-IPO performance. Reaching IPO is the last step for a startup, and backing by a prestigious VC can lead to fewer post-IPO failures. Indeed, Chou, Cheng, and Chien (2013) find that the given status of its investors can impact a startup's long-term performance, but that it results in direct effects of characteristics making for prestigious investors, not prestige itself.

In addition to the cash that business angels and venture capital (VC) firms provide, these investees add value to the startups they fund. This added value or "smart money" is represented by services in the form of counseling, recruitment of talent, and structuring; which doesn't stop at the simple role of providing funds to the startup (Hellmann and Puri, 2002). Those value-adding services significantly affect the startup development, which can be disentangled from the sole selection effect of the investment by VCs (Croce, Martí, and Murtinu, 2013). There is evidence of those effects both at the macro level, as Morten (2007) find that VC-backed startups are more likely to go public; and at the micro level, as Rossi, Blake, Timmermann, Tonks, and Wermers (2018) show that at the manager level, there exists a positive relationship between the centrality of the manager and the performance of their investments. In that regard, VCs act as defenders of their investees to help them develop (Hallen, Katila, and Rosenberger, 2014).

However, financial literature has provided a more contrasted view of the topic. While on the one hand, in a meta-analysis, Haslanger, Lehmann, and Seitz (2022) found no general relationship between Corporate Venture Capital (CVC) investments and startup performance. On the other hand, Ivanov and Xie (2010) find that this performance link does exist, but mainly in cases where there is a strategic fit between the investor and investee, as backed companies exhibit higher valuations at IPO. This makes for an interesting puzzle as we incorporate centrality, sectoral/strategic fit, and performance, among others, in our paper. Indeed, this study contributes in several ways to the existing literature on startup funding and networks based on a quantitative

analysis of financial and network data.

In this paper, we are taking a longitudinal approach to articulate a discussion around the importance of investors' centrality and its impact on investees' performance. We show how investors' network position impacts startup performance across the startup's life cycle; we go mechanically through several key steps. In particular, we examine whether early-stage investment from a central investor increases the chances that the investee will secure subsequent funding and put the startup on a path toward further performance.

First, we study the impact of investors' network centrality on a startup's fundraising regarding the likelihood of receiving more funding and the subsequent funding amounts. Then we look at the likelihood of making it to IPO and how it can be impacted by pre-IPO characteristics inherent to the startup. Next, we look at the drivers impacting their valuation after completing the IPO. Later, we dig into post-IPO performance for the newly listed company (a statistically rare occurrence in our dataset). We decompose this phase into short-term (one-year) and long-term (five-year) performance.

Finally, following a discussion focusing on the exhibited impact of centrality and other factors, we use our results to provide theoretical and practical implications regarding the startup and conclude on the choices left to the entrepreneurs.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Most of the literature on VCs has focused on investors' performance but rarely on startups' performance (Drover, Busenitz, Matusik, Townsend, Anglin, and Dushnitsky, 2017). In our study, we focus on the effects of investors' centrality on the startup rather than the investors themselves.

The role of funding

One of the ways for startups to develop is to receive funds from VCs. This is not a random process, as startups look after their best interests while investors want to attract companies that are "the next big thing."

Deal making A primary aspect is the matching process between an investor and a startup. This deal-making process is risky for an investor as his investment in a startup carries a lot of possible hazards.

The investor decision highlights some level of uncertainty. Bygrave (1988) notes that a firm's co-investing percentage is influenced by its uncertainty level ². They find that top venture capitalists form a strongly correlated network. Regarding the centrality of investors, Keil, Maula, and Wilson (2010) show that venture capitalists can rapidly attain central positions in venture capital syndication networks by investing significant amounts. They also find a negative relationship between past centrality and investors' resources.

Uncertainty is directly linked to the entrepreneur's abilities, thus showing the need for investors to consider the human factor. However, Baum and Silverman (2004) indicate that the environment in which new businesses develop is likely heavily shaped by financial intermediaries like venture capital companies. They find that VCs are knowledgeable but seem to overemphasize companies' human capital in their investment decisions, which is a typical attribution error.

According to Hopp and Lukas (2014), the choice of VCs to syndicate integrates experience as a strong signal of quality in the form of frequency and existence of previous joint ventures with the lead VCs. The authors find that one's readiness to invite people to transactions shows the capacity to reciprocate through one's deal flow. They conclude that the value of this signal vanishes over time, whereas signals from recent years are more informative than those from more distant years.

The investors' reputation can drive the decision to agree with a VC for a startup, according to Drover, Wood, and Fassin (2014). They use a model to examine how their ethical reputation affects entrepreneurs' collaborating decisions with venture capitalists. They find that the propensity to conduct business is adversely impacted by explicit awareness of prior unethical activity ³. They conclude that entrepreneurs are increasingly inclined to work with unethical investors as the costs of turning down money rise; hence, investors would be willing to close their

²Uncertainty, in that case, is due to many variables being out of control for the investor, such as, for example, the entrepreneur's fundamental skills, their capacity to develop a product that would fit the market, or their ability to keep raising funds

³"Ethical" referring to the behavior they publicly exhibited in previous deals.

eyes to past unethical behavior of the investor if they were in urgent need of funding.

Another essential aspect for startups is the type of investor they are contracting. Schwienbacher (2013) considers a business owner looking for early-stage funding from a specialized or a generalist investor. He finds that utilizing generalists ensures effective follow-up investment, but early-stage experts are less willing to finance subsequent stages. He further explains that this trade-off causes business owners with solid projects to select specialists more frequently than those with poor initiatives.

Syndication There are three main reasons for syndication investments for a VC company (Lerner, 1994). Better decisions reduce syndicate members' moral hazard and align their interests (Bayar, Chemmanur, and Tian, 2019). Informational advantages (Admati and Pfleiderer, 1994) derive from better access to more accurate information on the startup. This can enable more accurate assessment related to later funding rounds and opportunities for future deals and their pricing. Finally, syndication also can provide the investor with organizational learning skills (Khurshed, Mohamed, Schwienbacher, and Wang, 2020). Syndication also can be seen as "window dressing" (Lakonishok, Shleifer, Thaler, and Vishny, 1991) and allows investment with other investors that would have been impossible for the individual investor. In that case, rather than being purely profit-driven, the investor aims to market him or herself by appearing as a "better" investor. Thus, as the investor aims to attract attention rather than receive a good return on the investment, syndicate membership might be disproportionately expensive. Ewens, Nanda, and Rhodes-Kropf (2018) and Gompers et al. (1995) highlight risk management as a motive for syndication since joint investment allows the investors to diversify their portfolios better ("spray and pray") and, if necessary, reduce their funding.

While research shows that syndicates make most investments in startups, we know little about the investors' respective network positions and their impact on the development and success of the investee companies. In the present paper, we focus on the network of connections enabled by syndication to analyze investment history to determine the most central actors in the investment

scene and the impact of their status on investees.

Startup development

The literature studies several aspects of explaining syndication, including smart money's impact, human capital's growth, and the contribution to startup structuration. Investors' competencies are essential for the development of the startup and can include counseling and technical/legal help, which reinforce relations with the company (Mosey and Wright, 2007).

Smart money The idea carried by smart money is that investors provide more than cash. Startups must make links beyond the entrepreneur's immediate network (Hallen, 2008). Venture capitalists can intervene in non-monetary ways to foster innovation, reduce the time to market of new products (Hellmann and Puri, 2000), and increase the startup's professionalism (Hellmann and Puri, 2002). They can contribute with their experience and the resources leading to firm success (Morten, 2007). As per Bernstein, Giroud, and Townsend (2015), VCs can increase the startup's innovation activities and the likelihood of a successful exit. They find that this is achieved through greater involvement and attention to monitoring the company's activities and providing services in various forms. Chang (2004) investigates how venture capital financing and strategic partnerships impact Internet firms' capacity to get the resources required for development. The amount of money a company raised, and the extent of its network of strategic alliances increased directly with the standing of the participating venture capital firms and strategic alliance partners it developed.

Human Capital Management Investors can also contribute to the structuration of the startup by shaping its human capital resources. Colombo and Grilli (2010) examine the effects of founders' human capital and access to venture capital financing. The link that they make is that businesses without VC backing have tech firms' competencies that match those of their founders. But once a company receives venture capital, this link disappears, highlighting VC investors' "coach" role. Entrepreneurs value additional services and see them contributing more to venture

success than a pure cash offer. VC investors can play a direct role in firm growth through board membership, allowing better monitoring opportunities (Kaplan and Strömberg, 2005). Backing from a renowned investor can help recruit talent (Bernstein, Mehta, and Townsend, 2020).

Davila, Foster, and Gupta (2003) investigate the relationship between the availability of venture capital (VC) and the expansion of startups' workforce. They are determining whether growth indicates a need for VC or whether VC drives growth, finding that staff numbers drive startup financial valuation throughout financing rounds. Yet, a fundamental decision (and carrying a powerful symbolism) is the removal or change of the founder CEO for a more experienced one. This change is a call that professional VC investors can trigger. Indeed, Sapienza (1992) finds that CEO experience accounts for a sizeable amount of the difference in the value of venture capitalist engagement. In contrast, the venture's stage and the CEO's expertise had little effect on the value created. Finally, Bruton, Fried, and Hisrich (1997) study looked at CEO terminations by boards of directors finding that CEO change often has a significant favorable impact on the performance of new ventures.

Startup Structuration Investors can directly contribute to the startup's growth. Fernhaber and McDougall-Covin (2009) highlight that venture capitalists can help new ventures' internationalization by offering expertise and reputational resources. This effect is reinforced when the VC is well-known internationally. Bygrave (1987) explains that rather than the quantity of money spent, the degree of uncertainty connected with an investment best explains the efforts made to network. They anticipate venture capitalists becoming more specialized as technology develops quickly and becomes increasingly sophisticated. They find that venture firms learn about initiatives turned down by other firms through their networks. The fact that venture capitalists frequently invest in businesses offering new goods and services allows them to amass important strategic data about upcoming discoveries. Their network position can then provide additional information. Ter Wal, Alexy, Block, and Sandner (2016) mention that while closed networks provide duplicate information that is more difficult to analyze, open networks provide

diverse, non-redundant information to actors. The authors find that enterprises have the best odds of success if their syndicating investors have open-specialized⁴ or closed-diverse networks⁵.

But there is also a counter-effect to the benefits presented by those powerful networking links. The more connection, the less attention a VC can pay to a startup. Jackson, Bates, and Bradford (2012) inform us that it takes time to advise portfolio companies, which forces trade-offs between VC activism and portfolio size. Advice access may be reduced if the number of enterprises receiving assistance rises, hurting the prospects for portfolio companies. This study highlights that aggressive VC activism does predict greater returns. This idea is reinforced by Jääskeläinen, Maula, and Seppä (2006). Indeed, they find there exists an ideal portfolio size and isolate moderating effects held by VCs' syndication. They also find that venture capitalists' engagement is a critical factor for startups.

Investor attributes and startup performance

Several elements can explain an investor's impact on a startup. In the following part, we focus on attributes that could lead to increased performance for a startup. Certification has an effect since an investor's trust relationship with a startup sends a signal to other investors regarding the young firm's quality and hidden capacities. Then an investor's reputation can shine on its investee as both names are linked once funds are sent. Finally, an investor's engagement is critical to developing a young company. If relationships matter, the intensity of that link is also crucial.

Certification Certification effects can be described as the fact that an investor's presence generates assurance to the markets regarding the company receiving funding. Certification bias originates from information asymmetry and lack of information concerning investments made by private funds.⁶ Megginson and Weiss (1991) highlight the impact of certification in the case of

⁴"Open-specialized" are open networks in term of closure, where agents are sharing specialized characteristics in terms of knowledge similarity

⁵"Closed-diverse" are closed networks in term of closure, where agents are displaying diverse characteristics in term of knowledge similarity

⁶This does not hold for public investors, e.g., grant funding from government agencies shows no observable signs of certification effects (Howell, 2017).

startups with prestigious VC investors. They show that the more favorable position of investors regarding the investees' information allows extraction of surplus by VC investors.

Investors' willingness to invest their own money in the startup is a significant signal of trust in the quality of the entrepreneur (Lewis and Sappington, 2000), and since the entrepreneur's abilities or lack of them may penalize the firm's success, and the investor will bear these costs. They also highlight that the more prestigious the investor, the stronger the signal that the company's prospects are good. Signaling effects apply to other firm characteristics such as affiliation to an established firm (Stuart, Hoang, and Hybels, 1999; Ozmel, Reuer, and Gulati, 2013) or especially for science startups to a prestigious university (Colombo, Meoli, and Vismara, 2019). This is confirmed in Bertoni, Colombo, and Grilli (2011), which analyzes selection compared to real effects. They show that startups achieve disproportionately more benefits from investments than those typically derived from simple selection bias (which would identify only high-performing firms).

Reputation Another effect linked to startup syndication funding is the investors' reputation. More powerful and wellknown investors with central network positions are likely to provide the firm with more beneficial effects (Lee, Pollock, and Jin, 2011). Nahata (2008) finds that more reputable VC investors (controlling for characteristics such as connectedness and syndication) will likely induce better short-term performance by the investee company. The role of VC in exploiting structural holes is defined in Podolny (2001), which makes a difference between the two categories of market uncertainty. It contends that whereas alter-centric (regarding other participants in the network) uncertainty does not improve the value of "structural holes," egocentric uncertainty does. They conclude that high-status actors should market with low egocentric/high altercentric uncertainties. Pollock, Chen, Jackson, and Hambrick (2010) make the case that, depending on the degree to which they offer certification or significant perks, various prominent affiliates (i.e., executives and VC firms) transmit different signals of IPO worth. They find that while the payoffs from venture funding and underwriter prestige build curvilinearly,

those from prestigious executives and directors do so linearly.

Gompers (1996) shows that young venture capitalists keen to increase their reputation are more likely to promote faster development and a shorter time to IPO. Thus, even young, less well-known venture capitalists have a noticeable impact on startup development. Gulati and Higgins (2003) suggest that the likelihood of successful IPO increases with VC signals in cold markets⁷ (whereas investment banks have a more significant impact in hot markets⁸).

Based on the study of a network of selected industry participants, Walske, Zacharakis, and Smith-Doerr (2007) find that startup success increases with the strength of venture syndicate ties. Reputation also matters for the bank supervising the IPO process (the underwriter). There is a direct positive relationship between underwriter prestige and IPO price (Liu and Ritter, 2011), and in the short-term, underperformance is reduced by a more prestigious underwriter managing the transaction (Carter, Dark, and Singh, 1998). Booth and Smith (1986) propose a theory of the underwriter's role in certifying that potentially damaging inside information is contained within risky issue prices. They find that the underwriter's reputation asserts the product quality.

Engagement Yet, reputation can be balanced with the level of engagement. Ragozzino and Blevins (2016) state that venture capitalist engagement in new enterprises impacts the possibility of an entrepreneurial exit through an acquisition or an IPO. Each engagement variable (i.e., timing, amount invested, importance of VCs, and how many VCs have invested in a specific business) directly explains entrepreneurial exit. VC fund performance increases with the position of the VC investor in the network, as shown in (Hochberg, Ljungqvist, and Lu, 2007; Checkley, Añón Higón, and Angwin, 2010), also demonstrate that companies with more central investors (or investors that can rely more diverse ties) have a higher chance of survival.

However, another factor to account for is the top management team (TMT) quality involved with the startup's success. Zimmerman (2008) investigates the connection between TMT

⁷Referring to the IPO market, "cold" would mean a cycle phase where the market is seeing less issuance and fewer cases of oversubscription.

⁸Referring to the IPO market, "hot" would mean a cycle phase where the market is seeing more issuance and more case of oversubscription.

heterogeneity and the funding a company raises through an IPO. Heterogeneity signals to potential investors the caliber of the IPO and is thus linked to higher capital accumulations. Therefore, TMT's functional and educational backgrounds are related to the money obtained during an IPO. The quality of the TMT can also lead to a more significant level of innovation. Chemmanur, Gupta, and Simonyan (2022) observe that businesses with more renowned/skilled TMT engage more in creative endeavors and employ more talented innovators. They also find that the IPO market rewards more innovative private enterprises with greater IPO company valuations.

Hypotheses

Progressing to the next round Startups aim to keep raising funds. After the first obtained round from VCs, their preferred objective is to secure further funding. The first round of funding exhibits a level of secrecy around new startups that VCs have to alleviate. Additional information regarding entrepreneurial enterprises is especially relevant for a venture capitalist's appraisal process since significant levels of information asymmetry characterize venture capital investments (Koenig and Tennert, 2022). As highlighted by Davila, Foster, and Gupta (2003), venture capitalists make staged investments, as a first investment does not obligate them to make another investment. Therefore, after this initial round, the entrepreneur and investor enter an agency relationship⁹, and the entrepreneur aims to reduce the agency expenses connected to this connection.

The previous literature has presented conflictual results regarding VCs' centrality effect. Walker, Gottschalg, and Kim (2012) find that the more considerable portfolio size, not its higher quality, causes the effect on performance (in terms of book value and IPOs). Thus having a more central investor would not significantly impact an individual startup since they face dilution of the VC's attention toward them. But for startups, this social capital can benefit entrepreneurs (Dudley, 2021) by enabling inter-unit resource exchanges, which can significantly affect product

⁹Agency relationships are defined as relationships "between two (or more) parties when one, designated as the agent, acts for, on behalf of, or as representative for the other, designated the principal, in a particular domain of decision problems." (Ross, 1973)

innovation.

We want to check the validity of the previous arguments to see what affects access to funding. Thus we test whether the centrality of the startup's investors increases the probability of subsequent funding for a given startup.

Hypothesis 1. The participation of a more central investor in the first round of fundraising increases the likelihood of obtaining further funding.

Increasing funding amount If the startup's funding increases in line with its needs, the company is better positioned to develop (Davila, Foster, and Gupta, 2003). The first round can act as a signal of quality for the startup that received money from private investors, as the company already faced the judgment of investors first. For example, Howell (2020) shows that gaining outside funding is around 35 percent more likely after winning a round in a new venture competition. The findings highlight significant difficulties for information flows in new venture funding. This competition result in a certification effect which could help resolve some of those issues.

The literature shows that such a gain in prestige and social capital could trigger a more prosperous startup development. Indeed, raising the question of competition and reputation effects over VCs and startups, Ersahin, Huang, and Khanna (2021) find that reputable VCs' profits are reduced by rising competition, which reduces their motivation to make investments and spend on expensive screening processes. Hence, top startups are less inclined to collaborate with VCs whose performance is declining. Thus, competition could crowd out less fortunate investors, and startups may see a flow of further funding from more prominent funds. While this sort of "winner takes all" phenomenon illustrates the bipartite nature of deal funding, it also informs us again of the role that an investor's centrality could have. Alexy, Block, Sandner, and Ter Wal (2012) show that the amount of funding is influenced by the VC investor's social capital (based on past syndications), and current investments affect the willingness to make future investments. They also find that the social networks of venture capitalists give them better access

to knowledge about available investment opportunities and objectives. They conclude that the function and impact of venture capitalists' social capital on startup companies may be more nuanced than previously theorized.

In our study, we want to link investors' centrality with its impact on young firms that previously received backing. Thus, we aim to uncover more insights regarding the trajectory of startups backed by central funders after their first round.

Hypothesis 2. The participation of a more central investor in the first funding round increases the likelihood of obtaining a higher amount of funding in a subsequent round.

Going public Following the growth phase of a company, we subsequently study the effects of investor centrality and its influence on startups going public. We focus on this outcome given its prevalence as the primary measure of startup success (along with being acquired.)

Yu Wang (2021) demonstrates that the IPO process will be facilitated when venture capital investment expertise is adequately matched with a firm's remarkable growth. They conclude that venture financing will significantly influence the company's listing. An opposing argument is brought in Guo, Li, Yu, and Wei (2021); their analysis reveals that instead of highlighting the benefits of information sharing, VC syndication's involvement plays a function of "adverse selection." Indeed, the more a syndicated VC has a solid reputation, the more it may use the "certification effect" to lessen the knowledge asymmetry brought on by R&D expenditure. Consequently, they find a decrease in the IPO underpricing effects of R&D. Therefore, this would exhibit a different impact of VC syndication on the startup than previously stated.

For our study, we want to test in our dataset whether investor centrality plays a role in success at IPO. We first study the impact of obtaining funds from a central investor, possibly many years later, regarding a company's IPO.

Hypothesis 3a. The participation of a more central investor in the first funding round increases the likelihood of going public.

Then we focus on investors involved in the final round of funding experienced by the startup

before going public. This split in temporality is helpful as we know that the pool of investors and their impact will likely change between rounds due to the company's different needs and status (Podolny, 2001).

Hypothesis 3b. The participation of a more central investor in the final funding round before the IPO increases the likelihood of going public.

Furthermore, a link has been established between certification effects and the consequent growth of a startup. According to Amini, Mohamed, Schwienbacher, and Wilson (2020), VC funds can postpone entry into the corporate bond market, thus prolonging the growth phase of a startup. VC's participation in delaying decisions will likely result in favorable stock price responses. They find a certification impact highlighting prospects for going public and creating future growth.

Building on this finding, for a sub-sample of companies that made it to the IPO, we want to test their financial performance in terms of valuation at IPO.

Hypothesis 4. The participation of a more central investor increases the likelihood of a higher valuation for the startup at IPO.

Growth Once a company goes public (which remains a rare event overall), its next step is to develop and grow. Growing is easier for a firm relying on solid backing from investors and owners. According to Lungeanu and Zajac (2016), investors' experiences produce distinct and changing competencies. When matched to a firm's unique and evolving strategic demands, these competence overlaps can provide value for the firm. They find support for the performance benefits of well-matched owners and firms.

On the VC side, the quality of this matching can produce more performant startups. VCs are more inclined to help businesses with inadequate governance structures solve any control issue. Liao, Lu, and Wang (2014) find that at the time of their IPO, VC-backed companies have fewer agency issues linked to excess control than non-VC-backed enterprises.

We analyze firm growth rates in the first (short-term) years of activity after IPO. We want to

identify a possible effect of investor centrality on the company's financial performance in the market. We test in the short term for aspects capturing some temporal effects (i.e., euphoria, announcements, marketing).

Hypothesis 5a. Participation of a more central investor increases the short-term likelihood of a higher share price after the IPO.

However, the long-term impact can also come from persisting effects resulting from VC's reputation. Krishnan, Ivanov, Masulis, and Singh (2011) investigate the relationship between a VC firm's reputation and the portfolio companies it invests in over the long term following an IPO. They find that more respected VCs participate more actively in the companies' corporate governance in their portfolio after the IPO, and this ongoing VC participation has a beneficial impact on post-IPO business performance. In the same vein, Chou, Cheng, and Chien (2013) looks at how venture capitalist attributes affect the post-issue survival of IPOs, focusing on high-tech companies. They find that prestigious¹⁰ VCs have capacities to increase IPO survivability by relying on their investment expertise. Hence, long-term survival after IPO is driven more by VCs' capabilities than by their prestige. (Hsu, 2005) shows that more prestigious venture capitalists are more likely to have their offers accepted and to pay a discounted rate (around 12%).

Subsequently, we test for long-term effects that would persist effect and would more likely be credited to the firm's quality.

Hypothesis 5b. Participation of a more central investor increases the long-term likelihood of a higher share price after IPO.

METHODS

Our analysis relies on external data on startup investments and stock markets. Our primary source of data is Crunchbase (crunchbase.com) which provides access to data on the world's most innovative companies for use by investors and analysts. We use these data to build a network of

¹⁰Prestige here is based on the VC's market share of previously listed IPOs

past investment deals¹¹, and to derive the network centrality values used in our subsequent estimations. The data span from 1968 (with an investment in a promising chip company, Intel) to 2020. Until the end of the 1990s, syndicated deals were rare. The data provide information on around 240,000 funding rounds, from small seed funding to multibillion deals. They cover all open economies over five decades. This allows a good representation of market activities and reduces the risk of bias.¹²

Network

Using data from Crunchbase, we obtained information on the investments made by investors in each project, allowing us to map the investors who worked together (in a syndicate). This mapping is conducted for 1968-2010 and is similar to the pattern for 1968-2019 in terms of computation of centrality measure (most of the leading investors were already present in the market in 2010). For the next part of the analysis, this period is used as training data to allow us to derive degree and other centrality metrics. The remaining data (accounting for the largest share of entries from 2010 to 2019, immediately before the start of the COVID-19 pandemic) are used as our test set to estimate the coefficients.

To check the robustness of our results, we conduct the same computations by moving the 2010 ‘cutoff’ date to 2005 and 2000; results remain sensibly the same.

The data cover investors from all five continents, although there are differences in representation, i.e., the Americas account for 53%, Europe 30%, and Asia 14%. Most startups in our dataset achieved less than five rounds of funding. Our study sample includes a large proportion of syndicated deals (70%).

The result is an undirected network¹³ in which the nodes are investors and the edges are the connections between them created by joint (syndicated) deals. The network shows a clear

¹¹This means that both syndicates and individual investments are included in the data.

¹²Bias can arise from excluding undisclosed deals, i.e., if those undisclosed deals are correlated, this could induce bias.

¹³We examine an undirected network rather than a directed network primarily due to the existence of inconsistencies in our dataset and to avoid introducing bias. The lead investor (the investor that initiated the syndication and around which other investors aggregated) is not reported for every deal.

distinction between a large core of highly connected actors and an extended set of relatively isolated investors, with a large cluster and 91,313 weakly connected components.

We employ the Blondel, Guillaume, Lambiotte, and Lefebvre (2008) algorithm, which identifies a few large communities of investors and numerous isolated investors.¹⁴ There are some communities within the range of 1200 to 2000 nodes, a few more 10-500 nodes communities, and a substantial number of isolated players which is to be expected given the basic segmentation of investors around locations and industries. We obtain a high average clustering coefficient of 0.695, spread unequally among investors. Many investors have a coefficient close to 0 with a small percentage with higher indices.

Centrality measures

After building a usable network, the next step is to extract the centrality measures used later in the paper. We employ degree and eigencentrality, commonly used in the network literature.¹⁵ Both measures are based on a common construction.

Degree measures the number of the agent's connections in the network. We find that their distribution is uneven. While the average degree is 1.71, most agents have few connections, while a few powerful ones have as many as 2,000. By relying on straightforward links without related information, we lose a layer of information but reduce the risk of bias.

Eigencentrality (or eigenvector centrality) is a measure taken from graph theory that assigns a score for the influence of a node in a network. Newman (2010), p.169, describes it as "think of degree centrality as awarding one 'centrality point' for every network neighbor a vertex has. But not all neighbors are equivalent. Instead of awarding vertices just one point for each neighbor, eigenvector centrality gives each vertex a score proportional to the sum of the scores of its neighbors."

We find that eigencentrality and degree show similar patterns of a large share of loosely

¹⁴Communities should be understood according to (Newman, 2010), page 371, as: "groups of vertices that have few connections between them."

¹⁵(Marsden, 2004)

connected agents with a few critical, highly connected agents. We find a large count of agents stuck at 0 and a few spread across $]0, 1]$. Given the extra value derived from syndication, we find that pools of investors make a significant portion of investments. Indeed, VC firms may find it beneficial to pool their resources for a deal. For completeness, we collect the same information for an unrestricted time frame (1968-2019); we find that the results (the distinction between many less connected and a few highly connected actors) are persistent, highlighting a recurrent pattern in forming investor links.

The last step consists of constructing a measure for investee investment success. We focus on three factors: First, did the firm obtain subsequent funding? Did the startup go to IPO? Did the firm's financial performance improve? In the first two cases, the data is available from Crunchbase.

As a measure of short-term and long-term success, we measure growth in the company's stock price after IPO.¹⁶

Other measures

We rely on the CRSP stocks database and third-party databases for financial metrics to get historical stock prices and risk-adjusted stock returns.

Variables

In what follows, we define the variables used for our estimations.

Dependent Variables *Next round* is a dummy equal to 1 if the startup obtained more than one round of funding and 0 otherwise. *First raised amount* and *last raised amount* are logs of the amounts raised in USD in the first and last funding rounds. *IPO* is a dummy equal to 1 if the startup went public and 0 otherwise. *Value* is the firm valuation on entry to the market at IPO.

¹⁶Although (Koller, Goedhart, Wessels, et al., 2010) argue that this would be valid only in an ideal world, given data availability and in the interests of simplicity we adopt this measure.

$Growth_{firstyear}$ and $Growth_{n-year}$ is the growth in stock prices in the first year and over several years over the annual rate of growth of the startup since IPO.

Independent Variables *log (highest degree)* is the log of the degree of the most central investor in the funding round. *Higher centrality* is the higher eigencentrality among the round's investors. *Max centrality* is the global maximum eigencentrality among all the investors that invested in the startup. *Macroeconomic activity* is an economic proxy used in our regression; it accounts for the GDP growth rate in the period. *Growth raised amount* is the relative increase factor of the amount raised in USD between the first and last funding rounds. *Total funding* is the log of the sum of all the funding from all funding rounds in USD. *Investor count of investments* is the total number of rounds carried by an investor in past periods. *Investor funding activity* is the total amount of funds operated by an investor in past periods. *Prestige* is the computed network rank prestige¹⁷ of the startup.

Controls *Geographical area* is a group categorization of the startup localization.

Founder education is a categorical variable based on the ARWU ranking¹⁸ of the observation year. We take the ranking of the better-ranked founder of the company. It can take four values corresponding to top 10, top 50, top 500, or else.

We define *Sector Fit* as a binary variable equal to 1 if the investors in a funding round are specialized predominantly in the same sector of activity as the investee company (e.g., mainly techfocused investors backing a tech startup). By "specialized," we mean that most investments are in companies operating in that sector. The sectors considered are defined according to the Global Industry Classification Standard (GICS) as *Energy, Materials, Industrials, Consumer Discretionary, Consumer Staples, Health Care, Financials, Information Technology, Telecommunication Services, Utilities, and Real Estate*. We included the sector *Diversified* for

¹⁷Rank prestige is a network metric that we applied to our graph, defined as an indicator of social influence. Its implementation in Gephi is described in the documentation: <https://gitlab.fhnw.ch/marco.romanutti/gephi-plugins/-/tree/master-forge/modules/PrestigePlugin>

¹⁸<https://www.shanghairanking.com/rankings/arwu/2022>

investors with investments in several sectors.

ANALYSIS

In the analysis, we observe two dimensions. The first, pre-IPO, includes the factors required for a successful startup IPO. We focus on two measures: how investor centrality affects the probability of obtaining another round of funding and increases the chance of funding beyond the next round, and how investor centrality influences the likelihood of going public. The second dimension, post-IPO, includes the firm's financial success after going public. We focus on whether investor centrality impacts the firm's short-term (1-year) or longterm (5-year) stock price.

Progressing to the next round

To test *Hypothesis 1*, we employ a simple logit model to estimate the factors affecting the probability of obtaining another round of funding. This is written as:

$$\begin{aligned} \text{Next round} = & \beta_0 + \beta_1 \times \text{Log(raised amount)} + \beta_2 \times \text{Log(highest degree)} \\ & + \beta_3 \times \text{Sector fit} + \beta_4 \times \text{Macroeconomic activity} + \beta_5 \times \text{Founder education} + \epsilon \end{aligned} \quad (1)$$

Note that slightly less than 70% of the companies in our sample achieved one round of funding with one investor, and the remaining 30% obtained two or more investors to participate in investment rounds. Hence, a significant proportion of the deals are not syndicated.

Increasing funding amount

We next investigate whether investor centrality increases the future amounts of funding raised by the startup (*Hypothesis 2*). We test whether more central investors translate into higher funding in the future. We are interested in the factors that might affect the capital the startup can raise in the final round of funding before going public. For startups not involved in an IPO, we use the

last available round of funding. We restrict the sample to the population of startups across all sectors that benefited from two or more funding rounds.

$$\begin{aligned} \text{Raised amount}_{\text{last}} = & \beta_0 + \beta_1 \times \text{Raised amount}_{\text{first}} + \beta_2 \times \text{Highest degree} \\ & + \beta_3 \times \text{Sector fit} + \beta_4 \times \text{Macroeconomic activity} \\ & + \beta_5 \times \text{Founder education} + \epsilon \end{aligned} \quad (2)$$

Going public

Since we are interested in IPO activity, we study startup performance induced by investor centrality. This excludes acquired companies since we cannot monitor the firm's development after a merger with another company.¹⁹

To test *Hypotheses 3a* and *Hypothesis 3b*, we use the following regression:

$$\begin{aligned} \text{IPO} = & \beta_0 + \beta_1 \times \text{Log(Raised amount)} + \beta_2 \times \text{Higher centrality} \\ & + \beta_3 \times \text{Sector fit} + \beta_4 \times \text{Macroeconomic activity} + \epsilon \end{aligned} \quad (3)$$

IPO Valuation

We examine startup valuation after IPO to test *Hypothesis 4*.

$$\begin{aligned} \text{Value} = & \beta_0 + \beta_1 \times \text{Log(Raised amount)} + \beta_2 \times \text{Higher centrality} \\ & + \beta_3 \times \text{Sector fit} + \beta_4 \times \text{Growth Raised amount} + \epsilon \end{aligned} \quad (4)$$

¹⁹Following a merger, although the original startup brand and logo may be retained, the firm's financial performance will be linked to the acquirer, making it impossible to track the startup's performance.

Post-IPO

Short-term growth To test *Hypothesis 5a*, we examine the rate of change in a firm's price.²⁰

$$\begin{aligned} \text{Growth}_{\text{first year}} = & \beta_0 + \beta_1 \times \text{Higher Centrality} + \beta_2 \times \text{Price at IPO} + \beta_3 \times \text{Number of rounds} \\ & + \beta_4 \times \text{Macroeconomic activity} + \beta_5 \times \text{Prestige} + \epsilon \end{aligned} \quad (5)$$

Long-term growth In the case of *Hypothesis 5b*, we are interested in whether investor centrality plays a role in financial performance over an extended period (i.e., more than one year). We use updated stock prices until 2019 and compute the startup's annual growth rate since the IPO.

$$\begin{aligned} \text{Growth}_{5 \text{ years}} = & \beta_0 + \beta_1 \times \text{Higher Centrality} + \beta_2 \times \text{Price at IPO} + \beta_3 \times \text{Number of rounds} \\ & + \beta_4 \times \text{Macroeconomic activity} + \beta_5 \times \text{Prestige} + \beta_6 \times \text{Growth}_{\text{first year}} + \epsilon \end{aligned} \quad (6)$$

RESULTS

Progressing to the next round

We find a significant effect of investor centrality on the investee's likelihood of obtaining more funding (*Hypothesis 1*). Table 1 shows strong significance (at the 0.001 level) and a positive effect of 0.39 per 1 log of degree. Using the degree's log of the centrality of the investor and the highest degree of centrality among syndicate members, we found a consistently positive impact. Thus, the investee's likelihood of receiving further funding increases with a more central investor rather than a less well-connected investor. We test for endogeneity of the results to factor

²⁰ Although we obtained a large proportion of stock prices for startups that went public, there may be a small induced bias. We could not get this information for some less well-connected markets.

characterizing the investors (namely, its past investment in terms of quantity and total previous amount of funds managed, our results on centrality remain robust to this test (see table A1 in the appendix.)

The chances of obtaining further funding are affected by other metrics. The amount raised in the first round has a noticeable impact. This relationship points to the benefits of a larger first round of investment, with investors exhibiting their trust in the company via subsequent funding. We also find that sector fit significantly impacts the odds of success in terms of further funding. We also find that having a founder who attended a better-ranked university ultimately leads to greater chances of additional funding compared to alums from lesser-known institutions. Finally, geography plays no significant role in this equation.

Insert TABLE 1 about here.

Increasing funding amount

A linear regression model in line with equation 2 shows that the effect of investor centrality is strong and significant (above the 0.001 level) for all the dimensions tested (see table 2), supporting *Hypothesis 2*.

Capital raised during the first round has a strong and significant effect. Its coefficient of 0.76 indicates a stable positive impact of the initial amount raised on the amount raised in the final round. Again, we find that startup founded by alums of top 10 schools tends to have better results in term of funding compared to other alums. Finally, we tested the impact of startup location; we found that Americas based startups and Asian corporations tend to raise more funds.

To check those results, we test the endogeneity of the investor's centrality, which its previous investment activity could impact. We find that results regarding the centrality of the investor remain valid (see table A2 in appendix).

Insert TABLE 2 about here.

Going public

Our analysis measures the odds of going public for a startup through a dummy of 1 for companies pursuing an IPO and 0 otherwise. Table 3 presents the results of our logit regression from equation 3. We find that the effect of investor centrality is significant and positive on IPO. A higher level of centrality (corresponding to the centrality of the most central investor participating in the first funding round) has a coefficient of 0.1, which makes for a significantly greater probability of going public. The amount of money raised at the first round of financing has a significant and positive impact on the probability of IPO, with a coefficient of 0.33 per log of raised amount. This effect, combined with the impact of high centrality, strongly indicates that investor centrality and the amount of cash raised affect the chances of going public (which supports *Hypothesis 3a*). We also observe a solid and significant negative constant, indicating the barriers to going public.

The support of a central investor for initial funding is essential, but the effect is weaker for the last round of funding. However, the coefficient of centrality is also weaker, decreasing from 0.1 to 0.09. This finding is interesting since the amount raised in the final funding round tends to be higher than in the initial round. We also observe decreased relevance of the effect of centrality in the last round (which rejects *Hypothesis 3b*.) One interpretation could be that the impact of centrality is shifting towards other variables, such as the amount of cash raised and the size of the syndicate, which might be more critical immediately before the IPO.

Wu, Wang, Chen, and Pan (2008) suggest that the need for backing differs as the startup develops, perhaps explaining the previous result and explaining the significant role of investor centrality in the first round of funding compared to pre-IPO funding. Table 3 suggests that *ceteris paribus*, the entrepreneur might benefit equally from accepting a smaller investment from a central investor or a larger offer from an “average” investor.

Insert TABLE 3 about here.

IPO Valuation

We find a robust positive effect of the amount of money raised in previous rounds (whether first or last, see table 4). The centrality of the most central investor in the last round appears to have a small but negative effect on the company's valuation at IPO (*Hypothesis 4*). In contrast, the investor-company fit has a low negative impact on that last variable. This might be due to the signaling effect of a central investor in the last stage of funding. Indeed, it could turn from a blessing (helping the company to get funds and grow) to a curse later on (inhibiting the startup's ability to prosper).

Insert TABLE 4 about here.

Post-IPO

Short-term growth We find no clear relationship between our centrality metrics and stock price growth in the first year (*Hypothesis 5a* is rejected). Table 5 shows that none of our estimators are important in the short-term analysis. Hence there seem to be no persistent effects in this time frame that we can isolate in our sample. We conclude that there is no noticeable impact of investor centrality in the network on the investee's short-term financial performance after IPO.

Insert TABLE 5 about here.

Insert TABLE 6 about here.

Long-term growth Table 6 shows the relevance of the last funding round's data for predicting long-term growth. The growth rate in the first year as a public company is significant in all our estimations (*Hypothesis 5b*). It makes sense as it contains information about the startup released since IPO. Moreover, the positive relationship between the growth rate over five years

and the value of the one-year growth rate is logical since the former includes the latter. We test for the relevance of the centrality of the most central investor. It is significant (although only at the 0.05 level) for predicting the startup's longterm growth. The effect is non-negligible since a 1% more central investor predicts a 0.55% increase in growth over the long term.

DISCUSSION

This study brings new elements to the ongoing conversation on the role of investors' networks for their investees. First, we highlight that the impact of relationship effects can be perceived pre-IPO and post-IPO. Second, we find that the duration of those effects can vary over time. Finally, we can conclude that there is a choice to be made for investees regarding their decision to receive funds (where they can balance the origin of the funds they receive, where a more central investor would be beneficial, and the amount of funds perceived.)

Theoretical implications

Lewis (2016) test hypothesis on firm entrance and network imprinting. He highlights that new businesses entering an existing network core aren't inevitably better off, and neither are new firms arriving at the network's edges always inherently worse off. He concludes that venture capital business that joins the network core is less likely to fail, but they are also less likely to achieve exceptional success.

Our results exhibit a similar pattern. Indeed, we can isolate effects due to having a better fit in the link investor-investee, in addition to the sole centrality of the investor. Thus centrality is a strong force for performance but not the only element in the mix.

Accessing the market The pre-IPO phase shows that investor centrality affects the chances of obtaining additional funding, the amount of funding received, and going public. This is the logical development path for the most promising startups, which can be assumed to be driven by prominent investors. While previous research provides evidence of a certification effect

(Megginson and Weiss, 1991), the pre-IPO phase highlights that startups can secure funding from a group of central investors likely to signal to the investing community that it is a good prospect. This means the company is expected to get noticed and more easily obtain additional funding from a larger group of investors. Consequently, it can extract value from this signal and obtain sufficient financing.

The reputation derived from investors' centrality can enable the firm to develop faster than competitors. In turn, investor centrality may derive from previous suitable investments, which provide increased network links and more resources for the investee firm to access. These benefits promote startup growth while increasing the need for more capital to enable expansion. They also improve the chances of obtaining larger amounts and more funding rounds. These centrality effects are observed in all industries. However, they seem to be the most important in *Communication Services, Health Care, and Information Technology*. Our estimates are robust to the inclusion of different centrality measures and account for endogeneity effects regarding investors' centrality. Interestingly we isolate the impact of education on fundraising, as belonging to a better-ranked alum network helps to raise relatively more funds. This phenomenon could be explained by a certification effect at the individual level or based on homophily with investors (Garfinkel, Mayer, Strebulaev, and Yimfor, 2022).

Finally, we observe that investors' centrality increases the chances of further funding. This result builds on Ter Wal, Alexy, Block, and Sandner (2016) who look past the direct effects of ventures' intrinsic quality and find that ventures have higher or lower chances of success depending on the shape of their syndicating network. We also find that more elevated amounts of funding increase the chances of an IPO. This aligns with Banerjee, Güçbilmez, and Pawlina (2016), who suggest that higher growth firms tend to go public earlier than low growth firms. This earlier entry into the market provides a competitive edge following an IPO.

Achieving McEvily, Jaffee, and Tortoriello (2012) find that bridging ties result in network advantages over a long period and go back to the early stage of tie formation. They conclude that

characteristics acquired at tie formation result in long-term network advantages. We find evidence going along that line, as our dataset exhibits long-term effects on the startup's performance. For the post-IPO phase, the results are less intuitive. Indeed, we find that investor centrality affects long-term but not short-term performance. This result might be because, after the IPO, the effect of investor centrality as a means of certification vanishes, whereas the smart money effect persists. This would go against previous findings pointing to the prevalence of certification on monitoring (Bajo, Croci, and Marinelli, 2020).

The certification effect is critical for startups to signal quality and promote firm growth. In this first phase, startup expansion is fostered by certification and smart money effects. After the IPO, more information becomes public, and investors are more likely to cash in on their investment, as suggested by Paeglis and Veeren (2013), to focus on developing new startups. Affiliation may become a double-edged sword for VCs, as the presence of a new acquirer makes for a positive sign on markets (Arikan and Capron, 2010).

As time passes, the firm's intrinsic qualities are revealed. Hellmann and Puri (2002) suggest that the smart money effect persists over the long term. Professionalization is strengthened, as are the links that connections to central investors enable. This is evidence of a smart money effect that increases the firm's competitiveness. This point might explain the lack of a clear relationship among the empirical results post-IPO. While the certification effect fades quickly, it can take time for the smart money effect to emerge.

Practical implications

Based on the imprinting literature, Milanov and Fernhaber (2009) suggest that one must look beyond the first partner and instead concentrate on the original partner's ongoing connections with other companies. They conclude that a new venture's first partner's network size and centrality impact the subsequent size of its network. Those results are extended in Zarea Fazlelahi, Obschonka, Burgers, and Davidsson (2020). They detect a positive effect on the reputation of the new firm's founding partners but no appreciable moderating influence of prior cohesiveness.

Our study displays implications for entrepreneurs and suggests that they should choose, to some extent, the most central investors regardless of the amount of funding offered. It's also interesting to get funds from an investor investing in the same industry to tap into their extensive experience and resources. Of course, this is far from an easy call, and startups needing liquidity may rightfully go for the most significant amount of cash. Therefore, a powerful backer is critical for improved survival chances and better performance. This highlights the need for the backing of well-connected investors as the company develops.

However, in the case of the last funding round, the amount of funding dominates investor centrality. Hence, it might benefit the entrepreneur to broaden their source of funds concerning their final round of funding. This suggests that the size of the investor base becomes more important than the backing from a famous investor in the last stage of the company development.

Limitations and future research

We can only see real deals while estimating deals that fall short of realization is much more challenging. Hence it might mean that a survival bias exists. There could also be selection bias whereby the best startups are chosen by the best investors (in our set, the most central investors). This bias would mean that these firms find it easier to access funding, go public, and increase their value. Yet, if it could indeed be the case that some startups present a higher potential and face more favorable conditions, it's not evident that it should be the rule. There is a correlation between the eigencentality of an investor and the number of investments it made, its investment mean amount, and its likelihood of being a deal leader. However, for most of our regressions, we take the first amount of raised funds for an investor into account, accounting for publicly available data about the company for subsequent deals. Bertoni, Colombo, and Grilli (2011) disentangle the treatment from the effects of the selection of VC and show that investments significantly impact startup development. Thus, the higher profile of startups/investors does not explain our dataset's observed absence of short-term growth in valuations. Indeed, startups should benefit more from greater access to finance enabled by an IPO. This link suggests that a startup

with more central investors should be more competitive, but we don't find this result in the short term. Finally, since our study covers all available data, this would not apply. Given our finding of the significant place of investment on the startups in our sample throughout the study, the difference between high potential/low potential startups is insufficient to explain the coefficients. However, it is possible that some deals were not disclosed and are invisible in our sample. If these deals are correlated, this could lead to potential bias.

The first part of the analysis focuses on the first stages of the startup; Nanda, Samila, and Sorenson (2020) show that there can be the persistence of early success of a VC to lead startups to IPO. In their view, this is not attributable to the capacity to identify the best investment opportunities/timings but to the following of more significant deals through syndication. This contradicts the idea that successful investments are linked to stellar early ventures; some investors do not decide to invest until they can prove startup success. We took measures to mitigate the risk of possible bias and endogeneity by including some additional independent variables. In addition, our data on some deals/companies in our sample are incomplete. For example, some items have missing values, which makes them impossible to be used even though they would be pertinent if available (i.e., about 27% of funding rounds are missing information on lead investors.) Future work may try to collect and exploit additional data. Finally, unlike previous studies, we do not consider investor size or resources. We took into consideration only the investor's position in the network. Future research could consider the influences of different factors, for example, by including additional data regarding investors' capacity and workforce.

CONCLUSION

This paper examined the effect of investor centrality within the global investor network. We decomposed its relevance on the pre-IPO development and found that investor centrality increased the chances of further and higher funding and going public. We attribute those positive factors to a certification effect that provides the startup with a reputation and easier access to funding. Our results are robust to the selection effect on the startup side and endogenous effects

regarding the investor's centrality.

We also found that investor centrality is relevant to startup development and the startup's future valuation. This is due to the persistence of a smart money effect which improves the startup's chances of survival and makes it more competitive based on access to the resources and ties of its backers. This is the reason why cash may not be what matters the most.

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TABLE 1: Ordered probit estimation of the probability of getting more than one round of funding.

	Access next round of funding (1= startup had 2+ rounds)			
	(1)	(2)	(3)	(4)
Most central investor's degree	0.184*** (0.00924)	0.184*** (0.00925)	0.394*** (0.0139)	0.392*** (0.0141)
First raised amount (USD)	0.0438*** (0.00690)	0.0436*** (0.00691)	0.0611*** (0.00811)	0.0602*** (0.00822)
Macroeconomic activity	0.0870*** (0.0252)	0.0875*** (0.0253)	0.104*** (0.0261)	0.104*** (0.0263)
<i>Founder education (base top 500+)</i>				
Top 10	0.371*** (0.0369)	0.371*** (0.0370)	0.358*** (0.0383)	0.341*** (0.0394)
Top 50	0.310*** (0.0372)	0.309*** (0.0372)	0.289*** (0.0386)	0.277*** (0.0396)
Top 500	0.203*** (0.0399)	0.198*** (0.0399)	0.180*** (0.0413)	0.172*** (0.0416)
Sector fit		0.114*** (0.0275)	0.125*** (0.0283)	0.122*** (0.0286)
Investor count of investments			-0.00356*** (0.000192)	-0.00347*** (0.000195)
Investor funding activity (USD)			-0.0793*** (0.00904)	-0.0800*** (0.00912)
<i>Geographical area (base Americas)</i>				
Africa				-0.171 (0.169)
Asia				-0.0555 (0.0403)
Europe				-0.0360 (0.0326)
Oceania				0.235 (0.141)
Constant	0.537*** (0.109)	0.590*** (0.110)	-0.276 (0.143)	0.326* (0.145)
Observations	14151	14151	13946	13793
Pseudo R^2	0.063	0.064	0.104	0.103

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data: worldwide, 2010-2019.

TABLE 2: Regression of the determinants impacting the last amount of capital (USD) raised by startups.

	Last raised amount (log of USD)			
	(1)	(2)	(3)	(4)
Most central investor's degree	0.00214*** (0.000159)	0.00213*** (0.000159)	0.00171*** (0.000177)	0.00155*** (0.000179)
First raised amount (log of USD)	0.780*** (0.00425)	0.780*** (0.00425)	0.760*** (0.00508)	0.752*** (0.00515)
Macroeconomic activity	0.0225 (0.0168)	0.0218 (0.0168)	0.0444* (0.0191)	0.0416* (0.0191)
Sector fit		-0.0761*** (0.0192)	-0.0826*** (0.0220)	-0.0853*** (0.0222)
<i>Founder education (base top 500+)</i>				
Top 10			0.429*** (0.0272)	0.399*** (0.0280)
Top 50			0.310*** (0.0277)	0.282*** (0.0283)
Top 500			0.265*** (0.0293)	0.250*** (0.0295)
<i>Geographical area (base Americas)</i>				
Africa				-0.533*** (0.126)
Asia				0.0646* (0.0293)
Europe				-0.207*** (0.0239)
Oceania				-0.190* (0.0767)
Constant	3.585*** (0.0692)	3.633*** (0.0702)	3.788*** (0.0822)	3.978*** (0.0839)
Observations	23624	23624	18512	18301
Adjusted R^2	0.626	0.626	0.600	0.598

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data: worldwide, 2010-2019.

TABLE 3: Logit estimation of the probability of going public. The first column is a Firth Logit estimation; methodology is described in Firth (1993). The second and third columns are IV regression estimations.

	IPO dummy (1 = startup went public)		
	(Firth)	(IV I)	(IV II)
Most central investor's degree (first round)	0.234*** (0.0441)	0.109** (0.0349)	
Most central investor's degree (last round)			0.0926** (0.0298)
Sector fit	0.0359 (0.169)	0.0183 (0.0855)	0.0297 (0.0853)
Macroeconomic activity in period	0.620*** (0.149)	0.331*** (0.0726)	0.377*** (0.0724)
First raised amount (log of USD)		0.332*** (0.0232)	0.347*** (0.0229)
Constant	-5.541*** (0.388)	-8.058*** (0.415)	-8.343*** (0.422)

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data: worldwide, 2010-2019.

TABLE 4: Regression of the determinants impacting the valuation of a startup at IPO.

	Company valuation (USD)				
	(1)	(2)	(3)	(4)	(5)
First raised amount (USD)	0.228*** (0.0480)				
Last raised amount (USD)		0.666*** (0.0398)	0.673*** (0.0496)	0.674*** (0.0489)	0.649*** (0.0497)
Most central investor's degree			-0.131** (0.0398)	-0.130** (0.0392)	-0.133*** (0.0389)
Sector fit				-0.479** (0.182)	-0.439* (0.182)
Growth raised amount					0.000562* (0.000251)
Constant	16.45*** (0.806)	8.468*** (0.707)	8.797*** (0.876)	9.062*** (0.870)	9.481*** (0.882)
Observations	275	275	216	216	216
Adjusted R^2	0.073	0.505	0.461	0.475	0.485

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data: worldwide, 2010-2019.

TABLE 5: Regression of the determinants impacting the growth of the short-term startup price.

	Growth over 1 year	
	(USA)	(World)
Most central investor's degree	-6.93e-02 (3.21e-01)	-9.86e-01* (4.95e-01)
Macroeconomic activity	-3.89e-01* (1.75e-01)	-3.10e-01 (3.52e-01)
Price at IPO	1.22e-03 (5.06e-02)	-4.42e-01* (1.99e-01)
Number of rounds	3.18e-02* (1.56e-02)	-3.59e-03 (1.47e-02)
Prestige measure	-5.88e-06 (5.03e-06)	8.52e-06 (9.05e-06)
Sector fit	-1.25e-01 (1.83e-01)	3.78e-01 (4.05e-01)
Constant	7.88e-01 (4.27e-01)	2.41e+00* (1.16e+00)
Observations	66	126
Adjusted R^2	0.132	0.128

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data: worldwide, 2010-2019.

TABLE 6: Regression of the determinants impacting the growth of the long-term startup price. The first column is a standard regression estimation. The second and third columns are estimations using the Heckman two-step procedure (Heckman, 1979).

	Growth over 5 years		
	(I)	(II)	(III)
Most central investor's degree	5.46e-01* (2.59e-01)	7.51e-01** (2.80e-01)	7.25e-01* (2.94e-01)
Price at IPO	-1.51e-02 (5.87e-02)	-3.79e-02 (5.44e-02)	-1.19e-02 (1.92e-02)
Growth over 1 year	4.52e-01** (1.51e-01)	4.60e-01** (1.47e-01)	2.14e-01*** (6.19e-02)
Macroeconomic activity	-1.81e-01 (1.67e-01)	-1.94e-01 (1.58e-01)	-1.54e-01* (6.91e-02)
Number of funding rounds before IPO	-1.17e-02 (1.59e-02)	-7.72e-03 (1.48e-02)	3.95e-03 (8.82e-03)
Growth raised amount	9.21e-05 (1.02e-04)	4.20e-05 (1.09e-04)	
Prestige measure	-4.91e-06 (6.58e-06)	-4.32e-06 (6.23e-06)	-1.81e-06 (3.51e-06)
Sector fit	4.22e-01 (3.26e-01)	4.26e-01 (3.25e-01)	8.63e-02 (9.67e-02)
Constant	1.75e-01 (4.26e-01)	-1.21e+00 (9.37e-01)	-4.04e+00*** (1.00e+00)
<i>Select</i>			
Investor count of investments		-7.69e-04 (4.34e-04)	-4.54e-05 (3.35e-04)
Investor funding activity (USD)		1.79e-01*** (4.28e-02)	7.35e-02* (3.00e-02)
Constant		-6.11e+00*** (8.46e-01)	-4.00e+00*** (5.64e-01)

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data: worldwide, 2010-2019.

APPENDIX A: FURTHER CALCULATIONS

TABLE A1: IV probit estimation of the probability of getting more than one round of funding.

	Access next round of funding (1= startup had 2+ rounds)			
	(1)	(2)	(3)	(4)
Most central investor's degree	0.261*** (0.0129)	0.260*** (0.0130)	0.227*** (0.0159)	0.314*** (0.0120)
First raised amount (USD)	0.0183** (0.00587)	0.0182** (0.00588)	0.0311*** (0.00785)	-0.00326 (0.00757)
Macroeconomic activity	0.0442* (0.0206)	0.0443* (0.0206)	0.0893*** (0.0252)	0.0885*** (0.0252)
Sector fit		0.214*** (0.0223)	0.110*** (0.0275)	0.104*** (0.0275)
<i>Founder education (base top 500+)</i>				
Top 10			0.339*** (0.0382)	0.266*** (0.0373)
Top 50			0.294*** (0.0374)	0.258*** (0.0372)
Top 500			0.189*** (0.0400)	0.167*** (0.0400)
Constant	-0.317*** (0.0861)	-0.417*** (0.0871)	-0.515*** (0.112)	-0.233* (0.113)
<i>Most central investor's degree</i>				
First raised amount (USD)	0.207*** (0.00436)	0.206*** (0.00436)	0.205*** (0.00516)	0.0417*** (0.00517)
Macroeconomic activity	-0.0468** (0.0171)	-0.0467** (0.0171)	-0.0375* (0.0189)	-0.0213 (0.0166)
Investor count of investments	0.00570*** (0.0000553)	0.00569*** (0.0000553)	0.00599*** (0.0000625)	0.00263*** (0.0000726)
Sector fit		0.140*** (0.0187)	0.0391 (0.0210)	0.00309 (0.0185)
<i>Founder education (base top 500+)</i>				
Top 10			0.346*** (0.0253)	0.201*** (0.0223)
Top 50			0.163*** (0.0266)	0.0615** (0.0235)
Top 500			0.110*** (0.0296)	0.0383 (0.0262)
Investor funding activity (USD)				0.318*** (0.00470)
Constant	-1.082*** (0.0730)	-1.144*** (0.0734)	-1.116*** (0.0850)	-4.440*** (0.0894)

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data: worldwide, 2010-2019.

TABLE A2: Regression of the determinants impacting the last amount of capital (USD) raised by startups using Heckman procedure (Heckman, 1979).

	Last raised amount (USD)			
	(1)	(2)	(3)	(4)
Most central investor's degree	0.00146*** (0.000170)	0.00146*** (0.000170)	0.00125*** (0.000186)	0.00109*** (0.000188)
Macroeconomic activity	0.0493* (0.0206)	0.0494* (0.0206)	0.0613** (0.0226)	0.0568* (0.0226)
First raised amount (USD)	0.698*** (0.00547)	0.698*** (0.00547)	0.683*** (0.00629)	0.676*** (0.00634)
Sector fit		0.0277 (0.0234)	0.0152 (0.0259)	0.0167 (0.0259)
<i>Founder education (base top 500+)</i>				
Top 10			0.373*** (0.0301)	0.363*** (0.0310)
Top 50			0.254*** (0.0316)	0.242*** (0.0322)
Top 500			0.251*** (0.0347)	0.236*** (0.0348)
<i>Geographical area (base Americas)</i>				
Africa				-0.371* (0.162)
Asia				0.204*** (0.0358)
Europe				-0.198*** (0.0290)
Oceania				-0.284** (0.108)
Constant	4.898*** (0.0884)	4.884*** (0.0893)	4.972*** (0.102)	5.123*** (0.103)
<i>Select</i>				
Investor investments' count	0.00569 (0.00587)	0.00569 (0.00588)	0.00432 (0.00542)	0.00433 (0.00545)
Investor funding activity (USD)	-0.120 (0.147)	-0.120 (0.147)		
Most central investor's degree	-0.00764 (0.00924)	-0.00764 (0.00925)	-0.00800 (0.00900)	-0.00800 (0.00905)
Constant	5.821* (2.830)	5.822* (2.831)	3.526*** (0.233)	3.523*** (0.233)
Observations	16757	16757	13875	13755
Adjusted R^2				

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data: worldwide, 2010-2019.

CHAPTER 2

SPACs and Trust

SPACs and Trust:
A Study of Trust Building in Investor
Networks

INTRODUCTION

Trust is an integral part of every transaction. No deal can occur without a minimal amount of confidence within another party. Bottazzi, Da Rin, and Hellmann (2016) examine the impact of trust on venture capital investments and show that trust positively predicts investment decisions but negatively correlates with successful exits. They conclude that earlier-stage investments require higher trust, syndication is more valuable in low-trust situations, and higher-trust investors use more contingent contracts. Haiyan (2019) introduces a dynamic trust model that leverages reinforcement learning to uncover the motivations and processes underpinning trust dynamics. The findings highlight the paramount role of trust in fostering cooperation and information sharing between VCs and entrepreneurs. The author reveals that trust dynamics result from mutual learning experiences, showcasing that VCs and entrepreneurs adapt their trust levels based on previous interactions. Furthermore, Haiyan (2019) shows that trust is a powerful tool for curbing opportunistic behavior, simplifying formal management, and reducing transaction costs in such ventures.

Trust can be modeled and incorporated into network studies. For example, Klabunde (2015) explores the role of trust in startup financing within an agent-based model. Trust, as measured by social distance, is a prerequisite for investment. Investors assess their investments by comparing returns with those of others in a network-like structure. The study determines the optimal trusting strategy for a collective of investors and assesses whether it is rational for an individual investor to deviate from this strategy. The findings indicate that in a collective setting, investors benefit from critically comparing returns but maintaining trust levels, preventing the premature termination of profitable relations. However, individual investors may deviate from this strategy, being less easily disappointed and decreasing trust in larger steps. Such individual deviations can lead to suboptimal outcomes when too many unproductive firms persist. Our paper focuses on examining the role of trust between investors relying on their social capital and its effect on deal-making.

We look more deeply at investors' connections and build a model to approximate the trust

they display by using both structural and agency variables. Tasselli, Kilduff, and Menges (2015) link individual attitudes, behaviors, and outcomes in the organizational contexts. Furthermore, they underscore that understanding the structuring and evolution of social networks within organizations is intrinsically tied to understanding the psychology and intentions of individuals actively participating in these networks, highlighting the complex interplay between individual agency and network structures. They shed light on the micro-foundations of social networks and the indispensable connection between individual psychology and network sociology in organizational settings. We build a model based on dyadic relationships and construct an instrument to infer an observed behavior (deals) based on past investors' encounters. We specifically aim to uncover the factors that help build trust between investors and the effect that this trust has on them. Our model departs from the previous literature as we focus on networks of past social experience (education and professional activities) and simulate the communication of agents.

People tend to talk to each other. By speaking, they transmit information they either observed themselves or received from someone else. Without "friction," this process would continue, and everyone in a network of people would know everything about everybody. Yet, it appears that this is not quite the case. Alatas, Banerjee, Chandrasekhar, Hanna, and Olken (2016) study this phenomenon. In their paper, they aim to explain and simulate the information transmission process to identify the most important component of a network (i.e., a local leader) to implement policy more efficiently or develop research surveys at a lesser cost. Starting by asking people questions about their counterparts (i.e., asking the richest and poorest people they knew), they could aggregate information (adding kin relations) to end up with a complete network. While some people decided to report that they had no information on someone, it may be the case that they did have added information, implying that they did not trust the information they had or may be lying. This absence of reporting happened when an agent was, on average, five links away from another they were asked about.¹ The paper explains that not reporting is

¹There was no monetary motivation to misreport or act strategically.

explained by a degree of uncertainty about the initial information for the agent to be willing to report. Thus, information transmission mechanisms can facilitate or restrain information sharing. We adapt this model to introduce trust as a facilitator of transmission. Applying this model to our dataset, we study the effect of trust on deal-making.

To study the role of trust and information transmission, we opted to apply this model to startup deals and SPAC data as it is a setup that presents several key characteristics. A special-purpose acquisition company (or SPAC) is a publicly traded vehicle made only of cash. Its only goal is to act as a "blank check" built to merge with a private company (the target, a startup) (Berger, 2008). For a startup, this represents a way to go public without directly floating on the market. It guarantees the target company to raise capital without the risk of poor performance on IPO day and for the institution sponsoring the SPAC (Hale, 2007; Shiffman, 2015) as the entrusted money is invested. Yet, Okutan Nilsson (2018) analyze the structure and costs linked to a SPAC. He finds that even though some saw SPAC as a cheaper alternative to an IPO, there are still costs and risks of dilution absorbed by investors. Since cash out happens after completion of the deal, there are incentives for the management to take on a short-term view of the deal and maximize their profits rather than looking at long-term objectives.

SPAC investments are cyclical. After the last wave reached its peak in 2021, they have since been losing pace², as activities have been halted for many projected SPACs (which therefore did not get to merge), and as many realized SPACs had bad year³ or were delisted following poor performances⁴. Yet, since the first SPACs were created, their design has evolved noticeably. Indeed, they had to obey changes in regulations (i.e., the Penny Stock Reform Act (PSRA)), which aimed to provide more protection to shareholders (Murray, 2017; Castelli, 2009), while pricing remains an issue (Murray, 2012). Even though a sponsor's involvement in the firm governance can provide added long-term performance, there is still an observed decreased performance from deals settled as the 2-year deadline⁵ gets closer, compared to a deal forged earlier on (Dimitrova, 2017).

²<https://news.crunchbase.com/public/sec-spac-momentum-proposed-rule-change/>

³<https://news.crunchbase.com/business/terrible-spac-performers-stock-drop-lmnd/>

⁴<https://news.crunchbase.com/public/spac-merger-vc-backed-delisting-enjoy-lotz-crxt/>

⁵When a SPAC is made, if it doesn't close the deal with the target company within two years, then the SPAC will

SPAC investments also include a significant degree of secrecy, as the SPAC's sponsor, usually a well-known investor himself, selects a startup. Hence, this mechanism exhibits investors' trust in the person making the deal, the sponsor. We are particularly interested in the network perspective of this matter. Indeed, investors tend to have previous work or social interaction in their corporate or personal lives. Hence, it makes for an interesting setting to examine how and what similarity and network centrality dimensions influence trust building, leading to a joint SPAC investment.

In the following chapters, we introduce the theoretical frame that supports our research and present our hypotheses. We introduce our model, and test it with data gathered on startup deals and SPACs. Finally, we will discuss the results and consequences that our model exhibits.

THEORY AND HYPOTHESES

Information Transmission and Relative Dyadic Interaction

The basic model on which we build was first introduced by Degroot (1974). It depicts the consensus formation within a group of individual agents. Literature finds that concentrating decision power on a limited set of opinion leaders does not make for improved innovative global answers (Golub and Jackson, 2010). Indeed, it influences others' beliefs disproportionately, which hurts the formation of a rational consensus. Bramoullé, Kranton, and D'Amours (2014) study the question of network structure, identifying that a critical insight is that nodes exhibit some direct effect on other nodes and also indirect effects on different nodes, taking place via the network. They highlight that, on the one hand, an investor network allows for better information sharing when everyone is linked together. On the other hand, it does not contribute to information transmission when the network is split into clusters. Detemple, Rindisbacher, and Robertson (2020) find similar results regarding communication in networks for financial markets with a split equilibrium. Transfer of information allows ideas to flow. Johnson (1986) looks at Burt's innovation adoption model based on structural equivalence and finds that structurally equivalent actors tend to adopt innovations simultaneously.

be liquidated.

Our model is derived from two central propositions. We first state that an agent has some value which can be expressed as his/her centrality in a given network. This value will lead an agent to gain trust from its peers. Trust is a continuous value between $[0,1]$, where 0 is the extreme case where no trust is given to an agent, and 1 is the extreme case where an agent is seen by his peers as entirely trustworthy.

Another factor we consider is the difference in value (i.e., centrality) between agents. In that case, we believe that agents exhibit various levels of value and that this variation will directly induce a different allocation of trust among themselves. As a simplistic illustration of this phenomenon, in a world with only two nodes, a low-value and a high-value node, the low-value node is likely to grant high trust to nodes of equal or superior value and, therefore, assign maximal trust to the high-value node. In contrast, the high-value node would trust nobody in that setting as the other node is not of equal or superior value. We define this relation in hypothesis 1.

Hypothesis 1. Centrality difference in dyadic relationships leads to diminished (increased) levels of trust between investors when an investor observes directly a lower (higher) level of value than its own.

Social Capital and Trust

In our paper, we focus on social dimensions to explain the construction of trust. Social capital has already been used to describe startup/investor relationships and success. van Beuningen and Schmeets (2013) aggregate social capital indicators (participation and trust dimensions) into an index using structural equation modeling. They find validity in this index to predict well-being and health. We show that social dimensions can be used to build an index that describes different trust factors and explains subsequent link creation in the form of deal-making. We develop a composite trust index to measure trust between investors.

Literature has already made the link between agents' behavior and their networks. Faust (1988) finds that social status positions are revealed through interactions and showcase similar networking patterns. Gu, der Luo, and Liu (2019) look at VC networks to uncover their properties and factors influencing their evolution and find that elites act as bridges toward other groups.

Adding embeddedness to improve predictive power in modeling the network, the authors show the significance of elite cliques in small-world industrial networks. Haniffa, Hudaib, and Nawaz (2022) study the role of social capital in the success of SPACs. They find that structural, relational, and cognitive social capital contributes to the success of SPAC IPOs. Moreover, a decisive factor is the founder's social capital in attracting investors and achieving market success. Neumeier and Poncela-Casasnovas (2016) take a social network perspective to model entrepreneurial ecosystems. They find social boundaries related to venture type, support institutions, gender, and ethnicity. Ultimately, Pittz, White, and Zoller (2021) find that "dealmakers" shape entrepreneurial behavior, investor focus, and innovation in specific industry sectors. Using their connections made in multiple companies, they contribute to the network and drive entrepreneurial performance within a regional context. For our study, we aim more precisely to uncover the effects of investors according to their network position, behavior, and resulting trust.

Focusing on trust, studies find a strong effect linked to the network structure. Buskens (1998) studies the influence of network structures on trust levels in cooperative relations. He looks at the impact of network measures on trust levels and finds that they are, outdegree in particular, positively correlated with trust. Frey, Buskens, and Corten (2019) find that network embeddedness has mitigating effects on trust formation. Indeed, trust is facilitated when exchange partners are embedded in social structures that share information on past behavior. Wuebker, Hampl, and Wüstenhagen (2015) examine the joint influence of social ties and status hierarchies on venture capital investment decisions. They document the prevalence of personal ties compared to status in investment decision-making, with market structure and experience moderating the role of personal networks. Finally, Lusher, Robins, Pattison, and Lomi (2012) study the convergence of expressed and perceived trust relations within top management teams. They find differences in the structural logic underlying expressed and perceived trust relations. The authors highlight the importance of considering psychological mechanisms in trust relations within organizations, as people tend to overestimate the trust they get. We depart from those observations as we aim to uncover a direct effect of the trust itself on subsequent deal-making by investors. As we focus our

attention on studying relationships in the startup investment scene, we first want to test the effect trust (our estimator, a composite trust index) has on an investor deal-making (hypothesis 2.)

Hypothesis 2. Higher trust leads to an increased deal connection probability between investors at the individual level.

The SPAC Process

A particularity of the SPAC process is the need to acquire a target start-up. The selection and approval of a start-up contribute to the secrecy sentiment surrounding SPAC development, exhibiting the faith needed in the sponsor quality to identify and choose the target well. Cumming, Haß, and Schweizer (2014) study the selection process and highlight factors that influence SPAC approval probability. An increase in active investors (hedge funds and private equity funds) and big players (known and large underwriters) make for a significant adverse effect on the odds of the vote being accepted⁶. In contrast, increased voting rights by the SPAC management increase the likelihood of success, but market conditions remain predominant, and closure probability increases upward-trending markets. A more nuanced view is proposed by Kolb and Tykvová (2016) and Everhart and Amani (2020), characterizing acquired targets as often a sub-optimal choice to an IPO, thus offering a way out to go public, especially in time with volatile markets and low IPO activities such as the 2008 market crisis. Timing is crucial, Lakicevic, Shachmurove, and Vulcanovic (2014) give it as an essential success factor for the deal to go through.

If SPACs are particularly lucrative for the sponsor initiating the process, their impact on other stakeholders is not as straightforward. The spread is not that different between more classical IPOs and SPACs (Rodrigues and Stegemoller, 2014; Kim, Ko, Jun, and Song, 2020). Hence, the difference in return is explained by information scarcity. On the one hand, in the case of an IPO Jain and Kini (1994) find a positive relationship between performance exhibited by the public company and the retention of shares by founders/entrepreneurs. At the same time, the IPO prices do not play a significant role, exhibiting the importance of trust in the company by the proxy of its insiders. Krishnan, Ivanov, Masulis, and Singh (2011) find a positive impact of the

⁶This might be the case for situations of arbitrage on the SPAC liquidation

VC's reputation on a start-up going public and its performance post-IPO. On the other hand, focusing on the European market, Ignatyeva, Rauch, and Wahrenburg (2013) show that SPACs tend not to focus on a particular location regarding investors or target companies. A determinant factor in financial performance remains the choice of a strong target company. Boyer and Baigent (2008) provide a comparable view for the US market, highlighting that larger SPACs tend to show more value. While SPAC originated from the US, they are now used similarly throughout the globe (Schumacher, 2019).

Since SPAC deals are characterized by less publicly available information for investors compared to IPOs, we assume that it is crucial for potential SPAC investors to have preestablished trust in the SPAC sponsor. We want to focus on the pre-SPAC phase and test whether we can establish a relationship between the previously defined trust index and the propensity for an investor to partner with a sponsor to conduct SPAC deals. In that case, deals are driven by higher-status individuals (i.e., well-known VC investors). We formulate hypothesis 3 such as:

Hypothesis 3. Higher trust between investors leads to an increased SPAC connection probability when linking to higher-status investors.

Structure and Agency

We contribute directly to the structure-agency debate by providing practical elements by applying the trust index to a network of investors. Agency is described by Emirbayer and Mische (1998) as a complex, temporally embedded process of social engagement that draws from the past, is oriented towards the future, and focuses on the present. Emirbayer and Goodwin (1994) contend that network analysis offers a powerful way to describe social interactions, surpassing other structural perspectives that solely focus on categorical attributes of individuals and groups. Their work argues that network analysis often neglects or simplifies the role of human intention, motivation, and normative commitments in shaping social networks. In doing so, it does not fully explain how intentional actions contribute to social network formation, reproduction, and transformation. It underscores the importance of reconciling the structural aspects of network analysis with the agency-driven dynamics of human behavior and culture to provide a more holistic

explanation of social phenomena. We want to shed light on how investors' choices and behaviors impact the trust they generate for other investors to co-invest in their funding rounds or SPACS.

Some work has already been done to highlight the role of social capital in relationship building. Lee and Jones (2015) examine the relationship between social capital, network structures, and human agency for entrepreneurs. Sørheim (2003) use social capital theory to study investors' identification and evaluation of deals. They conclude that common ground is a needed precedent for long and trustful relationships. Pasquini, Robiolo, and Sarria Allende (2019) study matching in networks of startups and investors, showing that network distance can outweigh preferences for experience and education in matching. In our work, we build on those notions to separate the structural (centrality) and agency (similarity) impacts of networks.

The previous literature on the topic showcase that the last action (i.e., in term of commitments to investments) are building credibility (Sears, McLeod, Evert, and Payne, 2022) and that it's in their interest to maintain a high trust level so as not to sever a profitable relationship (Klabunde, 2015). In our work, we separate the structural (centrality) and agency (similarity) impacts of networks. We aim to decompose the role that various factors entering the construction of the trust index may have. Hence, we first split those effects between general centrality and general similarity⁷, which enter our index. Following the literature, we predict that shared experiences (agency variables) dominate more structural aspects of the network construction, and we expect that similarity will have a more substantial effect than centrality in predicting trust (H4.)

Hypothesis 4. General similarity plays a stronger role in trust-building than general centrality.

We further look in detail at the dimensions (career, education) that we study, as we want to decompose each factor's impact further. Studies have already covered the role of agency within a network framework. Halgin, Gopalakrishnan, and Borgatti (2015) explore workplace relationships in networked distributed work environments, focusing on the role of human agency, particularly work engagement, in forming necessary networks for success. They find that highly

⁷"General" is the denomination we take here for each factor composing the index and can be broken down themselves into each dimension such as career, board membership, and education.

engaged individuals successfully bridge global locations to improve work performance. In contrast, less engaged employees desire such ties but do not achieve them, emphasizing the role of motivation and agency associated with work engagement in networked work settings. Gulati and Srivastava (2014) introduce a conceptual framework where an actor's position within a social structure influences the resources available to them and shapes their motivations for action. They emphasize the need to move beyond simplistic structural explanations and explore the micro-foundations of agency within network dynamics. Finally, Domurath and Patzelt (2016) find that social ties positively affected generalized trust for entrepreneurs. For our study, we find agency at the level of human interactions, and we aim to highlight which effect is predominant. We predict that for investors, shared experience tends to have the most considerable impact, among other factors. Also, we expect that board members do not spend as much time together, are less involved with daily business, and exhibit less assiduity than colleagues. Thus, we foresee that career similarity dominates the similarity mix:

Hypothesis 5. Shared life experience in the form of career similarity is the biggest predictor of trust among other similarity factors (education, board member.)

Imprinting Ties

We lastly use our dataset to study the existence of imprinting ties that developed in the distant past and keep having an effect later on. The notion of imprinting ties is set in McEvily, Jaffee, and Tortoriello (2012) as they examine the temporal and historical conditions under which bridging ties from the past impact current organizational outcomes. Their findings contrast with the conventional view of the rapidly decaying effects of bridging ties. The authors demonstrate that bridging ties produce network benefits over an extended period, thereby having a long-lasting "imprinting" effect due to their creation at formative career stages. The literature also shows the existence of several factors entering the formation of ties. Zhang, Gupta, and Hallen (2017) examines the formation of multiparty venture capital syndicates and demonstrates that those syndicates are influenced by various group-level factors, revealing distinctions from dyadic syndication processes. McEvily and Zaheer (1999) propose that firms in geographic clusters with

diverse connections and ties to regional institutions have better access to valuable information and opportunities. The results highlight the link between a firm's network and its capability acquisition. Further on, the literature has shown that the existence of particular links carries an effect on their behavior. Ewens and Malenko (2020) investigate VC-backed startup boards, finding that independent directors play a critical role in mediating conflicts between VCs and entrepreneurs. When shared control emerges, these directors typically join after the second financing round.

In our case, we have information about shared experiences between investors at different life stages: we know which actors attended the same alma mater and graduated in the same subject area and year and were, hence, likely to have met as students. We also know which contacts worked at the same time and place for the same employer, making them work colleagues. Finally, we also know which contacts were part of the same board simultaneously, hence being board director colleagues. In this setting, centrality is affected by investors' early careers and education; we predict that such an effect of imprinting ties may arise and lead to initial experiences, such as education, being the predominant factor.

Hypothesis 6. Initial experience in the form of education centrality is the biggest predictor for trust among other centrality factors (career, board member.)

DATA AND METHODS

Data

We use data from SPAC Track⁸ to retrieve past SPACs operations. This dataset grants us access to information covering 979 deals that took place or were in preparation during the 1999-2019 period. Hence it provides critical information about sponsors, leaders, and the company they are working with. We also use the CrunchBase⁹ dataset to get information about investors, their networks, and past deals.

⁸<https://spactrack.io/>

⁹<https://www.crunchbase.com>

Model

We briefly present the model we estimate in our paper; for a more detailed explanation of the development of the model, see annex A. We use a network of investors i , with $i \in \mathbb{N}$, is described by its wealth w , with $w \in \mathbb{R}$ (here the investor centrality), and by its links in the network, modelled in a matrix $\mathbf{G}$. We want to estimate the trust that an investor attributes to another investor, which we write as:

$$\hat{\theta}_{ij} = \prod_{k=i+1}^j \frac{\log \min(w_i, \hat{v}_{k-1,k})}{\log w_i}$$

Where v is the estimated value that an investor attributes to other investors, with j the other investor and k any node in between, such that :

$$\hat{v}_{ij} = \hat{v}_{kj} + \epsilon |w_i - w_k| + \gamma$$

Given the size of our dataset (several hundred thousand investors), we have to adapt this initial model to keep computation within a reasonable time and computing power consumption. We use python, including networkx, pandas, dask, and igraph to make use of the parallelization options to reach this objective.

Burt (1988) studies different relation and pattern similarity measures in structural equivalence analysis. He finds better results from computing structural equivalence from path distance measures rather than binary choice data patterns. We take this approach and look at investors' paths in the network. Starting with our dataset, we build several graphs encompassing several investors' relationship types. We create a subgraph that covers relations from investors sharing the same job position at the same office as well as the length of this relationship (J), the same cohort for a degree, and the years together in their shared study track¹⁰ (D), and the number and magnitude of syndicated deals (G). Then, we compute applied values for w, v , and θ from our initial model, that we respectively rename as $\tilde{w}$, $\tilde{v}$, and $\tilde{\theta}$. We compound the centrality of each

¹⁰We collect this information whether the degree was obtained or not.

sub-network for a node as the proxy for his value in the network, thus we get:

$$\tilde{w} = \sqrt{\lambda_D * \lambda_J + \lambda_D + \lambda_J}$$

With λ_X , a vector of eigenvalues for nodes in the corresponding subgraph X . In our original model, we obtain $\tilde{v}$ by recursivity of observation. However, this does not scale well for a large dataset. Hence, we compute a similarity matrix as a proxy for this information. Global similarity, which we refer to as *sim*, is given by compounding the similarity matrices corresponding to different subgraphs, such as

$$\begin{aligned} \text{sim} &= \sqrt{\text{sim}_J * \text{sim}_D + \text{sim}_J + \text{sim}_D} \\ \tilde{v}_{ij} &= \begin{cases} (((\tilde{w}_j + 1)^2 - 1) / \tilde{w}_i) * \text{sim}, & \text{if } i \neq j. \\ \tilde{w}_j, & \text{if } i = j. \end{cases} \end{aligned} \quad (1)$$

Finally, $\tilde{\theta}$ is computed using $\tilde{w}$ and $\tilde{v}$, such that:

$$\tilde{\theta}_{ij} = \begin{cases} 1, & \text{if } \tilde{v}_{ij} / \tilde{w}_i > 1. \\ \tilde{v}_{ij} / \tilde{w}_i, & \text{otherwise.} \end{cases} \quad (2)$$

Insert Figure 1 about here

We visually represent the intuition behind this model in figure 1. In this straightforward case, information is broadcasted between high-value nodes, while the flow is cut as soon as it reaches the low-value node.

Variables

The *Composite trust index* (referred also as *theta*), is our valuation of trust between two individuals. More precisely, it is the value an individual assigns to his/her trust towards another

individual in the network.

*Education*¹¹ *centrality*, *Career*¹² *centrality*, and *Board Member*¹³ *centrality* are measures of the centrality of individuals in each respective network, computed as their eigencentrality. *Education*¹¹ *similarity*, *Career*¹² *similarity*, and *Board Member*¹² *similarity* are measures of similarity of individuals in each respective network, computed as their simRank similarity.

Deal connection, respectively *SPAC*¹⁴ *connection*, are boolean variables equal to one if a VC deal, respectively SPAC deal, was drafted in conjunction by two individuals. *Gender* is a boolean value equal to one if two individuals identify as the same gender.

RESULTS

We first want to test hypothesis 2. Hence, we regress the existence of a deal between two agents on our value of trust, theta. We use a Firth Logit regression (Firth, 1993) to compute our results.¹⁵

Insert Table 1 about here

Results are displayed in table 1. We observe a positive and significant coefficient for trust, at a value of 1.81, on the real deal-making between two agents. Such a positive relationship exhibits a clear impact of our measure of trust on deals, thus validating H2. This result could seem as not surprising; however, by looking solely at agents' centralities together, we don't find such a relationship (as displayed in appendix, table B1.) Hence, we interpret that this positive and significant coefficient on trust captures the impact of the relative level of trust, as defined in the construction of this indicator (H 1.)

¹¹For education, we use a weighted graph accounting for years spent together in class between two investors.

¹²For career, we use a weighted graph accounting for years spent together at work between two investors.

¹³For board membership, we use a weighted graph accounting for years spent together at a company's board between two investors.

¹⁴The variable that we use in that case is the collaboration of a person as a leader in the management team to a SPAC with another designated sponsor.

¹⁵Computations are done using the 'firthlogit' package in python, which is a 'sklearn' compatible package. It implements Firth Logit regression as previously defined in Heinze and Schemper (2002).

Insert Table 2 about here

We then turn to table 2 for results concerning SPAC deals. Here, we find a positive and significant coefficient for trust on SPAC collaboration¹⁶, with a value of 1.46. This is an indication that the measure of trust that we constructed contains information relevant to the (rare) occurrence of such deals, confirming H3.

Insert Table 3 about here

We then break down which factors enter the trust index and how they contribute to information transmission (table 3.) We see in columns (3) and (4) that similarity contributes more largely to the trust index than centrality, thereby confirming H4. We find in column (1) that the centrality index exhibiting the greatest impact ($9.7e+01$) is education, which confirms hypothesis 6. This shows that a strong positive effect of initial network position persists throughout an investor's career, originating from their alma mater. Finally, we find that the most potent factor tends to be career similarity, implying that shared experience working at the same company is the most critical factor contributing to trust (H5.)

DISCUSSION

We hypothesize and show that trust plays a positive role in decision-making around deal creation (H2). Indeed, an increase in trust explains a statistically significant share of deals. If this finding is intuitive, it is interesting to observe that it captures the relative role of value where a higher trust is granted to agents with greater value at the individual level. It also demonstrates that it is not sufficient for one actor to have a high absolute value, but value is perceived, and trust is created through the comparison of two actors. Specifically, we find that this proposed trust index relies significantly on the notion of relative value (H1). Indeed, the model expresses that each

¹⁶Given the relatively rare nature of SPAC deals, they exhibit a high degree of confidence in an investor's skills from the sponsor. This choice allows us to examine trust for an external person while the project is still in the making (i.e., the acquired company's identity is not public knowledge.)

actor's general behavior and knowledge are determined by choices originating at the dyad level, as agents evaluate themselves compared to each other. These findings further highlight how personal characteristics based on previous behaviors and accomplishments are a source of network connections, not only mere structure. Still, the network's shape plays a role in agents' trust building as it is based on a 1-to-1 comparison among themselves. Furthermore, this link still holds for data regarding SPAC deals (H3). Also, it is essential to note that from each social layer added to the model (i.e., studies, career experiences), some induce more potent effects on the aggregated index. Indeed, we find that initial education centrality (H6) drives trust creation, demonstrating the prevalence of shared experiences over less intense relationships. We subsequently observed that career similarity (H5) increases trust. While board members may have much in common, they do not exhibit the same assiduity in their relationship. Also, the fact that they are at a more advanced professional career phase than as students or employees may mean that a single contact has less significance and hence lesser imprinting on them than in early formative phases.

Our study makes several contributions about the mechanisms of network trust formation for deal-making. First and interestingly, it is not the absolute value of centrality that counts for investment decisions, but it is a relative evaluation. When it comes to attributing trust to investment decisions, the attribution does not happen solely based on an objective structurally advantageous position. It is based on the assessment of how similar or dissimilar the two parties are in their centrality positions. This trust then translates into a higher deal-making. Thinking about the consequences and practical implications of this finding, it helps us to understand the stickiness of investment constellations where actors of the same "centrality league" will make transactions but will be rather weary of investing with actors with a considerably higher or lower centrality.

Second, we tease out how much structural versus personal attributes matter for trust formation for joint investments. We show that for deal-making, overall similarity matters more than overall centrality. This is important since network research has traditionally emphasized the structural aspects (Powell, Koput, Smith-Doerr, and Owen-Smith, 1999) and advantages coming

with particular network positions. It is noteworthy that for investment decisions where actors make choices in a big, supposedly transparent marketspace that presents them with a great variety of investment options, personal characteristics that reveal similarities between investors play such an important role. In a wider context, these results also bear relevance for questions about the stickiness of the dominance of "old boys club" features (Kanze, Huang, Conley, and Higgins, 2018; Cullen and Perez-Truglia, 2019) in investing in general and in particular in asset management (Babalos, Caporale, and Philippas, 2013), VC (Aidis and Schillo, 2017; Balachandra, Briggs, Eddleston, and Brush, 2019), board membership positions (Agarwal, Qian, Reeb, and Sing, 2016; Solal and Snellman, 2019) and banking (Sahay and Cihak, 2018; Hospido, Laeven, and Lamo, 2019). The similarity of attributes such as schooling and joint working experience thereby serve as a signaling factor to inspire trustworthiness. Sharing these similar features may act as a counterforce to balance the anonymity of a marketplace with the reassurance of finding something familiar in the investment partners.

Finally, our work also highlights the importance of early ties. As McEvily et al. (2012) already showed, not all ties are equal. We find that early and direct exposure through joint work experiences (and schooling) has a long-term effect on trust formation, translating into investment decisions. Again, this longitudinal aspect contributes to a stickiness of investment constellations and points to the fact that outsiders who did not share these early tie-formation experiences will be disadvantaged.

Theoretical Implications

Our study contributes to the literature on network structure applied to investors' networks in several key ways. First, we determine that, even though statistically, absolute centrality does have an impact in aggregate, what matters most for trust between a pair of investors is the dyad level of relative centrality between them. Hence, trust is built partly by comparing and validating other individuals compared to oneself. It is thus interesting to find those results in a setting of investors while similar conclusions have been made in other domains. Namely, Elfenbein,

Eisenkraft, Curhan, and DiLalla (2017) finds that in the case of negotiation, the dyadic interaction effect makes for a large part of the variation in outcomes. Hong, Zhang, and Gajendran (2023) find that status disparity partly explains why an employee would not be seeking or giving help. Indeed, in their study, low-status employees would display more will to help but seek less help from other members. Tang, Lam, Kan, Huang, and Tse (2021) extend the case of dyadic interaction to triadic relations in leader-member exchanges. Using social comparison theory, they find that when members compare simultaneously and perceive others to hold a higher status than their own, they are more likely to increase their engagement and participation quality.

Second, by decomposing the impact of centrality and similarity, we find that the latter drives trust creation more strongly. This question contributes to the structure and agency debate (Emirbayer and Mische, 1998), as we find that structure is not the primary force directing trust in our study. Instead, it becomes clear that shared experiences are a cornerstone of trust and relationship building. Thus, agency effects lead investors to realize deals with a higher likelihood. This observation could also be, in part, the result of tie homophily, where investors would naturally be more likely to link with individuals closer to them regarding their own origins and personal activities (i.e., social or religious groups), which may coincide with the same education or career path. Choi (2023) observes the role of homophily in angel investing, concluding that similarity in background and education increases the odds of angels co-investing.

Third, we find that education and employee life/career development are prevalent phases of professional construction, which ultimately contribute to increased trust and subsequent deal-making. This could result from a form of certification effect (Megginson and Weiss, 1991) where individuals with higher status would benefit from a positive quality signal from their peers. We find that this relationship is only marginally influenced by other demographic factors such as gender, thus making it even more stringent that what truly matters are shared experiences to increase trust. This confirms the persistence of a form of imprinting (McEvily et al., 2012) leading individuals to allocate more trust to individuals with whom they shared past experiences and connections.

Practical Implications

A direct implication for agents is to boost their value. An agent should seek to develop their centrality by completing studies and working for companies that are breeding grounds for future investors. Having agents compare themselves to one another implies that, for example, a rookie investor would be wiser to seek deals with other young investors. At the same time, finding an agreement with a more seasoned player is more challenging as s/he will more easily turn down propositions as he/she allocates less trust to the newcomer.

As more central agents tend to interact with each other, this may lead to some first-mover advantage. Indeed, as a highly central node will remain highly central with a greater likelihood, it has an advantage over less central nodes in accumulating subsequent contacts/deals.

CONCLUSION

In this study, we show that people with close or equal value (here evaluated in network metrics) are more conducive of information sharing in an investor network. This helps us to understand how actors' would prefer to give their trust and be cautious of actors presenting value that is far from their own. We show that while structural network characteristics such as centrality matter, they matter especially on a relative level of the dyad for attracting investments.

Equally or more important than structural factors is similarity in terms of shared experiences in education, working for the same company, and board membership, which all matter to inspire trust for co-investments. Hence, actors benefit from revealing similarities in personal characteristics with other investors, as those features contribute to certifying them as trustworthy partners.

Early ties carry on and display long-term effects on trust formation, ultimately resulting in enhanced business opportunities. Individuals with higher trust assigned by their peers (as modeled by our composite trust index) tend to participate in more deals or SPACs. Therefore, we can conclude that agents in an investment environment are judged not only on their own value but also compared to their observing peers on a 1-to-1 basis.

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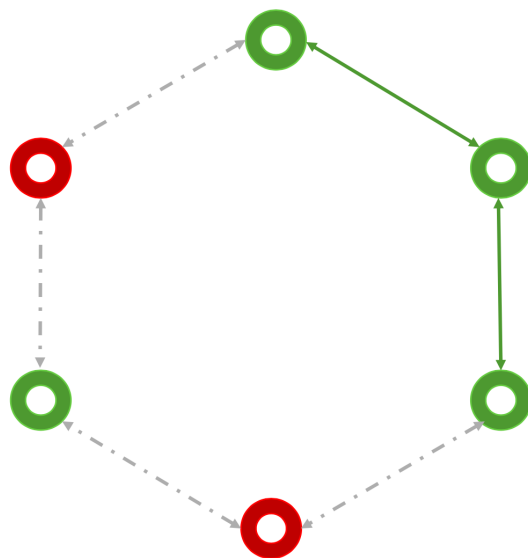


Figure 1
Broken flow of information between high-value nodes (green) and low-value nodes (red).

Table 1
Firth Logit regression of deal connection on trust.

Variable	Coefficient	Std. Error	[0.025	0.975]	p-value
Trust (θ)	1.81***	0.29	1.26	2.42	2.04×10^{-13}
Intercept	-4.90***	0.27	-5.48	-4.41	0
Model Information					
Log-Likelihood		-763.94			
Newton-Raphson Iterations		8			

Table 2
Firth Logit regression of SPAC connection on trust.

Variable	Coefficient	Std. Error	[0.025	0.975]	p-value
Trust (θ)	1.46**	0.55	0.44	2.67	0.0038
Intercept	-5.22***	0.48	-6.31	-4.37	4.49×10^{-142}
Model Information					
Log-Likelihood		-154.53			
Newton-Raphson Iterations		8			

Table 3

Regression of theta on similarity index, gender; education, career and board membership centrality.

	Theta (trust index)			
	(1)	(2)	(3)	(4)
Constant	3.8E-01*** (1.1E-02)	2.1E-01*** (1.2E-02)	1.2E-01*** (1.2E-02)	1.3E-01*** (1.1E-02)
Same gender	1.6E-01*** (1.2E-02)	2.3E-02* (1.2E-02)	9.5E-02*** (1.1E-02)	8.6E-02*** (1.1E-02)
Board member centrality	1.3E+00*** (5.7E-02)		9.9E-01*** (6.1E-02)	1.2E+00*** (5.5E-02)
Education centrality	9.7E+01*** (4.3E+00)		7.3E+01*** (4.3E+00)	8.6E+01*** (3.9E+00)
Career centrality	9.0E+00*** (3.5E-01)		8.3E+00*** (3.0E-01)	8.9E+00*** (3.4E-01)
Similarity index			1.4E+00*** (5.5E-02)	
Board member similarity		3.1E+02*** (2.6E+01)		2.4E+02*** (2.4E+01)
Education similarity		3.1E+02*** (4.5E+01)		1.6E+02*** (4.1E+01)
Career similarity		8.1E+02*** (3.1E+01)		8.0E+02*** (2.9E+01)
N	5424	5424	5424	5424
R2	0.15	0.16	0.26	0.28

APPENDIX A: THEORETICAL MODEL

Base Model

We first produce a simplified version of the Alatas et al. (2016) model, which we will modify further in this paper for our needs. The model consists initially of transmitting information from agent to agent, thus raising two cases: direct transmission (where an agent observes the information directly) and non-direct transmission (where an agent receives a signal on information through its network).

The framework we use is that of a network of agents. An agent i , with $i \in \mathbb{N}$, is described by its wealth w , with $w \in \mathbb{R}$; and by its links in the network, modeled in a matrix $\mathbf{G}$. Each entry g_{ij} corresponds to the existence of a link from i to j : that is: $g_{ij} = 1$ means that agent i knows agent j , it takes value 0 otherwise (with $\mathbf{G}$ a symmetric matrix).

- Direct transmission

In this first case, the agent receives "first-hand" information, as he can gather the data by observing it since he knows the other agent directly. Therefore, this is the case that applies to all person that maintains a link ($g_{ij} = 1$), where both agents observe directly the other agent's wealth.

The value of the observation is:

$$v_{ij} = w_j + \epsilon$$

With v_{ij} the value that agent i guess for the wealth of agent j , w_j the wealth of agent j , and ϵ some standard noise that appears on the wealth (as the agent can't perfectly observe the wealth of another agent).

Also, agent i assigns a quality status to the information he receives from agent j . In this case, since he observes the wealth directly, he sets the value: $\theta_{ij} = 1$, where θ_{ij} can be seen as the trust that i put on the information he has on j .

- Indirect transmission

In the indirect case, the agent receives information that has transited in the network

through a set of other agents and thus cannot observe wealth directly; instead, he gets a signal of it. Then the value an agent i assigns to an agent j is:

$$v_{ij} = v_{kj} + \epsilon$$

Here, we find v_{ij} recursively, as v_{kj} is the value that agent k (the closest agent to i on the path to j) assigns to agent j . We see that, as one agent is more distant from another, the noise on the signal grows, and the quality becomes automatically weaker.

The quality status is now computed recursively on a measure of the relative wealth of each agent compared to the agent gathering the information. It exhibits the trust that he's putting in the quality of the data.

$$\theta_{ij} = \prod_{k=i+1}^j \frac{\log \min(w_i, v_{k-1,k})}{\log w_i}$$

The trust index θ is thus calculated using the ratio of logs of wealth. We take the minimum of the agent i 's wealth and of the agent k 's wealth such that an agent shows equal trust in someone with equal or superior wealth and exhibits less trust in an agent with lower wealth.

The result we get out of those computations is a square matrix of known information, $\mathbf{X}$, where an entry, x_{ij} , corresponds to the amount, if any, an agent i is associating to the wealth he thinks corresponds to agent j and is defined as:

$$x_{ij} = v_{ij} \times \mathbb{1}_{\theta_{ij} > 0.5}$$

In this setting, we can set an arbitrary threshold and define that an agent trusts another if his level of trust toward another agent, θ is above 0.5. To illustrate this model, we use Mathematica to observe how people would report information in the canonical form of networks under our simple assumptions.

Intuitions

Star network. Networks under a star form (as in figure A1) are generally stable, yet we can see that the results vary in how information is sent.

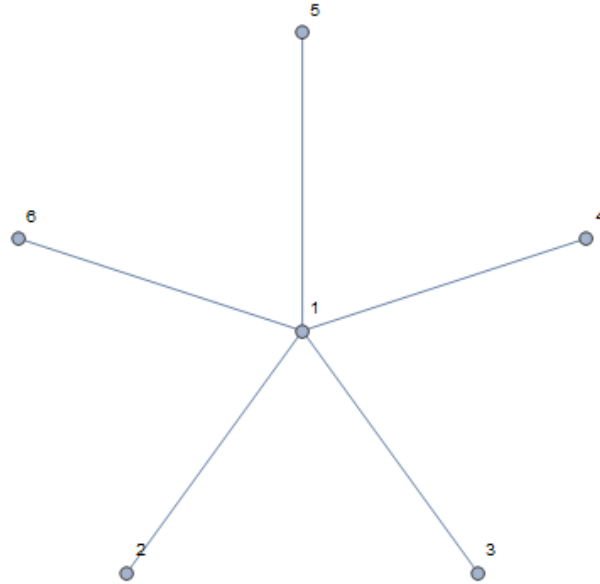


Figure A1
Star Network

We distinguish 3 cases: a low-wealth central agent (i), low-wealth external agents with a richer central agent (ii), and only similar wealth agents through the whole network (iii).

For each of them, the wealth is defined as:

$$w^{(i)} = \{2, 9, 9, 9, 9, 9\}$$

$$w^{(ii)} = \{9, 2, 9, 9, 9, 9\}$$

$$w^{(iii)} = \{9, 9, 9, 9, 9, 9\}$$

For case (i), we observe an extreme situation where the central agent (agent 1) knows perfect information on everybody. Still, other agents don't want to report anything (except agent 1's value that they observe directly) as they see him as having a wealth too low to be worthy of

conveying the information.

$$\theta^{(i)} = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

$$X^{(i)} = \begin{pmatrix} 2 & 9.6 & 8.3 & 9.5 & 8.4 & 9.2 \\ 1.5 & 9 & 0 & 0 & 0 & 0 \\ 2.1 & 0 & 9 & 0 & 0 & 0 \\ 2.0 & 0 & 0 & 9 & 0 & 0 \\ 1.4 & 0 & 0 & 0 & 9 & 0 \\ 2.9 & 0 & 0 & 0 & 0 & 9 \end{pmatrix}$$

Indeed, in $\theta^{(i)}$ and $X^{(i)}$, we can observe that agents all perfectly know their value, and the value of agent 1 with some noise, yet agent 1 is the only one that is confident enough on information he has on every other agent (as in this model he is poorer which makes him likely to trust equal/higher wealth agents) to report their wealth.

This case is the exact opposite of case (iii). In this case, we can observe that all agents have the same wealth, therefore that all have a good level of trust toward each other, resulting in the following matrix:

$$X^{(iii)} = \begin{pmatrix} 9 & 9.8 & 9.2 & 9.2 & 8.0 & 8.2 \\ 8.9 & 9 & 7.3 & 9.6 & 7.0 & 9.0 \\ 9.9 & 8.3 & 9 & 9.2 & 8.4 & 8.8 \\ 8.4 & 9.2 & 7.4 & 9 & 8.5 & 9.7 \\ 8.9 & 7.6 & 9.3 & 9.1 & 9 & 8.8 \\ 9.4 & 8.3 & 9.5 & 10.7 & 9.8 & 9 \end{pmatrix}$$

It is clear that all agents have information that is somewhat close to the true level of wealth of the other agents (depending on the noise during the transmission). To conclude on this network form, we see in case (ii) that the effect of an external agent with low wealth is limited :

$$X^{(ii)} = \begin{pmatrix} 9 & 2.9 & 9.6 & 9.6 & 9.1 & 8.0 \\ 8.8 & 2 & 1.5 & 0.6 & 3.4 & 1.9 \\ 8.4 & 0 & 9 & 8.1 & 7.7 & 8.6 \\ 8.1 & 0 & 9.8 & 9 & 9.5 & 9.3 \\ 9.9 & 0 & 9.5 & 10 & 9 & 9.7 \\ 8.3 & 0 & 9.9 & 9.8 & 10 & 9 \end{pmatrix}$$

Indeed, we see that agent 2 receives a signal from other agents that he is willing to report. Other agents are receiving a signal from agent 2 but are unwilling to report it (except the central agent).

Circle network. A circle is a simple form where each node has two connections (figure A2). Here we observe two settings, the first with one low-wealth agent and other agents with similar wealth (iv), and the second with only agents of similar wealth (v).

We operate as previously, from the two wealth vectors:

$$w^{(iv)} = \{2, 9, 9, 9, 9, 9\}$$

In this case, we obtain that a single low-wealth agent (here agent 1) has an impact on many

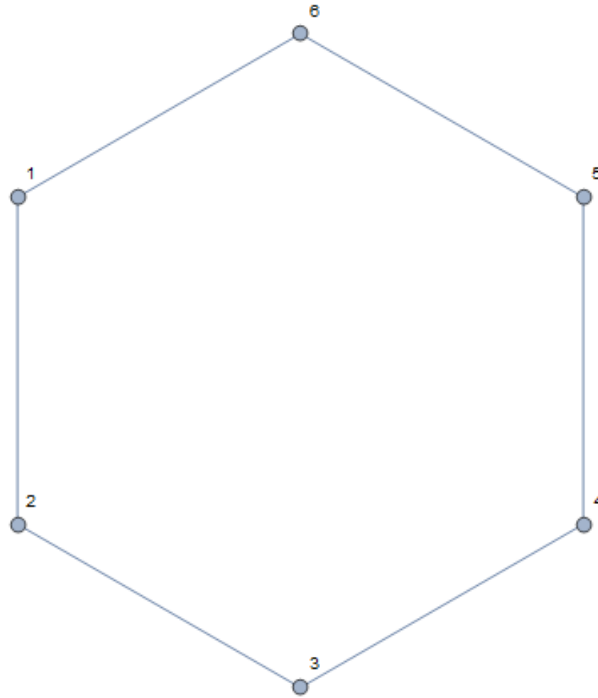


Figure A2
Circle Network

other agents' valuation:

$$X^{(iv)} = \begin{pmatrix} 2 & 9.2 & 1.7 & 2.9 & 1.9 & 8.0 \\ 1.8 & 9 & 9.3 & 0 & 0 & 10.3 \\ 0 & 8.7 & 9 & 8.2 & 0 & 0 \\ 0 & 0 & 8.5 & 9 & 8.0 & 0 \\ 0 & 7.1 & 0 & 8.6 & 9 & 8.8 \\ 2.8 & 10.1 & 0 & 0 & 8.2 & 9 \end{pmatrix}$$

Indeed, in that case, the low-wealth agent has information of good quality that he is willing to report. But he also "breaks" the chain of transmission. His presence in the loop assigns a low-quality signal in addition to the noise. Consequently, some agents perceive the signal quality as too low and stop transmission.

The following case of similar wealth among agents is trivial :

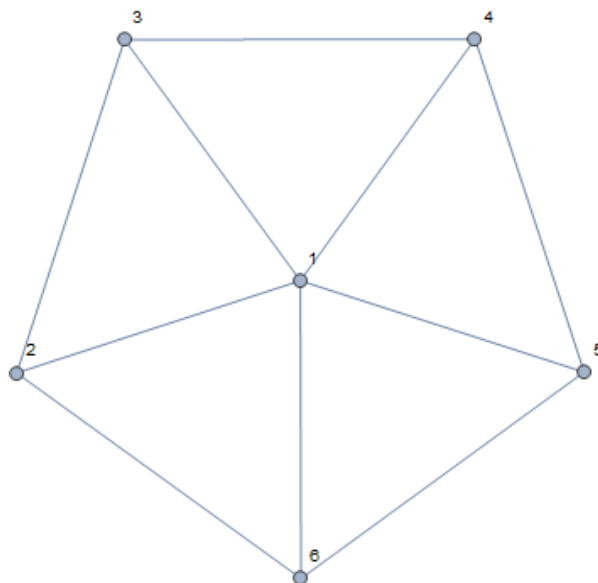


Figure A3
Wheel Network

$$w_{(iv)} = \{9, 9, 9, 9, 9, 9\}$$

$$X^{(v)} = \begin{pmatrix} 9 & 8.3 & 8.9 & 10.4 & 7.3 & 8.7 \\ 9.9 & 9 & 9.5 & 8.3 & 9.4 & 10.1 \\ 9.0 & 9.7 & 9 & 9.7 & 9.2 & 8.2 \\ 10.7 & 8.6 & 8.0 & 9 & 8.5 & 9.6 \\ 7.3 & 8.6 & 9.0 & 8.7 & 9 & 9.8 \\ 8.8 & 8.2 & 8.3 & 10.0 & 9.4 & 9 \end{pmatrix}$$

Indeed, as we could expect, here we observe that the signal circulates perfectly through the circle. Everyone would be perfectly informed if it were not for the noise.

Wheel network. The wheel can be seen as a mix of star and circle networks (figure A3). Hence we find four major cases: a central low-wealth agent with a low-wealth exterior agent (vi) or with similar wealth exterior agents (vii), an exterior low-wealth agent with all other agents presenting similar wealth (viii), and a network with only agent holding similar wealth(ix).

Given the very nature of this form, the results are as expected in case (ix); the information is perfectly carried, as well in case (vii) and (viii); we obtain the results of a usual circle and star, respectively. Thus we focus on the only case that differs from those simple cases, case (vi).

$$w^{(vi)} = \{2, 2, 9, 9, 9, 9\}$$

In this case, the center of the wheel (agent 1) in figure A3 and an exterior agent (agent 2) both present a lower value than the rest of the agents.

$$X^{(vi)} = \begin{pmatrix} 2 & 1.5 & 8.9 & 8.1 & 8.9 & 8.9 \\ 1.5 & 2 & 8.1 & 2.0 & 2.5 & 8.5 \\ 2.5 & 1.0 & 9 & 8.1 & 0 & 0 \\ 2.8 & 0 & 8.7 & 9 & 8.9 & 0 \\ 2.6 & 0 & 0 & 9.1 & 9 & 8.3 \\ 1.3 & 1.2 & 0 & 0 & 8.4 & 9 \end{pmatrix}$$

We see that though limited, this low wealth of those two agents have an impact on the reporting of other agents (as in case (iv), this boils down to the same representation of a "broken" circle).

Results. We observe that when wealth is equal (absence of friction in our model), the status of value can transit through the whole network. At the same time, it stops more or less rapidly when wealth is heterogeneous (presence of more friction). For example, two groups of respectively equal wealth agents could be linked together and still have no information on one another if the node connecting them is an individual with meager wealth - as they are not willing to trust him. We can see that the choice of the agent not to transmit information may well be a rational choice as he associates too little trust with it.

Introducing Endogeneity

This simple model introduced earlier is limited in the fact that agents don't face many choices and mechanically apply the threshold allowing them to transmit information. Therefore, we want to refine this simple model and introduce new features to make it more relevant and allow the agent to maximize its utility under constraints. The model is re-framed, starting with the transmission of information. As previously, in the case of direct observation, the agent can see an altered value close to the actual state of the world:

$$\hat{v}_{ij} = w_j + \epsilon |w_i - w_j| + \gamma$$

Now the assigned value is sensitive to a noise that is dependent on the difference in wealth: people with the same wealth are more likely to assess the value of each other correctly; γ being a slight noise that applies to every observation.

Similarly, for indirect observation, we get :

$$\hat{v}_{ij} = \hat{v}_{kj} + \epsilon |w_i - w_k| + \gamma$$

Again, the calculation happens recursively, and the agent i receives its information from k (that is the case as agent k is himself willing to transmit the information he holds).

The status of quality is calculated in the same manner as previously, incorporating the new definition of the value. For direct observation, we still have the following that: $\hat{\theta}_{ij} = 1$. While for indirect observations, we have that :

$$\hat{\theta}_{ij} = \prod_{k=i+1}^j \frac{\log \min(w_i, \hat{v}_{k-1,k})}{\log w_i}$$

In this setting, the agent wants to take an action that is either to transmit information ("T") or not ("N"), such that the solution space is $z \in \{N, T\}$.

He does so to minimize its loss in case of a false report, in the following way:

$$L(z) = \begin{cases} L(N) = c & c \in \mathbb{R} \\ L(T) = (\hat{v}_{ij} - w_j)^2 \end{cases}$$

Hence, we find that the loss function corresponds to the following:

$$L(z) = c \times \mathbb{1}^{z=N} + (\hat{v}_{ij} - w_j)^2 \times \mathbb{1}^{z=T}$$

Given that the agent can't know the true wealth of an agent other than himself, he evaluates:

$$L(z) = c \times \mathbb{1}^{z=N} + (\hat{v}_{ij} - \mathbb{E}(w_j | \hat{v}_{ij}, \theta_{ij}))^2 \times \mathbb{1}^{z=T}$$

So the agent will optimize its choice z given the loss function $L(z)$ and the parameters $\{c, \hat{v}_{ij}, \theta_{ij}\}$, and do so for any agent j .

Implications. Our theoretical model presents several exciting features. For conciseness, we offer a summary of those intuitions. We suspect that $\mathbb{E}(w_j | \hat{v}_{ij}, \theta_{ij})$ is the rational agent expectation that tends to a number close to w_j as the quality of the signal, θ , increase.

We can then infer that:

- As c increases, so does the chance of playing "T": as the cost of non-reporting increases, it becomes more interesting to report even low-quality information. The agent will transmit any information for $c \rightarrow \infty$.
- As c decrease, the reverse hold, and the agent is less likely to report its information: an extreme case is for $c = 0$ where the agent has no incentives to report anything and will play "N" whatever the signal and its quality.
- As θ_{ij} increases, the agent is more likely to report its information since he is more confident in the quality of what he knows/received.
- As θ_{ij} decreases, the agent is less likely to report its information, up to a point where he

doesn't report anything (as it becomes too risky to report virtually worthless information).

As a consequence of our theoretical findings, we can formulate the following interpretation regarding agents' behavior in society:

- **A single agent can substantially affect transmission** (for example, the center of a star).
If all information someone receives is delivered by someone to whom he assigns a poor trust rating, the data are likely graded as noisy/bad signals.
- **If agents form a constant chain of persons with similar values, the message can be transmitted far in the network.** For example, information can flow perfectly in a circle through a network of equal wealth agents. This can be seen as homophily, and thus this cohesion allows stronger ties to be made: making the information more likely to be transmitted in a tied group rather than a group of heterogeneous people (here, for simplicity, defined by solely their value).
- **The shortest path isn't necessarily the preferred route.** Indeed, a longer path may be the one with "more trust" if agents forming it are more trustworthy, and thus, this information will be preferred to the one transiting through a shorter path that would present less quality of trust.

Those are general findings that can be tested in more specific setups to exhibit differences in value's impact on actions in a network.

APPENDIX B: ADDITIONAL CENTRALITY RESULT

Table B1

Regression of deal centrality on education, career and board membership centrality. Deal centrality is measured as the eigencentrality of the investor in the network of occurred deals; education and career centrality are measured respectively as the eigencentrality of the investor in the network of previous schools attended, and professional positions he held.

	Deal centrality		SPAC Centrality
	(1)	(2)	
Board member centrality	7.6E-02* (4.1E-02)		2.0E-02 (5.6E-02)
Education centrality	3.1E-01 (2.7E-01)	3.1E-01 (8.1E-01)	-1.2E+00 (3.9E+00)
Career centrality	2.3E-01*** (4.3E-02)	2.3E-01* (1.2E-01)	1.9E-01 (3.2E-01)
Gender	2.0E-02*** (1.2E-03)	2.0E-02*** (1.3E-03)	9.9E-03*** (3.6E-03)
N	730	730	287
R2	0.35	0.34	0.03

Intertemporal Connections and Entrepreneurship

Intertemporal connections and Entrepreneurship:
A longitudinal network study of French
biotech startups

INTRODUCTION

Entrepreneurial networks refer to entrepreneurs' social relationships and connections with other individuals and organizations. These networks can be instrumental in providing access to resources, information, and support that can facilitate the success of an entrepreneurial venture (Aldrich and Zimmer, 1986). Research has shown that the structure and composition of an entrepreneur's network can significantly impact their ability to start and grow a successful business (Mason and Brown, 2014). Entrepreneurs with a diverse network with ties to various sources of information and resources are more likely to have access to the knowledge and resources needed to identify and pursue new opportunities (Burt, 1992; Baker and Nelson, 2005). Entrepreneurs can benefit from their network position in various ways, depending on the type of links they have. For example, entrepreneurs with access to advisors and mentors within their network receive valuable advice and guidance on matters related to their business (Frederick, O'Connor, and Kuratko, 2016). On the other hand, friendship networks can provide emotional support and a sense of belonging for entrepreneurs, who often face significant challenges and uncertainty in the early stages of their ventures (Shane, Locke, and Collins, 2003).

The evolution of the network is conditioned by the individual actions of each of its members. This phenomenon and the parallel of an evolving network is described by Neergaard and Leitch (2015). This paper aims to analyze the evolving relationships built by entrepreneurs in the biotechnology sector in France, using a unique dataset on entrepreneur interpersonal ties. We focus on a mature European market that can rely on a solid fabric of research centers and an accessible offer of university education. The paper focuses on the ties entrepreneurs create as they develop their companies and progress in their careers during the following years.

We develop this study around two consecutive phases of "exploration-exploitation" (March, 1991; Gupta, Smith, and Shalley, 2006). Indeed, in the initial phase, entrepreneurs would seek to create new connections. It has been observed that entrepreneurs' networks tend to evolve and change over time as their businesses grow and mature (Aldrich and Fiol, 1994). Studies have

found that entrepreneurs may intentionally seek out new network connections to access specific resources or knowledge they require while developing their business (Frederick et al., 2016). Later on, those created connections can be used by entrepreneurs to develop. The literature states that startups' networking and alliances-making at their foundation can lead to differences in their early performance (Baum, Calabrese, and Silverman, 2000) and survival rate (Bruderl and Preisendorfer, 1998; Rank, 2014). Evidence suggests that entrepreneurs' networks can significantly impact the performance of their startups. Social capital can positively affect the performance of entrepreneurial firms (Lin, 2001), and it can also play a role in the development of entrepreneurial ventures (Nahapiet, 2000). Entrepreneurs with strong networks are more likely to have access to potential customers, partners, and investors, which can facilitate the development and growth of their ventures (Elfring and Hulsink, 2003). Hite (2005) shows that network ties allow for identifying opportunities and acquiring resources. Hence, controlling relationally embedded links has strategic implications for new businesses. However, tie types can spread ideas differently.

We want to test whether, as their network evolves, entrepreneurs can extract value from their position and if their conferred social capital and influence appear as a resource that they can then use to foster the development of their firm. In particular, we look at the relationships built through time on their entrepreneurial journey. Relationships are described as following the type of "friend" or "advice," thus adding a social component to the network. Gibbons (2004) established that friendship should facilitate the development of professional values, while advice links are less likely to transmit changes in values. Therefore, we look for insights originating from the entrepreneur's background to the evolution of its network and the impacts it has on their companies' trajectories and performance. We find evidence of the prevalence of strong social ties, of renewing links with fitting partners, and show the relevance of those links carried over time for the startup's fundraising campaigns. We use a unique dataset and financial metrics from leading industry data providers. Thus, we dispose of a longitudinal dataset that allows us to uncover movement at the entrepreneur and startup levels. Having an original dataset laying the

social relationship between entrepreneurs, we focus on the two described dimensions of exploration-exploitation. First, we explore the impact of diversity on link creation between agents and value creation for the company. We want to estimate the effects of having diverse counterparts for an entrepreneur. Then, we study the impact of an entrepreneur's network alteration and the changes he's going through with time, namely losing or creating new links or changing a relation type with an existing connection. Here, we want to explore the impact of network renewal and change in the kind of relationship for creating value for the company. In the following sections, we develop our hypotheses based. We then elaborate on the methods we employ before presenting our findings and discussing the impact those findings have from a theoretical and practical perspective.

THEORY AND HYPOTHESES

Corporate connections

Interpersonal connections play a significant role in forming and developing entrepreneurial ventures. The literature suggests that interpersonal networks are an essential aspect of entrepreneurship, as they facilitate the exchange of resources and knowledge between organizations (Ahuja, 2000). As startups evolve, entrepreneurs develop industry-wide networks (Marion, Eddleston, Friar, and Deeds, 2015). Those connections may arise from business contacts and friendship ties, contributing to the company's success and performance as it helps them expand and develop new products. Therefore, networks are used to access resources and ideas.

Kaish and Gilad (1991) finds that entrepreneurs are less likely to use obvious business sources and media and more likely to use non-business and untraditional sources to expose themselves to opportunities. They conclude that entrepreneurs exhibit more general alertness than managers by spending more non-business time searching for prospects and ideas. Concerning resources, Jing Zhang, Soh, and Wong (2010) studies indirect ties between entrepreneurs and resource owners through a referrer. They find that information asymmetry issues vanish as they share existing knowledge of the venture's products. This allows for more accurate venture

valuation and enhances resource acquisition possibilities. Wesley II, Kong, Lubojacky, Kim Saxton, and Saxton (2022) show that the relationship between resource providers' investment propensity and venture evaluation is stronger among founders without investing experience (i.e., non-investor founders) than investors without founding experience (i.e., non-founder investors) (or among investors with founding experience than those without founding experience). And finally that resource providers' venture evaluation is positively related to their willingness to provide financial and social resources to support the new venture under evaluation.

However, it is also important to note that entrepreneurial networks are complex and dynamic, and the nature of these relationships can impact their early performance (Baum et al., 2000). Stam, Arzlanian, and Elfring (2014) find a positive and substantial connection between entrepreneurs' networks and small company performance. They found that network diversity had the most beneficial impact on performance, whereas weak ties had smaller effect sizes than structural holes. They also find that the relationship between social capital and performance depends on the age of small businesses, with young firms benefiting from weak ties. In contrast, stronger ties would help older firms.

Types and power of ties

If ties can benefit actors in transmitting information and resources, their constitution and shape vary. Their type and content can hold different effects; indeed, the network's social capital dimensions (structural, cognitive, or relational) significantly affect knowledge transfer (Inkpen and Tsang, 2005). For example, Gómez-Solórzano, Tortoriello, and Soda (2019) exhibit that affective ties can lead to increased innovation. Indeed, they observe that embedded relationships matter for innovative performance. Yet this can backfire since innovative performance declines when inventors combine embedded instrumental ties with embedded affective ties. Engel, Kaandorp, and Elfring (2017) show that entrepreneurs do not necessarily exercise conscious choice about their networking activities. Instead, they describe a dynamic networking process that develops with initiatives to launch a new business. But the strength of a relationship is also

relevant while networking (Omar, Higgs, Shiau Wei, and Ali, 2020). The argument is that ties' strength involves "strong intimacy and high emotional attachment" and trust. It is also driven by the tie's human capital, making for most network relationships' content. They conclude that for ties to increase in strength, they could require entrepreneurs to screen the attitudes of ties.

Therefore, network structure affects its transmission role. Gibbons (2004) show that, on the one hand, advice networks support the company's current professional ideals and are less likely to spread new ones. On the other hand, friendship ties can aid in forming new professional values based on closeness and trust. However, they find that friendship networks can provide added support, but the relationship isn't as clear-cut. Those effects can have lasting impacts, de Jong and Marsili (2015) find no significant relationship between close-tie inspiration and post-entry survival. Still, start-up founders' inspiration by close entrepreneurial ties is related positively to post-entry survival if they started by taking over an existing business.

Social capital

The literature on social capital and entrepreneurship highlights the importance of network activities and relationships in starting and growing a business. An initial effect is found in the constitution of the startup from academic entrepreneurs or looking at initial investors. Mosey and Wright (2007) explore the relationship between human capital and social capital in academic entrepreneurs and find that entrepreneurs with prior business ownership experience have broader social networks and are more effective in developing network ties. However, less experienced entrepreneurs may encounter structural holes between their scientific research and industry networks, making building relationships with industry partners challenging. Zhang, Souitaris, Soh, and Wong (2008) studies networking for initial investors, looking more precisely at the entrepreneur's human capital dimensions. They highlight that the previous occupational status of entrepreneurs is positively correlated with their propensity to use existing networks when approaching initial investors. They find that the similarity of the industrial sectors between entrepreneurs' prior employment and their new ventures is positively correlated with their

propensity to use existing networks when approaching initial investors. However, they also document that prior work experience of entrepreneurs in marketing or business management reduces the positive impact of occupational status and industrial experience on the probability of network utilization.

Then social capital impact may vary according to the company's development and influence its survival. Greve and Salaff (2003) examine the network activities of entrepreneurs in different countries and phases of establishing a firm and found that entrepreneurs build networks that vary systematically by stage of entrepreneurship and that family members are present in their networks throughout all phases. These studies demonstrate that developing social capital and network activities is crucial for entrepreneurs to take advantage of opportunities and successfully enter the market. Kleinhempel, Beugelsdijk, and Klasing (2022) studies the impact of social capital on an entrepreneur's initial interest in starting a company and its survival. They find a positive significant effect of regional social capital on the likelihood that individuals have advanced beyond the pre-establishment stage to higher engagement levels by formally starting a venture. But they don't isolate any significant effects of regional social capital when comparing the likelihood of growing from a young venture to an established company.

Hypotheses

Diversity of links First, we want to answer the question: How does an entrepreneur's background impact their networking and subsequent companies' performances? There exists a significant effect of homophily ties which lead to endogenous tie formation (i.e., through reciprocity, transitivity, preferential attachment) (An, 2022) and company creation (Nann, Krauss, Schober, Gloor, Fischbach, and Führes, 2010). Bi, Boh, and Christopoulos (2021) showed that entrepreneurs tend to display more trust toward another entrepreneur. Ter Wal (2014) find that while the direct influence of distance on tie creation declines, inventors increasingly rely on network resources by connecting to partners of partners. The paper shows that triadic closure strengthens the geographic distance effect by completing triads among nearby innovators. Later

on, it develops into a more potent tool for creating cooperation relationships across greater distances.

We test the impact of the diversity of entrepreneurs on their fundraising capacities (H1 to H3).

Gender disparity in funding for female entrepreneurs is a well-documented issue. In the context of startup funding, Greenberg and Mollick (2017) found that female founders are more successful due to "activist choice homophily" based on shared structural barriers stemming from a common social identity. However, Kanze, Huang, Conley, and Tory Higgins (2018) identified a gender bias in the questions investors pose to entrepreneurs. Investors tend to ask male entrepreneurs promotion-focused questions and female entrepreneurs prevention-focused questions, leading to divergent funding outcomes.

Regarding their career development, Kirchmeyer (1998) studies the effects of gender on professional success. They find that if experience and tenure had more substantial effects on progression and perceived success for men than for women, having a professional degree at the same level was more significant for women. They also exhibit that having a mentor had stronger effects on men's progression than women's. Finally, they document no differential effect of the family variables on career success. Woehler, Cullen-Lester, Porter, and Frear (2021) also aims to understand the relationship between gender and network in career trajectories. They isolate two mechanisms: differences in career success originate from either different network characteristics or different returns on those characteristics. They find that men's and women's networks appear to have a similar structure but differ in composition. They highlight that the proportion of same-gender contacts in men's and women's successfully mobilized networks appears to contribute to career inequality through differences in network characteristics. They conclude that, on the one hand, men actors tend to benefit more than women from the same degree of general network openness and contact status. On the other hand, women tend to benefit more from their contacts' general network openness.

In venture capital, women have made progress in attracting funding, but there is still a significant gender gap (Brush, Greene, Balachandra, and Davis, 2018). Veer and Bringmann

(2021) found that startups with female CEOs receive significantly lower valuations than firms with male CEOs after controlling for a wide range of startup characteristics. They suggest that the role congruity theory may explain the gender bias in VC deals and that self-initiation and negotiation experience may moderate this bias. Milanov, Justo, and Bradley (2015) examine the impact of between and within gender differences on their company's performance and find a positive link with the presence of experienced female authority for other female members. They estimate that the number of within-group ties positively influenced microcredit entrepreneurs' performance, but the relationship was more positive for male entrepreneurs. On the individual level, prior industry experience reinforced the relationship and at least partially compensated for the status deficit of experienced females compared to their non-experienced counterparts. On the group level, the presence of a female loan officer positively reinforced the effect of the number of within-group ties on performance.

This disparity could explain differences in behavior and outcomes. Cromie and Birley (1992) dig into the existence of gender-related issues and how they may be linked to networking activities. They find that women tend to be less active networkers, have less dense networks, are inclined toward discussing with other women, and focus on family members as their most important contacts. Subsequently, they find that female personal contact networks are as diverse as men regarding the nature of their employment and the relationship. However, females tend to rely heavily upon a male colleague as their prime contact but then revert to their sex for other activities. Lerner, Brush, and Hisrich (1997) studies the factors of success for women-led businesses. They find a positive effect of motivations, goals, network affiliation, related occupational experience, and business skills on business performance; they also show that social learning negatively affects performance.

The literature on gender disparities in funding for female entrepreneurs highlights a range of issues, including activist choice homophily, gender bias in investor questions, and lower valuations for startups with female CEOs; hence we first want to study the role of gender and its impact on fundraising (H1).

Hypothesis 1 (H1) *Having more diverse (gender) counterparts affects fundraising.*

The literature also looks at broader aspects of diversity. Wise, Yeganegi, and Laplume (2022) investigate the impact of ethnic diversity on startup fundraising. The study finds that startup team ethnic diversity is positively associated with the aggregate amount of investment capital startups raise. The authors suggest that "diversity as advantage" theories may be more appropriate for theorizing about startup fundraising than "diversity as disadvantage" theories.

Gimenez-Fernandez, Bogers, and Sandulli (2019) examine the relationship between the diversity of cooperation partners and startups' innovation performance. The study finds that startups benefit more from cooperation breadth than incumbent firms, and the effect is more substantial for high-tech startups. The authors conclude that the range of cooperation partners is essential in knowledge exploration and exploitation in startups. D'Acunto, Tate, and Yang (2021) use employer-employee linked data to track the employment histories of team members before startup formation. The study finds that startups with diverse collective skill sets grow faster than peer firms in the same industries and local economies. A one standard deviation increase in teams' skill diversity is associated with an increase in five-year employment and sales growth.

These findings point towards the benefits of diversity in startup teams, challenging the notion of diversity as a disadvantage and underscoring its potential as a competitive advantage. Our study looks at the impact of having a diverse network regarding initial training.

Hypothesis 2 (H2) *Having more diverse (initial training) counterparts affects fundraising.*

Finally, another factor could be that founders are behaving differently. Hsu (2007) explores the relationship between prior entrepreneurial experience, social capital, and venture capital (VC) funding. The study finds that entrepreneurs with previous founding experience, especially financially successful expertise, are likelier to obtain VC funding and higher venture valuations. Founders' ability to recruit executives via social networks is positively associated with venture valuation.

We take a different angle and study the role of network diversity in terms of startup founders as links to fundraising.

Hypothesis 3 (H3) *Having more diverse (founder status) counterparts affects fundraising.*

Network evolution Subsequent to an initial creation phase, the network is likely to evolve as its members use it. As explained by Walker, Kogut, and Shan (1997), social capital plays a decisive role in creating the network's form. The seminal work from Burt (2004) on structural holes as a gap between two individuals displays complementary resources or information, then filled by another agent, leading to competitive advantage. Stranger and Lazega (2010) presents an inter-organizational level study showing that the lack of a formal hierarchy leads agents to build relationships. Complex and dispersed sources of knowledge lead to more innovation using network positions of agents (Powell, Koput, and Smith-Doerr, 1996). Nai, Lin, Kotha, and Vissa (2022) investigates the selection of connections by entrepreneurs. They find that referral success is responsive to the selection of investor-centric contacts. They also find that while reciprocity as a persuasion tactic positively influences referrals, rather than simply economic motives, social capital endowments have an even more significant positive impact on referrals. Finally, entrepreneurial teams' external networks could impact their ventures' performance (Vissa and Chacar, 2009). They find that structural holes in the entrepreneurial team's external network are positively associated with increased venture performance. They also document that an entrepreneurial team's external structural holes complement functional diversity and are enhanced by strategic consensus and team cohesion.

As the network evolves, some links may overlap according to different aspects. Multiplex ties are links that carry several kinds of relationships between two agents; in our case, that would mean that people sharing an advice link are also friends. Multiplexity is an essential source of creation for new ties to emerge in the network (Kenis and Knoke, 2002). It is crucial in a network of corporate relationships (Ertug, Brennecke, and Tasselli, 2023). Such ties may represent a matching of values between entrepreneurs, who are more likely to benefit from such a relationship (Drnovsek, Zorn, and Martincic, 2008). Grossman, Yli-Renko, and Janakiraman (2012) target the initial phase of a startup formation. They find that startup networking is evaluated through its

benefits of resource acquisition, increased by eventual interpersonal similarities. Furthermore, they find that resource multiplexity offered by a network contact will be positively associated with the perceived value of that contact and that this relationship goes positively with age and gender similarity. Schjoedt, Monsen, Pearson, Barnett, and Chrisman (2013) investigate the effect of initial team and family members on performance. They find relationships critical in family business and new venture success over skill diversity. They decompose those motives on performance as achievement, economic necessity, and independence.

Connecting to a different set of people may become a necessity to develop. Newbert, Tornikoski, and Quigley (2013) studies the development of entrepreneurial networks and finds that to build a company, they must obtain resources from an increasingly diverse set of relatively stronger and weaker ties throughout the emergence phase. They exhibit that more heterogeneous duration, multiplexity, frequency, or emotional intensity of nascent entrepreneurs' relationships with their supporters in this initial phase coincide with higher odds for a startup to develop. Brennecke and Rank (2017) studied the relationship between knowledge and social networks in the context of innovation. They found that the knowledge networks of a firm positively affect the work-related interactions among its inventors and that the social network structures of inventors moderate this relationship.

However, not all ties are equal in creating multiplexity, as social ties dominate economic ones (Ferriani, Fonti, and Corrado, 2013). Constant, Sproull, and Kiesler (1996) studied the usefulness of weak electronic ties, or relationships between strangers, in an organizational context for exchanging technical advice. They found that these distant employees could provide useful advice despite the absence of personal relationships and that the firm-specific resources and organizational motivation of those who provide advice predicted the usefulness of the advice. Lomi, Lusher, Pattison, and Robins (2014) examined how organizational members' identification with social foci, or settings for interaction, affects advice-seeking ties' propensity to crosscut organizational subunits' boundaries. They found that organizational members who identify strongly with local foci tend to seek advice within those foci. In contrast, those who identify

strongly with a global focus tend to be sources of advice across the boundaries of the local foci.

Together, these studies highlight the importance of considering multiple types of ties in understanding social network structures and their implications for organizational outcomes. First, we want to test the impact of links turning multiplex in our network as agents develop relationships. Hence, we look for the effect that multiplex ties carry on fundraising (H4a, H4b).

Hypothesis 4a (H4a) *In an early stage, initial advice contact that becomes multiplex (friendship contact) affects the funds raised.*

Hypothesis 4b (H4b) *In an early stage, initial friendship contact that becomes multiplex (advice contact) affects the funds raised.*

Entrepreneurs' networks are subject to modification. Vissa and Bhagavatula (2012) analyzes the causes and consequences of churn in technology entrepreneurs' networks. The authors examine how the entrepreneur's networking actions affect churn and increase their venture's portfolio of exchange partners. They find that entrepreneurs who establish greater interpersonal knowledge or relationally embed ties with existing contacts experience lesser network churn, while those who pace interactions with existing contacts experience more churn. The research provides insights into the dynamics of technology entrepreneurs' core personal networks and their effects on their ventures. Leung, Zhang, Wong, and Foo (2006) document the evolving needs of startups and how they adapt through changes in conjunction with their network to attract talent. They find that the type of networks entrepreneurs use to attract talent varies from a mixed pattern during the initial phase to a focus on business networks during the growth phase. They conclude that this modification in the network pattern originates from the need for different types of talents due to the firm's changing environmental conditions and strategic requirements.

Eventually, the stability in the network may highlight the alignment to their values and goals as they initially recruited core team members. We test the impact of having a higher renewal rate of contacts on fundraising (H5).

Hypothesis 5 (H5) *Startups' renewal rate of contact affects their fundraising.*

DATA AND METHODS

For this project's scope, we benefit from a unique dataset to build our network. It encompasses a selection of French biotechs contacted in two waves. This dataset is the work of Alvaro Pina Stranger, who collected the first wave in 2008 for his dissertation (Pina Stranger, 2011) and the second wave in 2013 (with Ana Maria Falconi) for a follow-up project within the economic sociology program led by Emmanuel Lazega (Lazega and Mounier, 2002). Pina-Stranger's thesis focuses on biotech entrepreneurs in the human health segment of the sector. He argues that their success hinges on their collective ability to assess, validate, control, and capitalize on new knowledge. The dissertation studies this interpersonal social learning mechanism at the inter-organizational level. It shows that the heterogeneity of the biotech industry polarizes its social milieu, opposing epistemic authorities coming from science and others from management and finance, which often reduces the effectiveness of collective learning. To mitigate the adverse effects of this polarization, entrepreneurs take part in various integration processes based on intensive social networking: they build "social niches," coordinate at the level of regional clusters, and personalize their knowledge exchanges with advice-seeking and friendship ties. In addition to describing the patterns of direct advice and friendship relationships among these biotech entrepreneurs, Pina-Stranger and Lazega (2011) show that when two entrepreneurs share a personal collaboration tie, or a personal friendship tie with a VC investor, the probability of having an advice tie and thus exchange tacit knowledge with one another increases significantly. They confirm the importance of this kind of social embeddedness in the biotech industry where personalized ties—as differentiated from contractual relationships—at the inter-organizational level had not yet been examined systematically at this level of granularity. Their results suggest that strategies of personalization of exchanges are vital for inter-organizational collective learning and stimulation of co-opetition among rival peers. These strategies help entrepreneurs to access resources, participate in knowledge building, and co-orientate activities in this sector. This measures and models the added value of personal

relationships at the inter-organizational level for the survival not only of these firms but also of the sector itself.

We build upon those results by introducing in this case in point financial data to study the longitudinal effects exhibited by actors within this network. As previously stated in Pina Stranger (2011), actors seek to create their network according to their social niche of interest; we want to focus on the effects carried by their networking behavior and delve into the nature of links that are made and the consequences held for those entrepreneurs' startups. This is made possible by the intrinsic values of this rich dataset. In order to use it for our needs, we supplement this initial dataset with data provided by Crunchbase (crunchbase.com), which gives us a large panel of data points on these entrepreneurs and startups that we can cross reference with Pina-Stranger's dataset.

Variables

Regarding network data, the dataset is focused on agents' interactions in 2008 and 2013. Thus, we know if a link of "friendship" or "advice" exists between two persons. Data was collected from a sub-population of firms in the biotech industry in France using face-to-face interviews. Companies in the sample work in the life-sciences domain; they represent total financial investments above 500K€ and are French-founded and owned companies.

The characteristics that are present in this dataset for both periods as dummies cover the following basic elements: initial training (scientific or economic), professional origin (biopharmaceutical origin, research center or finance), geographical origin (Parisian or non-Parisian), function (CEO, CFO, CSO or COO), activity type (economic, pharmaceuticals, generalist or scientific) and founder status (yes or no). Therefore, this part covers the background of participants in the study and allows us to observe how it can affect their networking.

From this existing dataset, we can derive, using standard network tools, the different centrality indexes for each agent that are then used as variables. Namely, we track the agent's degree, eigencentrality, page rank, betweenness, closeness, and clustering coefficient for both

types of links and periods. We then integrate data from Crunchbase into the existing dataset to track, match, and assess the startup's progress. They give us hints about the real-world impacts on the companies after the two waves of the study were finished. This grants us information on the funding rounds the company went through.

Descriptive Statistics

The study encompasses a total of 88 companies evolving in the biotech sphere in 2008, comprising 165 individual members. The network grew to 243 persons in the follow-up stage while covering 138 startups. Refer to the table 1 for the sample breakdown into groups linked to their backgrounds. One important factor to take into consideration is the strong presence of agents with a scientific background.

Insert TABLE 1 about here.

Methods

Once we can gather our complete dataset, as indicated previously, we use standard statistical tools to isolate the effects we want to uncover. This process is done thanks to Python using statistical packages. It allows us to run either OLS or logit regression on our variables, as highlighted in the next part covering our results.

RESULTS

As preliminary results, we first study the creation of links in our network, and results are displayed in the appendix, see table A1. The dependent variable is the existence of a link between two individuals at a given period (i.e., being a friend in 2008, or "any" which corresponds to either friend or advice link). This variable is also used as an independent variable to test for second-wave data, where we want to see the effects of first-wave lag. We also use data that define

agents: namely, those agents sharing the same characteristics (i.e., same origin, same training, etc.)

We can observe that having the same function as another agent will lead to decreased odds of forming a link, with a -0.66 factor of having any type of link between them. Sharing the same activity with someone else also seems to lead to lower chances of linking (i.e., friends with a -0.58 factor). However, sharing the same funder status increases the chances of linking together (at a factor of 0.72). Indeed, we isolate founders to tend to network with other founders. It appears that agents are more likely to connect with individuals presenting a different background. Finally, having an advice link is a better predictor than friendship to sustain a link in the next period (3.14).

Insert TABLE 2 about here.

Table 2 shows that, in an early stage, making friends of advice givers (thus moving the relationship to a multiplex of advice and friendship ties) leads to positive expected gains in fundraising, hence confirming H4a. However, receiving advice from friends (friendship to multiplex relationship) leads to lower expected fundraising for an entrepreneur, which validates H4b.

Insert TABLE 3 about here.

We now want to find which characteristics significantly impact an agent's centrality in the network. We take here as independent variables a selection of centrality measures standardly used in the literature (degree, eigencentrality, closeness). Only a handful of factors seem to change the centrality of an individual significantly. Table 3 displays a positive and significant coefficient for the renewal rate for early-stage fundraising, and the opposite - a negative coefficient - for later-stage fundraising (which validate H5, even though the complete answer is to be found with this dual temporality). On the same table, we observe that greater diversity in peers regarding gender has a positive and significant impact on fundraising, which validates H1. We also keep

that some values are alternating. Indeed, being in contact with people presenting diverse initial training is beneficial in the early stage but not in the later stage (confirming H2). We find a reverse relationship for founder status, as in an early stage, having more diverse counterparts negatively affects fundraising, while in a later stage, having more diverse counterparts positively affects fundraising (confirming H3).

DISCUSSION

Diversity

We can identify a positive relationship between gender diversity in an entrepreneur's network and fundraising abilities (H1). This is an encouraging result to find that more diversity regarding gender would enhance a company's ability to raise more funds. Even if there is a well-documented gender gap in startup financing McGuire (2019); Kanze et al. (2018); Brush et al. (2018), we see it as a positive signal and an element going in the good direction in the gender gap conversation.

Results are more nuanced concerning initial training and founder status. We find an initial boost in fundraising for entrepreneurs presenting a diverse network in terms of formation, which later becomes negative (H2). Thus, it may be helpful to know complementary knowledge holders earlier but not later as the company scales and needs to be focused on growth. This effect could also be read as the impact of best practices sharing, where two agents would get a mutual gain in connecting to learn about new knowledge from their counterpart's domain of expertise.

The reverse hold for entrepreneurial status, as an adverse effect, is seen for diversity at first, which then turns into a positive (H3). Being in contact with entrepreneurs has a positive impact once the company grows later, possibly to share experience, gain comparative knowledge, and keep evolving. Beckman and Haunschild (2002) already highlighted the importance of collective experience in decision-making. We illustrate that the diversity of profiles also plays a role in a firm's decision success.

Homophily

We find that there seems to be a mechanism that would attract founders to connect and make them build more connections than other agents. A simple explanation could be that of basic homophily (McPherson, Smith-Lovin, and Cook, 2001), where they would develop such links because they share similar traits (Currarini, Matheson, and Vega-Redondo, 2016; Hart, 2014). In that regard, founders would be bound because they share a common set of values, which can also lead to the creation of startups (Powell and Baker, 2017). Yet assortativity or other mechanisms could also play a role in matching individuals, as per Snijders and Lomi (2019).

Regarding building those bridges, it can very well be a decision taken by the entrepreneur as he sees benefits in having a central position (Phillips, Tracey, and Karra, 2013). Lazar, Miron-Spektor, Chen, Goldfarb, Erez, and Agarwal (2022) suggests that using a "dual formation strategy," which combines interpersonal attraction and resource-seeking strategy in building a team, is critical for the early performance of new ventures. As per three studies, this approach leads to stronger coordination and improves early success in seed funding, entrepreneurial competitions, and initial product sales. It might also result from the individuals' adaptation to their surroundings, as displayed in Smirnov and Thurner (2017). However, it is more likely to end up in a diffusion mechanism that would benefit the members in this setup of a high level of consolidation (Zhao and Garip, 2021).

Complementarities

We noticed that agents connect with individuals from different backgrounds and consistently do so unless that person is a friend. Thus, they are willing to adjust and attach to agents, which benefits them with complementary knowledge; this coincides with the famous proposition of structural holes (Burt, 2000). This factor may lead the company to grow as it will contribute directly to its development thanks to complementarities from different pools of knowledge that the startup can tap into for access to expertise or funding. It can counter the natural tendencies of founders to surround themselves with people exhibiting a similar skill set, which can be

detrimental to the development of the early-stage company (Gray, 2017).

We found that it had a positive impact on entrepreneurs in their fundraising campaign to turn their advice givers into friends (H4a) while the opposite relation didn't hold (H4b). Therefore, it is more pertinent for entrepreneurs to keep their friends as friends and develop stronger relationships with their advisors. We observe a reminiscent effect of Pina Stranger (2011), which stated that agents were willing to invest in networking so as to create their own social niches, consistent with Lazega and Mounier (2002) theory of the relational patterns facilitating co-opetition. In our case, we isolate that their networking behavior would result in the initial creation of links with agents exhibiting complementarity of knowledge and background to their own set of skills, but we also find that they benefit from creating more personalized links with other agents (thus turning advice givers at their benefit into friends).

We find that a higher renewal rate is associated with more fundraising for early-stage startups (H5), which would coincide with an initial phase of exploration, where the focus would be on creativity. However, for a later stage, it coincides with less fundraising, which signals an exploitation phase in which the company is willing to focus on scaling. This signals an early need to create new links, which fades later as the company grows in scale and, therefore, must rely on its existing connections. This could be explained by the need to get involved differently with other agents while keeping the same status, which would be observed as some sterile status quo that doesn't help creativity. Vissa and Bhagavatula (2012) examined the causes and effects of changes in the composition of an entrepreneur's core personal network, known as "churn." It found that entrepreneurs who take actions to establish greater interpersonal knowledge and strengthen existing relationships experience less network churn, while those who focus on quickly building many new relationships experience more churn.

The impact of those complementaries can be found in the firm's chain of command. This will then help the company to finance its activities, which will help the startup grow (Heuven and Groen, 2012). The development can also occur at the board level, and the company can connect at a higher level, which would induce higher performance for the organization (Wang, Lu, Kweh,

Nourani, and Hong, 2021). A more focused view could infer that relying on external knowledge could be a better approach for a lower-status firm (Kim, Park, and Kim, 2018) and would need to be adapted according to the situation (Ahuja, 2000). Access to the key competencies can also lead the company to an enviable position to seek innovation as it can feel where the market is going. Indeed, bridging different parties can help the startup generate new ideas (Tortoriello, 2015; Cowan and Jonard, 2007). However, a more nuanced view is that this positioning can be a double-edged sword in that it will contribute to the firm innovation but may lead to a lesser capacity to build trust and exploit the knowledge at hand (Zang, 2018). It can be detrimental in high-density networks (Tan, Zhang, and Wang, 2015).

Theoretical implications

This paper contributes to the discussion on exploration-exploitation networking behaviors exhibited by entrepreneurs. We can indeed summarize our findings according to the following theoretical implications.

Exploration We find a positive impact on fundraising for early-stage diversity in terms of gender (H1), initial training (H2), and founder status (H3). Hence, we understand that diversity is a strength that initially allows entrepreneurs to reach complementary individuals. We also find that a high early renewal rate (H5) results in an early shuffling in contacts, contributing to the entrepreneur finding the right individual ultimately making for more fundraising. Finally, we can decompose the effects of overlapping contacts. Indeed, while advice links turning multiplex proves beneficial (H4a), the opposite doesn't hold as friendship turning multiplex (H4b) decreases the funds raised.

Overall, we find that this phase constitutes a building phase, as entrepreneurs build relevant connections and multiply complementary knowledge, which helps them evolve in the startup ecosystem.

Exploitation In the second phase, we find opposite relationships. Indeed, later on, we observe that diversity in terms of initial training (H2) and founder status (H3) impact fundraising but negatively. We also find that a higher renewal rate is associated in a later stage with fewer raised funds (H5).

We conclude that in this second phase, entrepreneurs appear to make fewer changes to their networks and exploit their existing relationships. They also rely on the same type (less diverse) contacts, which can be read as the need to focus on specialist rather than generalist roles to build their business.

Practical implications

We can draw some implications that would reflect our observations in this paper. Given the nature of knowledge hubs, the government must foster knowledge creation. This is widely accepted in France as the basis of a meritocratic system within the French education system (Musselin, 2022). But this system appears to present some breaches^{1 2 3}, it would be detrimental for the nation to have meritocracy collapse. A powerful implication lies in the positive impact for an entrepreneur to network with diverse individuals that will be helpful in their journey as it faces evolving needs and must adapt. However, it is not a case of "more is always better." Ideally, the best approach would be to build a network of complementary knowledge that impacts the startup's development at different stages of its growth.

Another central point is the need for infrastructure and knowledge hubs accessible to startup founders. Incubators, for example, are a widely used platform to develop new startups and local entrepreneurial ecosystems (Roundy, 2021). University technology business incubators help to foster innovative technology-based businesses (Mian, 1997). However, Ebberts (2014) focuses on networking behavior as a dependent variable of link creation among entrepreneurs in business

¹https://www.lemonde.fr/campus/article/2019/02/05/la-meritocratie-est-la-bonne-conscience-des-gagnants-du-systeme_5419241_4401467.html

²<https://www.andese.org/contributions/chroniques-de-nadia-antonin/513-pourquoi-un-tel-acharnement-en-france-contre-la-meritocratie.html>

³<https://start.lesechos.fr/societe/egalite-diversite/pourquoi-les-francais-ne-croient-plus-en-la-meritocratie-1370159>

incubators. He doesn't find a connection between networking behavior and the number of business partners who employ entrepreneurs. But alternative arguments are brought by Busch and Barkema (2022). They are focusing on how incubators support the network embedding of entrepreneurs in an unpredictable environment. They find that a flexible social structure may provide the circumstances that permit unforeseen discoveries. Some initiatives took place in that sense to create regional clusters (Levy, Hussler, and Triboulet, 2012); they need to be reinforced by concrete political action. There is, therefore, a need for mobility. Mobility toward the economic center also contributes to creating knowledge hubs that attract more talent to contribute locally. This is especially true regarding academic mobility, as observed in various countries (Jöns, 2015). This development then leads to a more sustainable path to growth for the concerned economies (Wang and Shi, 2022). The direct consequence of this specific form of migration is the accrued ability to innovate. Indeed, skilled workers make it more likely for a firm to stay at the edge of technology changes (Fink and Miguelez, 2017). This, in turn, directly affects innovation and value creation (Miguelez and Fink, 2017; Miao, 2021). Of course, there are shreds of evidence of this mechanism in different places (Beaverstock and Hall, 2012; Greenwood, 1969; Carrasco and Ruiz-Castillo, 2019), or other industries within France (Patron, 2012).

Finally, universities must make the link to help carry young startups (and eventually join incubators). Acting at a time of formation is very important to set up a company. Clarysse and Moray (2004) finds that shocks to the founding team and the role of its champion co-evolve with shocks to business development. Smilor, Gibson, and Dietrich (1990) shows that the University of Texas at Austin has long contributed significantly to the creation and growth of spin-out businesses. They find that "push" elements are less significant than "pull" factors (such as awareness and motivation). They also highlight the university's role as a supplier of research knowledge and consultants. Kolympiris, Kalaitzandonakes, and Miller (2015) show that academic entrepreneurs will optimize their utility by dividing their time and energy between academic and entrepreneurial endeavors. They find that the best distribution depends on internal and external variables that influence the relevant payoffs, where age and other

entrepreneur-specific traits affect businesses' location disproportionately. Technology transfer from academic institutions to the commercial sector is increasingly seen as significantly impacting new company launches, business expansion, and job creation (Harmon, Ardishvili, Cardozo, Elder, Leuthold, Parshall, Raghian, and Smith, 1997). They find that transfer may occur between a university and an existing business, between the institution and a freshly launched new enterprise, or it may lead to the formation of a new company. They suggest that entrepreneurs who want to launch new technology-based enterprises should spend time networking.

Limitations

Our dataset covers a rich social aspect of entrepreneurs' relationships. However, sadly, we had to keep a more conservative take on our analysis. Indeed, some data were missing for various reasons: either we couldn't find the related company in other databases, some company got acquired and thus became "invisible" to us, or, of course, some data points may be missing due to selection bias (i.e., entrepreneurs moved to another project and stopped reporting). Thus, it mechanically decreased our sample size to keep a more stable sample for our analysis, a hard limit we cannot overcome.

CONCLUSION

In this paper, we identify effects that isolate some characteristics of diversity. We find that having a more diverse network in terms of gender, training, and specialty is beneficial in the long run for entrepreneurs in our study as they can exhibit performance metrics. However, those effects vary in time, so looking at the timing of events makes sense. Hence, getting more diverse knowledge complementarities in an exploration stage is beneficial. Still, once the company reaches an exploitation stage, getting a hold of a more focused set of connections is useful. Indeed, agents are more likely to get advice from agents from different backgrounds (activity and function). We can interpret that phenomenon as a direct illustration of structural holes in a knowledge-intensive industry, which draws entrepreneurs' attention toward seeking complementary connections.

We find that the ability to create more profound links to advice givers is positive for entrepreneurs as they make relationships multiplex. This result corroborates the dual exploitation-exploration approach, as initially shuffling relationships and creating new links is critical to entrepreneurs as they develop a network that can prove helpful in their endeavors. Eventually, entrepreneurs can exploit their network as they build a capacity to renew their network, adapt its composition, or surround themselves with people whose diversity complements them.

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TABLE 1: Description of agents' background. Data from 2008 and 2013, covering 138 entrepreneurs in France.

Variable	Type	Frequence (2008)	Frequence (2013)
Function	CEO	0.54	0.57
Function	CFO	0.12	0.16
Function	CSO	0.12	0.17
Function	COO	0.22	0.10
Founder	No	0.73	0.60
Founder	Yes	0.27	0.40
Initial Training	Scientific	0.80	0.83
Initial Training	Economic	0.20	0.17
Paris region	Yes	0.39	0.46
Paris region	No	0.61	0.54
Professional origin	Biopharma	0.52	0.52
Professional origin	Research	0.29	0.27
Professional origin	Finance	0.19	0.21
Activity type	Economic	0.67	0.67
Activity type	Pharmaceutics	0.02	-
Activity type	Generalist	0.11	0.13
Activity type	Scientific	0.20	0.20
Former Entrepreneur	Yes	-	0.40
Former Entrepreneur	No	-	0.60

TABLE 2: Funds raised on links type, data from 2008 to 2019. Funds are aggregated at the company level for the covered period. Centrality is measured as the eigencentality of agents in the deal network. Advice tie maintained, and respectively friendship maintained, is the evolution of the weight of advice tie, respectively friendship types, between both periods. Friendship becomes advice tie, and respectively advice tie becomes friendship, is the evolution of the weight of friendship becoming advice tie, respectively advice tie becoming friendship types, between both periods. Advice tie becomes multiplex, and respectively friendship becomes multiplex, is the ratio of advice ties, respectively friendship, becoming multiplex from the first to the second period.

	Funds raised 2008-2013		Funds raised 2013-2019	
	I	II	I	II
Constant	9.0E-01*** (2.4E-01)	9.3E-01*** (2.4E-01)	-1.2E-01 (4.8E-01)	-2.1E-01 (4.8E-01)
Centrality	-1.1E+02** (4.4E+01)	-1.1E+02** (4.2E+01)	4.5E+00** (1.9E+00)	4.5E+00** (1.8E+00)
Advice tie maintained		5.4E+00 (4.9E+00)		-7.3E-01 (2.6E+00)
Friendship becomes advice tie		-4.6E+00** (1.8E+00)		1.3E+00 (9.5E-01)
Advice tie becomes friendship		8.6E-01 (5.0E+00)		1.3E+00 (2.8E+00)
Friendship maintained		4.4E+00** (1.9E+00)		-1.5E+00 (1.0E+00)
Advice tie becomes multiplex	2.4E+01*** (4.7E+00)		1.7E-01 (2.8E+00)	
Friendship becomes multiplex	-3.3E+00** (1.3E+00)		-3.3E-01 (7.7E-01)	
N	46	46	14	14
R2	0.61	0.65	0.39	0.58

TABLE 3: Funds raised on tie diversity, data from 2008 to 2019. Funds are aggregated at the company level for the covered period. Centrality is measured as the eigencentrality of agents in the deal network. The renewal rate is the ratio of gained ties to lost ties.

	Funds raised 2008-2013	Funds raised 2013-2019
Constant	9.1E+06*** (1.6E+06)	3.3E+07*** (7.8E+06)
Centrality	-9.1E+08*** (6.8E+06)	-2.5E+07 (1.8E+07)
Renewal rate	9.0E+08*** (4.3E+06)	-3.5E+07*** (7.7E+06)
% links same entrepreneur status	2.3E+08*** (6.8E+06)	-2.6E+07** (1.2E+07)
% links same initial training	-1.8E+08*** (3.9E+06)	1.9E+07*** (6.6E+06)
% links same origin (Paris)	8.7E+06** (4.2E+06)	4.0E+07*** (6.8E+06)
% links same activity	2.6E+08*** (8.7E+05)	2.3E+06* (1.2E+06)
% links same gender	-8.3E+08*** (3.2E+06)	-1.3E+07*** (4.4E+06)
N	46	46
R2	0.83	0.05

APPENDIX A: LINK ANALYSIS

TABLE A1: Link analysis: Existence of a link between two agents

	Friend 13	Advice 13	Any 13	Any 13
Constant	-2.77*** (0.07)	-2.38*** (0.06)	-0.75*** (0.04)	-0.85*** (0.04)
Same activity	0.26*** (0.09)	-0.58*** (0.09)	-0.31*** (0.07)	-0.19*** (0.06)
Same function	0.14 (0.09)	0.06 (0.09)	0.00 (0.07)	0.08 (0.07)
Same funder status	-0.55*** (0.09)	-0.78*** (0.09)	-1.13*** (0.07)	-0.98*** (0.06)
Same gender	-1.42*** (0.09)	-1.34*** (0.09)	-2.18*** (0.07)	-1.87*** (0.06)
Same training	-0.73*** (0.09)	-0.69*** (0.09)	-1.12*** (0.07)	-1.04*** (0.07)
Same origin (Paris)	-0.41*** (0.09)	-0.28*** (0.09)	-0.75*** (0.07)	-0.59*** (0.06)
Same prof. origin	-0.44*** (0.09)	-0.08 (0.09)	-0.52*** (0.08)	-0.36*** (0.07)
Advice 08	2.05*** (0.12)	2.11*** (0.12)	3.08*** (0.09)	
Advice 13	3.54*** (0.08)			
Friend 08	1.35*** (0.11)	0.70*** (0.12)	1.73*** (0.09)	
Friend 13		3.50*** (0.08)		
Any 08				3.48*** (0.08)
N	32089	32089	32089	32089
R2	0.50	0.49	0.36	0.30

Conclusion

In three chapters, we journeyed through different aspects of the startup ecosystem. First, at the global level, we studied the impact on startup's performance of their investors' centrality. The first chapter examines the role of investor network centrality in facilitating funding, IPO success, and long-term growth.

Then, at the dyad level, we covered the role and construction of trust between investors. In the second chapter, we delve into the dynamics of trust within these networks, emphasizing the significance of shared experiences.

We conclude with a detailed view of dynamic relationship-making between entrepreneurs. Indeed, the third chapter shifts focus to the French biotechnology sector, where interpersonal ties and diversity play pivotal roles in shaping entrepreneurial outcomes.

Theoretical Contributions

Our theoretical contribution can be structured into two primary dimensions, commencing with a focus on investor dynamics before delving into findings pertaining to entrepreneurs. The first contribution that we make is to highlight the critical role of trust in investor relationships. As we saw, trust can affect the propensity to participate in funding rounds or in SPACs for an investor. Even though we validate this finding using a novel index to measure trust, this positive relation between trust and deal-making is not new. However, we differ from previous studies in the field as we assert that the level of relative centrality between investors in a dyad is a fundamental determinant of trust. This means that trust is built, in part, by comparing and validating one's network connections with those of other investors. This argument, therefore, indicates that we do not simply observe a positive linear function of trust and deal-making but a more complex dynamic foundation of trust on mutual comparison between investors. Moreover, in our findings, we reveal that trust is strongly influenced by shared experiences and similarities between investors, challenging the conventional idea that network structure is the primary driver of trust. An important notion here is that we observe the existence of persistent ties that allow investors to yield benefits from their previous encounters. This highlights the significance of personal connections and shared experiences in fostering trust, underlining how homophily and the certification effect can play a role in trust building.

We then focus on the interplay between investor centrality and fundraising outcomes. We explain how an investor's centrality within a network affects their ability to secure additional funding, the amount received, and the likelihood of going public. Our work goes beyond previous studies realized in this field as it covers

multiple continents, relies on a complete dataset offered by industry data providers, and is robust to eventual endogeneity in our estimation (which is a predominant risk in such studies.) Importantly, it's noted that the reputation derived from an investor's centrality can facilitate a startup's faster development and increased access to resources. Hence, we provide valuable information from the startup point of view by looking at investors, which is an added result compared to previous studies that focused on the benefits obtained solely by the investor. Thus, the study emphasizes on the broader implications of investor centrality on a startup's growth trajectory and funding prospects.

Regarding entrepreneurs, we find valuable insights into the exploration-exploitation networking behaviors that they exhibit. Benefiting from a unique dataset displaying information on the personal relationships of individuals, we are able to depict a sharper view of phenomena that were previously unseen in this industry. In the exploration phase, the study finds that early-stage diversity in gender, initial training, and founder status positively impacts fundraising, underscoring the importance of diversity in building complementary connections. This phase is characterized by establishing relevant connections and accumulating complementary knowledge to navigate the startup ecosystem effectively. In contrast, during the exploitation phase, diversity in initial training and founder status negatively influences fundraising, and a higher renewal rate is associated with reduced funds raised. This suggests that entrepreneurs tend to maintain their existing networks and rely on less diverse contacts, emphasizing the need for specialization over generalization in building their businesses. These findings illuminate the evolving networking strategies of entrepreneurs as they transition between exploration and exploitation, stressing the importance of adaptability at different stages of business development. Our find-

ings directly expose this two-step behavior, which was previously hidden. It, therefore, proposes an explanation for observed micro-level entrepreneurial behavior, highlighting the best strategies adopted by individuals in this dataset.

Practical Implications

In the first set of implications, the study highlights the importance of an entrepreneur's choice of investors in different stages of a startup's development. It suggests that, initially, entrepreneurs should prioritize central investors with extensive networks and experience in the same industry, as this can lead to improved survival and performance. Under such circumstances, the startup is able to benefit from the investor's extended network and extract value from that position.

However, as the startup progresses, the size of the investor base becomes more critical than the reputation of a single investor, particularly in the last funding round. This underlines the evolving significance of investor centrality in different phases of a company's growth. Hence, the startup and its evolving need remain to be prioritized for the choices of its investors to be the most pertinent.

We then emphasize the need for entrepreneurs to build networks of complementary knowledge to support their startup's development at various growth stages. The study also highlights the importance of accessible knowledge hubs and infrastructure for startup founders, such as business incubators, to foster innovation and discovery. Indeed, at this stage, the startup is able to benefit the most from an influx of new ideas and the complementary knowledge of its partners.

In our study, we suggest that the government should encourage knowledge creation and reinforce regional clusters to attract talent and promote economic growth. This results in a win-win situation as entrepreneurs can develop their companies while being active members of a comprehensive set of mutually benefiting partners. Moreover, universities play a vital role in supporting young startups by providing research knowledge, consultants, and technology transfer, contributing to

the launch of new businesses and job creation. This role remains crucial as it also fulfills the extended mission of the university to create more knowledge.

Finally, we suggest that investors enhance their centrality through education and career development to increase their value. Indeed, we observed that agents benefited greatly from the previous ties they could develop at this stage of their lives. It also underscores the concept of homophily, where more central agents interact, potentially creating a first-mover advantage for highly central nodes in accumulating subsequent contacts and deals. Thus highlighting the importance of strategic choices as we modeled that agents make comparisons based on their networks.

Limitations

In this research effort that we carried out, we met some limitations. We were able to alleviate the effects of most of them, but there remain areas where we met some hard limitations that we could not wholly go past.

While we managed to eliminate the risk of endogeneity in our dataset using standard statistical methods, there may be survival and selection biases in evaluating real deals versus unrealized ones. Indeed, the central investors are more likely to choose successful startups, which might lead to easier access to funding and higher value for those firms. However, not all startups follow this pattern.

Another easy-to-grasp limitation is that we had missing data in some datasets, including companies that became invisible due to acquisition and data points missing for various reasons, leading to a reduced sample size for analysis. This offers quite a challenge for an outsider to those companies to collect data. It may require additional data-gathering work if they are found to be available using other sources. While it may be possible to harvest complementary data either internally in cooperation with those firms or through expensive third-party data providers, we were not able to do so for all companies given the scope of this project.

Our analysis also considers the impact of investment on startup development and the absence of short-term growth in valuations. There is the possibility of undisclosed deals affecting the data. In that sense, there is a chance of missing data due to response bias, which we cannot estimate even though we are using the most complete dataset available on the market. As our analysis focuses on early-stage startups, it's a bias that we cannot completely alleviate.

Finally, there remains a risk of response bias in data gathered through inter-

views. Indeed, either by mistake or willingly, we cannot exclude the chance that some participants failed to report a complete set of their friends or were unable to characterize them as such (even more given the notion of reciprocity that friendship naturally includes). Even if this risk remains small, given the benevolent nature of the conducted interviews, we cannot rule it out with certainty.

Outlook

Despite previously mentioned limitations, we found great value in the position of actors in the network toward their success. Future research should continue pushing in this direction by adding more data points or expanding to other business cases.

For example, one could add different layers of social variables to the trust index in order to enrich the results given by the model. This could lead to highlighting the role and weight of different factors in the equation of trust building.

We believe that there would be great value in focusing as well on other actors of the funding ecosystem for startups. Indeed, angels are given as some of the first investors in a startup. While we did not investigate the creation of trust at their level, it would be pertinent to evaluate and check for the validity of extended results at their level. Furthermore, the porosity between angels and VC investors could be another research field for implementing a review of trust exhibited between those private actors.

Finally, it could be possible to adapt methods from the last chapter to refresh and tune the estimate by conducting a second follow-up round of interviews to check on our results' validity and test the robustness of studied relationships.