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Peer Networks and Entrepreneurship: A Pan-African RCT

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ABSTRACT

Peer Networks and Entrepreneurship: A Pan-African RCT*

Can large-scale peer interaction foster entrepreneurship and innovation? We conducted an RCT involving almost 5,000 entrepreneurs from 49 African countries. All were enrolled in an online business course, and the treatment involved random assignment to either face-to-face or virtual (Internet-mediated) interaction. We find positive treatment effects on both the submission of business plans and their quality, provided interaction displays some intermediate diversity. Network effects are also significant on both outcomes, although diversity plays a different role for each. This shows that effective peer interaction can be feasibly implemented quite broadly but must also be designed carefully, in view of the pursued objectives.

JEL Classification: C93, D04, D85, O12, O31, O35

Keywords: social networks, peer effects, entrepreneurship, innovation, semantic analysis

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1 Introduction

Peer networks play a prominent role in many different social and economic contexts. They are essential, for example, to understanding how firms, markets and, generally, large production and financial systems operate.[1] They are, of course, particularly important as well in successful innovation and entrepreneurship,[2] for which peer networks are typically involved in effectively supporting the following phenomena:

1. *cooperation* – peers cooperate and therefore must trust each other;

2. *learning* – new information is gathered from peers as it diffuses through the network;

3. *competition* – peers compete for funding, and often operate in related markets as well.

There is, in the network literature, a substantial amount of research that studies ***separately*** each of the above dimensions of the problem, mostly from a theoretical viewpoint.[3] But, to the best of our knowledge, there is no existing body of research that jointly studies the interplay between the three of them. We argue, however, that in order to understand/model how peer networks operate on innovation and entrepreneurship it is of fundamental importance to account for such an interplay. The challenge, however, is that, being the problem at hand so rich and complex, it is difficult to pinpoint what the main forces at work are: How do agents (attempt to) reconcile their incentives to collaborate with the fear of favoring a potential competitor? How important is it for agents to enjoy broad and flexible channels of communication? How does the structure of the network (itself emerging rather than imposed) bear on both the diffusion of information and the support of trust? What interaction rules and communication protocols render interaction most effective?

To address at least some of the previous questions, we need a solid modeling approach, which in turn requires comparably solid empirical evidence to build upon. Since such evidence is not yet available, to gather it systematically seems a first important step in addressing the problem, and has been one of the primary motivations of our present research. Its aim, therefore, has been to study in detail how, in a large and rich environment, the key phenomena discussed above shape a process of peer-based innovation and entrepreneurship. More specifically, we have focused on addressing the following questions:
(a) how, over time, entrepreneurs search for useful peers;
(b) what sort of communication they undertake and how their behavior evolves;
(c) what effect (a) and (b) have, in the end, on their innovation performance.

With this objective in mind, we have conducted a randomized control trial (RCT) involving a large population of African entrepreneurs (almost 5,000 of them) from all over the continent (49 countries represented).

[1] The recent Handbook on the topic of social networks edited by Bramoullé, Galeotti, and Rogers (2016) provides a good panoramic view of the state of the art. The reader may check, specifically, the contributions by Dessein and Pratt (2016) for a discussion on how network structure affects the operation of firms and other organizations; by Beaman (2016) on how social connections impinge on hiring and employment in labor markets; by Breza (2016), on how informal networks strive to compensate for poorly performing institutions in less-developed economies; by Acemoglu, Ozdaglar and Tahbaz-Salehi (2016), as well as Cabrales, Gale and Gottardi (2016), on how the network pattern of connections (input-output relationships in the first case, assets and liabilities in the second) determine the overall systemic risk faced by large economies.

[2] On this matter, see Section 2 below for a discussion of relevant literature.

[3] On cooperation in social networks, we may refer to the papers by Karlan, Mobius, Rosenblat, and Szeidl (2009), Lippert and Spagnolo (2011), Jackson, Rodriguez-Barraquer, and Tan (2012), and Ali and Miller (2016); on learning in networks, those of Bala and Goyal (1998), DeMarzo, Vayanos and Zwiebel (2003), and Golub and Jackson (2010); on competition/conflict in networks, Franke and Ozturk (2015), König, Rohner, Thoenig, and Zilibotti (2017), and Heijnen and Soetevent (2018).

The experiment itself lasted for about two and a half months, and involved two different interventions. First, spanning this period, the whole population (treated and control alike) underwent an online business/entrepreneurship course that was specifically tailored to the nature of the experiment. Second, in an essentially parallel manner, the treated subpopulation also interacted in peer groups consisting of 60 entrepreneurs, according to three different sub-treatments. In one of the treatment arms (implemented in Uganda), groups interacted face-to-face. In the other two, they interacted virtually through an Internet-based chatting platform, which was designed to allow for flexible communication, giving entrepreneurs full discretion on how to modulate privacy and organize content.

The two virtual arms differed in the composition of the groups. In the treatment arm that we label "virtual-within" every group was nationally homogeneous (i.e., all its members belonged to the same country). Instead, in the other arm, labeled "virtual-across," groups were formed randomly in a nationally heterogeneous (and balanced) manner. Whereas the virtual-within arm was circumscribed to entrepreneurs from the five countries in the sample with the largest representation (Nigeria, Ghana, Kenya, South Africa, and Tanzania), the virtual-across arm involved individuals from all African countries represented in our population.

All along the interaction (which lasted for slightly more than two months), we recorded the evolution of the process exhaustively, including the full networking activity and the whole set of messages exchanged in the virtual treatment arms. Then, at the end of the intervention, all entrepreneurs – treatment and control alike – were asked to submit a business proposal. This in turn allowed us to obtain a measure of *business quality* (or innovation performance) through the following two-stage procedure. First, all submitted proposals were evaluated and graded in a 1-5 scale by a panel of 15 African professionals belonging to investment firms, entrepreneurship hubs, and accelerators. Then, in a second stage, the business proposals that ranked highest in the first stage (together with a smaller additional set selected by a European academic panel) were again evaluated, ranked, and some funded by a panel of 24 senior investors (VCs, investment-fund managers, and angel investors), who acted as the financial partners of our project.

At a very high level, our results can be summarized in the following two-fold manner. On the one hand, the treatment is most effective – both on the rate of submission of business proposals as well as on their professionally-evaluated quality – when interaction groups are formed as in the virtual-within arm (instead, face-to-face interaction had a positive effect only on submission). On the other hand, concerning the network (bilateral) peer effects – i.e. the average impact on an entrepreneur's behavior/outcome of that of her connected peers in the social network – our analysis shows that they are significantly positive only when they operate in the virtual-across arm, while for submission they are so only in the virtual-within arm.

In essence, these results lead to the following main insights:

1. Virtual interaction – which allows for a cost-feasible way of implementing peer interaction in large scale and with a wide scope – is an effective way of promoting entrepreneurship, as measured by the two dimensions considered (the submission and quality of business proposals).

2. Intermediate levels of peer diversity – as induced by interaction that is virtually implemented but within nationally homogeneous groups – is the most effective, also in the two aforementioned dimensions.

3. Network peer effects – identified on the emerging social network of bilateral interaction in the assigned group of potential peers – are stronger when the group is relatively homogeneous (i.e. in the virtual-within arm) if the outcome is submission, but if the outcome is business quality then it is higher group diversity (virtual-across interaction) that yields strong peer effects.

From the viewpoint of economic policy, the former discussion points to the feasibility of, and the potentially high payoffs to be expected from, a large-scale implementation of virtual mechanisms of peer interaction among entrepreneurs. It also underscores the importance of adopting what, in Hurwicz's (1973) celebrated terminology, we may call a designer's social-network viewpoint to the entrepreneurship problem.[4] That is, the importance of being well aware that alternative rules of interaction may have subtle but important effects on the outcome (in particular, through agents' incentives), and therefore should be carefully designed before the intervention.

Naturally, it goes without saying that our formal study of the problem will raise a number of important technical and conceptual issues: the risk of attrition-induced selection bias, a univocal econometric identification of the effects, a suitable construction of the peer social network, the study of composition and heterogeneity effects, and various robustness checks. All these issues will be tackled in due order by our analysis, but are best abstracted away from at this introductory stage.

Finally, we highlight that, as a powerful and complementary way to better understand and interpret our results, the experiment has also provided an exhaustive record of the extent and content of inter-agent communication: over 140,000 messages exchanged by the entrepreneurs assigned to the virtual treatment arms. Naturally, there is a lot that one can hope to learn from a thorough ***semantic analysis*** of this massive flow of communication. Here we rely on the machine-learning tools that have been developed by the booming field of Natural Language Processing (NLP) to start looking into the back box of the interaction process. This helps us identify some interesting features of peer communication – e.g. the balanced interplay observed between business focus and small (encouraging) talk – which should provide valuable guidance in the aforementioned design problem.

The rest of the paper is organized as follows. First, in Section 2 we provide a summary of related literature. Then, in Section 3 we describe the different components of the experimental design and describe the main objectives of our analysis. Section 4 focuses on the estimation of the treatment effect on the two performance dimensions considered here (submission and business quality), exploring in detail delicate identification and robustness issues. Section 5 turns to studying the phenomenon of peer interaction from a network perspective. We start by formulating an operational specification of the social (peer) network, then proceeding to the estimation of peer network effects and again a discussion of key robustness and identification issues (in particular, the so-called reflection problem). Section 6 provides the aforementioned advance on the semantic analysis of the inter-subject communication recorded throughout the experiment. Finally, Section 7 ends the main body of the paper with a summary of conclusions and longer-run plans for future research. Additional material (in particular, secondary tables) is included in an Appendix.

[4]See Vega-Redondo (2019) for a discussion of how such an approach can be applied to mechanism design in the field of social networks.

2 Related literature

One of the leading ideas underlying the fast development of the field of social networks has been that inter-agent connections are an important conduit for sharing information, and hence they are important as well in promoting innovation (see, for example, Granovetter (1973) and Burt (1992, 2004)). For the specific case of firm-based innovation in the marketplace, there is ample empirical evidence showing that much of the R&D conducted in the most dynamic sectors of the economy is carried out through inter-firm collaborations. As a very small sample of this large literature, good concrete illustrations can be found in Zhao and Aram (1995), Powell, Koput, and Smith-Doerr (1996), Edquist, Eriksson and Sjögren, (2000), or Dahl and Pedersen (2005), while for a panoramic view of the phenomenon with a discussion of its aggregate implications, Hagedoorn (2002) is a good empirical source.

The previous papers mostly focus on inter-firm research collaboration aiming at the introduction of new better products or the development of more efficient production processes. But, of course, interaction among firms can also serve them to improve management practices, as studied by Fafchamps and Quinn (2016) or Cai and Szeidl (2017). The first paper reports on a field experiment conducted in three African countries (Ethiopia, Tanzania and Zambia), while the second one discusses an experiment involving Chinese entrepreneurs. Both of them find that, indeed, peer-manager interaction improved management practices. And in the case studied by Cai and Szeidl, the authors also document a positive effect on profitability and growth.

Naturally, peer effects may also involve, rather than established firms, aspiring entrepreneurs who are exploring fresh business ideas in the hope of starting up a *new* firm. We are not aware of much literature concerned with this important context. Interesting exceptions are provided by the papers of Nanda and Sorensen (2010), Lerner and Malmendier (2013), and Hacamo and Kleiner (2018). The first paper studies, for an exhaustive data set on Danish workers, the influence exerted by peers on the probability that any given worker may create a firm thereafter – here, two individuals are declared to be peers if they have been co-workers in a firm at some point during the preceding years. The latter two papers, on the other hand, ask an analogous question concerning the MBA students of two different American universities. In these cases, peers are defined to be those students who, upon entrance, are (randomly) assigned to the same section or cohort. The results reported in these three papers are not perfectly aligned. While the first one reports a positive peer effect on average, the latter two find that *experienced* students (i.e. those with some previous management record) induce a negative effect on the probability of firm creation by their peers. Further analysis of the data suggests that such a negative impact can be attributed to the discouragement effect resulting from the following simple observation: a good fraction of experienced students have gone through a prior *unsuccessful* venture. Our experiment identifies a related negative composition effect induced by experienced peers, although in our case it pertains to the quality of the business proposal submitted.

Another interesting context where similar peer effects are also expected to be at work is that of the so-called "ecosystem accelerators" – a relatively recent type of organizations, arising worldwide, whose objective is the support of early entrepreneurship. Despite their growing importance, however, there have been only a few papers studying them systematically. An interesting instance is given by the paper of Gonzalez-Uribe and Leatherbee (2018). They focus on a Chilean accelerator, Start-Up Chile, for which they have data of circa 1,000 different start-up ventures, spread over a period of five years. The paper shows that the basic services provided by the accelerator (including, of course, the peer networking indirectly allowed to participants by their sharing of co-working facilities) has a significant effect on the ensuing business performance of entrepreneurs *only if* combined with formal training. This conclusion resonates well with our work. For it is precisely an analogous complementarity, conjectured to be important also in our case, that has motivated the incorporation of a substantial training component in our experimental design.[5]

To motivate an additional key feature of our design – its outcome variables – we now turn to the literature discussing the relative merits of alternative schemes for the evaluation of entrepreneurs and business plans. Recall that the key outcome variable that measures the quality of business proposals in our case is generated through a two-stage procedure. First, the submitted proposals are assessed and ranked by junior professionals active in the African entrepreneurial ecosystem; second, those proposals identified to be among the best ones in the earlier stage are evaluated (and possibly funded) by our partner senior investors.

Our evaluation procedure raises the question of how relevant its assessment may be as an indicator of economic potential and firm survival. Two recent papers, Fafchamps and Woodruff (2017) and McKenzie and Sansone (2017), study the problem by contrasting in practice, for specific contexts, the performance of two alternative evaluation methods: surveys and expert panels.[6] Their main conclusion is that neither of the methods does a good enough job at "picking winners."[7]

In view of the previous discussion, the reader may wonder why we rely on panel rankings to generate our measure of business quality. The essential reason is that, in the minds of the entrepreneurs, their main short-run objective was (as confirmed by the baseline survey) crystal clear: to produce a business proposal that is funded. Thus, in this sense, it is reasonable to argue that their "innovation efforts" will be largely steered in the direction of matching the criteria they anticipate will be used by the investors to select the "winners." Obviously, whether or not such criteria are good at predicting economic success is a very important question, as emphasized by the two aforementioned papers. We abstract from this issue here, however, since the primary focus of our research is to understand how peers strive to improve the *investor-perceived* business quality, as this is precisely what is relevant for their immediate purposes.

Finally, we close this literature review by referring to a basic question: why is it that peer interaction may enhance innovation? One reason has already been discussed: peers can be a source of *motivation*, although in some cases they can also operate negatively by inducing discouragement. Another channel through which innovation can also be promoted is diversity (see e.g. Ottaviano and Peri (2006)). For, in some cases, social networks allow individuals to access and combine information, skills, and different approaches to problems in ways that expand substantially the range of possibilities that would be available otherwise. But does this mean, at least as far as innovation is concerned, that maximum group diversity is optimal? Again, the literature documents that there can be various effects at work, offsetting each other, and sometimes leading

[5]Even though, as discussed in the survey by McKenzie and Woodruff (2014), the effects of training on performance reported by the literature are at best weak, these authors also indicate that there is "stronger evidence that training programs help prospective owners launch new businesses more quickly." This suggests that in our context, where many of the entrepreneurs are involved in start-up ventures, business training should have a significant impact.

[6]Fafchamps and Woodruff (2017) focus on the business plans submitted to a business competition they ran in Ghana. McKenzie and Sansone (2017), use data from a very large business competition (YouWin!) run by the Nigerian government in collaboration with the World Bank. Besides the two methods mentioned in the text, McKenzie and Sansone also consider, as alternative options, machine-learning approaches and find comparable results.

[7]Even though Fafchamps and Woodruff (2017) find some complementary predictive power to both methods, it is a quite weak one. On their part, McKenzie and Sansone find that while some survey variables are weakly correlated with firm performance, panel decisions display essentially no correlation.

to a non-monotonic relationship. In general, therefore, while some diversity is typically welcome, too much of it can be detrimental.

In fact, the empirical literature studying the effect of diversity on innovation is itself a "diverse" body of work. So to mention just a few illustrative examples, we list the following papers: Lungeanu and Contractor (2015), who study a large collection of research teams world-wide in the medical field of oncofertility; Letaifa and Rabeau (2013), who focus on the large ecosystem of Canadian ICT firms in the Montreal area; Dayan, Ozer, and Almazrouei (2017), who consider the product development teams of manufacturing firms operating in the Ankara area; or Tavassoli and Carbonara (2014), who study the comparative innovation performance of the 81 different areas categorized in Sweden as distinct "functional regions." In all these empirical analyses, a suitable version of the aforementioned trade-off between the positive and negative effects of diversity is encountered, highlighting the complex way in which this feature enters into the social process of innovation. In this paper, we explore how national diversity (which itself should be associated to significant variation in a number of dimensions) bears on entrepreneurial innovation in a peer networking context.

3 Experimental design and main objectives

Our intervention was named *Adansonia*, a reference to a widely quoted African proverb that underscores the importance of "peer interaction" in the generation of knowledge.[8] Besides the research team, it involved a set of 15 young professionals and 24 senior investors (mostly VCs and angel investors) originating from different parts of the African continent. The role of both of these groups is explained below. For expositional clarity, the description of the experiment is organized in various subsections, each focusing on one of its constituent parts.

3.1 Recruitment

The entrepreneurs were recruited from all over Africa through a variety of different methods. The main ones were the following.

- **Social media**: We implemented a massive campaign on social media – mainly, Google and Facebook – that was targeted to reach either aspiring or operating entrepreneurs throughout the continent. These campaigns were based on a selected set of profiles, keywords, and sites, where our intervention was advertised.
- **Viral campaign**: Already registered participants were encouraged and incentivized to bring further participants into the experiment. The incentives were induced through a lottery to participate in a two-week program of different events (training, networking, and pitching) that were organized at Bocconi University at the end of the experiment. Further details on this program are provided below.
- **Information events on the ground**: A set of face-to-face events were organized in universities and entrepreneurial hubs where local partners explained the intervention and encouraged aspiring and established entrepreneurs to join.

[8] A Ghanaian version of the proverb reads: "Wisdom is like a baobab tree; no one individual can embrace it." Adansonia is the *genus* of the trees generally known as baobabs.

In the end, our recruitment efforts led to almost five thousand participants (4,958) from 49 different African countries. They were typically young and well educated individuals spreading quite widely over different sectors and demographic characteristics. Information on these characteristics was collected by an extensive baseline survey, as discussed in the next subsection.

3.2 Baseline survey

Prior to the intervention – and a prerequisite to be effectively part of it – all recruited individuals were asked to complete a survey consisting of 92 questions that took around 30 minutes to complete.

Table A1 in the Appendix provides a selected summary of the baseline information gathered from this survey. The information included in it can be essentially organized as follows.

- **Demographics**: Geographically, the population was quite disperse throughout the continent, although there were some significant biases as well. For example, Northern Africa was hardly represented in our full sample (most of the population originated from Sub-Saharan countries) and there was a larger representation of West Africa as compared to East Africa (53% *vs.* 35%), even though each part of Africa is quite similarly populated. Slightly over 30% of the population were female and 63% already had a business. They were also generally well educated (more than 80% had completed university education), about 1/3 were married, and they were quite young as well (the average age was around 30 years old).

- **Business profile**: Most of the subjects entered the experiment with some business idea – for more than half (55%) this idea was about a new business, while for 38% it was for an existing business. Concerning the sectoral distribution, agriculture, service, and technology were the dominant ones, in that order. On financial matters, most of them (90%) had savings in a bank account, but few (9%) ever got a loan from a bank. Concerning their desired source of funding, a sizable fraction (45%) preferred equity-based funding to loans, although there were also many (34%) that would be happy with either of them. They had an average of slightly more than 5 years of experience and 55% were employed at the time.

- **Networks**: The average number of people with whom our subjects typically discussed business topics was 4.6. To identify their taste for diversity, they were asked the profile of the person they would prefer to discuss business with. Only 11% expressed their preference for someone from another sector, of different gender (13%), or different country (18%).

- **Personal traits**: The personality of the participants was recorded along several dimensions. They displayed a moderate level of risk aversion in that they chose a lottery of intermediate risk out of six notionally offered. On the other hand, they exhibited an intermediate trust level, with an average of 4.81 in a 0-10 scale that measured their trusting attitudes through their elicited behavior in a hypothetical trust game. Concerning expectations and desires, while on average they placed themselves in a middle position in the socio-economic scale (4.82 in a 0-10 range), they *expected* to escalate up to an average of 7.84 and *desired* to reach an average of 9.06.

3.3 Treatment

In our RCT, the treatment involved being exposed to peer interaction. Such an interaction was conducted in randomly formed groups of 60 individuals (with some small deviations due to indivisibilities). We implemented two different mechanisms of interaction (face-to-face and virtual) and three different treatment arms (since virtual interaction was carried out in two different setups, compactly labeled "within" and "across"). In all three arms, interaction was promoted by means of so-called "tokens." We now explain each of these items in turn.

- **Face-to-face interaction** (f2f): In this treatment arm, the interaction was conducted *face-to-face*, the group meeting regularly for around three hours every two weeks in a certain location (the large premises of a partner institution). They met bilaterally or multilaterally, also subdividing themselves in subgroups of varying sizes to discuss their business ideas. This was mostly done in a self-organized manner. Around 6% of the treated individuals (all from Uganda, as explained below) were part of this arm.

- **Virtual interaction**: Most of the peer interaction (the remaining 94% of the treated population) was performed virtually and anonymously[9] through an open-source Internet-based platform that we customized, adapting it to our needs. Individuals were again partitioned in groups (also called "instances"), each of them including as well 60 individuals. Every individual could create as many "channels" (or rooms) as he/she wanted, and could also choose their focus and modulate their privacy at wish (e.g. restricting access). As it turned out, around 30% of the channels created were bilateral. In all instances, however, there was a general channel where anyone could participate and the information generated was public.

  As explained later in more detail, there were two different treatment arms among the entrepreneurs interacting virtually:

  - **Virtual-within** (vw): In this arm, groups were formed with all individuals in any given group being of the same nationality.
  - **Virtual-across** (va): In this alternative case, all groups were formed of mixed nationalities in proportion to their frequencies in the overall population.

- **Tokens**: To stimulate interaction, we provided an incentive mechanism that was intended to induce entrepreneurs to search for the best "matches" among their peers. It worked as follows. Every two weeks in the virtual arms, and at the start of every bi-weekly meeting in the f2f arm, individuals were provided with 10 tokens. They were advised to hand these tokens to those peers whom they found most helpful, both as a reward and as a means of keeping them "loyal" and involved in giving fruitful feedback. The value of tokens derived from the fact that, at the end of the intervention, the tokens given by the 50 highest-ranked entrepreneurs – as arising from the evaluation underlying our outcome (see Subsections 3.6 and 3.7) – acted as lottery tickets for one of the 30 (attractive) rewards that we labeled a "Bocconi Prize."[10] The tokens were meant to operate in both directions – that is, not only

[9] Each participant was exogenously given a nickname, which contained no information on nationality, gender, or age.

[10] The prize involved a fully-covered two-week trip to Milan that, among other things, included the following: an intensive entrepreneurship course offered by the Bocconi Business School; a pitching event where they submitted their project to European VCs for funding; the participation in a three-day high-level conference on Africa, and some tourism (e.g., a trip to Venice).

as a way of attracting good peers on the part of the token-giving entrepreneurs, but also as a stimulus for the peers to find "promising" entrepreneurs for whom they could prove to be most beneficial (thus improving their chances of being highly ranked). In fact, the messages exchanged by entrepreneurs show that tokens often played such a twin role in their interaction.

3.4 Randomization

In order to evaluate the impact of the alternative treatment conditions described above, it is useful to divide the overall population into the following three (disjoint) samples – see Figure 1 for an illustration of the experimental design.

- **The Uganda Sample** (UgS). This sample included all the individuals (568 of them) originating from Uganda who lived in the vicinity of Kampala. They were randomly partitioned into three essentially equal-sized subsamples: **control, f2f-interaction, and vw-interaction**. The first subsample was offered no peer interaction, while for the latter two the interaction provided was of the f2f or vw type, respectively.
- **The Large-Country Sample** (LCS): This sample included all individuals (3,333 of them) who originated from one of the five countries that we labeled as "large," i.e. Ghana, Kenya, Nigeria, South Africa, and Tanzania. These were the countries whose number of entrepreneurs in the total population was high enough to allow for the formation of enough groups of the same nationality. This sample was, therefore, the only one in which vw-interaction could be suitably tested against va-interaction. The test was implemented by creating three equal-sized subsamples: **control, vw-interaction, and va-interaction**. While individuals in the first one were offered no peer interaction, the other two had access to virtual interaction of either type.
- **The Small-Country Sample** (SCS): This sample consisted of all individuals (1,057 of them) who originated from the 44 small countries obtained by excluding the five large ones. In this case, of course, all interaction among the treated entrepreneurs was of the va-type.

By splitting the data into the above three samples, we shall be able to identify not only whether the peer-interaction treatment may be effective but, if it is, what type of such interaction (f2f or virtual) and how much peer diversity (within or across) yields the strongest impact. For each of these samples, the randomization across the constituent subsamples was conducted by stratifying according to the following baseline characteristics: gender; country (for the LCS) or region (for the SCS); having a prior business; and submitting the first "milestone" of the course on time (which was prior to the randomization, as explained below in our description of the online course). This stratification was implemented in order to ensure control-treatment balance on those characteristics, which was judged particularly important. In fact, as shown in Tables A2-A4 in the Appendix, balance was obtained across treatment arms for all three samples: UgS, LCS, and SCS.

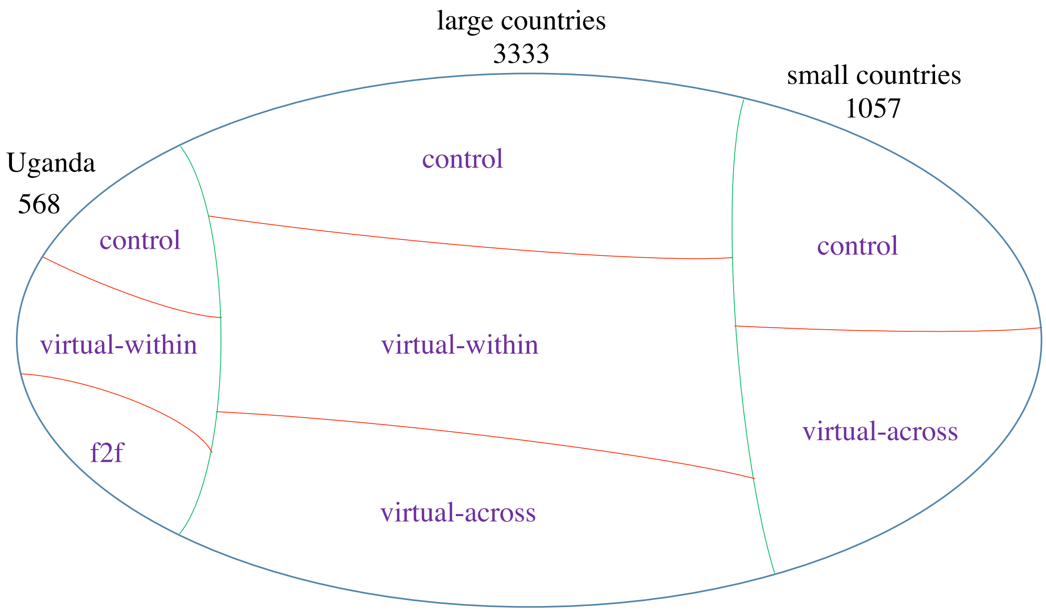


Figure 1: **Experimental design: schematic representation of the randomization conducted for each of the three samples: UgS, LCS, and SCS.**

3.5 Online course

In parallel with the process of peer interaction, an online course on entrepreneurship was provided to all participants, treated and control alike. The completion of this course was required in order to be able to submit the business proposals at the end of the intervention. The course was structured in six modules and four milestones. The first of these milestones, labeled Milestone 0, was completed early on, before the randomization was performed and the peer interaction started. It included a short description of the initial business plan of the entrepreneur, which was externally evaluated and then identified with the *baseline quality* of the entrepreneur.[11] On the other hand, the last milestone, Milestone 3, involved the submission of the final business proposals. These proposals were then evaluated (and selected for possible funding) by the two-stage procedure described in Subsection 3.6. For a schematic description of the course, please refer to Figure A1 in the Appendix.

The online course and the peer interaction were implemented in parallel with a less-than-perfect time overlap (see below for the precise timing). The lectures were given by Bocconi professors and African VCs. They were video-recorded and supported by companion ongoing slides. At the end of each module, the participants had to take an online multiple-choice quiz, which was corrected and evaluated automatically. The content of the course was a relatively standard entrepreneurship course, but with an approach and

[11] The evaluation was conducted by one of the 15 African professionals who undertook the first-stage evaluation of the full-fledged business proposals submitted at the end of the experiment.

content adapted to the African environment (e.g., concerning the case studies). The main objective of the course was simple: by the end of it, each participant should be able to draft an economically coherent business proposal and have some basic notions on how to pitch it.

3.6 Timeline

The field experiment was conducted during the spring-summer of 2017. The following steps took place in sequence:

1. The **online course** lasted for ten weeks, from *May 22nd to July 31st.* Milestone 0 (where the participants summarized their initial business idea) had to be completed no later than May 29th.

2. The **peer interaction** (in all treatment arms) ran from *June 6th to August 14th.* Thus, it had the same duration as the course, ten weeks, but started two weeks later. This meant, in particular, that the treatment had no effect on Milestone 0.

3. The **submission of business proposals** could be performed at any point within the period running from *August 8th to August 15th.* All participants were allowed to resubmit a revised version up to the deadline.

4. **The first-stage evaluation** of business proposals took place from *September 15 to October 15.* It was conducted by a panel of 15 African professionals with ample experience in entrepreneurship programs throughout the continents (mentoring, training, and investment). They graded all the submitted proposals in a 1-5 scale. These grades defined one of the primary outcome variables of the experiment (see Subsection 3.7).

5. The **second-stage evaluation** took place from mid November 2017 to February 2018, involving a group of 36 partner investors affiliated to the Adansonia program (mostly VCs and angel investors). This evaluation applied to the subset of 608 proposals that, on the basis of the ranking resulting from the first stage, qualified as "good enough."[12] These proposals were distributed to investors, according to their expertise and declared interest.[13] They were not only graded (again in a 1-5 scale) but also considered for possible funding. A total of 93 proposals actually moved into this last phase.

3.7 Outcomes

Our experiment delivered a wide variety of outcomes, thus calling for a multi-sided approach to the analysis of the resulting evidence. The main outcome dimensions to be considered are the following.

[12] More precisely, the evaluation involved two steps. First, the proposals that were assigned one of the top two grades (4 or 5) in the first stage by the panel of African professionals were included into the selected set. This amounted to 444 proposals. Second, in order to increase the size and diversity of the pool of proposals considered, an evaluation analogous to that of the first stage was conducted by a panel of 15 advanced students from the Bocconi Ph.D. program of Business Administration. Any ***new*** proposal assigned a top-two grade by these evaluators was also included in the selected set. This added 164 proposals.

[13] Eventually, only 24 out of the 34 original investors completed their task on time to be considered, which reduced to 454 the set of proposals actually evaluated. This happened for a variety of reasons. Some investors quit business since the time when they were recruited, while others were too busy or simply lost interest in partnering in the intervention.

1. **Submission**
   A first and important outcome variable is the number of participants (both treated and in the control) who actually submitted a business proposal at the end of the intervention (see item 3 above). As we shall see, there is a significant fraction of individuals who did not submit a proposal, and the alternative treatment arms had a differential effect on the extent of submission.

2. **Business quality**
   Recall that the evaluation of the business projects submitted was conducted in two stages, in both of them a grade in the range 1-5 being assigned to the proposals in the corresponding pool. The grade obtained in the first stage (the only one where *all* submitted proposals were ranked) is the outcome variable we use in our experiment to measure business quality.

3. **Network**
   As explained in Subsection 3.3, 96% of the treated population interacted virtually through the Internet-based platform designed for this purpose. For these treated participants, we have a comprehensive longitudinal (panel) recording their interaction throughout the intervention. Operationally, we rely on these data to construct the social network by considering different procedures – i.e. different ways of declaring that a link exists between any two entrepreneurs, as well as alternative forms of quantifying the density of every such link. For each of these formulations, we record how the pattern of (weighted) connections unfolds, depending on different circumstances (e.g. particular treatment) and individual characteristics (e.g. gender, age, or experience).

4. **Messages**
   Concerning the interaction taking place within the treated population, not only do we have information on the intensity of inter-agent links but we also have full access to the posts themselves. As explained, to categorize and analyze them, we have applied the techniques used in the field of Natural Language Processing (NLP) to the whole communication undertaken (a total of 140,000 sentences).

The items listed above (submission, business quality, network, and messages) correspond to the four main *outcome dimensions* studied in our experiment. Each of them, of course, can be studied separately, and this is what we initially do. However, a proper analysis of the problem must account for the interplay of all of them, thus moving well beyond a black-box analysis of the treatment effect. Undertaking such a multidimensional perspective on the problem, we shall shed light on the *concrete* process through which the treatment, when successful, ends up working its way through.

4 The treatment effects

As explained, the treatment – in its different variants – may have an effect on a number of different experimental outcomes. In this section, most of the focus is on what may be regarded as the two most basic effects of the treatment, namely, the impact it has on the rate at which the subjects submit their business proposals (Subsection 4.1) and its influence on the quality of the proposals submitted (Subsection 4.2). The complementary analysis of how the treatment impinges on inter-agent networking and the sign and magnitude of the entailed bilateral effects is postponed to Section 5

4.1 Submission

Prior to studying how the treatment affects the quality of the business proposals that are actually submitted, an important concern is how it influences the extent to which entrepreneurs submit their business proposals. The results in this respect are summarized for the different treatment arms in Table 1, where we code no-submission/submission as a binary variable $\sigma \in \{0, 1\}$, and partition the analysis into our three leading samples: UgS, LCS, SCS. This table has two columns. The first one considers the full samples in each of the three aforementioned cases, while the second column restricts attention to the subsample of those who submitted M0 (Milestone 0) on time in the business course – cf. Subsection 3.5. The composition of such "M0 completers" could not be affected by the treatment since, as explained, M0 had to be submitted prior to randomization. Moreover, we stratified the randomization on M0 submission, which guarantees balance across treatment arms within this subgroup. Those entrepreneurs (55% of the population) are interpreted as being those who were especially motivated (or otherwise more available to focus). An indication that this interpretation is reasonable follows from the observation that the submission rate under this condition is *uniformly* (and substantially) higher than in the unconditioned case (in particular, it is around 20 points higher among the control subpopulation for each of the three original samples). We observe that for this subgroup not only were submission rates higher, but also the level of participation in the interaction treatments was stronger, which implies a significantly higher statistical power to detect treatment effects.

A first observation that can be gathered from Table 1 is that, if one computes the overall submission rate of the different treated subpopulations and compares it with that of the control, the former is higher than the latter. Specifically, for the full samples we arrive at a combined average of 41.7% across the different treatment arms and 38.1% in the control, while the respective rates for the M0 completers are 63 and 58.3%. This aggregate account, however, conceals the marked contrast in the magnitude and sign of the treatment effect on submission that is displayed by Table 1 among the three samples. Let us then discuss them in turn.

The first column of the table separately includes *all* the entrepreneurs belonging to each of the three samples: the Uganda Sample (UgS), the Large-Country Sample (LCS), and the Small-Country Sample (SCS). For the UgS we find that whereas the treatment effect on submission is positive and statistically significant for the face-to-face (f2f-) treatment, the positive effect arising under virtual-within (vw-) interaction is not statistically significant. Since for the LCS the vw-treatment is positive and significant, it is reasonable to understand the non-significance of the vw-treatment for the UgS as a consequence of the smaller sample size. The fact that this small-sample handicap does not crucially impinge on the f2f-treatment means that in this case the effect is strong enough to arise as significant despite the low numbers involved.

Next, to understand the comparative effect of the treatment in the v-within and v-across we focus on the LCS, the only context where the two subarms are implemented. Then we find that, in contrast with the aforementioned positive and significant impact of vw-interaction, no significant effect is induced by va-interaction. Indeed, the non-positive effect on submission arises even more starkly on the SCS, where the effect is negative. This suggests that, at least on submission, there are consequential differences between vw- and va-interaction. While in the former case the effect is positive, in the latter it is either negative or, at best, very weakly positive, although our sample size does not allow us to reject the hypothesis of equal effects for both arms in the LCS. This is remedied if we pool our estimation for each treatment arm across all three samples, as shown in Table A5 in the Appendix.

Table 1: **Treatment effect on the submission of business proposals**

	(1)	(2)
	Full samples	M0 completers
Panel A. Uganda Sample (UgS)		
Face-to-face treatment	0.126^{***}	0.151^{**}
	(0.038)	(0.065)
Virtual-within treatment	0.022	0.041
	(0.034)	(0.064)
Control mean	0.34	0.55
p-value face-to-face = virtual within	0.00	0.05
Number of entrepreneurs	568	291
Panel B. Large-Country Sample (LCS)		
Virtual-within treatment	0.036^{**}	0.048^{**}
	(0.015)	(0.023)
Virtual-across treatment	0.014	0.018
	(0.018)	(0.026)
Control Mean	0.38	0.58
p-value virtual-within = virtual-across	0.18	0.15
Number of Entrepreneurs	3,333	1,848
Panel C. Small-Country Sample (SCS)		
Virtual-across treatment	-0.057^{**}	-0.036
	(0.024)	(0.037)
Control Mean	0.42	0.61
Number of Entrepreneurs	1,057	596

Notes: Estimated coefficients for OLS regressions of the submission outcome on indicators for treatment (face-to-face, virtual-within, and virtual-across interaction) in the three different samples considered: UgS, LCS, and SCS. Column (1) applies to the whole population in each of the samples, while Column (2) restricts to those who submitted M0 on time in the business course. We include strata fixed effects and cluster the errors at the group level for treated individuals (reported in parenthesis). The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

A quite parallel behavior is observed if the analysis is restricted to the subset of individuals who completed M0 on time, the results being reported in the second column of Table 1. Across the three subsamples (UgS, LCS, and SCS), the pattern of treatment effects is similar to that of the full sample except for one difference: for the SCS, the effect is negative but not statistically significant. Overall, therefore, one can informally summarize our analysis of how the treatment affects submission as follows. There is a progressively decreasing effect that runs from the context where interaction is most "***direct***" and the peer pool is more ***homogeneous*** and ***motivated*** (f2f in the UgS for M0 completers) down to the case where the interaction is "***indirect***" (virtual), the pool is more ***heterogeneous*** and on average ***less motivated*** (SCS, full sample).

4.2 Business quality

Now we extend our previous submission analysis to the study of the effect that the treatment has on business quality. This quality is assessed through the first-stage evaluation described in Subsection 3.6, and therefore it is only available for the proposals actually submitted. Specifically, the quality outcome variable assigned to each of those submitted proposals is the grade $\varpi \in \{1, 2, ..., 5\}$ it obtained in that evaluation.

The estimated treatment effect on this outcome variable is reported in Table 2 for the different treatment arms. If we focus again our attention on the subsample of "motivated" entrepreneurs (those who submitted M0 on time), we observe in the second column that vw-interaction produced a statistical significant positive effect, both in the UgS and the LCS (amounting, for example, to 0.12 of the standard deviation in the latter case). Instead, for f2f- and va-interaction, no significant effect is identified. A similar pattern arises for what we label the *quality effect*, defined as the difference in average quality increase between the submitters that belong to the different treatment arms and the control subpopulation.

Clearly, the validity of the previous conclusions is exposed to the risk of a selection (or composition) bias since the set of submitters is endogenous. And indeed, in our context, this possibility cannot be *a priori* discarded since a significant subset of participants did not submit (recall Subsection 3.7) and, furthermore, treatment and control displayed quite different extents of attrition. In view of this, we need to contemplate additional considerations that may reasonably rule out (or at least bound) a potentially distorting impact.

To this end, we pursue the approach proposed in Attanasio *et al.* (2011), also pursued by Alfonsi *et al.* (2017). The key assumption underlying it is that the population does not have any so-called "defiers," i.e. individuals who do not submit a proposal when treated, while they do so when not treated. This appears to be a plausible assumption in that it reflects the idea that, when an entrepreneur is given the ***opportunity*** to interact with peers (which, of course, can be simply ignored), this should not discourage her from submitting a proposal when she should have done it otherwise (i.e. as part of the control). This is in fact supported by our results on submission (Table 1) for the treatment arms where a positive treatment effect is identified, and even fully across all subsamples if we restrict to "motivated" entrepreneurs (M0 completers).

To formalize matters denote by $S(\theta) \in \{0, 1\}$ the *contingent* decision of whether to submit ($S(\theta) = 1$) or not ($S(\theta) = 0$) where $\theta \in \{0, 1\}$ is an indicator for treatment ($\theta = 1$) or not ($\theta = 0$). With this notation in place, we can identify each of the four possible types of individuals with a corresponding pair $(S(0), S(1)) \in \{0, 1\}^2$. The aforementioned *defiers* are characterized by the pair $(1, 0)$, while those described by the pair $(0, 1)$ can be called *compliers*. In contrast, the individuals of type $(1, 1)$ will be called *always submitters*, and those of type $(0, 0)$ *never submitters*. For any such possible type $t \in \{0, 1\}^2$, $\mathbb{P}(t)$ will denote the fraction/probability of individuals of type t in the population.

Attanasio *et al.* (2011) show that, if the following assumption holds:

Table 2: **Treatment effect on business quality**

	(1)	(2)
	Full samples	M0 completers
Panel A. Uganda Sample (UgS)		
Face-to-face treatment	0.180	0.059
	(0.267)	(0.230)
Virtual-within treatment	0.335^{*}	0.427^{**}
	(0.179)	(0.204)
Quality control mean if submitted	2.61	2.66
Quality effect face-to-face	0.18	0.03
Quality effect virtual within	0.30	0.38
Number of entrepreneurs who submitted	221	179
Number of entrepreneurs	568	291
Panel B. Large-Country Sample (LCS)		
Virtual-within treatment	0.070	0.138^{**}
	(0.070)	(0.068)
Virtual-across treatment	-0.021	-0.007
	(0.079)	(0.083)
Quality control mean if submitted	2.70	2.71
Quality effect virtual within	0.08	0.16
Quality effect virtual across	0.02	0.03
Number of entrepreneurs who submitted	1,322	1,118
Number of entrepreneurs	3,333	1,848
Panel C. Small-Country Sample (SCS)		
Virtual-across treatment	0.033	0.074
	(0.108)	(0.115)
Quality control Mean if submitted	2.65	2.65
Quality effect virtual across	0.05	0.09
Number of entrepreneurs who submitted	409	351
Number of entrepreneurs	1,056	595

Notes: The table presents, for each panel, the results obtained from OLS regressions of the business quality of submitted proposals (as derived from their first-stage evaluation) on indicators for treatment (face-to-face, virtual-within, and virtual-across interaction). The dependent variable takes discrete values from 1 to 5 representing the quality score (in ascending order) given by the evaluators. Column (1) applies to the whole population in each of the samples, while Column (2) restricts to those who submitted M0 on time in the business course. Following Attanasio *et al.* (2011), we also report for each sample the corresponding *quality effect*, which is defined as the (absolute) increase in average quality induced by the treatment. We include strata and evaluator fixed effects. Standard errors are clustered at the group level for treated individuals (reported in parenthesis). The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

No Defiers (ND): $\mathbb{P}(1,0) = 0$,

i.e., the population has no defiers, then the expected intensive-treatment effect on business quality $\varpi \in \{1, 2, ..., 5\}$ among submitted proposals (i.e. conditional on $\sigma = 1$) can be decomposed as follows:

$$\begin{aligned}\mathbb{E}[\varpi \,|\, \sigma = 1,\, \theta = 1] - \mathbb{E}[\varpi \,|\, \sigma = 1,\, \theta = 0] = {} & \{\mathbb{E}[\varpi \,|\, t = (0,1),\, \theta = 1] - \mathbb{E}[\varpi \,|\, t = (0,1),\, \theta = 0]]\} \, \frac{\mathbb{P}(0,1)}{\mathbb{P}(0,1) + \mathbb{P}(1,1)} \\ & + \{\mathbb{E}[\varpi \,|\, t = (1,1),\, \theta = 1] - \mathbb{E}[\varpi \,|\, t = (1,1),\, \theta = 0]\} \, \frac{\mathbb{P}(1,1)}{\mathbb{P}(0,1) + \mathbb{P}(1,1)} \\ & + \{\mathbb{E}[\varpi \,|\, t = (0,1),\, \theta = 0] - \mathbb{E}[\varpi \,|\, t = (1,1),\, \theta = 0]\} \, \frac{\mathbb{P}(0,1)}{\mathbb{P}(0,1) + \mathbb{P}(1,1)}.\end{aligned} \tag{1}$$

The LHS of (1) is the effect we can measure from the data whereas the effect that we are truly interested in here is given by the sum of the first two terms of the RHS of that expression. The difference between these two magnitudes is given by the third term of (1), which involves precisely the composition bias that concerns us here – $\mathbb{E}[\varpi \,|\, t = (0,1),\, \theta = 0] - \mathbb{E}[\varpi \,|\, t = (1,1),\, \theta = 0]$. More precisely, the issue is that a positive sign for the treatment effect could be *incorrectly* estimated if the aforementioned term is positive and large enough to "mask" a non-positive effect resulting from the two first terms in (1).

Attanasio *et al.* (2011) explores two different ways of addressing the issue. One of them involves bounding the difference between $\mathbb{E}[\varpi \,|\, t = (0,1),\, \theta = 0]$ and $\mathbb{E}[\varpi \,|\, t = (1,1),\, \theta = 0]$ by relying on the observed distribution of business quality observed for the non-treated submitters. In their context, however, this approach proves unsuccessful because the wedge between the estimated upper and lower bounds is too wide, and hence a negative effect in the intensive margin cannot be discarded.[14] As it turns out, an analogous procedure applied to our context delivers as well inconclusive results.[15]

The alternative approach proposed by Attanasio *et al.* (2011) to deal with the composition bias relies on the following assumption:

Better Always Submitters (BAS): $\mathbb{E}[\varpi \,|\, t = (1,1),\, \theta = 0] - \mathbb{E}[\varpi \,|\, t = (0,1),\, \theta = 0] \geq 0$,

which states that the expected business quality of those who submit in every case (both when they belong to treatment and control) is no lower than that of the entrepreneurs who switch into submitting only when they are treated. Arguably, this is a reasonable assumption to make. It reflects the idea that those who, even in the absence of peer interaction, would always submit a proposal are entrepreneurs who are relatively more self-confident or/and were keener on the prospect of receiving funding. Another complementary reason might be that they were those who benefited the most from the online course.

Under (BAS) one may be sure – maintaining the assumption (ND) that underlies (1) – that the estimated effect given by the RHS (1) *can only underestimate* the true impact of the treatment on intensive margin. That is, it may be asserted that the effect estimated by relying on the evaluation of the submitted proposals is a lower bound of the effect of the treatment on the quality of *any* treated entrepreneur (whether she

[14] See Blanco *et al.* (2013) or Alfonsi *et al.* (2017) for recent applications of a similar approach to different context.

[15] In particular, for the two samples where our estimation yields a significant treatment coefficient (cf. Table 2), the bounds implied do not remain in the positive region, not even if one restricts to the M0 subsample. For UgS the bounds computed to the aforementioned subsample define the interval $(-1.76, 1.82)$, while for the LCS the corresponding interval is $(-0.30, 0.35)$.

finally submits her proposal or not). Therefore, if the estimated treatment effect *conditional* on submission is positive and significant for M0 completers under vw-interaction, so is the *unconditional* effect as well.

As we did for the submission outcome, a sharper estimation of the treatment quality effect is obtained in Table A6 of the Appendix by pooling the observations obtained from the vw treatment arms across all three subsamples considered: UgS, LCS, and SCS. Combining it with our previous discussion on submission we may conclude that *vw-interaction is the only treatment arm that leads to a positive effect on both outcomes: submission and business quality*. In contrast, recall that f2f-interaction induces a positive impact only on submission, while va-interaction displays no significant effect on either of the two outcomes. Intuitively, this state of affairs could be understood as a reflection of the benefits derived from a suitable (intermediate) trade-off between familiarity/homogeneity and diversity/heterogeneity. We shall elaborate further on this idea when discussing our network-based results in Section 5.

To complete our present analysis, we report in Table 3 the estimated *marginal* effects of the treatment, obtained through a corresponding ordered-Probit regression. As expected, the treatment shifts weight from the lowest scores (1 and 2) to the highest ones (3 to 5) in the virtual-within arms (with a non-significant effect for score 3 in the UgS) while it yields no significant weight reassignment in all other cases.

Table 3: **Marginal quality effects (ordered Probit), M0 completers**

	(1)	(2)	(3)	(4)	(5)
	Score = 1	Score = 2	Score = 3	Score = 4	Score = 5
Panel A. Uganda Sample (UgS)					
Face-to-face treatment	-0.012	-0.010	0.007	0.012	0.004
	(0.050)	(0.042)	(0.028)	(0.048)	(0.016)
Virtual-within treatment	-0.078**	-0.094**	0.026	0.101**	0.045*
	(0.036)	(0.042)	(0.022)	(0.046)	(0.024)
Number of entrepreneurs = 179					
Panel B. Large-Country Sample (LCS)					
Virtual-within treatment	-0.032**	-0.019**	0.007*	0.028**	0.015**
	(0.016)	(0.009)	(0.004)	(0.014)	(0.007)
Virtual-across treatment	0.002	0.001	-0.001	-0.002	-0.001
	(0.020)	(0.010)	(0.006)	(0.017)	(0.008)
Number of entrepreneurs = 1,118					
Panel C. Small-Country Sample (SCS)					
Virtual-across treatment	-0.016	-0.009	0.005	0.016	0.005
	(0.027)	(0.016)	(0.008)	(0.026)	(0.009)
Number of entrepreneurs = 351					

Notes: The table presents the *marginal* effects on the predicted probabilities for the different business-quality scores estimated by ordered Probit regressions on indicators for treatment (face-to-face, virtual-within, and virtual-across interaction) in the three different samples considered: UgS, LCS, and SCS. We restrict the sample to entrepreneurs who submitted M0 on time (M0 completers) and include strata and evaluator fixed effects. Standard errors are clustered at the group level for treated individuals (reported in parenthesis). The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

4.3 Peer-composition effects

In this subsection we study the treatment from the interesting angle of how its effect depends on the profile of individual characteristics of the peers in the interaction group. Even though, obviously, such an effect must be mediated by interaction, the way in which individuals influence each other in this respect is very different from the network-based channel that will be studied in Section 5. The main contrasting features of the present approach can be summarized as follows.

(a) It is defined at the level of each group rather than at the link (bilateral) level.

(b) It is exogenously imposed on entrepreneurs (as the outcome of randomization) rather that endogenously chosen by the entrepreneurs themselves.

(c) It reflects the impact of peers' (fixed) baseline characteristics rather that the influence exerted by peers' (evolving) behavior.

In Table 4 we consider two prominent baseline characteristics, restricting for the sake of focus to the virtual-within treatment in the Large-Country Sample. One of those characteristics is the average baseline quality of peers, as obtained from the external evaluation of the initial business outline (see Subsection 3.5). The second characteristic considered is the average experience of peers, as measured by the fraction of those who were already operating a business at baseline. For the sake of clarity, the results are reported only for our largest sample, LCS, where we find positive and significant treatment effects for both outcomes: submission and business quality. Panel A in the table presents the results for the full sample, while Panel B considers the subsample of M0 completers.

Table 4: **Effects of peer composition on submission and business quality**

	(1) Submission	(2) Business quality	(3) Submission	(4) Business quality
Panel A. Full Sample in large countries				
Virtual-within treatment	0.024	0.116	0.024	0.124^{*}
	(0.015)	(0.071)	(0.015)	(0.070)
Own baseline quality	0.116^{***}	0.246^{***}	0.116^{***}	0.247^{***}
	(0.015)	(0.046)	(0.015)	(0.045)
Average baseline quality of peers	0.017	-0.424^{**}		
	(0.046)	(0.168)		
Share of peers with business			0.078	-1.539^{***}
			(0.107)	(0.502)
Number of entrepreneurs	2,222	899	2,222	899
Panel B. Sample who completed M0 on time in large countries				
Virtual-within treatment	0.034	0.147^{**}	0.035^{*}	0.167^{***}
	(0.020)	(0.066)	(0.020)	(0.059)
Own baseline quality	0.116^{***}	0.249^{***}	0.116^{***}	0.250^{***}
	(0.014)	(0.046)	(0.015)	(0.045)
Average baseline quality of peers	-0.028	-0.350^{*}		
	(0.051)	(0.191)		
Share of peers with business			-0.082	-1.600^{***}
			(0.135)	(0.363)
Number of entrepreneurs	1,231	758	1,231	758

Notes: The table uses data for entrepreneurs in the virtual interaction arms in the Large-Country Sample, both for virtual-within and virtual-across interaction. In all regressions we include strata fixed effects and control for *own baseline quality* (as obtained from Milestone 0). For those who did not complete Milestone 0 on time and were not assigned a baseline quality, we impute a value of 0 and add a corresponding dummy. *Average baseline quality of peers* is the average of this baseline score across other group members, while *share of peers with business* is the fraction of other group members that had a business at baseline. In columns (1) and (3) the outcome is the submission of a proposal, whereas in columns (2) and (4) the outcome is the quality evaluation for those who submitted a proposal. Panel A restricts the sample to those who completed Milestone 0 on time (before the randomization), while Panel B uses the full sample. Standard errors are clustered at the group level (reported in parenthesis). The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

Interestingly, we find that both the average baseline quality and the share of experienced peers exert a negative effect on the business quality of treated entrepreneurs, significant in every case. It is also worth highlighting that this occurs together with a positive effect of vw- (versus va-)interaction, even if one controls for own baseline quality, and both in the unrestricted subsample and that restricted to M0 completers.

These negative composition effects are reminiscent of those identified by Lerner and Malmendier (2013) and Hacamo and Kleiner (2018), discussed in Section 2. Recall that these authors suggest that the reason why the influence of peers with prior business experience tends to be detrimental is that those peers often tend to provide discouraging feedback. Here, not only do we find a negative effect of peer experience on performance – in our case, on the business quality of proposals – but even encounter a similar effect for the baseline quality of peers. This highlights that peer influence is, in general, a double-edged sword, whose positive or negative impact may depend on both the context of the interaction and the perspective of the analysis (e.g. group- or link-based).

4.4 The second-stage evaluation

As explained in Subsection 3.6, the set of submitted proposals that ranked highest in a first stage of the evaluation procedure were then evaluated in a second stage (and considered for possible investment) by a panel of investors. In principle, there is no reason to expect that the average quality of the proposals selected into the second stage should be any different depending on whether they originated from the control or the treated subpopulation. For, in both cases, they were evaluated "blindly" according to the same criteria. It is therefore not surprising that, as shown in the regression results reported in Table A7 in the Appendix, the effect of both the virtual-within and virtual-across treatments on the entrepreneurs who reached the second stage is non-significant.

4.5 Robustness

In this subsection, we describe some of the robustness checks we have conducted on the treatment analysis. For the sake of brevity, they are only informally described here, while the detailed results are reported in the Appendix.

First, we have considered replicas of our regressions that re-estimate the treatment effects on business quality, after adding controls for all the variables listed in the balance tables (see Tables A2-A4). The result of this exercise is displayed in Tables A8 (treatment effects) and Table A9 (marginal effects). All the previous conclusions remain essentially unchanged.

Second, we have revisited the effects of peer composition included in Table 4 and checked their robustness from two complementary viewpoints. In Table A10, we carry out a placebo test in which, relying on the same procedure used in the randomization of our experiment, groups are randomly formed among the entrepreneurs from the LCS that were assigned to the control. Then, we estimate whether significant effects of peer composition exist for such a randomization and find that, in contrast with the results found for the treated population, no composition effects are present. We also conduct a second exercise similar to that conducted by Cai and Szeidl (2017). We compute a "surprise effect" on business quality associated to the deviation of the average peer profile of every group from the one that one would expect in a randomly formed group. The difference between the two magnitudes reflects a surprise that, in the absence of bias, should be of the same type (sign and significance) as the formerly estimated effect. Indeed, Table A11 shows that the sign and pattern of significance obtained from such a construction is largely aligned with that displayed in Table 4.

5 Network analysis

In the present section we turn to studying how peer influence is channeled through the social connections that treated entrepreneurs ***choose*** to establish within their respective interaction group. Our primary objective will be to estimate the sign and magnitude of those network effects, understanding as well how they might differ across the different treatment arms. To do so, we first need to construct the social network out of the exhaustive data available we have collected on how the entrepreneurs connect and communicate. Such a network-construction task is undertaken next in Subsection 5.1, where we also provide some early description of the most prominent characteristics displayed by the resulting peer networks.

5.1 Network construction

Constructing the peer entrepreneur network requires specifying a way in which links are to be "operationalized" in terms of our data – in other words, we need to determine how to identify and measure the informational content flowing between any two entrepreneurs. Our approach will consider different complementary routes to it. The one we shall use as our benchmark identifies a link from i to j as a message sent by i that is followed by another message by j that can be interpreted as representing some feedback to i's message. More precisely, we define *link–formation* **(LF)** as follows:

(LF) (a) A *directed link* $i \rightarrow j$ is established for every message that i has posted in a particular channel/room[16] of the chatting platform such that j has subsequently written another message in the same channel. We also impose the requirement that j's subsequent message is written "not too long after" the message by i, as captured by a parameter τ to be described precisely below.

(b) When a link $i \rightarrow j$ exists, its *weight* is identified with the number of sentences included in the message sent by i that marks the start of the communication exchange. Then, adding the weight over all such links $i \rightarrow j$, we obtain what is defined as the *aggregate interaction flow* directed from i to j.

The simple idea captured by (LF) is that if j has been active on a certain channel shortly after i wrote a message on it, j has been exposed to (and probably read) the content of i's message. Therefore, there is some significant probability that whatever i wrote in that channel motivates j's subsequent message. In this sense, j's message can be viewed as a possible reaction to (or feedback on) the earlier i's message.

Clearly, the way in which we identify and measure communication between two entrepreneurs, i and j, can be conceived only as an approximate (and thus imperfect) assessment of their actual exchange of information and feedback. A more precise measurement of this flow would necessarily involve, *inter alia*, a

[16] Refer to Subsection 3.3 for a description of the chatting platform used in the experiment.

detailed analysis of the content of the messages themselves. This would allow, for example, to discern when j's message is indeed a reaction to i's prior one. To implement it, however, would require a detailed semantic analysis of the messages that goes beyond the scope of this paper. It seems nevertheless quite plausible that our ongoing application of the NLP methods outlined in Section 6 should be able to deliver such a refined identification of inter-peer communication and hence improve significantly our network analysis.

Still, one extension of our approach that we do explore in this paper pertains to the way in which the weight of a link is determined. For, in principle, one may argue that a limitation of (LF) is that, whereas it quantifies the intensity of communication in one direction – i.e. it measures, for each link $i \to j$, how "elaborate" is i's initial formulation of the problem or request of feedback – it is silent on the elaboration/richness of the response. A simple way (and hence also imperfect) to account for these reciprocal considerations is analyzed in Subsection 5.3.2, where the extent of communication across two agents is measured in both directions. As we shall see, this extension of the framework has no significant impact on our identification of peer effects.

Now we provide a concrete formulation for the phrase "not too long after" that was informally used in (LF). As explained, this notion is parametrized in terms of some τ, understood as the maximum "delay" that may separate the two messages involved in the declared link. In fact, such a delay is not measured time-wise but in terms of the number of *intermediate* sentences that have been posted in the channel, detaching one from the other. Such sentence-indexed "time" appears to be a better choice than calendar time for our purposes in that the number of intermediate postings reflects how far down the timeline of j this entrepreneur finds i'message (hence affecting its call on j's attention). The maximum lag τ is a modeling parameter that, as it decreases, has the obvious effect of (weakly) reducing the density of the induced network. As we shall show in Subsection 5.3.1, our results are robust to (i.e. essentially unaffected by) this parameter, provided it is not too small. For the sake of focus, we defer addressing such robustness concerns to Subsection 5.3, thus carrying out our present analysis within what we shall label the *benchmark setup*. This is a setup where the network is constructed under (LF) with no bound contemplated on the communication delay, i.e., formally, for $\tau = \infty$.

Next, some useful notation is introduced. Let the matrix $M = (m_{ij})_{i,j=1}^n$ capture the pattern of directed communication across every two agents, each entry m_{ij} standing for what we have called the aggregate interaction flow directed from j to i (which, as indicated in part (b) of (LF), is given by the total weight of the links $j \to i$). When no link $j \to i$ exists, we simply make $m_{ij} = 0$. Thus, for each $i = 1, 2, ..., n$, the ith row of matrix M embodies an absolute measure of the influence exerted on the specific entrepreneur i by all her peers $j \neq i$. From this information, one can readily construct the matrix $G = (g_{ij})_{i,j=1}^n$ of *relative influence* by normalizing each row of M so that, for every pair of entrepreneurs $i, j \in N$,

$$g_{ij} = \frac{m_{ij}}{\sum_{j=1}^n m_{ij}} \tag{2}$$

so that $\sum_{j \neq i} g_{ij} = 1$ for all $i = 1, 2, ..., n$. Such a matrix G defines the *adjacency matrix* of the weighted influence/peer network on which we shall base our ensuing analysis.[17]

[17] In general, one may be interested in accounting not only for relative weights but also for absolute intensities. Since the two perspectives – relative and absolute – may indeed be relevant, a richer specification would have to integrate both of them in some suitably combined manner. We choose, however, to abstract from these considerations in the present paper.

In the Appendix, Figures A2 and A3 provide a graphic illustration of the peer networks arising for two peer groups, one interacting in a virtual-within scenario (based in Nigeria) and another where interaction was of the virtual-across type. The appendix also includes a summary account in Table A12 of some canonical network measures such as average in- and out-degrees, clustering, and various notions of centrality. Throughout the remaining part of the paper, in order to focus on the truly engaged part of the population, we shall confine our analysis to the entrepreneurs who had some activity in the chatting platform, among those whom we have called M0-completers (i.e. those who completed Milestone 0 on time). Platform-active entrepreneurs represented 66% of M0-completers, amounting to a total of 1082 entrepreneurs. For short, those entrepreneurs will simply be called hereafter the *active* ones.

5.2 Network peer effects

Now we turn to what is the main aim of this section: the estimation of the network-based peer effects under the different treatment arms considered in our experiment. We start in Subsection 5.2.1 by discussing how we deal with some important identification issues, while the estimation itself of the core peer effects is conducted in Subsection 5.2.2. The robustness of our formulation and econometric approach is studied in Subsection 5.3.

5.2.1 The identification problem: reflection and homophily

As advanced, an important problem that needs to be tackled in estimating network peer effects in our context is one of identification. There are two main concerns in this respect. One is related to the well-known reflection problem raised by Manski (1993), which is a consequence of the fact that the choices and outcomes of peers are jointly determined. This renders it difficult in some cases to identify the structural parameters from the reduced form specification of the model. Another concern pertains to the confounding effect of homophily. In this respect, the problem derives from the fact that the network itself is endogenous in our case (i.e. it is the object of choice by individuals). Therefore, any observed correlation of behavior among peers might be not a result of network-mediated influence but of the tendency to interact with others who are alike in some relevant respect – say, similar in age, operating sector, or education level. For, as the ancient proverb goes, "birds of a feather flock together."

The approach we pursue here to tackle the reflection problem follows Bramoullé *et al.* (2009) and De Giorgi *et al.* (2010). In essence, it relies on the fact that, if the network structure is irregular enough, it is possible to instrument peers' behavior in terms of the exogenous characteristics impinging on the behavior of second neighbors – i.e. of entrepreneurs who are two steps away. Such instrumentation can then be used to identify the underlying peer effects. Of course, the key assumption here is that every influence across entrepreneurs has to be mediated by the network, i.e. through interaction among those who are connected. Then, the second neighbors of an entrepreneur can only affect her through intermediate peers, and this in turn implies that the usual exclusion restriction is satisfied, a requirement for successful identification.

Now we describe matters formally, as applied to our context. Denote by $\boldsymbol{y} = (y_i)_{i \in N}$ the outcome profile over the set N, the population sample of interest. The two outcomes that will be *separately* considered here are the same ones that were studied in the treatment analysis: submission and business quality (cf. Section

4). Recall that $G = (g_{ij})_{i,j=1}^{n} \in \mathbb{R}_+{}^{n\times n}$ represents the network adjacency matrix, whose typical entry g_{ij} is the weight of the link directed from i to j (as given by the number of messages written by i that can be "effectively" read by j). The outcome variables listed in $\boldsymbol{y}$ that are associated to the peers given by G are the main regressors in our estimation, in that they induce the network-based peer effects of interest. In addition, we also include the set of m exogenous baseline variables given by the individual characteristics obtained for each participant from the initial survey. They are arranged in the matrix $X = (x_{i\ell})_{i,\ell} \in \mathbb{R}_+{}^{n\times m}$ where a typical entry $x_{i\ell}$ stands for the ℓth characteristic of individual i.

We can then compactly describe the two-stage structure of the IV estimation considered here as follows:

$$\boldsymbol{y} = \alpha + G\boldsymbol{y}\,\beta + X\boldsymbol{\gamma} + \varepsilon \tag{3}$$

$$G\boldsymbol{y} = \varrho + X\boldsymbol{\delta} + G^2X\boldsymbol{\lambda} + \nu, \tag{4}$$

where ε and ν stand for stochastic noise satisfying the standard conditions. In line with our previous discussion, the key feature displayed by the above econometric estimation procedure embodied by (3)-(4) is that the variables in G^2X (the total influence weights associated to the peers lying two links away) are used as instruments for $G\boldsymbol{y}$ (the influence weights bearing on each entrepreneur, associated to her direct peers).

Besides the vertical intercepts α and ϱ, the coefficients to be estimated in (3)-(4) are the following:

- $\beta \in \mathbb{R}$ is the peer effect reflecting how $G\boldsymbol{y}$ – the (G-weighted) average of (direct-)peers' outcomes estimated from (4) – affects own outcomes;

- $\boldsymbol{\gamma} = (\gamma_1, \gamma_2, ..., \gamma_m)'$, $\boldsymbol{\delta} = (\delta_1, \delta_2, ..., \delta_m)' \in \mathbb{R}^m$ are the column vectors of regression coefficients for the m own baseline covariates considered in the first and second stage of the estimation, respectively;

- $\lambda = (\lambda_1, \lambda_2, ..., \lambda_m)' \in \mathbb{R}^m$ is the column vector of regression coefficients associated to the m baseline covariates of second-order neighbors used as instruments in the second stage of the estimation;

The framework given by (3)-(4) defines the basic model within which we shall undertake our estimation of the peer effects. As explained in Bramoullé *et al.* (2009), if G^2, G, and the identity matrix I are linearly independent (a condition satisfied in our setup), the above framework suitably identifies the peer-effect coefficient β of interest. As indicated, however, the IV estimation conducted here requires two further assumptions for proper identification:

(**ER**) The instruments satisfy the familiar exclusion restriction, which in our case amounts to the requirement that all peer influence be channeled through the network.

(**NE**) The peer network is either exogenous or, if endogenous, the biases induced by the link-formation process can be suitably controlled for.

The essential idea underlying (ER) has already been explained: since our peer network is irregular enough, there are second-order neighbors whose behavior can be used as a valid instrument. Concerning (NE), on the other hand, the problem is that in our case we *cannot* of course assert that the network is exogenous, for its endogeneity is indeed one of the distinctive features of the experimental setup. Therefore, what we put forward instead is the claim that, in view of the quite wide range of individual characteristics gathered at baseline from the survey and the course (recall Table A1), most of the correlation in peer performance induced by network-formation forces (e.g. homophily) may be suitably explained in terms of those baseline (exogenous) covariates. Controlling for them, in other words, the estimated peer effects should be largely free of the bias that might otherwise be induced by the endogeneity of the network. In this respect, an important point to bear in mind is that, since interaction in our experiment is online and fully recorded, we (analysts) observe and know everything that subjects observe or know about other participants.

5.2.2 Core effects

Here we turn our attention toward estimating the impact of direct bilateral interaction along the same lines as we did for the treatment effects in Section 4 – i.e., on the two dimensions of entrepreneurial performance (submission and business quality) and within the three virtual-interaction contexts (v-within and v-across in the LCS, v-across in the SCS).[18] Overall, therefore, the analysis will be undertaken for *six* different cases, each of these matching a corresponding counterpart in the treatment analysis conducted in Subsections 4.1 and 4.2. Concerning the network specification, here we rely on what we have labeled the benchmark setup (cf. Subsection 5.1) – i.e. the network is constructed under no upper bound on the communication lag (i.e. $\tau = \infty$) and with the link weights determined as specified in (LF). Subsequently, we shall explore various extensions (in particular, with finite values of τ and bidirectional links).

A combined compact description of the estimated network-based peer effects is displayed in Table 5 below, while for a full description of the results, with estimates corresponding to all (*own*) baseline covariates, we refer the reader to Tables A13-A14 in the Appendix.

Table 5: **Network peer effects, benchmark setup**

	Virtual within, LCS	Virtual across, LCS	Virtual across, SCS
Proposal submission			
Peer effect	.533***	.014	.098
	(.160)	(.132)	(.289)
Number of entrepreneurs: 1016			
Business quality			
Peer effect	-.031	.087	.476***
	(.112)	(.140)	(.149)
Number of entrepreneurs: 779			

Notes: Estimated network-based peer effects for the benchmark setup ((LF) and $\tau = \infty$) on two different outcomes: the *submission* decision and the business quality of submitted proposals. The estimation is jointly conducted for the three subsamples: v-within and v-across for large countries and v-across for all small countries, restricted to those entrepreneurs who completed Milestone 0 on time. We control for all baseline individual characteristics, using as well their second-neighbor values as instruments in a corresponding two-stage OLS. For a full account of the estimated coefficients, see Tables A13-A14 in the Appendix. Standard errors are clustered at the group level, which gives rise to 44 clusters. The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

In attempting to understand the pattern of effects displayed in Table 5, it may be useful to put forward, in a largely heuristic/conjectural manner, the polar forces that might be at work in the different scenarios:

(a) Peer interaction in homogeneous contexts, because of the predictability/familiarity it entails, supports trust and encourages participation.

[18] For the sake of focus, we exclude the Uganda sample under virtual-within interaction since the effects are analogous to those observed for large countries under this type of interaction.

(b) Peer interaction in heterogeneous contexts, by exposing individuals to diverse environments fosters creativity/innovation and hence enhances the quality of business proposals.

(c) In contrast to (a), and for converse reasons, interaction in heterogeneous environments should not stimulate participation.

(d) In contrast to (b), and for converse reasons, interaction in homogeneous environments should not promote the quality of business proposals.

In combination, (a)-(d) may be used to rationalize the results displayed in Table 5. On the one hand, the context vw-LCS may be viewed as displaying the highest homogeneity in interaction. Thus, in line with (a) and (c), we expect to find in this case that, as the regression results do indicate, peer effects are positive and highly significant for submission but non-significant for business quality.

On the other hand, the entrepreneurs in the SCS under va-interaction can be regarded as being those exposed to the highest cross-country heterogeneity, the reason being that these are the entrepreneurs who, in mixed balanced groups, will typically have fewer co-nationals in them. Therefore, as suggested by (b) and (c), we would expect that the effect on submission is not significant whereas that on business quality is positive and highly significant. Again, this is consistent with the regression results.

Finally, the entrepreneurs from large countries subject to va-interaction face, in a sense, the worse of the two former cases. On the one hand, their conditions are not as homogeneous (and hence encouraging for participation) as in the context vw-LCS, for in this case a significant fraction of their group will include entrepreneurs who are not from their own country. On the other hand, their exposure to diversity is not as rich as that of agents in the SCS since, even in the nationally heterogeneous groups induced by va-interaction, the fraction of co-nationals they can interact with is typically much higher than for entrepreneurs from small countries.[19] Hence one may expect that neither the peer effect on submission nor that on business quality is strong enough to produce significant results, as in fact observed in Table 5.

The former heuristic discussion suggests the need to explore systematically the type of communication (in particular, its content and sentiment) that materializes in each of the treatment conditions of our experiment. Much could be learned from such *semantic analysis* – in particular, concerning the validity of the former heuristic rationalizations of the estimated peer effects. As already mentioned, the potential of this NLP-based approach is illustrated in Section 6, where some of the results in this respect obtained so far are briefly described.

Finally, one interesting issue to highlight at this point is the contrast between the treatment and network effects on business-quality outcome, as displayed in Tables 2 and 5. On the one hand, the treatment is found to have, on average, a significant (positive) impact on the quality of submitted proposals *only* when interaction is of the virtual-within type. On the other hand, we observe that the network peer effects on business quality are estimated to be significant (and positive) *only* under virtual-across interaction in the SCS. Even though, at first sight, this contrast may appear somewhat surprising, one should bear in mind that treatment and network effects are conceptually different notions. For, in general, treatment effects concern the *overall* impact of the treatment on performance, while network peer effects measure the extent to which

[19] The share of individuals of the same country in the virtual-across arms is, on average, only 4% for small countries while it is 29% for large countries.

an entrepreneur's outcome is affected by the corresponding outcomes displayed by her *direct* network peers. Thus, even if network effects on business quality are strong and positive, their impact on the individual quality of many entrepreneurs could well be insignificant (or even negative) if a good number of their direct-peers were of low quality. This, in principle, could be a possible explanation for the state of affairs observed in the virtual-across arms.

Conversely, it is also possible that, as it happens in the virtual-within scenarios of our experiment, a positive treatment effect on business quality arises in conjunction with weak (statistically insignificant) peer effects on that same outcome. This could happen if, for example, diffusion of information were to unfold vigorously through the network, not only directly but also indirectly along drawn-out paths. Then, one would observe sizable overall effects, even if it would be difficult to discern significant peer effects across directly communicating peers. The contrast between the situations arising between the two virtual-interaction contexts, within and across, can therefore be a consequence of different degrees of information diffusion, possibly a reflection of different degrees of trust in either a familiar or unfamiliar environment. Again, we suggest that in order to understand the actual mechanism at work (and therefore the validity of alternative explanations), the aforementioned semantic analysis of the inter-peer communication should provide an important contribution.

5.3 Robustness

In this section we check the robustness of our results to extensions of the underlying framework in two different directions. First, in Subsection 5.3.1, we explore the implications of having the maximum communication lag τ be finite, possibly relatively small. Second, in Subsection 5.3.2 we study whether our results are affected if the network is assumed to be bidirectional, the weight of each link reflecting the volume of information that flows both ways between the corresponding pair of entrepreneurs.

5.3.1 Parametrizing the communication lag

As explained in Subsection 5.1, our benchmark setup contemplates an unbounded communication/interaction lag, i.e. has $\tau = \infty$. In view of the starkness of this assumption, we have analyzed how the results – in particular, the estimated peer effects – vary as the value of τ varies within a *finite* range. The outcome of this robustness exercise is diagrammatically described in Figures 2-3. Each individual figure shows, for ***one*** of the two dimensions considered here (submission and business quality), how the estimated peer-effect coefficient and its corresponding confidence interval at 5% significance level change as a function of τ. This is displayed in three separate panels (a)-(c) for the following three different interaction scenarios: virtual-within for large countries, virtual-across for large countries, and virtual-across for small countries.

It is in the nature of the procedure used in network construction that higher values of τ must lead to a denser network. This in turn implies that, as displayed in Figures 2-3, the coefficient estimates and corresponding confidence intervals progressively stabilize as τ grows. Besides this simple observation, there are two main features we want to highlight from these diagrams:

(a) For any $\tau \geq 80$ (i.e. a maximum communication lag of at least 80 "intermediate" sentences) the estimated peer coefficient reaches in every case (i.e. for each of the two outcomes considered and for all three interaction scenarios) a value very close to the coefficient estimated in Table 5 for $\tau = \infty$.[20]

(b) For any $\tau \geq 40$, the estimated coefficients already achieve the statistical significance they enjoy in the benchmark setup.

The former two points are reassuring. They indicate that our results are quite robust to how the network is constructed, at least concerning the "immediacy condition" required for effective interaction/communication.

5.3.2 Two-sided communication flows

As suggested in Subsection 5.1, one may argue that the influence that an entrepreneur i exerts on another one j might depend on the stream of messages flowing in both directions. To capture this idea, we presently consider the following variation on the link-formation rule (LF) considered in the benchmark setup.

($\widehat{\mathbf{LF}}$): (a) A *directed link* $i \to j$ exists if (a) in (LF) applies.

(b) For any link $i \to j$ that exists (according to (a)), its weight is identified as in the first part of of (b) in (LF). In contrast to its second part, however, we now define the (symmetric) *aggregate interaction flow* across any i and j as the aggregate weight over all links $i \to j$ ***and*** $j \to i$.

As in the benchmark setup, we focus for simplicity on the case where the interaction lag $\tau = \infty$. Then, on the basis of item (b) in the new ($\widehat{\text{LF}}$) – and, in particular, due to its *bidirectional* formulation – we are led to a (symmetric) matrix of interagent influence:

$$\hat{M} = (\hat{m}_{ij})_{i,j=1}^{n} = M + M^{\top} \tag{5}$$

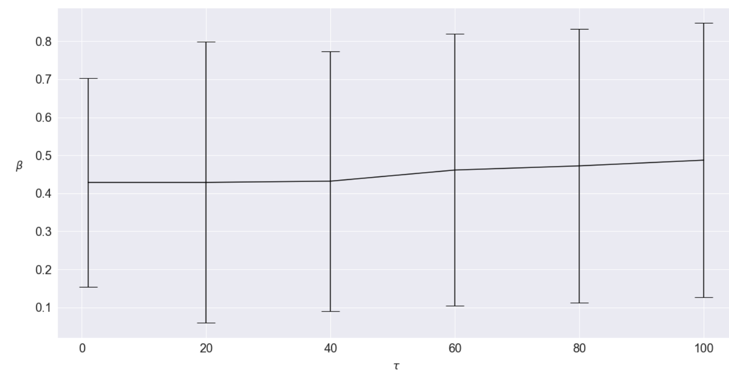
where M is the matrix of directed interaction constructed in Subsection 5.1 under formulation (LF) and $M^{\top}$ stands for the transpose of M. Then, row-normalizing the matrix $\hat{M}$ (as we did for M), we arrive at the matrix $\hat{G} = (\hat{g}_{ij})_{i,j=1}^{n}$ in which, as a counterpart of (2), we have:

$$\hat{g}_{ij} = \frac{\hat{m}_{ij}}{\sum_{j=1}^{n} \hat{m}_{ij}}. \tag{6}$$

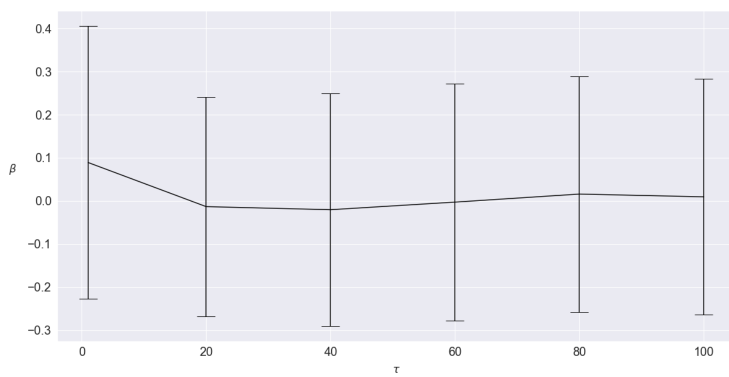
With this adjacency matrix (not typically symmetric in our case, due to normalization) representing the pattern of influence across entrepreneurs, we re-estimate the peer effects through the same econometric model used in Section 5.2, with G replaced by $\hat{G}$. The results are displayed in Table 6 below.

Comparing Tables 5 and 6, we find that the qualitative pattern of (significant) peer effects is exactly the same under (LF) and ($\widehat{\text{LF}}$), although the magnitudes of the corresponding coefficients differ somewhat. This happens despite the fact that the matrix M is highly non-symmetric, displaying an influence structure that is quite different from that of $\hat{M}$ – to be precise, the correlation between the entries of M and $M^{\top}$ is 0.39. Thus, even though the communication across agents is hardly one-sided (i.e. displays a quite "conversational" character), it is also substantially asymmetric across peers. The fact that such an asymmetry does not affect the gist of our results suggests that our benchmark analysis provides a quite robust description of the situation.

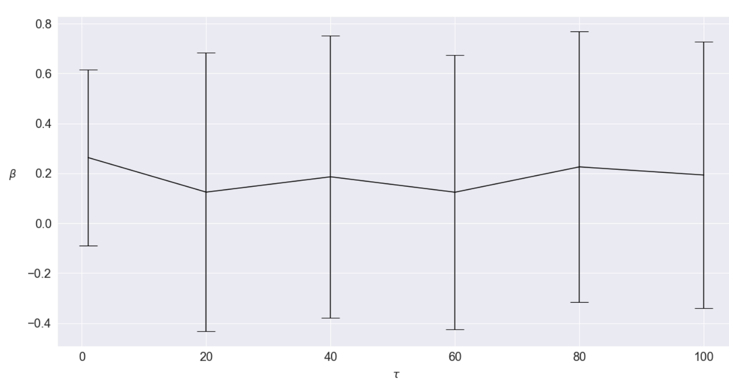
[20] In fact, we also find (although it is not shown in the diagrams for the sake of focus) that, as soon as τ exceeds the threshold of 80, the estimation results remain essentially unchanged around those obtained in the benchmark setup with $\tau = \infty$.



(a) Submission: virtual-within interaction, large countries

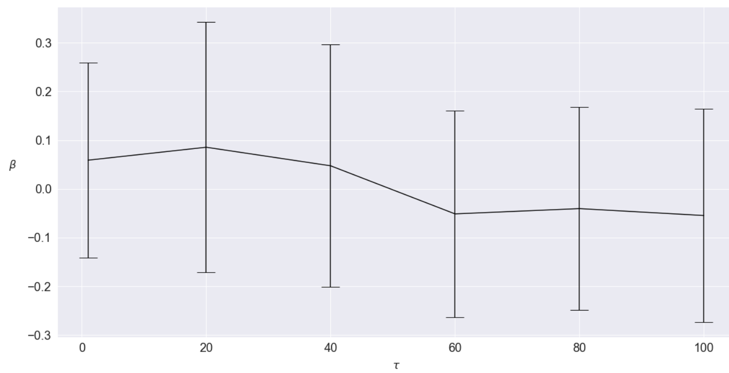


(b) Submission: virtual-across interaction, large countries

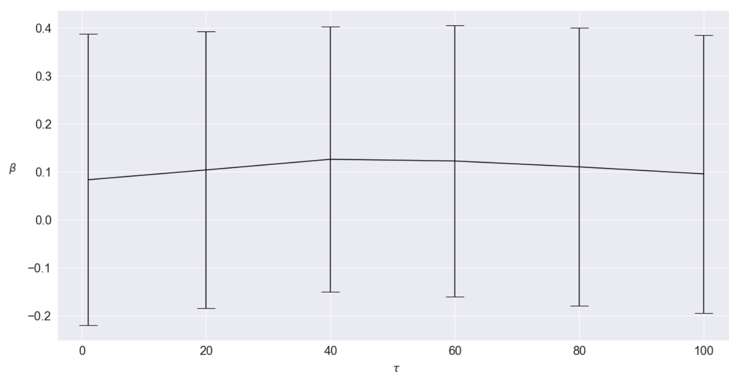


(c) Submission: virtual-across interaction, small countries

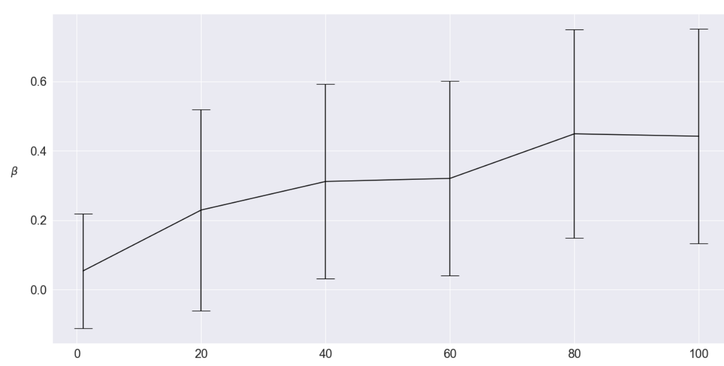
Figure 2: The diagram shows how the peer effects applied to ***submission*** depend on the upper bound τ on the maximum lag between constituent messages defining a link. The coefficient estimate and 95% confidence intervals are traced for each $\tau \in [1, 100]$ in three cases: the Large-Country Sample under the two treatment arms (virtual-within and virtual-across) and the Small-Country Sample under the virtual-across arm.



(a) Business quality: virtual-within interaction, large countries



(b) Business quality: virtual-across interaction, large countries



(c) Business quality: virtual-across interaction, small countries

Figure 3: The diagram shows how the peer effects applied to the ***intensive quality margin*** depend on the upper bound τ on the maximum lag between constituent messages defining a link. The coefficient estimate and 95% confidence intervals are traced for each $\tau \in [1, 100]$ in three cases: the Large-Country Sample under the two treatment arms (virtual-within and virtual-across) and the Small-Country Sample under the virtual-across arm.

Table 6: **Network peer effects, bidirectional influence**

	Virtual within, LCS	Virtual across, LCS	Virtual across, SCS
Proposal submission			
Control for ***all*** baseline info.	.869***	-.327	-.014
	(.135)	(.256)	(.395)
Number of entrepreneurs: 1016			
Business quality			
Control for ***all*** baseline info.	.123	-.075	.362**
	(.135)	(.167)	(.176)
Number of entrepreneurs: 779			

Notes: Estimated network-based peer effects for the bidirectional setup that differs from the benchmark setup considered in Table 5 only in that the link-formation rule ($\widehat{\text{LF}}$) substitutes the former (LF). In all other respects, the features contemplated for Table 5 apply (in particular, $\tau = \infty$). The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

6 The semantic analysis

In this section, we provide a succinct description of the research conducted on the semantics of peer communication unfolding in our experiment. First, we outline its methodological approach – what is often called Natural Language Processing (NLP), which relies on machine-learning techniques to extract "meaning" from large bodies of communication. Second, we illustrate the nature of our NLP analysis by presenting a few interesting results.

The NLP methodology

At a high level, semantic analysis can be described as aiming to classify the data along text-inherent semantic categories (for example, the business-relatedness of the communication), in order to provide insights into their relationship and embedding structure. In our context, this has been done for the whole set of over 140,000 messages written by entrepreneurs throughout the duration of the intervention. Given the magnitude of the data, this is a task that cannot be carried out "manually" and, therefore, we have relied on the aforementioned machine-learning techniques. As applied to our context, they can be essentially described as follows.

The first step has been to use machine-learning classifiers to infer semantic category labels for the entire communication data available. This entailed having five (human) coders/annotators go through a large sample of messages (2,500 each) in order to identify and label a number of pre-specified relevant categories. Among the categories considered, the following three proved to be the most informative:

- ***Business content***: a set of *binary labels*, $\{0, 1\}$, indicating whether the message concerns business or some professional activity.
- ***Sentiment***: measured on a five-point scale $\{-2, -1, 0, 1, 2\}$ that stand, respectively, for the following set of *ordered labels*: strongly negative, critical, neutral, encouraging, and enthusiastic.
- ***Audience scope***: given by a set of *binary labels*, $\{0, 1\}$, specifying whether the message is, respectively, addressed to a single person or to a larger group.

The human coding of the sample messages was then extended to the whole set of messages through the operation of randomized logistic regressions that eventually assigned, to every message label in each of the above dimensions/categories, a weight in $[0, 1]$. The outcome of the algorithm was also validated through a conventional process of cross validation, yielding a satisfactorily high precision. In the end, the procedure imputed for every pair given by

- a message m in the set M of all messages sent throughout the experiment,
- a label r in the set L_x of labels associated to each category x,

a weight/probability $\zeta(r, m) \in [0, 1]$. This weight indicates the strength/confidence with which the classifier posits/predicts that label r should be attributed to message m. Overall, the vector

$$\boldsymbol{\chi} = \left\{ \left[(\zeta(r, m))_{r \in L_x} \right]_{x \in X} \right\}_{m \in M} \tag{7}$$

compactly describes the *primitive data* generated as the first stage of the semantic analysis.

Our analysis of these data has produced a wide range of interesting conclusions. Here, we focus on the following three, which illustrate well the nature of the approach:

(i) Messages that are strong in business content display weak (i.e. essentially neutral) sentiment and *vice versa* – that is, strong sentiment is also associated to weak business content.

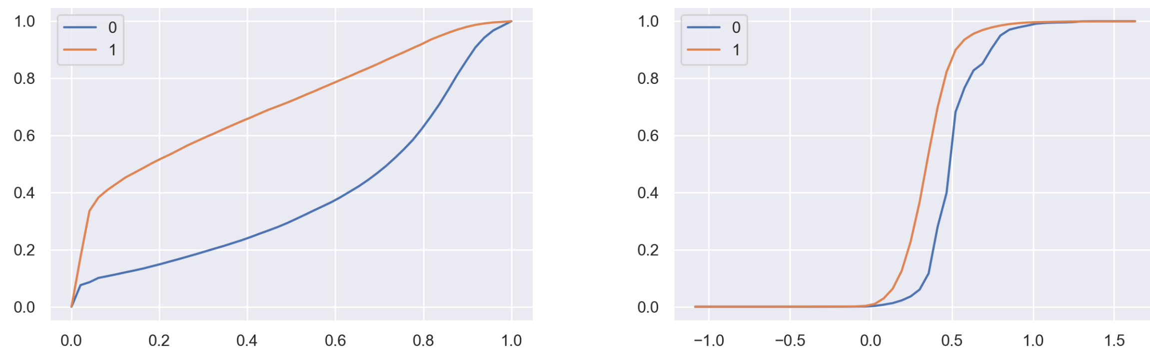
(ii) Despite the negative correlation asserted in (i), entrepreneur networks "projected" on the business or sentiment dimensions yield very similar peer effects.

(iii) Entrepreneurs whose business proposals were judged to be of high quality produce messages that are both strong in business content and weak in sentiment.

For the first conclusion, refer to Figure 4. There we observe in Panel (a) that the distribution over business content conditional on low (below-median) sentiment First-Order Stochastically Dominates (FOSD) the distribution conditional on high (above-median) sentiment. Reciprocally, Panel (b) shows that the sentiment displayed by messages whose business content is below median strength FOSD the distribution over messages with above-median business content.

Turning now to point (ii) above, the aim in that case is to study how different kinds of communication shape different networks and the corresponding peer effects. To this end, we construct separate networks, each measuring the intensity of interaction/communication by the weight of the messages in, alternatively, business or sentiment content (as these were determined by the NLP analysis). Following then a parallel analysis to that conducted in Section 5.1 for the benchmark setup, we can turn to estimating the corresponding peer effects – in a sense, these are a measure of how peers whose communication is strong in either the business or sentiment dimensions affect the behavior of others. A summary of the estimation of peer effects is found in Tables 7 and 8.

Our results show that either through business-weighted or sentiment-weighted links alike, peers exert a similar pattern of influence. This seems a remarkable feature of the data, reinforced by the observation that, in fact, the pattern and magnitude of the peer effects channeled through business- or sentiment-weighted



(a) Message business content cond. on positive sentiment

(b) Message positive sentiment cond. on business content

Figure 4: The diagrams depict (a) the cdfs defined over the business content of messages conditional on high or low sentiment, and (b) the cdfs defined over the sentiment of messages conditional on high or low business content. In both cases, the high or low level of the conditioning variable is interpreted as higher than the median (indicator 1) or below it (indicator 0).

links are very similar to those obtained for our benchmark network – i.e. those estimated when every sort of content was attributed the same weight (cf. Table 5). At first glance, these conclusions appear somewhat puzzling. A natural interpretation, however, is that, even though business-oriented messages are typically weak in sentiment content and *vice versa* (cf. (i) above), individuals tend to balance the two types of ***communication*** in a symmetric way in the interaction they establish with every ***given peer***. This suggests, in other words, that communication tends to be similarly multidimensional/balanced across all peers (either purposefully or not).

Table 7: **Network peer effects, business network**

	Virtual within, LCS	Virtual across, LCS	Virtual across, SCS
Proposal submission			
Control for ***all*** baseline info.	.521*** (.176)	.010 (.137)	-.009 (.288)
Number of entrepreneurs: 1016			
Business quality			
Control for ***all*** baseline info.	-.037 (.120)	.081 (.153)	.557*** (.144)
Number of entrepreneurs: 779			

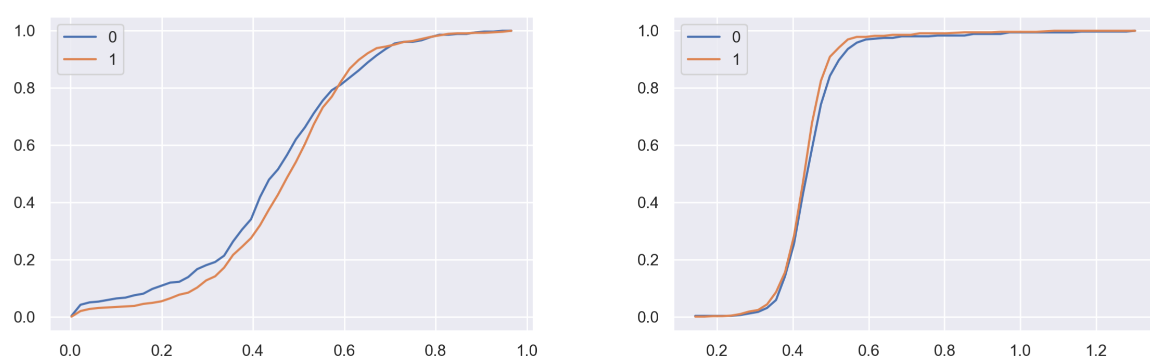
Notes: The table estimates the network-based peer effects channeled through the business-projected network on two different outcomes: the *submission decision* and the *business quality* of submitted proposals. The network-construction procedure is as described in Subsection 5.1, with each link weighted by its corresponding business-orientation index. As in the counterpart Table 5, no upper bound on the communication lag is contemplated (i.e. $\tau = \infty$). Standard errors are clustered at the group level, which gives rise to 44 clusters. The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

Table 8: **Network peer effects, sentiment network**

	Virtual within, LCS	Virtual across, LCS	Virtual across, SCS
Proposal submission			
Control for ***all*** baseline info.	.530***	.016	.099
	(.172)	(.141)	(.295)
Number of entrepreneurs: 1016			
Business quality			
Control for ***all*** baseline info.	-.040	.087	.445***
	(.119)	(.150)	(.147)
Number of entrepreneurs: 779			

Notes: The table estimates the network-based peer effects channeled through the sentiment-projected network on two different outcomes: the *submission decision* and the *business quality* of submitted proposals. The network-construction procedure is as described in Subsection 5.1, with each link weighted by its corresponding sentiment-orientation index. As in the counterpart Table 5, no upper bound on the communication lag is contemplated (i.e. $\tau = \infty$). Standard errors are clustered at the group level, which gives rise to 44 clusters. The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

Finally, for point (iii) above, we refer to Figure 5, where we show how the alternative dimensions of communication considered in Figure 4 (business focus and sentiment intensity) are correlated with our quality measure of performance (the grade obtained by the submitted proposals). The conclusion is hardly surprising, but also reassuring: entrepreneurs whose communication centers on business-related matters tend to perform well, while those whose messages display high sentiment intensity do worse. Again, the comparison is conducted through corresponding conditional cdfs for each type of communication.[21]



(a) Business focus of entrep'eur cond. on business quality (b) Positive sentiment of entrep'eur cond. on business quality

Figure 5: The diagrams depict the cdfs defined over the business content (panel (a)) or sentiment (panel (b)) of the messages sent by entrepreneurs conditional on the business quality of their proposals. In both cases, the high or low level of the business quality is interpreted relative to the population median (indicators 1 or 0, respectively) and the weight for business content or sentiment for each entrepreneur is computed as the average over all her messages.

[21] Though the situation appears less clear-cut than in Figure 4, a suitable adaptation of the classical Kolmogorov-Smirnov to test for FOSD for the corresponding conditional cdf's yields a low p-value.

In the working-paper version of the present paper (Vega-Redondo *et al.* (2019)), the reader can find a wider range of questions explored on the semantics of the communication data, as well as a discussion of the technical details involved in formulating and testing alternative hypotheses. Here, due to space constraints, we have just been able to discuss a small set of intuitive conclusions, illustrating how an integrated analysis of the treatment effect, network-based influence, and peer communication may shed further light on our experimental results.

7 Summary, conclusions, and ensuing research

In this paper, we have discussed the results of an RCT conducted in the African continent. Its objective has been to shed light on how peer networks, operating under alternative conditions, can help promote entrepreneurship in developing countries. To this end, we designed three treatment arms that differed in how interaction is conducted among peers: face-to-face; "virtually within" (i.e. in groups of the same nationality); and "virtually across" (in nationally heterogeneous groups). In addition to such peer interaction, which was enjoyed only by treated individuals, the whole population – control and treatment alike – followed an online course for the duration of the experiment (two and a half months). The problem has been mainly studied from two different perspectives: treatment impact and network peer effects, complemented by a semantic analysis of the extensive peer communication fully recorded throughout the experiment.

Very succinctly, our two main conclusions can be stated as follows.

1. Treatment effects – on both submission and the business quality of submitted proposals – are uniformly positive and significant if peers interact under virtual-within conditions but not otherwise.

2. Peer effects – as mediated by the entrepreneur interaction/communication network – are positive and significant only in some cases: for submission, under virtual-within interaction; for business quality, when interaction is of the virtual-across type and entrepreneurs belong to small countries.[22]

In view of these conclusions, our RCT can be seen as delivering a two-fold take-home message. On the one hand, the intervention is a "proof of concept" in that it shows that peer interaction can not only be effective but may also be implemented (and its benefits realized) at a large scale and involving non-prohibitive operating costs. On the other hand, the experiment also serves to highlight the fact that certain design features can be truly key. In our specific context, we have stressed the importance of striking a suitable balance between peer diversity and familiarity. However, in other cases, the main issues at stake may be of quite a different sort – for example, they may concern the extent to which peers are also competitors or, relatedly, whether the environment rewards the top innovators in a more or less extreme way in comparison to others. Exploring these alternative dimensions is one of the primary aims of future research. Another important objective will be to extend the semantic analysis conducted so far on the communication unfolding throughout the experiment. For, in view of the richness of the flow of messages exchanged by entrepreneurs, delving deeper into what, usually, is the black box of actual peer interaction should provide new important insights on the forces at work.

[22]Recall that what we have labeled as "small countries" are all those (44 of them) that have a number of entrepreneurs in our sample that is not enough to form enough (statistically sufficient) nationally-homogeneous groups. The five "large countries" are Nigeria, Ghana, Kenya, South Africa, and Tanzania.

In a complementary route, our research will also proceed on the theoretical front. For, as we explained in the Introduction, a key challenge here is to develop a formal model that provides a better (combined) understanding of the range of issues involved in the phenomenon of peer-supported entrepreneurial innovation. Specifically, an ideal such model should provide an integrated account of three phenomena: cooperation, learning, and competition. It should also allow for endogenous peer matching, hence making network formation be largely endogenous. Of course, to combine all this in a tractable manner is a tall order and therefore, realistically, we can only aspire to progress gradually. In so doing, we hope that the empirical evidence obtained from our experiment should prove quite useful – in particular, by suggesting reasonable assumptions and the main mechanisms at work.

By way of illustration, let us refer to one of the intriguing results of our experiment, namely, the contrasting strength of treatment and network (peer) effects in the virtual-within and virtual-across treatments. In our discussion, we have outlined a possible explanation for it that stresses the different degree of extended (far-reaching) diffusion that is likely to arise in those two contexts. Furthermore, we have suggested that the basis for this difference may be the diverse level of trust prevailing in each case. To test this hypothesis, we would need a suitable theoretical framework that produces a set of useful (hence operational) implications derived from it. These could pertain, for example, to characteristics of the underlying network (its density, average distance, or clustering), similar in spirit to those highlighted by the theoretical literature that has studied cooperation (exchange of "favors") or learning (the integration of disperse information through the exchange of connected individuals).[23]

The enhanced understanding that should result from such a theoretical effort would also be important in addressing what is one other important motivation of our research – namely the improved design of mechanisms that better profit from the distributed information, skills, and different resources that are available to a large and diverse population of entrepreneurs. Given the fast development of modern information technologies and the entailed improvement of virtual-interaction methods, the focus naturally shifts toward the need of designing corresponding mechanisms (incentive schemes, interaction protocols, and trust-supporting structures) that operate effectively under those circumstances. In the end, of course, the objective should be to arrive at an implementation design in which the benefits that have been identified in our experiment pass the crucial test of widespread external validity.

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Appendix: supplementary material

In this Appendix we include the auxiliary tables that either support the discussion or/and complement the tables included in the main text.

A.1 Baseline characteristics

Here we summarize the information gathered from our baseline survey.

Table A1: **Baseline survey, summary statistics: full sample**

	(1)	(2)	(3)
	Mean	S.D.	Obs.
Panel A. Demographics			
Northern Africa	0.01	0.11	4958
Western Africa	0.53	0.50	4958
Eastern Africa	0.35	0.48	4958
Southern Africa	0.07	0.25	4958
Middle Africa	0.04	0.19	4958
Female	0.31	0.46	4958
Has Business	0.63	0.48	4958
Age	30.96	7.79	4958
University Complete	0.82	0.39	4958
Married	0.38	0.49	4939
Panel B. Business Idea			
Has Idea about Existing Business	0.38	0.48	4958
Has Idea about New Business	0.55	0.50	4958
Has no Idea yet	0.08	0.27	4958
Sector: Agriculture	0.25	0.43	4958
Sector: Services	0.17	0.37	4958
Sector: Technology	0.13	0.34	4958
Sector: Manufacture	0.09	0.29	4958
Sector: Social Entrepreneurship	0.12	0.33	4958
Sector: Retail	0.05	0.21	4958
Has written business plan	0.59	0.49	4958
Participated in business competition	0.37	0.48	4958
Has employees	0.36	0.48	4947
Panel C. Financial Access			
Saves at a Bank	0.90	0.30	4958
Got Bank Loan for business	0.09	0.29	4958
Prefers equity debt to loans	0.45	0.50	4958
Prefers loans to equity debt	0.16	0.37	4958
Prefers either equity or loans	0.34	0.48	4958
Panel D. Labor Market Outcomes			
Reservation Wage (in USD)	1604	2102	4914
Years of work experience	5.11	3.27	4958
Has a job	0.55	0.50	4958
Panel E. Networks			
Number of People discuss business	4.63	3.37	4958
Prefers to discuss with different sector	0.11	0.31	4958
Prefers to discuss with different gender	0.13	0.33	4958
Prefers to discuss with different country	0.18	0.38	4958
Panel F. Personality Traits			
Risk Aversion (choice among 6 lotteries)	3.44	2.05	4948
Trust Measure (0 to 10)	4.81	2.77	4957
Position in your country: current (0 to 10)	4.82	1.63	4650
Position in your country: expected (0 to 10)	7.84	1.55	3642
Position in your country: desired (0 to 10)	9.06	1.54	4577

Notes: The table uses values of the variables collected in the online application form completed during May 2017.

A.2 Balance checking

In Table A2-A4 below, we check the balance across individual baseline characteristics in the randomization described in Subsection 3.4. This balance check is separately performed for each of our three samples: The Uganda Sample (UgS), the Large-Country Sample (LCS) and the Small-Country Sample (SCS).

Table A2: **Balance check, Uganda sample**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Control		Face to Face		Virtual Within				
	Mean	S.D.	Mean	S.D.	Mean	S.D.	p-value (control = f2f)	p-value (control =vwithin)	p-value (within =control =f2f)
Observations	189		189		190				
p-value Joint F test*							0.31	0.62	
Panel A. Stratification Variables									
Female	0.35	0.48	0.35	0.48	0.35	0.48			
Has Business	0.63	0.48	0.63	0.48	0.63	0.49			
Course first milestone on time	0.51	0.50	0.51	0.50	0.52	0.50			
Panel B. Demographics									
Age	30.60	8.11	30.02	8.01	29.48	8.37	0.49	0.17	0.41
University Complete	0.86	0.35	0.92	0.27	0.89	0.31	0.05	0.35	0.14
Married	0.36	0.48	0.32	0.47	0.30	0.46	0.47	0.19	0.42
Panel C. Business Idea									
Has Idea about Existing Business	0.39	0.49	0.39	0.49	0.35	0.48	0.97	0.36	0.58
Has Idea about New Business	0.49	0.50	0.51	0.50	0.58	0.50	0.77	0.08	0.17
Has no Idea yet	0.12	0.32	0.10	0.30	0.07	0.26	0.59	0.15	0.31
Sector: Agriculture	0.23	0.42	0.28	0.45	0.26	0.44	0.24	0.43	0.48
Sector: Services	0.12	0.33	0.16	0.37	0.11	0.31	0.25	0.58	0.24
Sector: Technology	0.15	0.36	0.12	0.33	0.17	0.38	0.46	0.48	0.36
Sector: Manufacture	0.08	0.27	0.07	0.25	0.10	0.30	0.67	0.48	0.55
Sector: Social Entrepreneurship	0.20	0.40	0.16	0.37	0.15	0.36	0.36	0.17	0.39
Sector: Retail	0.03	0.18	0.04	0.20	0.05	0.21	0.57	0.44	0.72
Has written business plan	0.57	0.50	0.61	0.49	0.54	0.50	0.45	0.57	0.43
Participated in business competition	0.31	0.46	0.35	0.48	0.32	0.47	0.35	0.82	0.64
Has employees	0.39	0.49	0.38	0.49	0.39	0.49	0.74	0.85	0.87
Panel D. Financial Access									
Saves at a Bank	0.81	0.39	0.84	0.37	0.85	0.36	0.48	0.26	0.52
Got Bank Loan for business	0.12	0.32	0.15	0.36	0.08	0.27	0.35	0.22	0.10
Prefers equity debt to loans	0.57	0.50	0.50	0.50	0.60	0.49	0.17	0.59	0.14
Prefers loans to equity debt	0.14	0.35	0.17	0.38	0.10	0.30	0.39	0.25	0.13
Prefers either equity or loans	0.26	0.44	0.30	0.46	0.26	0.44	0.34	1.00	0.55
Panel E. Labor Market Outcomes									
Reservation Wage (in USD)	1510	2008	1199	1596	1333	1947	0.10	0.39	0.25
Years of work experience	4.87	3.30	4.77	3.24	4.53	3.22	0.76	0.30	0.58
Has a job	0.54	0.50	0.60	0.49	0.54	0.50	0.22	0.97	0.37
Panel F. Networks									
Number of People discuss business	4.79	3.25	4.39	3.33	4.84	3.43	0.22	0.90	0.33
Prefers to discuss with different sector	0.13	0.33	0.10	0.30	0.09	0.29	0.41	0.31	0.58
Prefers to discuss with different gender	0.15	0.36	0.15	0.36	0.13	0.33	0.99	0.45	0.68
Prefers to discuss with different country	0.21	0.41	0.16	0.37	0.19	0.39	0.23	0.67	0.47
Panel G. Personality Traits									
Risk Aversion (choice among 6 lotteries)	3.48	2.00	3.38	2.06	3.46	1.96	0.64	0.90	0.88
Trust Measure (0 to 10)	4.70	2.69	5.12	2.96	4.69	2.51	0.14	0.99	0.24
Position in your country: current (0 to 10)	4.79	1.81	4.57	1.58	4.97	1.71	0.24	0.31	0.07
Position in your country: expected (0 to 10)	7.65	1.59	7.39	1.55	7.48	1.56	0.14	0.29	0.31
Position in your country: desired (0 to 10)	8.85	1.68	9.00	1.52	8.95	1.66	0.41	0.63	0.71

Notes: The randomization was stratified on gender, having a business and submitting the first milestone of the course on time. The table uses variables from the online application form (March-May 2017). Columns 7-9: p-values for tests of equality of means obtained from a regression of each variable on treatment controlling for randomization strata with robust standard errors. For the orthogonality test we replaced missing values with zeros and included dummies for variables with missing values.

Table A3: **Balance check, large-country sample**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Control		Virtual Within		Virtual Across				
	Mean	S.D.	Mean	S.D.	Mean	S.D.	p-value (control =vwithin)	p-value (control =vacross)	p-value (within =control =across)
Observations	1111		1111		1111		0.98	0.98	
p-value Joint F test*									
Panel A. Stratification Variables									
Ghana	0.13	0.34	0.13	0.34	0.13	0.34			
Kenya	0.12	0.32	0.12	0.32	0.12	0.32			
Nigeria	0.61	0.49	0.61	0.49	0.61	0.49			
South Africa	0.09	0.28	0.09	0.28	0.09	0.28			
Tanzania	0.06	0.23	0.05	0.23	0.05	0.23			
Female	0.31	0.46	0.31	0.46	0.31	0.46			
Has Business	0.65	0.48	0.65	0.48	0.65	0.48			
Course first milestone on time	0.56	0.50	0.56	0.50	0.55	0.50			
Panel B. Demographics									
Age	31.38	7.74	31.26	7.47	31.26	7.76	0.69	0.70	0.90
Unversity Complete	0.82	0.39	0.81	0.39	0.81	0.39	0.78	0.60	0.88
Married	0.38	0.49	0.39	0.49	0.40	0.49	0.50	0.32	0.60
Panel C. Business Idea									
Has Idea about Existing Business	0.34	0.47	0.37	0.48	0.35	0.48	0.09	0.49	0.23
Has Idea about New Business	0.59	0.49	0.56	0.50	0.59	0.49	0.06	0.82	0.11
Has no Idea yet	0.07	0.26	0.07	0.26	0.06	0.24	0.76	0.37	0.42
Sector: Agriculture	0.25	0.44	0.24	0.43	0.26	0.44	0.64	0.62	0.62
Sector: Services	0.17	0.38	0.19	0.39	0.17	0.37	0.41	0.77	0.53
Sector: Technology	0.14	0.35	0.13	0.33	0.14	0.34	0.36	0.92	0.60
Sector: Manufacture	0.10	0.30	0.12	0.32	0.10	0.30	0.23	0.78	0.29
Sector: Social Entrepreneurship	0.09	0.29	0.09	0.29	0.10	0.30	0.83	0.65	0.80
Sector: Retail	0.05	0.21	0.05	0.22	0.05	0.22	0.51	0.51	0.74
Has written business plan	0.58	0.49	0.62	0.49	0.60	0.49	0.06	0.40	0.17
Participated in business competition	0.36	0.48	0.38	0.49	0.38	0.49	0.34	0.23	0.45
Has employees	0.36	0.48	0.34	0.47	0.39	0.49	0.25	0.15	0.04
Panel D. Financial Access									
Saves at a Bank	0.93	0.25	0.94	0.24	0.93	0.26	0.69	0.70	0.73
Got Bank Loan for business	0.09	0.29	0.08	0.27	0.09	0.28	0.24	0.49	0.51
Prefers equity debt to loans	0.44	0.50	0.45	0.50	0.43	0.50	0.56	0.77	0.67
Prefers loans to equity debt	0.16	0.36	0.16	0.37	0.16	0.37	0.71	0.82	0.93
Prefers either equity or loans	0.35	0.48	0.34	0.47	0.36	0.48	0.62	0.59	0.58
Panel E. Labor Market Outcomes									
Reservation Wage (in USD)	1664	2173	1685	2204	1642	2147	0.76	0.84	0.87
Years of work experience	5.31	3.24	5.23	3.19	5.25	3.25	0.58	0.69	0.85
Has a job	0.54	0.50	0.54	0.50	0.55	0.50	0.87	0.73	0.88
Panel F. Networks									
Number of People discuss business	4.66	3.41	4.53	3.33	4.55	3.31	0.36	0.44	0.62
Prefers to discuss with different sector	0.10	0.30	0.09	0.29	0.11	0.31	0.27	0.83	0.35
Prefers to discuss with different gender	0.12	0.32	0.11	0.31	0.11	0.32	0.61	0.81	0.88
Prefers to discuss with different country	0.17	0.38	0.16	0.37	0.14	0.35	0.58	0.05	0.13
Panel G. Personality Traits									
Risk Aversion (choice among 6 lotteries)	3.45	2.06	3.39	2.03	3.41	2.07	0.44	0.62	0.74
Trust Measure (0 to 10)	4.74	2.73	4.75	2.77	4.78	2.82	0.92	0.69	0.92
Position in your country: current (0 to 10)	4.85	1.59	4.81	1.60	4.89	1.65	0.47	0.60	0.49
Position in your country: expected (0 to 10)	7.94	1.57	7.91	1.53	7.96	1.56	0.67	0.77	0.84
Position in your country: desired (0 to 10)	9.09	1.55	9.05	1.55	9.08	1.58	0.63	0.92	0.87

Notes: Randomization was stratified on country, gender, having a business and submitting the first milestone of the course on time. The table uses variables from the online application form (March-May 2017). Columns 7-9: p-values for tests of equality of means obtained from a regression of each variable on treatment controlling for randomization strata with robust standard errors. For the orthogonality test we replaced missing values with zeros and included dummies for variables with missing values.

Table A4: **Balance check, small-country sample**

	(1)	(2)	(3)	(4)	(5)
	Control		Virtual Across		
	Mean	S.D.	Mean	S.D.	p-value (control =vacross)
Observations	529		528		
p-value Joint F test*					.36
Panel A. Stratification Variables					
Northern Africa	.06	.24	.06	.24	
Western Africa	.17	.37	.17	.37	
Eastern Africa	.57	.5	.57	.5	
Southern Africa	.03	.17	.03	.17	
Middle Africa	.18	.38	.18	.38	
Female	.31	.46	.32	.47	
Has Business	.58	.49	.58	.49	
Course first milestone on time	.56	.5	.57	.5	
Panel B. Demographics					
Age	30.15	7.9	30.65	7.99	.29
Unversity Complete	.78	.41	.8	.4	.42
Married	.35	.48	.4	.49	.06
Panel C. Business Idea					
Has Idea about Existing Business	.45	.5	.46	.5	.84
Has Idea about New Business	.47	.5	.45	.5	.58
Has no Idea yet	.08	.28	.09	.29	.54
Sector: Agriculture	.22	.42	.21	.41	.6
Sector: Services	.16	.37	.16	.37	.98
Sector: Technology	.12	.33	.13	.33	.8
Sector: Manufacture	.06	.24	.08	.26	.41
Sector: Social Entrepreneurship	.18	.38	.18	.38	.87
Sector: Retail	.03	.17	.05	.21	.14
Has written business plan	.56	.5	.56	.5	.85
Participated in business competition	.4	.49	.36	.48	.15
Has employees	.32	.47	.33	.47	.54
Panel D. Financial Access					
Saves at a Bank	.81	.39	.83	.37	.39
Got Bank Loan for business	.1	.3	.11	.31	.87
Prefers equity debt to loans	.4	.49	.4	.49	.99
Prefers loans to equity debt	.17	.37	.18	.38	.69
Prefers either equity or loans	.37	.48	.37	.48	.95
Panel E. Labor Market Outcomes					
Reservation Wage (in USD)	1509.43	1921.24	1597.59	2038.58	.44
Years of work experience	4.6	3.3	5.07	3.44	.02
Has a job	.52	.5	.56	.5	.17
Panel F. Networks					
Number of People discuss business	4.79	3.54	4.73	3.37	.8
Prefers to discuss with different sector	.13	.34	.12	.33	.62
Prefers to discuss with different gender	.17	.38	.13	.33	.02
Prefers to discuss with different country	.24	.43	.23	.42	.7
Panel G. Personality Traits					
Risk Aversion (choice among 6 lotteries)	3.61	2.1	3.45	2.00	.21
Trust Measure (0 to 10)	4.99	2.87	4.92	2.72	.69
Position in your country: current (0 to 10)	4.6	1.64	4.88	1.68	.01
Position in your country: expected (0 to 10)	7.68	1.57	7.81	1.48	.26
Position in your country: desired (0 to 10)	9.12	1.39	9.06	1.46	.46

Notes: Randomization was stratified on region, gender, having a business and submitting the first milestone of the course on time. The table uses values of the variables collected in the online application form (March-May 2017). Columns 4-5: *p*-values for tests of equality of means obtained from a regression of each variable on treatment controlling for randomization strata with robust standard errors. For the orthogonality test we replaced missing values with zeros and included dummies for variables with missing values.

A.3 The online course: a schematic description of its structure

Here we outline the essential structure of the online course, providing information on its content, the teaching methods, and the corresponding instructors.

ADANSONIA TRAINING PROGRAM - COURSE STRUCTURE						
	WHAT	TOOL	WHO	VIDEOS	SLIDES	ADDITIONAL MATERIAL/LINKS
Module 0	Introductory session	recorded video	F. Vega-Redondo	1	no	
	You don't have to be an entrepreneur	recorded video	Ojijo Pascal (GoBigHub)	1	no	
	video youtube on campuslife	https://www.youtube.com/watch?v=xWbCi5t7ZKA		1		
	syllabus	downloadable pdf				
	website tutorial	downloadable pdf				a tutorial guide to be sent out on Uploadable as well on the platform
	mobile number request	1 question quiz				
MILESTONE 0 - fill in the business proposal form with your initial idea- not evaluated						
TRAINING STARTS HERE						
Module 1 Ideating a new value proposition: involving consumers in innovation	The nature of start-ups in Africa	recorded video	Ojijo Pascal (GoBigHub)	1	no	
	Identifying white spaces for innovation	recorded video	Paola Cillo	1	yes	
	Involving Customers in Innovation	recorded video	Paola Cillo	1	yes	
	Customers as a Source of Ideation	recorded video	Paola Cillo	1	yes	
	multiple-choice quiz - evaluated					
Module 2 Testing an Idea before launch	Testing a product before launch	recorded video	Paola Cillo	1	yes	
	Testing a market before launch	recorded video	Paola Cillo	1	yes	
	multiple-choice quiz - evaluated					
	Market Research (in data short markets)	recorded video	Leticia Browne (ICG)	1	no	
MILESTONE 1 - individual assignment due / ananlysis of real life examples / general fb with solutions						
Module 3 Launching a new idea: the marketing dimension	The Business Model Canvas	recorded video	Gaia Rubera	1	yes	
	Developing your value proposition	recorded video	Gaia Rubera	1	yes	
	Customer segmentation	recorded video	Gaia Rubera	1	yes	
	multiple-choice quiz - evaluated					
	Activity based marketing and sales system	recorded video	Ojijo Pascal (GoBigHub)	1	no	
Module 4 Launching a new idea: the cost dimension	Identifying your key partners	recorded video	Giuseppe Stabilini	1	yes	
	Identifying your key activities and resources	recorded video	Marco Morelli	1	yes	
	Pricing strategy	recorded video	Gaia Rubera	1	yes	
	Pricing strategy	recorded video	Gaia Rubera	1	yes	
	multiple-choice quiz - evaluated					
	Systems are more important than products	recorded video	Ojijo Pascal (GoBigHub)	1	no	
MILESTONE 2 - individual assignment due / BMC exercise //general FB						
Module 5 Finalizing your business plan	Financial forecast in your BP	recorded video	Leonardo Etro	1	yes	
	How to Value a Start Up	recorded video	Leonardo Etro	1	yes	
	multiple-choice quiz - evaluated					
Module 6 Getting ready to present your startup	Build your startup team	recorded video	Massimo Magni	1	yes	
	What are the key elements of an investment pitch	recorded video	Leticia Browne (ICG)	1	no	
	Guidelines for submission for funding/ mini tutorial					
	"How to pitch your idea"	recorded video	Massimo Pulejo	1		
	multiple-choice quiz - evaluated					
MILESTONE 3 - fill in the official business proposal form						

Figure A1: **Structure of the online entrepreneurship course.**

A.4 Pooled regressions for each treatment arm

In Tables A5 and A6 below, we present the estimated treatment effects on submission and business quality when the observations on the individuals subject to the vw- and va-treatment arms are pooled (we also include the f2f arm for completeness). The results are essentially as described in the text for a disaggregation of those observations intro our three subsamples: UgS, LCS, and SCS.

Table A5: **Treatment effect on submission: pooled regression for the virtual arms**

	(1)	(2)
	Full samples	M0 completers
Virtual-within treatment	0.023*	0.041**
	(0.013)	(0.021)
Virtual-across treatment	-0.008	0.003
	(0.015)	(0.021)
Face-to-face treatment (UgS)	0.123***	0.145**
	(0.031)	(0.056)
Control Mean	0.39	0.59
p-value virtual within = virtual across	0.03	0.06
Number of entrepreneurs	4,957	2,734

Notes: Estimated coefficients for OLS regressions of the quality outcome on indicators for treatment (face-to-face, virtual-within, and virtual-across interaction) when the observations on the virtual (vw- and va-) arms are pooled across the three different samples considered: UgS, LCS, and SCS. The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

Table A6: **Treatment effect on business quality: pooled regression for the virtual arms**

	(1)	(2)
	Quality. Full Sample	M0 completers
Virtual-within treatment	0.112*	0.181***
	(0.063)	(0.062)
Virtual-across treatment	0.012	0.029
	(0.062)	(0.063)
Face-to-face treatment (UgS)	0.088	-0.068
	(0.257)	(0.207)
Control mean	2.67	2.69
p-value virtual within = virtual across	0.14	0.01
Number of entrepreneurs	1,952	1,648

Notes: Estimated coefficients for OLS regressions of the submission outcome on indicators for treatment (face-to-face, virtual-within, and virtual-across interaction) when the observations on the virtual (vw- and va-) arms are pooled across the three different samples considered: UgS, LCS, and SCS. The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

A.5 The second-stage evaluation: treatment effects

In this section we summarize our results on the effect of the treatment on various outcomes associated to the second-stage evaluation. As conjectured, while some significant positive effects are found concerning the selection to the second stage, no significant results arise for different outcomes observed among the entrepreneurs selected into the second stage of the evaluation. These results are presented in Table A7.

Table A7: **Second-stage outcomes**

	(1) Reach stage 2	(2) Evaluated stage 2	(3) Investor interest	(4) Quality stage 2
Panel A. Uganda Sample (UgS)				
Face-to-face treatment	0.079*	-0.179	-0.069	-0.698*
	(0.041)	(0.168)	(0.191)	(0.334)
Virtual-within treatment	0.046	-0.120	0.128	-0.423
	(0.032)	(0.181)	(0.285)	(0.502)
Control mean	0.06	0.75	0.22	0.53
p-value face-to-face = virtual within	0.48	0.53	0.32	0.45
Number of entrepreneurs	568	60	37	37
Panel B. Large-Country Sample (LCS)				
Virtual-within treatment	0.026**	0.005	-0.090	-0.081
	(0.012)	(0.048)	(0.068)	(0.136)
Virtual-across treatment	0.003	0.049	-0.074	-0.051
	(0.012)	(0.048)	(0.062)	(0.141)
Control mean	0.12	0.77	0.28	-0.01
p-value virtual-within = virtual-across	0.02	0.31	0.79	0.83
Number of entrepreneurs	3,333	418	332	332
Panel C. Small-Country Sample (SCS)				
Virtual-across treatment	-0.020	0.054	-0.089	-0.096
	(0.018)	(0.090)	(0.099)	(0.253)
Control mean	0.13	0.64	0.20	0.04
Number of entrepreneurs	1,057	130	85	85

Notes: The table presents the results for OLS regressions of the outcome on indicators for treatment (face-to-face, virtual-within, and virtual-across interaction) in the three different samples considered: UgS, LCS, and SCS. The outcomes of the first three columns are all binary indicators. In column (1), the indicator specifies whether each entrepreneur is selected to reach the second evaluation stage. (As explained in Subsection 3.6, this selection was made on the basis of the evaluation conducted in the first stage.) In column (2), it indicates whether each proposal was actually evaluated by venture capitalists in the second stage – i.e. was not affected by exogenous disruptions. And in Column (3), the indicator records whether some investor reported interest in funding the project of the entrepreneur. Here, the sample is restricted to the 75% of the entrepreneurs selected to the second stage who were evaluated by venture capitalists. Finally, in column (4), also restricting the sample as in the previous case, the outcome considered is the quality score given to projects by the venture capitalists, these scores being standardized at the venture-capitalist level. In all regressions we include strata fixed effects. Standard errors are clustered at the group level for treated individuals (reported in parenthesis). The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

The first column of this table shows, as is to be expected, a positive treatment effect of reaching the second stage for f2f- and vw-interaction. Their corresponding (positive) coefficient is statistically significant only for f2f-interaction (in the UgS) and vw-interaction in the LCS. This is in line with the results displayed in Table 1 and 2, somewhat attenuated by the fact that, for the selection into the second stage, not only the evaluation by the African panel but also that by the European one was used as a subsidiary input.

The other three columns of A7 involve only the proposals that actually reached the second stage. First, Column 2 shows that the treatment had no significant effect on whether these proposals were actually evaluated by investors (i.e on whether or not the assigned investors did complete their evaluation task).[24] This indicates that, as one would expect, such investor-induced distortion did not have any significant differential effect on the issue at hand. Finally, the last two columns concern the different types of feedback provided by the investors. While Column 3 refers to the investors' interest in the project – as manifested in follow-up contacts with the entrepreneur for possible investment – Column 4 relates to the evaluation issued by the investors (in a 1-5 scale) on the quality of the proposals. We find that, for both of these outcomes, the treatment coefficients are statistically insignificant, except for a negative one (weakly significant) for the investor evaluation in the f2f-treatment in the UgS.

A.6 The treatment effect on business quality: full set of controls

Here we reproduce the regressions reported in Section 4 on the treatment effect on business quality, now including as controls the full set of baseline characteristics obtained through the initial survey.

Table A8: **Replicating Table 2, treatment effect on business quality with controls**

	(1) Full samples	(2) M0 completers
Panel A. Uganda Sample (UgS)		
Face-to-face treatment	0.381	0.198
	(0.251)	(0.244)
Virtual-within treatment	0.507***	0.576***
	(0.155)	(0.161)
Quality control mean if submitted	2.61	2.66
Quality effect f2f	0.02	-0.04
Quality effect VW	0.42	0.30
Number of entrepreneurs who submitted	221	179
Number of entrepreneurs	568	291
Panel B. Large-Country Sample (LCS)		
Virtual-within treatment	0.086	0.157**
	(0.072)	(0.070)
Virtual-across treatment	-0.040	-0.032
	(0.078)	(0.082)
Quality control mean if submitted	2.70	2.71
Quality effect virtual within	0.05	0.18
Quality effect virtual across	-0.02	0.01
Number of entrepreneurs who submitted	1,322	1,118
Number of entrepreneurs	3,333	1,848
Panel C. Small-Country Sample (SCS)		
Virtual-across treatment	0.026	0.081
	(0.111)	(0.116)
Quality control mean if submitted	2.65	2.65
Quality effect virtual across	0.22	0.17
Number of entrepreneurs who submitted	409	351
Number of entrepreneurs	1,056	595

Notes: The estimation details are as in Table 2 except that regressions also control for all variables listed in the balance table and baseline quality (obtained from evaluations of a summary of proposals submitted before treatment assignment).

[24] As explained in Subsection 3.6, some VCs did not finally fulfill their original commitment to evaluate the business proposals assigned to them for a variety of different reasons.

Table A9: **Replicating Table 3, marginal-quality effects with controls**

	(1)	(2)	(3)	(4)	(5)
	Score = 1	Score = 2	Score = 3	Score = 4	Score = 5
Face-to-face treatment	-0.040	-0.057	0.044	0.048	0.005
	(0.047)	(0.059)	(0.045)	(0.054)	(0.007)
Virtual-within treatment	-0.088**	-0.184***	0.063	0.177***	0.032**
	(0.036)	(0.043)	(0.041)	(0.044)	(0.014)
Number of entrepreneurs	179	179	179	179	179
Virtual-within treatment	-0.035**	-0.023**	0.008*	0.034**	0.016**
	(0.016)	(0.010)	(0.005)	(0.015)	(0.007)
Virtual-across treatment	0.009	0.005	-0.003	-0.008	-0.003
	(0.020)	(0.011)	(0.007)	(0.017)	(0.007)
Number of entrepreneurs	1,118	1,118	1,118	1,118	1,118
Virtual-across treatment	-0.017	-0.013	0.006	0.020	0.004
	(0.026)	(0.019)	(0.010)	(0.028)	(0.006)
Number of entrepreneurs	351	351	351	351	351

Notes: The estimation details are as in Table 3 except that regressions also control for all variables listed in the balance table and baseline quality (obtained from evaluations of a summary of proposals submitted before treatment assignment).

A.7 Peer composition: robustness check

Here we conduct two robustness checks on the peer composition effects estimated in Subsection 4.3: a placebo test for the control group, and an analysis of the surprise component.

Table A10: **Effects for peer composition on submission and business quality (I): placebo for control group**

	(1)	(2)	(3)	(4)
	Submission	Business quality	Submission	Business quality
Panel A. Sample who submitted M0 on time in large countries				
Own baseline quality	0.085^{***}	0.093	0.085^{***}	0.096
	(0.021)	(0.070)	(0.021)	(0.069)
Average baseline quality of peers	0.014	0.065		
	(0.074)	(0.228)		
Share of peers with business			0.091	0.439
			(0.154)	(0.522)
Number of entrepreneurs	617	360	617	360
Panel B. Full sample in large countries				
Own baseline quality	0.086^{***}	0.094	0.085^{***}	0.096
	(0.021)	(0.070)	(0.021)	(0.070)
Average baseline quality of peers	0.051	0.152		
	(0.038)	(0.177)		
Share of peers with business			0.146	-0.232
			(0.149)	(0.641)
Number of entrepreneurs	1,111	423	1,111	423

Notes: The table uses data for entrepreneurs in the control group (no interaction) in the Large-Country Sample (LCS). Groups are randomly created using the same procedure as for the interaction groups. In all regressions we include strata fixed effects and control for own baseline quality. For those who did not complete Milestone 0 on time and were not assigned a baseline quality, we add a corresponding dummy and impute a value of 0. In columns (1) and (3) the outcome is submission of a proposal, whereas in columns (2) and (4) the outcome is quality evaluation for those who submitted a proposal. Panel A restricts the sample to those who completed Milestone 0 on time (before the randomization), while Panel B uses the full sample. Standard errors are clustered at the group level (reported in parenthesis). The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

Table A11: **Effects of peer composition on submission and business quality (II): surprise component on business quality**

	(1)	(2)	(3)	(4)
	Submission	Business Quality	Submission	Business Quality
Panel A. Sample who submitted M0 on time in large countries				
Virtual-within interaction	0.035	0.169***	0.035	0.146**
	(0.021)	(0.058)	(0.021)	(0.067)
Own baseline quality	0.114***	0.249***	0.114***	0.247***
	(0.015)	(0.045)	(0.015)	(0.045)
Surprise peer quality	-0.117	-1.599***		
	(0.136)	(0.365)		
Expected peer quality	1.306	-5.615		
	(1.623)	(5.124)		
Surprise peers with business			-0.029	-0.357*
			(0.056)	(0.191)
Expected peers with business			1.036	-2.210
			(0.744)	(2.370)
Number of entrepreneurs	1,231	758	1,231	758
Panel B. Full Sample in large countries				
Virtual-within interaction	0.023	0.125*	0.024	0.117
	(0.015)	(0.071)	(0.015)	(0.070)
Own baseline quality	0.115***	0.244***	0.115***	0.247***
	(0.015)	(0.044)	(0.015)	(0.046)
Surprise peer quality	0.072	-1.499***		
	(0.104)	(0.502)		
Expected peer quality	3.039***	-8.975		
	(1.109)	(5.346)		
Surprise peers with business			0.004	-0.424**
			(0.046)	(0.165)
Expected peers with business			0.100	0.937
			(0.439)	(1.841)
Number of entrepreneurs	2,222	899	2,222	899

Notes: The table uses data for entrepreneurs in the virtual interaction arms in the Large-Country Sample (LCS), both for the virtual-within and virtual-across treatment arms. *Surprise Peer Quality* (*Surprise Peer with Business*) is the difference between average baseline quality of peers (share of peers with an ongoing business) and their corresponding expectations, the latter computed as the average across 1,000 realizations of the group assignment randomization. In all regressions we include strata fixed effects and control for own baseline quality. For those who did not complete Milestone 0 on time and were not assigned a baseline quality, we add a corresponding dummy and impute a value of 0. In columns (1) and (3) the outcome is submission of a proposal, whereas in columns (2) and (4) the outcome is quality evaluation for those who submitted a proposal. Panel A restricts the sample to those who completed Milestone 0 on time (before the randomization), while Panel B uses the full sample. Standard errors are clustered at the group level (reported in parenthesis). The number of stars (*, **, ***) codes for statistical significance at (10%, 5%, and 1%), respectively.

A.8 Network construction: graphical illustrations and some canonical measures

Here we first present two graphical descriptions of the network constructed for two illustrative instances: a peer group interacting in a virtual-within scenario based in Nigeria and another one under virtual-across interaction. Then, we summarize some canonical network measures obtained across all instances of the treatment arms interacting virtually.

The networks represented in Figures A2 and A3 exhibit a core-periphery structure that is common in social networks. In both cases, we also observe that there is a fraction of individuals who are not platform-active and therefore never interact with others.

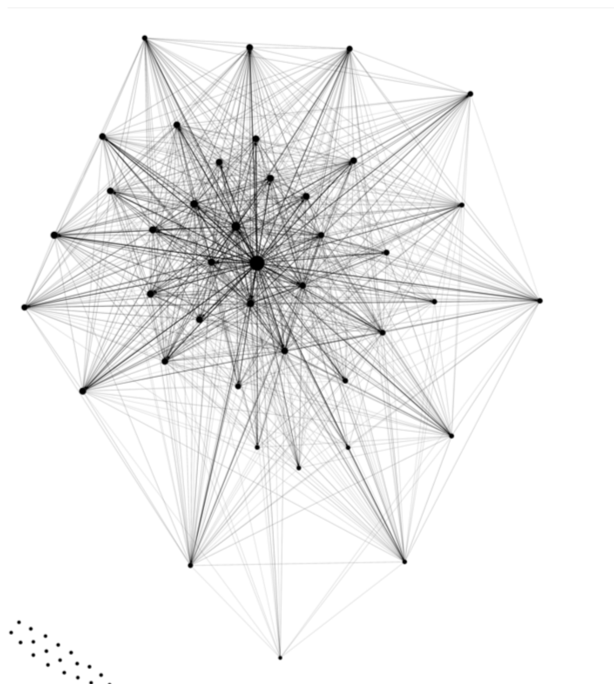

Figure A2: **Peer network for a virtual-within interaction group based in Nigeria.**

On the other hand, Table A12 displays some basic statistics on the following node-based information:[25]

(a) two reciprocal notions of *connectivity*, each reflecting one of the opposite directions in which peer influence flows, i.e. into a node (in-degree), or out from it (out-degree);[26]

(b) *clustering*, which captures the extent to which connections are transitive, i.e. whether an entrepreneur who influences another one, also influences those entrepreneurs the latter influences.

(c) three measures of *centrality* (pagerank, betweenness, and closeness), each assessing in a different way how crucial/prominent is the role played by an entrepreneur in globally connecting pairs of other nodes.

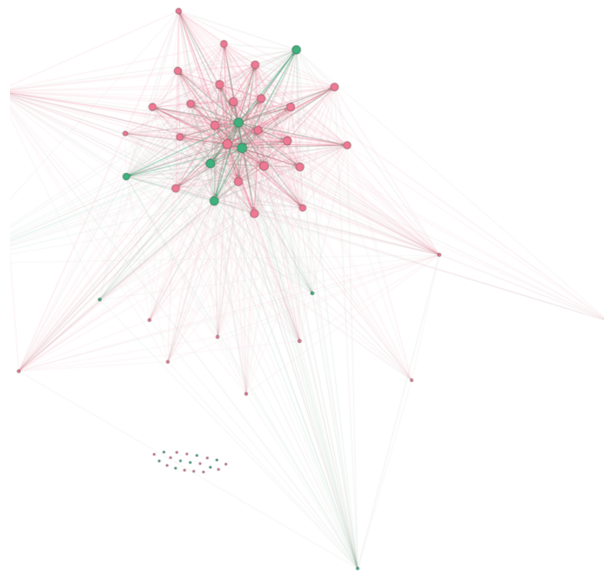

Figure A3: **Peer network for a virtual-across interaction group where red nodes correspond to entrepreneurs from large countries whereas those colored green correspond to entrepreneurs based in small countries.**

Table A12: **Network statistics: description**

	in-degree	out-degree	clustering	pagerank	betweenness	closeness
mean	443.5	443.5	0.039	0.036	0.052	0.627
stdev	731.6	1013.1	0.030	0.040	0.073	0.162
median	137.0	89.0	0.031	0.018	0.025	0.639
min	0.0	0.0	0.003	0.000	0.000	0.000
max	5445.0	10371.0	0.301	0.512	0.193	1.000

Notes: The table presents some basic statistics of selected network measures for entrepreneurs that delivered M0 on-time and also were active on the interaction platform. See the main text for a concise description of each network measure.

The statistics displayed in Table A12 show moderately left-skewed[27] distributions – except for closeness, which is slightly right-skewed. They also display moderate (normalized) variances, an indication that mean values are quite representative statistics for a typical entrepreneur. Concerning connectivity, in particular, we note an average of 443.5 sentences per entrepreneur "effectively" received/sent from/to peers, which represents a quite intense flow of communication.

A.9 Peer effects: complete results

In Tables A13-A14 below, we provide a complete account of the regression results partially presented in Table 5.

[25]See Vega-Redondo (2007), Jackson (2008), and Bloch *et al.* (2017) for a formal description of these measures and their interpretation. Recall that, in the present context, the networks under consideration are weighted ones.

[26]Note that, by an accounting identity, total/average in-degree must be exactly equal to total/average out-degree. In general, however, it is easy to construct simple examples illustrating that the in-degree and out-degree of individuals can be very different.

[27]Here, we identify skewdness in the simple-minded manner that declares a distribution to be left/right skewed if its median is below/above its mean.

Table A13: **Network peer effects, benchmark setup, complete results on submission**

	Virtual within, LCS	Virtual across, LCS	Virtual across, SCS
Peer effect	.533***	.014	.098
	(.174)	(.14)	(.296)
Baseline quality	.071***	.053*	.015
	(.025)	(.031)	(.037)
Female	-.031	-.098*	.026
	(.051)	(.051)	(.071)
Age	.002	.003	.009
	(.002)	(.002)	(.004)
Language English	-.174	-.128	.16
	(.17)	(.237)	(.158)
Language Arabic	.333***	.101	-.047
	(.105)	(.217)	(.232)
Language French	.038	.209	-.05
	(.118)	(.139)	(.071)
Language Other	-.004	-.211**	-.028
	(.061)	(.098)	(.075)
University complete	.012	.036	.102
	(.045)	(.056)	(.068)
Eastern Africa	-.037	.097*	-.012
	(.047)	(.053)	(.096)
Middle Africa	-	-	-.063
	(-)	(-)	(.113)
Southern Africa	.067	-.027	-.021
	(.088)	(.141)	(.153)
Northern Africa	-	-	.349*
	(-)	(-)	(.191)
Has Business	-.012	.083**	-.027
	(.049)	(.041)	(.075)
Has Idea about New Business	-.064	-.037	-.155**
	(.05)	(.054)	(.073)
Has written business plan	.084*	.012	.056
	(.048)	(.044)	(.064)
Sector: Manufacture	.018	-.018	.046
	(.061)	(.068)	(.139)
Sector: Mining	-.149	.226	-
	(.275)	(.148)	(-)
Sector: Other	-.044	.082	.131
	(.062)	(.062)	(.086)
Sector: Retail	.102	-.154	.01
	(.116)	(.096)	(.184)
Sector: Services	-.009	-.077	.198*
	(.073)	(.073)	(.107)
Sector: Social Entrepreneurship	.018	.009	.124
	(.082)	(.062)	(.116)
Sector: Technology	.042	-.064	.073
	(.063)	(.072)	(.127)
Risk Aversion	.005	0	-.018
	(.008)	(.009)	(.022)
Trust Measure	-.003	.005	-.002
	(.008)	(.008)	(.01)
Number of people discuss business	.014**	.019***	.023***
	(.006)	(.007)	(.009)
Number Facebook friends	0	0	0
	(0)	(0)	(0)
Time spent on Facebook	-.001	0	-.001
	(.001)	(.001)	(.003)
Number Twitter friends	0	0	0
	(0)	(0)	(0)
Time spent on Twitter	.002	.001	-.002
	(.002)	(.001)	(.003)
Number of entrepreneurs: 1016			

Notes: A complete account of the regression results on submission partially presented in Table 5.

Table A14: **Network peer effects, benchmark setup, complete results on business quality**

	Virtual within, LCS	Virtual across, LCS	Virtual across, SCS
Peer effect	-.031	.087	.476***
	(.121)	(.150)	(.149)
Baseline quality	.144*	.218***	.192**
	(.084)	(.077)	(.086)
Female	-.025	-.123	-.118
	(.152)	(.147)	(.176)
Age	.02***	.019**	-.018*
	(.007)	(.008)	(.011)
Language English	-1.261**	1.172***	-.324
	(.602)	(.366)	(.466)
Language Arabic	-.641*	2.388***	1.566**
	(.356)	(.439)	(.700)
Language French	-.109	1.747***	.027
	(.466)	(.611)	(.252)
Language Other	.19	-.224	-.357
	(.191)	(.31)	(.263)
University complete	.003	.127	.608***
	(.194)	(.176)	(.209)
Eastern Africa	.183**	.118	-.522*
	(.073)	(.155)	(.308)
Middle Africa	-	-	-.646
	(-)	(-)	(.359)
Southern Africa	.239	-.256	-.313
	(.217)	(.422)	(.637)
Northern Africa	-	-	-1.429**
	(-)	(-)	(.565)
Has Business	-.012	.323**	-.382
	(.132)	(.148)	(.275)
Has Idea about New Business	.091	-.223*	.551**
	(.088)	(.126)	(.22)
Has written business plan	.154	.116	.367*
	(.155)	(.119)	(.19)
Sector: Manufacture	-.105	-.197	-.301
	(.245)	(.202)	(.378)
Sector: Mining	-1.482***	-.886	-
	(.456)	(.533)	(-)
Sector: Other	-.043	.091	-.347
	(.223)	(.269)	(.330)
Sector: Retail	-.088	.187	.318
	(.393)	(.488)	(.405)
Sector: Services	.029	.197	-.602*
	(.221)	(.256)	(.346)
Sector: Social Entrepreneurship	.068	-.103	-.278
	(.23)	(.263)	(.295)
Sector: Technology	.278	.042	-.411
	(.260)	(.184)	(.372)
Risk Aversion	.002	.007	.028
	(.023)	(.035)	(.039)
Trust Measure	-.05***	.019	.068**
	(.018)	(.018)	(.035)
Number of people discuss business	.027*	.009	.027
	(.016)	(.018)	(.024)
Number Facebook friends	0	0	0
	(0)	(0)	(0)
Time spent on Facebook	0	-.004	.003
	(.003)	(.003)	(.007)
Number Twitter friends	0	.001**	.001**
	(0)	(0)	(.001)
Time spent on Twitter	-.002	-.002	-.009
	(.004)	(.004)	(.009)
Number of entrepreneurs: 779			

Notes: A complete account of the regression results on business quality partially presented in Table 5.