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Competition and gender in the lab vs field: Experiments from off-grid renewable energy entrepreneurs in Rural Rwanda

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ABSTRACT

We examine how gender attitudes and performance under competitive situations in the lab reflect microenterprise outcomes in the renewable energy sector of Rwanda – a country with progressive gender policies despite its traditional patriarchal setup. We adopt the standard Niederle and Vesterlund (2007) experimental design in addition to a unique dataset from off-grid microenterprises, managed by entrepreneurs who were working in mixed and single-sex teams prior to the lab experiments. After a piece-rate and a tournament compensation schemes, participants are offered to the opportunity to choose their compensation scheme between these two options in a third round. We find that female entrepreneurs are not less likely to compete and are not outperformed by male entrepreneurs. This stands in contrast to several studies, mostly conducted on university students of developed countries. Furthermore, we leverage administrative and self-reported business data to show that the female entrepreneurs who chose to compete in the lab perform as well as their male counterparts, providing some external validity to our lab results.

1. Introduction

Traditional job markets are mostly male-dominated despite recent efforts by development organisations to close the gender gap. Women often face various social restrictions (including overseeing most household chores, receiving less schooling, and lower returns to their labour) in both developed and developing countries (World Bank, 2015). This problem is more severe in rural areas, where social barriers such as culture and social norms play a significant role.

Despite the well-established advantages associated with the provision of modern energy sources to rural communities, studies in the renewable energy literature have shown that provision of energy sources alone is not enough to achieve the desired empowerment levels and economic freedom for women. Women's journeys towards better welfare opportunities and livelihoods could be fast-tracked if they were well represented at all levels of the energy supply chain (Baruah, 2017; Baruah, 2015). Entrepreneurship has, therefore, been used as a breakthrough point for women in this sector (Clancy et al., 2012; Clancy, Oparaocha & Roehr, 2004). This has resulted in several initiatives and projects targeted at female entrepreneurship. Typical examples are the Solar Sisters initiative, Women's Integration into Renewable Energy (WIRE) and Women's Entrepreneurship in Renewables (wPOWER) under the Energy4Impact initiative.

Though entrepreneurship is a vital tool for promoting women's empowerment, it is essential to note that a predominant characteristic associated with successful entrepreneurship is the ability to compete (Shane, Locke & Collins, 2003). Women have been shown to be less willing to compete and, in some situations, outperformed by men under competitive conditions[1] (Dato & Nieken, 2014; Niederle, & Vesterlund, 2011; 2008; 2007; Ergun, Rivas & García-Muñoz, 2010; Croson & Gneezy, 2009; Datta Gupta, Poulsen & Villeval, 2005). This suggests that, apart from the well-established social barriers affecting women's participation in the labour market, females' unwillingness to compete can also influence their performance levels even after taking up entrepreneurial roles. Hence, a deliberate attempt to empower women in the renewable energy industry through entrepreneurship initiatives may

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[1] It is important to note that women are not always outperformed by men. Studies such as De Paola et al., 2015 and Niederle & Vesterlund, 2007 show no significant difference in performance between men and women.

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have limited potential if due consideration is not given to women's competitiveness and performance abilities.

To date, very little is known about the competitive and performance abilities of women working as sales point entrepreneurs in the renewable energy sector. Our study contributes to the global discussion on women's competitive decisions and performance levels by using lab-in-the-field experiments to first examine how gender attitudes towards competition differ amongst village-level entrepreneurs (VLEs) in Rwanda. The study then demonstrates how performance under competitive situations in the lab reflects microenterprise operations in the field by using a unique dataset from off-grid microenterprises managed by entrepreneurs already working in mixed and single-sex teams since 2016.

Rwanda provides a unique study context for a number of reasons. Though a traditionally patriarchal society, the country is today frequently cited for its commitment towards women's participation and gender equality policies (Burnet, 2011). This comes after the 1994 genocide, which saw the death of at least 500,000 people, the majority of whom were men (Debusscher & Ansoms, 2013). Many women became widows and took over traditional male-dominated social and economic activities. The government of Rwanda has since implemented several gender policies, such as the integration of gender as a fundamental right in the constitution, enforcing a gender quota system for local and national government, and the creation of its first Ministry of Gender Equality. These top-down approaches brought about improved economic and career opportunities as well as higher levels of women's participation in government. Although such policies have substantially improved the postcolonial patriarchal gender roles, rural women are yet to harness the full benefits of the government's women-friendly policies (Burnet, 2011).

Furthermore, the renewable sector of Rwanda is booming as the government of Rwanda is determined to promote private sector involvement, in its quest to accelerate rural electrification to off-grid communities in order to provide energy access to its entire population. However, women's participation in the private energy sector of Rwanda is low, as there are no gender policies governing the private energy sector (Parshotam & van der Westhuizen, 2018). Examining women's competitiveness in this context not only enriches this branch of the economic literature but also provide key insights into women's abilities in the private energy sector of Rwanda.

To implement our objective, we partnered with Nuru Energy – a for-profit social enterprise. Nuru Energy provides low-cost solar mobile phone and light recharging centres to off-grid poor communities in rural Rwanda. They operate by delivering power in the form of rechargeable light-emitting diodes (LEDs) via local village enterprises. LEDs are recharged by a centralised pedal-and-solar-powered recharge station, which is operated by community-run microenterprises. As part of a more extensive study (Clarke et al., 2020; Visser et al., 2019) to understand the role of a gender quota business model in empowering women, 136 new microenterprises in Rwanda have been established. Villages were randomised into three treatment arms such that in each village, the enterprise is owned and operated by either an all-male team, an all-female team or a mixed gender[2] team, each consisting of four members, for a total of 544 microentrepreneurs. While such a gender quota-based business model provides an enabling environment for entrepreneurship and self-employment for women, it is essential to further investigate attitudes towards competition in such a context and examine whether performance in the lab reflects microenterprise activities in the field.

This study measures willingness to compete and performance under competition using the standard experimental design of Niederle and Vesterlund (2007) on a subsample of 374 entrepreneurs from the off-grid microenterprises described in the preceding paragraph. Subsequently, field outcomes – sales and self-reported incomes from microenterprise operations – are used to measure the field performances of gender teams. Our study shows that women operating off-grid microenterprises in Rwanda do not shy away from competition and perform as well as men in the lab. This outcome is mirrored in the field: female lab participants who self-selected into competition also have similar business performance as their male counterparts during the first three months of operation. Although our lab sample is broadly representative of the larger RCT sample, we are careful not to generalise our results due to potential selection limitations as there is a possibility that results for the different gender compositions could vary for the larger sample, or over a more extended period. Also, though the study extends the existing literature on gender and competitiveness to entrepreneurs in Rwanda, our finding of no gender gap in competition entry in our setting may owe to either our participant's characteristics or the country's gender policies. Given that we do not test the impact of gender policy on competition preferences, comments on Rwanda's gender policy are only suggestive and not conclusive and could serve as a point of departure for further studies.

The rest of the paper proceeds as follows. Section 2 presents a review of related literature. The experimental design and data used for the study are detailed in Section 3. This is followed by the empirical strategy of the study in Section 4. Results and discussion of findings are reported in Section 5. Section 6 concludes.

2. Related Literature

A growing experimental literature has explored gender differences in attitudes towards competition with a focus on three broad areas: competition entry decisions, performance levels and gender composition of competing groups.[3] Results show that women are less willing to compete (Zhong et al., 2018; Apicella et al., 2017; Sutter & Glaetzle-Ruetzler, 2015; Booth & Nolen, 2012; Niederle & Vesterlund, 2007) and may have lower performance levels than men when they do compete (eg., Dariel et al., 2017; Dato & Nieken, 2014; Niederle et al. 2013). This may partly explain why women are less represented in the labour market and why, at the subsistence level, female-operated firms are less profitable than those operated by their male counterparts (Buvinic & Furst-Nichols, 2016). In some cases, findings suggest no significant difference in performance between men and women (De Paola et al., 2015, Niederle & Vesterlund, 2007, Barron et al., 2020).

The literature on competition has, however, been skewed towards university student-based experiments in Western societies (*See Appendix 1:* Table I*for a summarised review of studies on students and non-students' samples including their respective study area to date)*. Developments in the literature show that culture or the context in which these experiments are conducted can influence competitive outcomes. Gneezy et al. (2009) explain this by comparing patriarchal and matrilineal societies. Whereas the observed gender gap in the patriarchal society of Masai in Tanzania emulates most findings in Western countries, the matrilineal society of Khasi in northeast India shows a reversed gender gap. A follow-up study by Andersen et al. (2013) shows that, although no gender gap exists between these two societies at age 7, by age 15, these two communities start exhibiting very different characteristics towards competition. These studies have since paved the way for more society-specific studies (Booth et al., 2018; Bönte et al., 2018; Dariel et al., 2017; Cassar et al., 2016; Apicella and Dreber, 2015).

Although the competition literature is extensive, the focus has shifted to applications of such experimental studies. There is still more to learn from the extent to which competition measures in the lab relate to real outcomes. Previous studies have attempted to examine competition

[2] The mixed gender team consist of equal representation of men and women: two men, two women per team.

[3] For a detailed review on these key areas, see Niederle and Vesterlund (2011) and Croson and Gneezy (2009).

Table 1
Background and Field Variables.

Variable	Observation	Mean	Min	Max
Background				
Age	374	42.19	18	76
Education	374	6.9	1	16
Female	374	0.49	0	1
Marital Status	374	0.90	0	1
Household size	343	11	1	12
Household Head	336	0.59	0	1
District = Rulindo	374	0.35	0	1
Risk measure (Switching Point)	374	6.33	1	22
Business Outcomes				
Number of recharges in 3-month period (Sales)	374	307.62	40	640
Income from Business	335	946.62	0	9000

Note: Age is the age of the VLE in years, education is in years of schooling, Female is a dummy showing whether the VLE is male or female, Marital status indicates whether VLE is married. Household size is the number of people living in VLE's household. Household head shows whether the VLE is a household head. Risk measure shows the level of VLEs' attitudes towards risk-taking, ranging from 1 (highly risk-averse) to 22 (risk-seeking). For the microenterprise outcomes, recharge frequency, which is used as a proxy for sales, is the number of times VLEs recharge lights for customers. Income is VLEs' self-reported income (in RWF) from operating the microenterprise.

in real-world situations or by using natural field experiments (Ors et al., 2013; Paserman, 2007; Lavy, 2012); however, the direct link of competition measures to real-world outcomes is still scarce. Zhang (2013) and Buser et al. (2014) directly examine how competition predicts educational choices of students. Both studies show that choices in the lab under competitive incentives correspond to choices of study but were unable to study students' performance outcomes under exam conditions. Berge et al. (2015) argue that an individual's decision to compete does not necessarily imply success in the real world. To test this, they use small-scale entrepreneurs in Tanzania. Findings from Berge et al. (2015) show a positive association between competitiveness in the lab and field choices. Their study, however, did not explicitly examine the gender differences associated with their results.

Our study contributes to this stream of literature by using a unique dataset from entrepreneurs operating in specific gender groups (all-male, all-female and mixed-gender teams) in rural Rwanda to examine the relationship between lab and field outcomes. The study does not only contribute to the competition literature but will also provide insights into the ability and performance of women, which is of relevance to microenterprise development in the renewable energy sector.

3. Experimental Design and Data

Our sample subjects are entrepreneurs operating off-grid microenterprises in the Rulindo and Ruhango districts of Rwanda, as part of a larger randomised control trial (RCT) focused on the use of a gender quota business model to empower women in the renewable energy sector (Visser et al. 2019, Clarke et al. 2020). These entrepreneurs have been operating in randomly assigned gender groups since 2016, with each group consisting of four members. Their core role is to recharge lights for customers at a fee.

Entrepreneurs in the larger randomised control trial study were recruited as follows. First, 272 villages in the Rwanda district of Rulindo and Ruhango were sampled to participate in a new Nuru business model. With the assistance of village leaders, villages were approached about the opportunity of setting up solar recharge stations with each station to be run by a four-person microentrepreneur team. For the purposes of the field experiment, interested villages were randomly sorted into three groups (all-male, all-female, and mixed teams). Community members formed their groups without any restrictions from the research team apart from the gender composition request. Prospective microentrepreneur teams were then requested to raise an investment capital (commitment fees) of 40,000 Rwandan Francs (~50USD) in exchange for their start-up recharging equipment. All 272 villages raised these commitment fees prior to assigning treatment groups. Potential microenterprises were informed that their village had a 50% probability of being selected into the first phase of the new Nuru business. Thus, half of the sample was randomly assigned to a treatment arm. Villages who were selected to a control group had their money returned to team members, while villages who were selected into the treatment group received recharging equipment and 100 lights per each village to commence business. The operations and management decisions were solely up to members of the team. Also, given that community members could form their own gender teams, there is a potential that team members could be familiar with each other before the commencement of business. Clarke et al. (2020) and Visser et al. (2019) provide a detailed account of the randomisation process.

As of March 2017, before conducting the experiments, there were 129 actively working microenterprises (one per village). This provided the study with a total population size of 516 entrepreneurs.[4] Out of the 516 actively working entrepreneurs, 374 participated and completed the experiment.[5]

3.1. Potential Selection Bias

To better understand how the 374 lab participants compare to the larger sample of 516 operational VLEs and to examine any potential selection bias, we compare the socioeconomic and business characteristics of lab participants with those who did not participate in the experiment. *Table I, Appendix 2* report results from the balance test. Results show no significant differences in age, the number of working hours, household income, household expenditure, the probability that an entrepreneur had a household member in wage employment and the likelihood that VLEs had an adequate roof. Besides being not statistically significant, the coefficients are small, and the confidence intervals are narrow. Furthermore, results show that experimental participants and non-participants were equally likely to have been assigned to a male, female or mixed-gender group. We also find that lab participants and non-participants were equally likely to be in either Rulindo or Ruhango district. In addition, there are no significant differences in the proportion of VLEs reported to feel happy and in their level of patience as measured in the survey.

However, there are a few statistically significant differences. First, lab participants had 11.7% more recharges than non-participants. At the mean value of 307 recharges, this difference amounts to 36 additional recharges over the entire three-month period, roughly two additional recharges every 5 days. Despite being statistically significant, this does not amount to an economically significant difference. Second, lab participants were 3.7 percentage points more likely to have secondary education than non-participants. This difference could be a cause for concern if education were a predictor of performance in the field. However, we show this is not the case in Table 6 below. Lastly, entrepreneurs who participated in the experiment were slightly less dissatisfied about their emotional health than non-experiment participants at a 90% of confidence, but the lack of difference in happiness or patience suggests there are no systematic differences in this regard.

Taken together, the evidence in this table suggests that the sample of participants in the lab experiments is broadly similar to microentrepreneurs who did not participate in the lab experiments, and hence our lab results could plausibly hold for VLEs who did not participate in the lab experiments. At the very least, our results would be informative of the slightly more competitive microenterprises.

[4] 129 x 4 = 516

[5] Most entrepreneurs who could not make it were not either available during the information stage or had other engagements on the day the experiment was conducted.

Table 2
Gender Group Composition.

Gender groups	Observation	Proportion
Experimental group composition		
All-male teams (%)	131	35.03
All-female teams (%)	130	34.76
Mixed gender teams (%)	113	30.21
Microenterprise group composition		
All-male teams (%)	127	33.96
All-female teams (%)	128	34.22
Mixed gender teams (%)	119	31.82

3.2. The Experiment

We conducted a series of experiments focused on entrepreneurs' attitudes towards competition, risk aversion and prosocial measures. A total of 24 experimental sessions were conducted by the same experimenter between March and June 2017. The sessions were conducted in school classrooms across 19 sectors (villages are grouped in sectors). Prior to the day of the experiment, individual entrepreneurs were personally invited to participate in the experiment and to additionally indicate their potential availability. Participants who indicated their availability were given further information about the specific venue and the time to arrive at the experiment venue. We made a phone call to remind them about the event the day before the experiment. Given the long distances participants needed to travel to the various experimental venues, we offered to cover the transportation cost of participants who showed up for the event. A minimum of 4 and a maximum of 8 groups were invited to each session depending on their proximity to the experiment venue. The average number of participants per each session was 18, with a maximum number of 30 people. Below, we describe in detail the experimental design and procedures of the two behavioural measures utilised in this study, namely the competition and risk experiment. Detailed instructions used for the experiment can be found in the *supplementary material.*

The competition games follow the standard experimental design of Niederle and Vesterlund (2007) with minor alterations in the payoffs offered to participants. VLEs solved real problems under piece rate and tournament incentivised schemes. For each session, VLEs were presented with a set of 20 simple addition problems to be solved in five minutes with no performance feedback between tasks. The addition problems were handed to VLEs in a booklet form such that each page had only one problem, as presented below:

75	85	60	15	ANSWER

For instance, participants were expected to add these four numbers and provide the answer (235 in this case) in the space labelled ANSWER, which was left empty on the actual decision sheets for all twenty questions.

VLEs were not allowed to use calculators. However, the booklets in which the problems were solved had enough space for scratch work. Instructions and incentives were read out loud to VLEs in Kinyarwanda (the official local language of Rwanda) before the start of each task. Participants performed these tasks (consisting of 20 problems each) under three different incentive schemes, namely: piece rate, tournament and preferred incentive scheme.

In the first round (piece rate), participants earned 50 Rwandan francs (RWF) –approximately 0.055 United States Dollars (USD) – for each correct answer provided. In the second task (tournament), participants competed in randomly assigned gender groups (mixed and single sex) of between two and six members. The study aimed to assign participants to only groups of four consistent with VLEs' group sizes in the field. However, since we had no control over the exact number and gender of participants who showed up for the sessions, we had to assign some participants to groups other than the intended group size of four. Most of our sample (224 out of 374 participants) participated in groups of four members, with 135 participants assigned to groups of 3 or 5 members. *Table II, Appendix 2* shows the group size distribution. The designated groups assigned to participants in the experiment were different from VLEs' actual microenterprise gender groups in the real world. This guaranteed the anonymity of group members and limited any potential informed decisions that could arise when the identity of team members is known to participants. Subjects were, however, informed about the demographic distribution of their respective groups (age, marital status and gender distributions).[6]

In the second round (tournament), participants were requested to solve a second set of addition problems. In contrast to the first task, only the participant with the highest score in each group received a payment. The amount was of 150 RWF (approximately 0.17 USD), which is three times more than the piece rate amount, for each correct answer. Other members of the group received nothing for their effort. In the situation of a tie, earnings were split equally among the top performers of the group.

In the third round (preferred incentive scheme) we offered VLEs the opportunity to choose a preferred payment incentive between the piece rate or the tournament payment scheme. Subjects then solved a third set of addition problems. VLEs who chose the tournament compensation scheme now had their scores from the third round compared to those of their group's opponent's scores from task 2.[7]

We continued with a risk experiment after VLEs completed the competition games. The risk experiments closely follow Brick and Visser (2015), which was based on the earlier design of Gneezy and Potters (1997) as well as Moore and Eckel (2006). This proceeds as follows: VLEs were asked to make twenty-two choices, with each choice providing VLEs with two options. The first option provided VLEs with a sure payoff (increasing from 160 RWF (~ 0.18 USD) in the first choice to 580 RWF (~ 0.64 USD) in the twenty-second choice). The second option offered a lottery with a 30% probability of receiving 1200 RWF (~1.33 USD) and a 70% probability of receiving nothing. A risk-averse VLE will prefer the first option (the certain payoff) while a more risk-loving VLE will prefer the lottery. A spinning wheel was used to determine the payoffs for VLEs who preferred the gamble. The choices of subjects enabled the study to calculate risk measures using VLEs' switching points between the sure payoffs and the lottery (Booth et al., 2018; Vieider et al., 2015; Brick & Visser 2015). Given that a series of practice rounds were played to confirm participants' understanding of instructions before proceeding to the actual experimental sheets for the study, no multiple switching behaviour was recorded, and participants did not feel pressurized to switch or stick to specific choices.

Participants were provided with feedback about their performance at the end of the experiment after all tasks were completed (including the risk task). Also, participants were paid for all tasks according to their performance with earnings ranging from 2000RWF (~2.09 USD) to 12500 RWF (~13.09 USD). The average earning received by participants was of 6000RWF (~6.28 USD). The average experimental earning is about twice the local average daily wage of 3256 RWF (~3.30 USD). The experiment lasted for approximately 2 hours.

3.3. Descriptive Statistics

Table 1 provides details of entrepreneurs' backgrounds and an overview of field outcomes used in the analysis. VLEs' background information is obtained from survey data conducted as part of the larger RCT study detailed in Clarke et al. (2020) and Visser et al. (2019). The

[6] This enabled the study to inform participants about the gender distribution of groups in a more subtle way by also including age and marital status.

[7] Thus, if a VLE chose to compete in Task 3, he/she receives RWF150 if his/her score in Task 3 is greater than his/her group members' score in the previous task (Task 2); if not, the VLE receives nothing. This is to ensure that a decision by a group member to choose the piece rate payment incentive does not affect comparison of scores in the third task (Niederle & Vesterlund, 2011).

Table 3
Performance Levels of VLEs in the Lab.

Variable		Obs	Whole Sample	Male	Female	Diff	*p*-value
Piece rate *(Task 1)*	Overall	374	7.73	8.38	7.06	1.32	0.002***
	Single- sex	261	7.54	8.23	6.85	1.39	0.003***
	Mixed	113	8.16	8.69	7.57	1.12	0.262
Tournament *(Task 2)*	Overall	374	9.83	10.56	9.09	1.47	0.004***
	Single- sex	261	9.49	10.12	8.85	1.28	0.023**
	Mixed	113	10.64	11.52	9.66	1.86	0.062*
Task 2–Task 1	Overall	374	2.10	2.17	2.03	0.15	0.488
	Single- sex	261	2.0	1.89	2.0	-0.11	0.793
	Mixed	113	2.48	2.83	2.09	0.74	0.292
Preferred incentive (Task 3):							
Tournament	Overall	172	11.7	12.19	11.22	0.98	0.256
	Single- sex	119	11.18	11.69	10.57	1.11	0.204
	Mixed	53	13	13.35	12.6	0.75	0.872
Piece rate	Overall	201	10.39	11.06	9.78	1.28	0.015**
	Single-sex	141	10.34	11.07	9.72	1.35	0.021**
	Mixed	60	10.5	11.03	9.93	1.10	0.353
Task3 – Task 2	Overall	172	1.02	1.03	1.02	0.01	0.730
(Tournament	Single -sex	119	1.03	1.07	0.98	0.09	0.788
Choosers)	Mixed	53	1.02	0.92	1.12	-0.19	0.899

Note: We used both the Mann Whitney U test and a two- sided t - test to test the differences in performance across different sample groups. Given that both tests produced similar results we only report the *p*-values from the Mann Whitney U tests. Values in the "whole sample", "male" and "female" columns are averages for the full sample and each group, respectively.

average village-level entrepreneur is married, 42 years of age, risk-averse, and has at least primary education (7 years of schooling) and household size of 11 people.

For field outcomes, we use administrative data on the number of recharges during the first three months of business operations and complement this information with self-reported incomes of VLEs, which measures the performance levels of microenterprises. Nuru Energy has a centralised server that regularly receives recharge data from the various enterprises. The centralised data station provides the study with the sales information for each microenterprise. Self-reported incomes from business operations are obtained from the survey data to complement the administrative information. Specifically, we consider the total number of recharges of lights for the three first months of business operations and the average income per month. A Nuru microenterprise on average has a total of 307 recharges in those three months, with the average VLE reporting an income of 946 RWF per month.

Table 2 shows the gender distribution of teams in the experiment and the field. In the experiment, 131 (35%) participants were assigned to all-male teams, 130 (34.8%) participated in all-female teams, and 113 (30%) were allocated to in mixed gender teams. For the microenterprise gender group compositions, 127 (34%) were in all-male teams, 128 (34%) operated in all-female teams and 119 (32%) worked in mixed-gender teams. This shows an approximately equal gender distribution for both entrepreneurial and experimental groups with no significant difference between the two distributions.

4. Empirical Strategy

The study aims at examining entrepreneurs' attitudes towards competition and comparing entrepreneurs' performance levels in the lab to performance in business. For entrepreneurs' attitudes towards competition, we estimate a standard probit model depicted in equation 1:

$$\Pr\left(Competition_{entry}=1\right)_i=\Phi(\gamma_0+\gamma_1 Female_i+\gamma_3 X_i+\gamma_4 V_i+\ \mathscr{E}_i)\ldots \quad (1)$$

where the dependent variable is a dummy variable measuring the willingness of entrepreneurs to participate in a competition such that $Competition\_entry_i=1$ if the VLE chooses the tournament and 0 if the VLE chooses piece rate in the third round of the experiment. $Female_i=1$ indicates that a participant is female. Other explanatory variables X_i include scores from round 2, response to competition among peers,[8] risk preferences, number of VLEs per session, and group size, are standard explanatory variables included in estimations of willingness to compete (Booth et al., 2018, Dariel et al., 2017, Niederle & Vesterlund, 2007). We also control for VLEs' background indicators V_i (age, education, marital status, household size, household head, geographical districts of operation, and gender composition of the VLE teams in the field).

To examine how entrepreneurs' performance levels compare to field outcomes, we estimate Eq. (2) using an Ordinary Least Squares (OLS) estimation approach:

$$Perfomance_i=\gamma_0+\gamma_1\ Gender\_Teams_i+\gamma_3 X_i+\mathscr{E}_i \quad (2)$$

Eq. (2) is estimated for lab and field outcomes. For lab outcomes, the dependent variable $Perfomance_i$ is VLEs' scores under competition, calculated as the number of correct answers in this task. *Gender_Team* is the real-world gender teams in which entrepreneurs are working: all-male, all-female or the mixed gender teams. Each team consist of four members such that the all-male and all-female teams have four males and four females respectively per gender group, while the mixed gender teams have two males and two females working together in a group. Individual background characteristics remains the same as in Eq. (1). For field outcomes, we use the recharge frequency of lights (sales) and the inverse hyperbolic sine transformation of self-reported incomes from VLEs to measure performance. We face the problem of some VLEs reporting zero income when considering the self-reported incomes. The inverse hyperbolic sine transformation approximates the natural logarithm of that variable and allows retaining observations with zero self-reported income. Standard errors for the field estimation are clustered at the village level since the gender composition of VLE teams in the field was randomly assigned at the village level.

[8] Response to competition among peers measures the difference between competition scores (task 2) and piece rate scores (task 1). Including this variable is a standard practice in all competition studies (see Booth et al., 2018, Dariel et al., 2017, Niederle & Vesterlund, 2007).

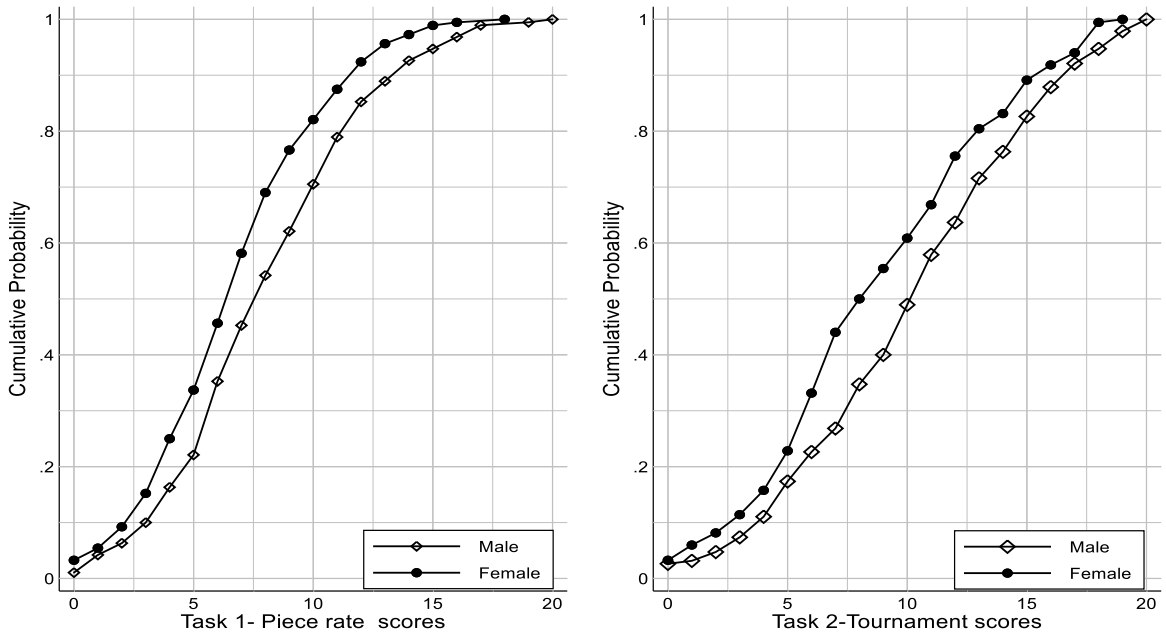

Fig. 1. CDF of Correctly Solved Problems (Task 1: Piece Rate & Task 2: Tournament).

5. Results and Discussion

5.1. Performance in the Lab Under Piece Rate, Tournament and Preferred Incentive Treatments

Table 3 shows the performance levels of VLEs in the lab for all treatments. In the first two rounds (Piece rate and Tournament), VLEs scored an average of 7.73 and 9.83 correct answers, respectively. This performance varies from 7.54 to 8.16 for single and mixed gender groups under the piece rate incentive. Men significantly perform better in the all-male groups, with an average score of 8.23 than females in the all-female groups, who scored 6.85 on the average (p-value = 0.003). In the mixed-gender groups, both men and women show no performance differences under the piece rate incentive (p-value = 0.262)

For the tournament incentive, performance ranges from 9.49 to 10.64 for single and mixed gender groups, with the all-male groups performing better than the all-female groups (p-value = 0.023). Performance under the tournament also improved significantly despite a high correlation between piece rate and tournament scores of approximately 0.73 and 0.72 for men and women respectively. On average, all gender groups solved two more problems under the tournament compensation scheme compared to the piece rate scheme with no significant difference (p-value = 0.488). This suggests no gender difference associated with improvement in performance after moving from the piece rate (task 1) to the tournament round (task 2). Improvement in performance from task 1 to task 2 may be due to the initial learning

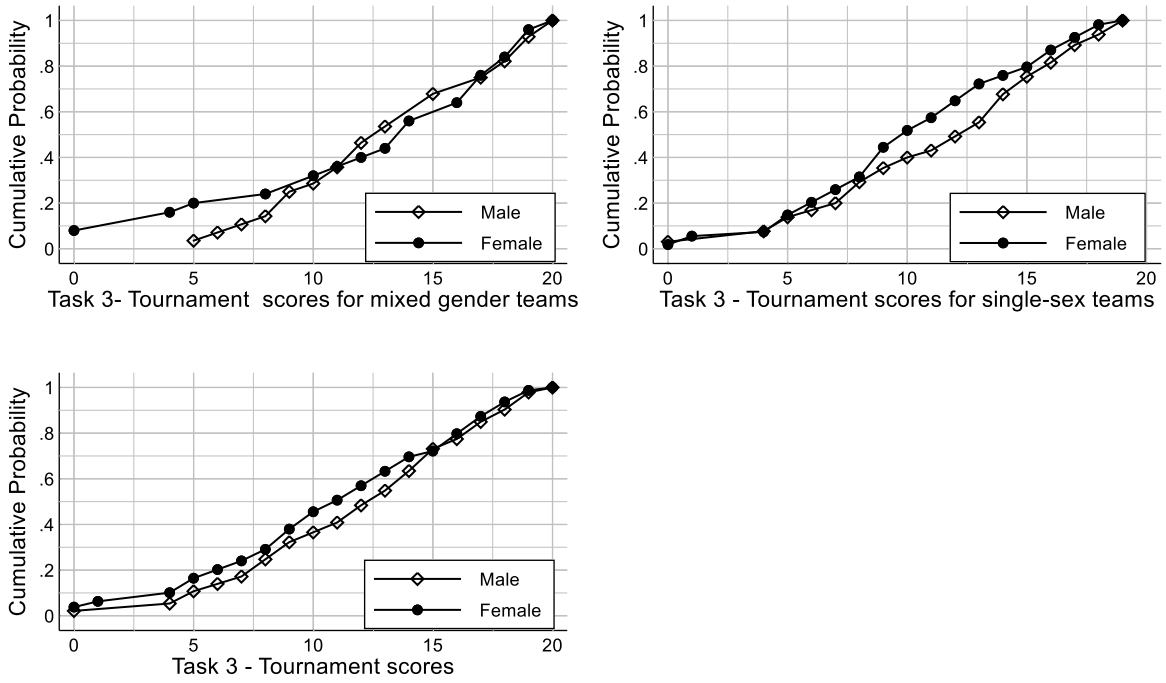

Fig. 2. CDF of Correctly Solved Problems (Task 3: Tournament).

Table 4
VLE's Competition Entry Decisions.

VARIABLES	(1) Whole Sample	(2) Mixed	(3) Single	(4) Female	(5) Male
Females	0.0461	0.0478	0.0253		
	(0.108)	(0.180)	(0.128)		
Experimental single-sex teams	0.0285				
	(0.0706)				
Scores from round 2	0.0178**	0.0400***	0.0069	0.0051	0.0049
	(0.0079)	(0.0112)	(0.0104)	(0.0160)	(0.0139)
Tournament - Piece rate	-0.0192*	-0.0412***	-0.0087	0.0127	-0.0146
	(0.0104)	(0.0156)	(0.0141)	(0.0217)	(0.0185)
Number of participants per session	-0.0036	-0.0274**	0.0012	0.0021	0.0052
	(0.0052)	(0.0112)	(0.0061)	(0.0094)	(0.0085)
Risk taking (Switching Point)	0.0089**	0.0104	0.0109***	0.0117*	0.0049
	(0.0036)	(0.0067)	(0.0042)	(0.0064)	(0.0063)
Education	0.0252**	0.0201	0.0315**	0.0350	0.0313*
	(0.0109)	(0.0169)	(0.0141)	(0.0219)	(0.0188)
Household head	0.0213	-0.0600	0.0746	0.160	-0.204
	(0.0811)	(0.141)	(0.0923)	(0.118)	(0.194)
Household size	-0.0219	-0.0412	-0.0167	-0.0210	-0.0098
	(0.0152)	(0.0267)	(0.0181)	(0.0270)	(0.0262)
Age	-0.0017	0.0082	-0.0038	6.41e-05	-0.0048
	(0.0027)	(0.0049)	(0.0030)	(0.0048)	(0.0041)
Rulindo District	0.0281	-0.0297	0.0489	0.0740	0.0423
	(0.0780)	(0.098)	(0.122)	(0.185)	(0.190)
Married	0.0542	0.176	0.0056	0.234*	-0.229
	(0.0920)	(0.140)	(0.115)	(0.141)	(0.228)
Field Gender Composition					
2.All- Females	-0.0233	0.0985	0.0057		
	(0.110)	(0.173)	(0.136)		
3.Mixed	0.0309	0.220*	-0.0035	0.0357	0.0088
	(0.0788)	(0.122)	(0.0949)	(0.109)	(0.0966)
Group Size					
2	0.268		0.229		0.244
	(0.241)		(0.258)		(0.272)
3	-0.144	-0.0424	-0.191	-	0.181
	(0.0995)	(0.191)	(0.118)		(0.200)
5	0.0122		-0.0228	-0.0793	0.0597
	(0.0738)		(0.0757)	(0.108)	(0.114)
6	0.172		0.124		0.224
	(0.144)		(0.154)		(0.162)
Observations	335	102	233	109	115
Log pseudolikelihood	-212.92	-57.19	-147.87	-68.45	-70.55

Results are marginal effects from a Probit estimation. Heteroskedasticity-robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The female variable indicates female = 1 compared to males = 0. The 'experimental single sex team' variable shows respondents in the single sex team = 1 compared those in the mixed gender team = 0. The reference category for the field gender composition variables is the all-male teams = 1. Household heads = 1 are compared to non-household heads = 0. Respondents from Rulindo district are compared to those in Ruhango district = 0. Respondents who are married =1, are compared to non-married = 0 participants.

effect, as explained by Niederle and Vesterlund (2007).

We also present average scores for the third task under the preferred incentive treatment. VLEs who chose to compete solved an average of 11.7 problems, with performance varying from 11.18 to 13 for single and mixed gender teams respectively. There is no significant difference in performance for all-male and all-female teams (11.69 for men and 10.67 for women) with a corresponding P-value of 0.204. Similarly, men and women in mixed gender groups have identical performance levels (13.35 and 12.6, respectively, p-value = 0.872). Comparing performance in task 2 (tournament) to task 3, Table 2 shows a slight increase in performance for VLEs who chose to compete and those who did not. Both men and women solved an average of one more problem in Task 3, but this difference is not statistically significant (p-value = 0.730). The improvement in performance under the preferred incentive treatment cut across all gender groups, with no gender group improving more than the other.

In Fig. 1, we show the cumulative distributions for piece rate and tournament treatments by gender. This shows the cumulative probability of correctly solving a given number of problems. The figure clearly emphasises the existing gender gap reported in Table 2 under the first two tasks (Piece rate and Tournament). In both incentive schemes, women show a higher chance of solving a lower number of problems than men. This indicates higher performance levels for men than women.

Fig. 2 shows the cumulative distributions of VLEs who chose to enter the competition under the preferred incentive scheme (task 3). In the first graph, we show the cumulative probability of solving a given number of problems for VLEs assigned to mixed gender teams during the competition games. The cumulative distributions for single-sex teams are shown in the second graph in the right panel. The third graph in Fig. 2 shows the distribution for all VLEs (combined) irrespective of their gender group assignment.

We find no substantial difference in the cumulative distributions for either men or women. Mixed and single-sex teams show similar performance trends for both men and women. However, in the single-sex teams, women show a slightly higher cumulative probability distribution for lower scores than men. The probability of correctly solving a given number of problems under the tournament in task 3 overall is similar for both men and women.

5.2. Entrepreneurs' Willingness to Compete

This section first analyses competition entry decisions of VLEs. Out of the 374 VLEs who participated in the experiment, 172 (46%) chose to

compete in the third experimental round. Comparing the 46% of participants who chose to compete in our sample to other tournament entry rates (29.6% to 54%) from previous studies (Dariel et al., 2017; Apicella et al., 2017; John, 2017; Khachatryan et al., 2015; Gneezy et al., 2009; Niederle & Vesterlund, 2007)[9] we see that, while our reported competition entry rate generally falls within the topmost percentile, it does not deviate from previously reported rates. Female entrepreneurs select into competition 43% of the time, while men select into competition 49% of the time. The Fischer exact test ($p = 0.299$) indicates that this difference between women's and men's competition entry is not statistically significant. While there is a possibility that high-ability participants may self-select into the competition, subjects in our study did not receive any form of performance feedback between experimental rounds, enabling the study to hedge against such potential selection bias. We, however, acknowledge that participants are still likely to have beliefs about their ability, but this caveat is inherent to all experiments of this type.

Table 4 shows the results for tournament entry decisions of entrepreneurs based on experimental gender group composition. Columns 1–3 show that females are not less likely to compete than males. Instead, there are a number of predictors of competition that we analyse in turn. For instance, education and risk-taking are more important predictors of competition entry decisions in the single-sex teams than in the mixed gender teams. Risk preferences (being risk-loving) is an important predictor of competition entry in the all-female groups (Column 4), whereas it does not play a significant role in mixed gender teams. Males with higher education levels in the all-male experimental groups are more likely to compete. Married women are more likely to enter competition in the all-female groups than in the mixed-gender groups, as shown in column 4.

Controlling for the different gender compositions in the field, we find that entrepreneurs operating mixed gender microenterprises and assigned to a mixed gender team in the lab are more likely to choose into competition. We find no significant effect for other field gender teams. We additionally control for the differences in group sizes encountered during the experiment. *Appendix 2, Table IV* further reports estimations when we restrict the analysis to only groups sizes of four, with similar results. In both cases, results show that differences in group sizes do not significantly impact the choice into tournament. Overall, findings suggest no gender gap in competition entry amongst entrepreneurs operating off-grid microenterprises in rural Rwanda.

Although our finding of no gender gap in competition entry contradicts a large body of literature which shows that women are reluctant to make competition entry decisions (Croson & Gneezy, 2009), it is perhaps not surprising in the context of Rwanda given its history and progressive gender mainstreaming policies implemented subsequently. Following the 1994 genocide which mainly targeted men and boys, 70% of Rwanda's population were women.

This forced the country to involve women in the rebuilding of the nation. As a result, traditionally male-dominated positions were offered to women. These national gender policies have gradually permeated the perceptions of the younger generation, which is evident in the baseline survey data collected as part of the larger RCT study. In the survey, children of VLEs were asked questions about their general gender perceptions. Their beliefs suggest that wives should be equally educated as husbands, boys should not get more resources for education, and daughters should have similar rights as sons in terms of inheriting property (*as reported in Appendix 2, Table III*).

In line with these beliefs, Burnet (2011) also identifies that the deliberate gender policies implemented by the government have translated into notable successes at the local level. These successes include increased levels of respect from village members and family, improved decision making at the household level, women's access to education, and enhanced capacity for women to freely speak and be heard at village meetings. This is an indication that the gender equality agenda in Rwanda is gradually changing perceptions and empowering women to take on challenging roles irrespective of the entrenched cultural barriers still existing in the country. It is likely that the progressive women's empowerment policies in Rwanda may be a contributing factor to explain why we see no significant gender difference in VLEs' decision to perform tasks under competitive situations.

Further, the original business model of Nuru before the current gender quota system under study also demonstrates how women expressed great interest in the entrepreneurship prospects of the Nuru program. Thus, the willingness of women to take on entrepreneurship roles despite its associated competitive characteristics could be an additional explanatory factor as to why no gender differences exist in the tournament entry decisions of VLEs. A more recent study by Dariel et al. (2017) supports our finding by showing that women in the United Arab Emirates are willing to participate in competition. Their results were also obtained in the context of a very entrenched patriarchal society after several policies towards women's empowerment and women's participation in the labour market were put in place.

Risk-taking and competitiveness, though different concepts, can be related in nature. Niederle and Vesterlund (2007) explain that competition involves uncertainty in earnings, such that any gender gap associated with risk preferences can influence decisions to compete. Our results show that VLEs with more risk-taking orientations are more likely to choose competition in single-sex teams, particularly in the all-female teams, but this is not the case for the mixed and all-male teams. The relationship between risk attitudes and competition entry decisions is well established in the literature. For instance, van Veldhuizen (2017) and Bartling et al. (2009) show that less risk-averse individuals self-select into competition. As a result, the gender gap observed in competition entry decisions is significantly driven by differences in risk attitudes. Similarly, Cardenas et al. (2012) explore this concept by comparing results from two countries: Sweden and Colombia. They find a positive relationship between risk-loving individuals and competitiveness in Sweden but find no such relationship amongst Colombian boys and girls. In line with Niederle and Vesterlund (2007), they conclude that, whereas risk-taking is a key driver of competition entry decisions, other factors such as overconfidence could also influence decisions to compete. Our results that risk-loving VLEs are more likely to choose competition is widely supported by these previous studies.

5.3. Performance in the Lab vs Field

In this section, we compare business performance in the field of women who decided to compete in the lab to their male counterparts. We further discuss how performance levels of gender teams in the lab compare to the performance in the field. Table 5 reports performance of entrepreneurs who chose to compete in the third round of the experiment. These are the main results in this study. Column 1 shows that the gender composition of teams in the lab experiment did not affect performance in the lab. All-female and mixed gender teams perform as well as all-male teams in the lab. Next, columns 2-4 show no gender differences in performance controlling for different sets of covariates, including the gender composition of field teams (Columns 3 and 4). Our preferred specification is Column 4, which also includes group size fixed effects.

A large body of literature finds that opponents' gender influences performance under competition, such that women tend to perform better in single-sex environments than in co-gender environments (Delfgaauw et al., 2013; Booth & Nolen 2012; Niederle & Vesterlund, 2008; Gneezy et al., 2003). These studies suggest that the gender gap increases when women compete with men – the basis for the continuous debate about single-sex schools relative to mixed gender schools. However, Lee, Niederle and Kang (2014) test the gender composition of teams by examining whether single-sex schooling reduces the gender

[9] We detail many more studies in Appendix 1

Table 5
Performance in the Lab.

Variables	(1)	(2)	(3)	(4)
Females		-1.219	-1.088	-0.616
		(1.187)	(1.565)	(1.596)
Experimental gender group:				
All-Female Teams	-0.820			
	(1.088)			
Mixed Teams	1.053			
	(1.162)			
Mixed Teams x Male		1.704	1.676	1.645
		(1.396)	(1.420)	(1.452)
Mixed Teams x Female		1.385	1.189	0.891
		(1.220)	(1.258)	(1.298)
Field gender Composition:				
All-Female Teams			-0.087	-0.318
			(1.543)	(1.558)
Mixed Teams			0.801	0.695
			(1.043)	(1.051)
Age	-0.031	-0.026	-0.021	-0.018
	(0.038)	(0.038)	(0.038)	(0.038)
Education	0.772***	0.764***	0.765***	0.765***
	(0.094)	(0.094)	(0.094)	(0.094)
Rulindo District	0.250	0.092	0.117	-0.140
	(0.990)	(1.023)	(1.027)	(1.175)
Household head	0.153	-0.406	-0.429	-0.381
	(0.971)	(1.142)	(1.141)	(1.139)
Household size	0.365*	0.330	0.306	0.352
	(0.214)	(0.211)	(0.219)	(0.225)
Married	1.532	1.604	1.469	1.424
	(1.430)	(1.400)	(1.386)	(1.327)
Risk taking (Switching Point)	-0.021	-0.026	-0.027	-0.033
	(0.052)	(0.053)	(0.054)	(0.054)
Constant	3.749	4.331	4.069	3.649
	(2.755)	(2.842)	(2.833)	(5.338)
Group Size	No	No	No	Yes
Observations	154	154	154	154
R-Squared	0.303	0.308	0.314	0.322

Heteroskedasticity-robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Females variable indicates whether the respondent is a female = 1 or male = 0. For the experimental gender groups: All-female teams =2 and mixed teams = 3 are compared to all- male teams=1. Similarly, the reference category for the field gender composition variables is the all-male teams = 1. Household heads = 1 are compared to non- household heads = 0. Respondents from Rulindo district are compared to those from the Ruhango district = 0. Respondents who are married =1, are compared to non- married = 0 participants.

Table 6
Performance in the field.

VARIABLES	(1) Log (Sales)	(2) Log (Sales)	(3) Income	(4) Income
Females		-0.338		0.463
		(0.224)		(2.099)
Field Gender Composition:				
All-Female Teams	0.048		0.550	
	(0.142)		(1.191)	
Mixed Teams	0.018		-0.128	
	(0.151)		(0.911)	
Mixed Teams x Male		-0.012		0.396
		(0.166)		(1.016)
Mixed Teams x Female		0.033		-1.506
		(0.181)		(1.193)
Age	0.001	0.000	-0.038	-0.034
	(0.004)	(0.004)	(0.038)	(0.038)
Education	0.010	0.007	-0.138	-0.152
	(0.012)	(0.012)	(0.105)	(0.108)
Rulindo District	-0.218	-0.294**	-0.540	-0.947
	(0.142)	(0.148)	(0.857)	(1.002)
Household head	0.138	0.142	0.914	0.294
	(0.091)	(0.120)	(0.902)	(1.094)
Household size	0.026	0.022	-0.166	-0.169
	(0.029)	(0.029)	(0.214)	(0.217)
Married	-0.262**	-0.260**	-0.319	-0.310
	(0.128)	(0.125)	(1.332)	(1.320)
Risk taking (Switching Point)	0.005	0.006	0.061	0.060
	(0.007)	(0.007)	(0.044)	(0.045)
Experimental gender groups	No	Yes	No	Yes
Constant	5.524***	6.006***	6.701***	5.017***
	(0.271)	(0.319)	(2.198)	(0.707)
Observations	154	154	149	154
R-Squared	0.0816	0.131	0.0512	0.139

Village clustered standard errors for all field estimations. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Females variable indicates whether the respondent is a female = 1 or male = 0. Field gender composition: All-female teams = 2 and mixed teams = 3 are compared to all- male teams =1. Household heads = 1 are compared to non- household heads = 0. Respondents from Rulindo district are compared to those from the Ruhango district = 0. Respondents who are married =1, are compared to non- married = 0 participants.

gap in performance. Contrary to other studies, their study reveals that single-sex schools do not necessarily reduce the gender gap in competitiveness. This is consistent with our finding that performance of women does not improve under single-sex tournaments. A subsequent study by De Paola et al. (2015) is also consistent with our finding that the gender of one's opponent does not affect competitiveness.

Consistent with Lee et al. (2014) and De Paola et al. (2015), we find that competing in single-sex teams does not improve performance in the lab. While the gender of VLEs and the gender composition of teams does not affect performance under competition, education is a significant predictor of VLEs' performance under competition. This is expected given the nature of the tasks that participants were asked to perform.

Previous studies demonstrate the importance of education as a key driver of performance when evaluating outcomes such as labour productivity and economic competitiveness (Cabrera & Le Renard, 2015; Sahlberg, 2006). In Rwanda, significant progress has been made by the government to ensure universal education access. For instance, the National Gender Policy (2010) and Girls Education Policy (2008) address gender gap issues through affirmative quota systems. More women after the genocide now have access to education, with many rural families convinced about the importance of educating girls (Burnet, 2011). The World Bank indicators show that between 1990 and 1992 (before the genocide) 14,000 fewer girls than boys accessed primary education; however, by 2008, approximately 16,000 more girls than boys were in primary schools. The increase in access to education for women could be a contributing factor for the high competitiveness levels of Rwandan women.

Results also show a weak significant level for household size in Column 1, which might originate from competition within the household for limited resources. Downey (1995) explains that household heads and parents have finite resources such as time, energy, and money. They are forced to share these limited resources with children and other members as the household increases in size, which can result in the dilution of resources. The fact that VLEs from larger households perform better compared to smaller households may be due to the urgent need to provide for household members, which increases their desire to perform well in return for higher experimental payoffs.

In Table 6 (Columns 1–4), we report results related to performance in the field. The dependent variable in columns 1 and 2 is the number of recharges in the first three months of business operation. The dependent variable in columns 3 and 4 is self-reported business income. The sample in this table is formed by the VLEs who self-selected into competition in the third round of the lab experiments. As with the experimental results, field outcomes indicate no significant differences in performance based on the gender composition of teams. An important caveat to keep in mind is that business performance data refers to the first three months of operation only, so subsequent differences in business performance could arise with the pass of time.

Married men and women also tend to have lower sales performance levels, although married women are more likely than unmarried women

to choose competition in our experiment. This finding contradicts studies in the entrepreneurship literature (Fairlie & Robb, 2009; Wickramasinghe & De Zoyza 2008), which suggest a positive relationship between marriage and business performance. These studies also explain that married women tend to have lower business performance levels than men. Our finding that married people do not perform as well as single people in business might be explained by a number of factors, including the additional time married people invest in maintaining their families, which may reduce hours of work and in effect, reduce business performance.

Business performance of women has been constantly underestimated (Brush and Cooper 2012; Minniti and Naude 2010; de Bruin et al. 2007; Ahl 2006) based on broader characteristics and context-related factors such as industry type, field experience and business size (Baker and Welter, 2017). Sappletton (2018) shows that the underestimation of women and the observed differences between female and male-owned businesses is due to the unequal comparison of business models in a given industry. For instance, women often engage in retail businesses focused on serving local markets. Such businesses are smaller in size, have lower growth rates and yield lower profits despite their high competition levels. Emerging management literature demonstrates how measures of business performance such as business sizes and growth rates of industry tend to favour men, whereas no performance differences are associated with more specific indicators such as profitability, number of employees, number of orders and closure rates (Zolin et al., 2013; Robb & Waston 2012). Among the lab participants who self-selected into competition, who are a selected subset of villages in the study by Clarke et al. (2020), male-owned enterprises did not outperform female-owned enterprises during the first three months of operation. This resonates with Zolin et al. (2013) and Robb & Waston (2012), given that we compare the performance of entrepreneurs working in the same industry under the same business model with similar terms and conditions.

The external validity of experiments is often low and continuously criticised by empirical researchers. The artificiality under which lab experiments are conducted makes it difficult for real-world generalizability (Schram, 2005). Roe and Just (2009) argue that the best way to overcome the limitations associated with a single research method is to apply multiple approaches to the same phenomenon. Showing that similar results can be achieved when experimental results are compared to real-world operations of microenterprises corroborates the external validity of our findings.

6. Conclusion

A large body of literature investigates gender differences in competition among student subjects in the lab. This study takes a different approach by examining competitiveness from the perspective of gender inclusivity in the renewable energy value chain in a context where the government of Rwanda is determined to promote private sector involvement, in their quest to accelerate rural electrification to off-grid communities.

Our study adds to the existing literature on competitiveness and gender testing these concepts in the renewable energy sector, using a unique subject pool of entrepreneurs operating off-grid gender-focused microenterprises in rural Rwanda – a country globally known for its progressive gender policies. Further, the extent to which competition results in the lab reflect real-world situations remains a point of interest in the competition literature. This study provides new evidence to support the extent to which experimental results are consistent with profitability in the field, to corroborate the external validity of our findings.

Our findings show that, under competitive situations in the lab, women operating off-grid microenterprises in Rwanda are not less willing to enter competition; female VLEs perform as well as men when they work in both all-female and mixed gender groups, and gender of opponents does not affect their performance. Results also show that, in single-sex groups, education and risk-taking are key drivers of the decision to compete; in the all-female teams, risk-loving women are more likely than risk-averse women to compete. Consistent with our experimental results, field findings also show no statistically significant differences in business performance between male and female VLEs that self-selected into competition in the lab experiments. One important caveat is that we use only the first three months of operations, so we cannot reject that differences in business performance could appear later on. Furthermore, this result is informative only of the VLEs more prone to competition, not for the average VLEs.

While the study unleashes the applicability of experimental results by adding to the competition literature, our research also provides insights into the private energy sector. Currently, women's participation in the private energy sector of Rwanda is low, as some companies potentially see the inclusion of women as a limitation for revenue maximisation (Parshotam & van der Westhuizen, 2018). By showing that women entrepreneurs in Rwanda can be as competitive as men entrepreneurs, and that women who self-select into competition can perform as well as males that do so, our study provides an impetus for private energy companies in Rwanda to reconsider the involvement of more women in this sector.

Although the study extends the existing literature on gender and competitiveness to entrepreneurs in Rwanda, we are careful not to generalize our finding of no gender gap in competition entry as this may be due to either individual characteristics or the impact of gender policy on competition preferences. A valuable extension to this study will be to establish the impact of Rwanda's gender policy on competition preferences.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.socec.2021.101662.

Appendices. Appendix 1

Table I
List of Studies Based on Niederle–Vesterlund (2007) Experimental Design.

Student Subjects					
Studies	Country	Task	Sample Size	Tournament Entry	
				Male	Female
Addition tasks					
Zhong et al. (2018)	Singapore	Addition	197	49%	25%
Dariel et al (2017)	UAE	Addition	147	50%	54%
Apicella et al. (2017)	USA	Addition	100	58%	38%
Halko & Saaksvuori (2017)	Finland	Addition	80	74%	54%
Reuben, Wiswall & Zafar, (2017)	USA	Addition	257	54%	27%
Buser, Dreber & Mollerstrom, (2017)	USA	Addition	104	52%	28%
Berlin & Dargnies (2016)	France	Addition	228	63%	35%
Brandts, Groenert & Rott, 2014)	Spain	Addition	112	59%	30%
Wozniak et al. (2014)	USA	Addition	128	54%	31%
Niederle et al. (2013)	USA	Addition	84	74%	31%
Cadsby et al. (2013)	Canada	Addition	132	36%	9%
Price, (2012)	USA	Addition	310	66%	49%
Mueller & Schwieren (2012)	Germany	Addition	127	42%	26%
Kamas & Preston (2012)	USA	Addition	310	41%	23%
Dargnies (2012)	France	Addition	76	85%	51%
Balafoutas, Kerschbamer & Sutter (2012)	Austria	Addition	134	59%	31%
Balafoutas & Sutter (2012)	Austria	Addition	72	64%	30%
Healy & Pate (2011)	USA	Addition	192	81%	28%
Niederle & Vesterlund (2007)	USA	Addition	80	73%	35%
Other tasks					
Buser, Gerhards & van der Weele, (2018)	Denmark	Mix	297	42%	26%
Banerjee, Gupta & Villeval (2018)	India	Memory task	168	22%	16%
Wozniak et al. (2014)	USA	Verbal	128	54%	31%
Gupta, Poulsen & Villeval, (2013)	France	Mazes	100	60%	34%
Shurchkov (2012)	USA	Verbal	128	39%	30%
Buser et al. (2017b)	Denmark	Mix	297	42%	26%
Banerjee et al. (2017)	India	Memory task	168	22%	16%

Non-student Subjects					
Studies	Country	Task	Sample Size	Tournament Entry	
				Male	Female
Adults					
Bönte et al. (2017)	Germany	Math	225	56%	45%
Cassar, Wordofa & Zhang (2016)	China	Addition	358	36%	26%
Apicella and Dreber (2015)	Tanzania	Skipping rope	191	45%	30%
		Bead collection	88	52%	37%
		Handgrip strength	70	67%	29%
Gneezy et al. (2009)	Tanzania (patriarchal)	Bucket toss	172	50%	26%
	India (matrilineal)	Bucket toss	146	39%	54%
Children					
(Zhang, 2015)	China (Han)	Addition	96	63%	48%
	China (Yi)	Addition	96	60%	38%
	China (Mosuo)	Addition	80	75%	48%
Buser, Peter & Wolter (2017)	Switzerland	Addition	249	68%	51%
Alma s et al. (2016)	Norway	Addition	483	52%	32%
Sutter et al. (2016)	Austria	Addition	246	44%	21%
Khachatryan et al. (2015)	Armenia	Addition	824	54%	52%
		Word search		57%	56%
Sutter & Glaetzle-Ruetzler, (2015)	Austria	Addition	717	40%	19%
Lee, Niederle & Kang (2014)	South Korea	South Korea	640	30%	22%
Dreber, von Essen & Ranehill (2014)	Sweden	Addition	216	36%	17%
		Word search	216	33%	28%

Appendix 2

Table I
Difference in characteristics between experimental and non-experimental Sample.

Variables	Lab Indicator
Age	-0.0007
	(0.0017)
Number of Working hours	3.77 e-08
	(3.14e-08)
Household Income	-3.55e-07
	(8.96e-07)
Household Expenditure	-3.48-07
	(6.76e-07)
Household Wage Employment	4.93e-08
	(1.28e-07)
Household roof	0.0016
	0.0215
Female Teams	0.0313
	(0.062)
Mixed Teams	-0.0186
	(0.0659)
District	0.0076
	(0.0615)
Happiness level	-0.0121
	(0.009)
Patience Level	-0.0057
	(0.010)
Sales	0.117***
	(0.0086)
Education	0.0378***
	(0.0106)
Emotional Health	-0.00881*
	(0.0043)
Constant	0.1607
Observations	504
R- Squared	0.2236

Village-level clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Notes: This table compares characteristics of lab participants to the VLEs who did not participate in the experiment in terms of business and socioeconomic characteristics. The dependent variable is a dummy that takes the value of 1 if the VLE participated in the lab experiments and 0 otherwise.

Table II
Distribution of Groups and Number of People per Experimental Group.

Number of people per group	Female Group	Male Group	Mixed-gender Group	Total Number of Groups
2	—	2	—	2
3	3	4	3	10
4	14	16	26	56
5	13	8	—	21
6	—	2	—	2

Table III
Baseline Differences in Expected Gender Behaviours by Children.

Variable	Male	Female	Difference	*p*-value
Wives should be less educated than their husbands	3.44	3.6	-0.3.6	0.34
Boys should get more resources/opportunities for education than girls	3.92	3.98	-0.05	0.64
Girls should be allowed to study for as long as they like - as high as they want	1.57	1.57	0.00	0.99
Daughters should have a similar right in terms of inheriting property as sons	1.72	1.82	-0.10	0.48
Women should get equal opportunities in all areas of life	1.6	1.59	0.00	0.92

Notes: Responses ranges from 1- strongly agree, 2- agree, 3- neither agree nor disagree, 4 - disagree and 5-strongly disagree. Children of VLEs agreed to the following statements: girls should be allowed to study for as long as they like, daughters should have similar rights in terms of property as sons and women should get equal opportunities in all areas of life, responses. It is worth noting that children gave a neutral response to the following statement wives should be less educated than their husbands but disagreed with the statement boys should get more resources/opportunities for education than girls. These answers demonstrated the extent to which perceptions about women are changing among younger generations living in rural areas of Rwanda.

Table IV
VLE's competition entry decisions for group sizes of four only.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Combined	Mixed	Single	Female	Male
Dummy for Females	0.0102	0.0833	-0.132		
	(0.131)	(0.171)	(0.156)		
Scores from round 2	0.0195**	0.0436***	0.00238	0.0147	-0.00804
	(0.00962)	(0.0107)	(0.0158)	(0.0229)	(0.0238)
Tournament - Piece rate	-0.0236**	-0.0481***	-0.0128	-0.00850	-0.0130
	(0.0120)	(0.0154)	(0.0199)	(0.0292)	(0.0296)
Number of participants per session	-0.0116	-0.0282**	-0.00797	-0.0145	-0.00319
	(0.00709)	(0.0112)	(0.0119)	(0.0175)	(0.0170)
Risk taking (Switching Point)	0.00842*	0.0136**	0.00439	0.00588	-0.00592
	(0.00466)	(0.00639)	(0.00726)	(0.00954)	(0.0133)
Education	0.0360***	0.0324**	0.0415**	0.0312	0.0518**
	(0.0128)	(0.0160)	(0.0205)	(0.0340)	(0.0252)
Household head	-0.0533	-0.0622	-0.101	-0.0563	-0.0768
	(0.102)	(0.133)	(0.146)	(0.218)	(0.278)
Household size	-0.0469**	-0.0457*	-0.0479*	-0.0668*	-0.000202
	(0.0199)	(0.0268)	(0.0266)	(0.0405)	(0.0425)
Age	-0.00121	0.0114**	-0.00679	0.000838	-0.0102*
	(0.00371)	(0.00484)	(0.00445)	(0.00757)	(0.00589)
Rulindo District	-0.0277	-0.0913	-0.0342	-0.119	0.0660
	(0.0929)	(0.0963)	(0.188)	(0.241)	(0.323)
Married	0.0128	0.105	-0.163	0.221	
	(0.122)	(0.153)	(0.154)	(0.233)	
Dummy for experimental single-sex teams	0.0393				
	(0.0748)				
Field Gender Composition					
2.All- Females	0.125	0.180	0.228		
	(0.137)	(0.166)	(0.203)		
3.Mixed	0.186**	0.311***	0.200	0.000740	0.280**
	(0.0942)	(0.111)	(0.125)	(0.191)	(0.141)
Observations	197	94	103	52	47
Log pseudolikelihood	-117.96	-48.06	-61.17	-32.18	-25.28

Results are marginal effects from a Probit estimation. Heteroskedasticity-robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

References

Ahl, H. (2006). Why research on women entrepreneurs needs new directions. *Entrep. Theory Pract., 30*(5), 595–621.

Andersen, S., Ertac, S., Gneezy, U., List, J. A., & Maximiano, S. (2013). Gender, competitiveness, and socialisation at a young age: Evidence from a matrilineal and a patriarchal society. *Rev. Econ. Stat., 95*(4), 1438–1443.

Apicella, C. L., Demiral, E. E., & Mollerstrom, J. (2017). No gender difference in willingness to compete when competing against self. *Am. Econ. Rev., 107*(5), 136–140.

Apicella, C. L., & Dreber, A. (2015). Sex differences in competitiveness: hunter-gatherer women and girls compete less in gender-neutral and male-centric tasks. *Adaptive Hum. Behav. Physiol., 1*(3), 247–269.

Baker, T., & Welter, F. (2017). Come on out of the ghetto, please! building the future of entrepreneurship research. *Int. J. Entrep. Behav. Res., 23*(2), 170–184.

Barron, M., Clarke, R. P., Elam, A. B., Klege, R., Shankar, A., & Visser, M. (2020). Gender and entrepreneurship in the renewable energy sector of Rwanda. *IDS Bull, 51*(1), 53–70.

Bartling, B., Fehr, E., Maréchal, M. A., & Schunk, D (2009). Egalitarianism and competitiveness. *Am. Econ. Rev., 99*(2), 93–98.

Baruah, B. (2017). Renewable inequity? Women's employment in clean energy in industrialised, emerging and developing economies. *Natural Resources Forum* (p. 18). Wiley Online Library.

Baruah, B. (2015). Creating opportunities for women in the renewable energy sector: findings from India. *Fem. Econ., 21*(2), 53–76.

Berge, L. I. O., Bjorvatn, K., Pires, A. J. G., & Tungodden, B (2015). Competitive in the lab, successful in the field? *J. Econ. Behav. Organ., 118*, 303–317.

Bönte, W., Procher, V., & Urbig, D. (2018). Gender differences in selection into self-competition. *Appl. Econ. Lett., 25*(8), 539–543.

Booth, A., Fan, E., Meng, X., & Zhang, D (2018). Gender differences in willingness to compete: the role of culture and institutions. *Econ. J., 10*, 12583.

Booth, A. L., & Nolen, P. (2012). Gender differences in risk behaviour: does nurture matter? *Econ. J., 122*(558), F56–F78.

Brick, K., & Visser, M. (2015). Risk preferences, technology adoption and insurance uptake: a framed experiment. *J. Econ. Behav. Organ., 118*, 383–396.

Brush, C. G., & Cooper, S. Y. (2012). Female entrepreneurship and economic development: an international perspective. *Entrep. Reg. Dev., 24*(1–2), 1–6. https://doi.org/10.1080/08985626.2012.637340.

Burnet, J. E. (2011). Women have found respect: gender quotas, symbolic representation, and female empowerment in Rwanda. *Politics Gend., 7*(3), 303–334.

Buser, T., Niederle, M., & Oosterbeek, H. (2014). Gender, competitiveness, and career choices. *Quar J Econ., 129*(3), 1409–1447.

Buvinic, M., & Furst-Nichols, R. (2016). *"Promoting women's economic empowerment: What works?"*. The World Bank Research Observer.

Cabrera, A., & Le Renard, C (2015). Internationalisation, higher education, and competitiveness. *New Perspectives on Internationalisation and Competitiveness* (pp. 11–16). Cham: Springer.

Cárdenas, J. C., Dreber, A., Von Essen, E., & Ranehill, E. (2012). Gender differences in competitiveness and risk taking: comparing children in Colombia and Sweden. *Jo. Econ. Behav. Organ., 83*(1), 11–23.

Cassar, A., Wordofa, F., & Zhang, Y. J. (2016). Competing for the benefit of offspring eliminates the gender gap in competitiveness. *Proc. Natl. Acad. Sci., 113*(19), 5201–5205.

Clarke, R.P., Barron M., Koning R., Visser, M. (2020). Gender composition, business performance, and spillover effects: experimental evidence from a solar microenterprise program. UCT Working Paper.

Clancy, J., Winther, T., Matinga, M., & Oparaocha, S. (2012). *Gender equity in access to and benefits from modern energy and improved energy technologies: World Development. Report Background Paper*.

Clancy, J. S., Oparaocha, S., & Roehr, U. (2004). Gender equity and renewable energies: thematic background paper. In *International Conference for Renewable Energies*.

Croson, R., & Gneezy, U. (2009). Gender differences in preferences. *J. Econ. Lit., 47*(2), 448–474.

Dariel, A., Kephart, C., Nikiforakis, N., & Zenker, C. (2017). Emirati women do not shy away from competition: Evidence from a patriarchal society in transition. *J. Econ. Sci. Assoc., 3*(2), 121–136.

Dato, S., & Nieken, P. (2014). Gender differences in competition and sabotage. *J. Econ. Behav. Organ., 100*(2), 64–80.

Datta Gupta, N., Poulsen, A., and Villeval, M. C. (2005). Male and female competitive behavior-experimental evidence. IZA Discussion Paper (No. 1833).

de Bruin, A., Brush, C. G., & Welter, F. (2007). Advancing a framework for coherent research on women's entrepreneurship. *Entrep. Theory and Pract., 31*(3), 323–339.

De Paola, M., Gioia, F., & Scoppa, V. (2015). Are females scared of competing with males? results from a field experiment. *Econ. Educ. Rev., 48*, 117–128.

Debusscher, P., & Ansoms, A. (2013). Gender equality policies in Rwanda: public relations or real transformations? *Dev. Change, 44*(5), 1111–1134.

Delfgaauw, J., Dur, R., Sol, J., & Verbeke, W. (2013). Tournament incentives in the field: gender differences in the workplace. *J. Labor Econ., 31*(2), 305–326.

Downey, D. B. (1995). When bigger is not better: Family size, parental resources, and children's educational performance. *Am. Sociol. Rev.*, 746–761.

Ergun, S. J., Rivas, M. F., & García-Muñoz, T. M. (2010). *Gender Differences in Economic Experiments*. Universidad de Granada. Departamento de Teoría e Historia Económica.

Fairlie, R. W., & Robb, A. M. (2009). Gender differences in business performance: evidence from the characteristics of business owners survey. *Small Bus. Econ., 33*(4), 375.

Girls Education Policy. (2008). Ministry of Education. Available at https://www.ilo.org/dyn/natlex/docs/ELECTRONIC/94008/110190/F-1833244927/RWA-94008.pdf.
Gneezy, U., Leonard, K. L., & List, J. A. (2009). Gender differences in competition: evidence from a Matrilineal and a Patriarchal Society. *Econometrica, 77*(5), 1637–1664.
Gneezy, U., Niederle, M., & Rustichini, A. (2003). Performance in competitive environments: gender differences. *Quart. J. Econ., 118*(3), 1049–1074.
Gneezy, U., & Potters, J. (1997). An experiment on risk taking and evaluation periods. *Quart. J. Econ., 112*(2), 631–645.
John, J. P. (2017). Gender differences and the effect of facing harder competition. *J. Econ. Behav. Organ., 143*, 201–222.
Khachatryan, K., Dreber, A., Von Essen, E., & Ranehill, E. (2015). Gender and preferences at a young age: evidence from Armenia. *J. Econ. Behav. Organ., 118*, 318–332.
Lavy, V. (2012). Gender differences in market competitiveness in a real workplace: evidence from performance-based pay tournaments among teachers. *Econ. J., 123* (569), 540–573.
Lee, S., Niederle, M., & Kang, N. (2014). Do single-sex schools make girls more competitive? *Econ. Lett., 124*(3), 474–477.
Minniti, M., & Naudé, W. (2010). Introduction: what do we know about the patterns and determinants of female entrepreneurship across countries? *Eur. J. Dev. Res., 22*(3), 277–293.
Moore, E., & Eckel, C. (2006). *Measuring ambiguity aversion. Working Paper*. University of Texas at Dallas.
National Gender Policy. (2010). Ministry of gender and family promotion. Available at https://www.ilo.org/dyn/natlex/docs/ELECTRONIC/94009/110188/F-1576743982/RWA-94009.pdf.
Niederle, M., Segal, C., & Vesterlund, L. (2013). How costly is diversity? *Manage. Sci., 59* (1), 1–16.
Niederle, M., & Vesterlund, L. (2008). Gender differences in competition. *Negot. J., 24*(4), 447–463.
Niederle, M., & Vesterlund, L. (2011). Gender and competition. *Annu. Rev. Econ., 3*, 601–630.
Niederle, M., & Vesterlund, L. (2007). Do women shy away from competition? do men compete too much? *Q. J. Econ., 122*(3), 1067–1101.
Ors, E., Palomino, F., & Peyrache, E. (2013). Performance gender gap: does competition matter? *J. Labor Econ., 31*(3), 443–499.
Parshotam, A., and van der Westhuizen, H. (2018). Women and the energy value chain: opportunities for a more inclusive renewable energy sector in Africa. GEG Africa Discussion Paper (Oct. 2018). http://www.gegafrica.org/item/844-women-and-the-energy-valuechain-opportunities-for-a-more-inclusive-renewable-energy-sector-in-africa, ac.
Paserman, M.D., 2007. Gender differences in performance in competitive environments: evidence from professional tennis players. NBER Working Paper, 07.
Robb, A. M., & Watson, J. (2012). Gender differences in firm performance: evidence from new ventures in the United States. *J. Bus. Ventur., 27*(5), 544–558.
Roe, B. E., & Just, D. R. (2009). Internal and external validity in economics research: tradeoffs between experiments, field experiments, natural experiments, and field data. *Am. J. Agricult. Econ., 91*(5), 1266–1271.
Sahlberg, P. (2006). Education reform for raising economic competitiveness. *J. Educ. Change, 7*(4), 259–287.
Sappletton, N. (2018). Gender and business performance: the role of entrepreneurial segregation. *Women Entrepreneurs and the Myth of 'Underperformance*. Edward Elgar Publishing.
Schram, A. (2005). Artificiality: the tension between internal and external validity in economic experiments. *J. Econ. Methodol., 12*(2), 225–237.
Shane, S., Locke, E. A., & Collins, C. J. (2003). Entrepreneurial motivation. *Hum. Resour. Manage. Rev., 13*(2), 257–279.
Sutter, M., & Glaetzle-Ruetzler, D (2015). Gender differences in the willingness to compete emerge early in life and persist. *Manage. Sci., 61*(10), 2339–2354.
van Veldhuizen, R. (2017). *Gender differences in tournament choices: Risk preferences, overconfidence or competitiveness?*. Discussion Paper (No. 14).
Vieider, F. M., Lefebvre, M., Bouchouicha, R., Chmura, T., Hakimov, R., Krawczyk, M., & Martinsson, P. (2015). Common components of risk and uncertainty attitudes across contexts and domains: evidence from 30 countries. *J. Eur. Econ. Assoc., 13*(3), 421–452.
Visser, M., Clarke, R. P., Barron, M., Klege, R. A, Okull, P., & Uppari, B. S. (2019). *Female microenterprise creation and business models for private sector distribution of low-cost off-grid LED lighting: Multiple Randomised Experiments*. ENERGIA Report 2019.
Wickramasinghe, V., & De Zoyza, N. (2008). Gender, age and marital status as predictors of managerial competency needs: empirical evidence from a Sri Lankan telecommunication service provider. *Gender Manage.: Int. J., 23*(5), 337–354.
World Bank Group. (2015). *Women, Business and the Law 2016. Getting to Equal*. Washington, DC: The World Bank.
Zhang, Y. Jane. (2013). Can experimental economics explain competitive behavior outside the lab? Available at http://dx.doi.org/10.2139/ssrn.2292929.
Zhong, S., Shalev, I., Koh, D., Ebstein, R. P., & Chew, S. H. (2018). Competitiveness and stress. *Int. Econ. Rev., 59*(3), Article 12631281.
Zolin, R., Stuetzer, M., & Watson, J. (2013). Challenging the female underperformance hypothesis. *Int. J. Gender Entrep., 5*(2), 116–129.