RUHR ECONOMIC PAPERS

Anna Klabunde

How much Should an Investor Trust the Startup Entrepreneur?

A Network Model

RUHR UNIVERSITÄT BOCHUM RUB

#450

Imprint

Ruhr Economic Papers

Published by

Ruhr-Universität Bochum (RUB), Department of Economics
Universitätsstr. 150, 44801 Bochum, Germany

Technische Universität Dortmund, Department of Economic and Social Sciences
Vogelpothsweg 87, 44227 Dortmund, Germany

Universität Duisburg-Essen, Department of Economics
Universitätsstr. 12, 45117 Essen, Germany

Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI)
Hohenzollernstr. 1-3, 45128 Essen, Germany

Editors

Editorial Office

Ruhr Economic Papers #450

Responsible Editor: Thomas K. Bauer

ISSN 1864-4872 (online) – ISBN 978-3-86788-507-2

Ruhr Economic Papers #450

Anna Klabunde

How much Should an Investor Trust the Startup Entrepreneur?

A Network Model

RUHR UNIVERSITÄT BOCHUM RUB

Bibliografische Informationen der Deutschen Nationalbibliothek

Die Deutsche Bibliothek verzeichnet diese Publikation in der deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über: *http://dnb.d-nb.de* abrufbar.

http://dx.doi.org/10.4419/86788507
ISSN 1864-4872 (online)
ISBN 978-3-86788-507-2

Anna Klabunde[1]

How much Should an Investor Trust the Startup Entrepreneur?

A Network Model

Abstract

Trust is an important determinant of start-up financing. In a simple agentbased model it is determined what the best trusting strategy is for a collective of investors and whether it is rational for an individual investor to deviate from this collective optimum. Trust depends on a measure of social distance and is the precondition for investment. Trust increases and decreases based on whether an investor is satisfied with the interest payments received from an entrepreneur. If an investor is dissatisfied, he terminates the relation with the entrepreneur. For assessing the quality of their own investments, investors communicate with other investors in a network-like structure. I find that, as a collective, it is best for investors to compare their returns critically in order to identify unproductive entrepreneurs, but to be tolerant regarding existing links to entrepreneurs in order not to terminate profitable relations because of minor productivity drops. However, it is optimal for an individual investor to deviate from this strategy and to be less easily disappointed, but to decrease trust in larger steps. In a sense, an individual investor can freeride on the others' critical assessment. If all investors behave according to this latter strategy, too many unproductive firms remain in the market and the average investor's return is lower than in the collective optimum.

JEL Classification: C63, G02, G24, L26

Keywords: Business angel investment; trust; entrepreneurship; agent-based simulation

October 2013

1 Ruhr University Bochum. – The author is grateful for helpful comments and suggestions by Simone Alfarano, Shu-Heng Chen, Gianluca Grimalda, Alan Kirman, Nadja König, Sandra Margraf, Michael Roos, Pietro Terna, participants at the essa@work Workshop 2013 in Osnabrück, participants at the 18th Annual Workshop on Economic Science with Heterogeneous Interacting Agents (WEHIA 2013) and seminar participants at Universitat Jaume I, Castellón and Ruhr University Bochum. She would like to acknowledge financial support by the RUB Research School. *– All correspondence to: Anna Klabunde, Ruhr University Bochum, Universitätsstr. 150, 44801 Bochum, Germany. E-Mail: anna.klabunde@rub.de.*

1 Introduction

Deciding whether or not to become an entrepreneur is a situation under true - Knightian - uncertainty: There is no way to quantitatively assess one's chances of success because by definition an innovation creates a new market situation for which no data is available. Often, an entrepreneur has to obtain external finance, a common source being the market for business angel investment. From an investor's perspective, the uncertainty he faces regarding a potential startup investment is even larger. To the same extent as the entrepreneur, he is confronted with uncertainty about the demand for the new product. In addition to that, an investor is confronted with uncertainty regarding the entrepreneur's characteristics: skills and capabilities that have an impact on his market success, as well as his personality, which can ease or complicate the investment relation. How do business angel investors decide whether or not to make a particular investment? Lewis and Weigert (1985) relate situations of high complexity to the need for *trust* as a substitute for a rational probabilistic decision rule: "Trust begins where prediction ends." (p. 976). Wong et al. (2009), Sudek (2006) and Prowse (2005) indeed find that trust is an important determinant of investment decisions in business angel finance, whereas Bottazzi et al. (2011) show empirically that trust matters even for the provision of venture capital.

I therefore model an agent-based angel investor market where sufficient trust is a precondition for investment, but where investors are otherwise as rational as possible given the available information. Trust is updated based on received returns only. Investors communicate with other investors in a network-like structure. Comparing returns with others, investors determine what level of returns constitutes an acceptable level for them. If this level is not reached, an investor becomes disappointed by an entrepreneur and his trust in him decreases.

Entrepreneurs are homogenous, apart from an idiosyncratic productivity shock each period. They produce according to a linear production function that takes as inputs capital provided by investors and an entrepreneur's own capital contribution that is paid out of savings. Each period entrepreneurs decide how to use their revenue. First, they have to pay back what they received from the investor. Then, they can use the remaining profit to pay an interest rate to the investors in the hope of attracting more funds in the future, or they can save it and invest in the firm themselves next period, or they can add the profit to their private wealth. They use heuristics to determine what proportion of their profit is returned as interest, what proportion is invested, and what proportion is added to their private wealth.

Investors are assumed to adjust their trusting behavior so that their returns are maximized[1]. I therefore investigate what an optimal trusting strategy is if all investors behave in the same way. In a second step I study whether it is rational for an individual investor to deviate from this strategy by trusting more, or less. Relevant decision parameters are the following: First, investors decide how easily they are

[1] It is often claimed that business angel investors follow altruistic motives as well, such as wanting to help young entrepreneurs with their own expertise. For the sake of simplicity and generalizability of the model I refrain from modeling this behavior here.

disappointed, i.e., how tolerant they are if the return from one of the entrepreneurs they invested with is lower than the average return the other investors received (*disappointment threshold*). Second, they decide how many disappointments they are willing to accept before they end the relation with an entrepreneur (*trust decrease*).

The model was calibrated so that it roughly fits criteria of the US business angel market. However, the model could easily be calibrated to match other settings, or it could be extended to model e.g. a banking network based on trust.

The paper is structured as follows. Section 2 provides a more detailed explanation of my understanding of *trust* and a literature review. Section 3 introduces the model and its calibration. Section 4 presents results, section 5 concludes.

2 Trust

Although the relevant literature abounds in definitions of trust - see, e.g., Gambetta (1988), Falcone and Castelfranchi (2001), Nowak and Sigmund (2005), Sapienza et al. (2013), Yamagishi (2001) - I define trust narrowly as "firm belief in the reliability, truth, or ability of someone or something" (Oxford Dictionaries). This implies that I also do not distinguish between *trust* and *confidence*, as it is sometimes done (see, e.g. Earle 2009).

Trust serves as a way of forming expectations when the future is highly uncertain. Therefore, trust has become a buzz phrase when refering to the recent financial crisis (see Guiso et al 2008, Sapienza and Zingales 2012, Mayer 2008, Tonkiss 2009, Earle 2009, Roth 2009). The aim of this paper is to formalize this often rather vague idea and to relate it to actual decision making. To do this, it is assumed that initial trust is related to cultural closeness, as found to be the case by Glaeser et al. (2000) and Yuki et al. (2005). Cultural closeness is determined among other things by the number of common acquaintances (Mayer and Puller 2008), geographic distance (Etang et al. 2011), race (Ravina 2012), gender (Galak et al. 2011), nationality (den Butter et al. 2003, Giannetti and Yafeh 2010, Guiso et al. 2009), religion (Tadesse and White 2010), organisational affiliation (McPherson et al. 2001) or educational background (Berger et al. 2012, Cohen et al. 2008). In order to create a cultural sphere, agents in the simulation are placed randomly on a two-dimensional grid. The Euclidian distance between two agents is assumed to represent their distance in the cultural sphere. Investors are assumed to prefer those entrepreneurs that are culturally close. There is a correlation between preferential attachment, higher initial level of trust towards culturally close individuals and lower *transaction costs* in evaluating and monitoring the trustee, because common social norms, "implicit, pre-existing and unspecified conditions for cooperation" (Nooteboom 1996), lower the necessity for specification and monitoring of contracts. Also, the return from monitoring might be higher if the cultural distance is low (Zak and Knack 2001). Bigley and Pearce (1998) provide an overview of the literature that relates trust and transaction costs. Investors in the model have a fixed time budget which they can spend on maintaining links to entrepreneurs.

Methodologically, this paper is most closely related to Gorobets and Nooteboom (2006), who employ an agent-based computational model to investigate whether and under what conditions trust is viable in goods markets, and to Roos and Klabunde (2013), who study the implications of different trusting behaviors of investors for entrepreneurs' market success using the same agent-based model employed here.

3 Model

There is a fixed number of investors and entrepreneurs [2]. While there is no entry or exit of investors, entrepreneurs leave the angel segment of the market voluntarily or forced. To keep the number of entrepreneurs fixed, each leaving entrepreneur is replaced by a new one with a random location in the social space. All investors and all entrepreneurs are homogeneous with the exception of an idiosyncratic productivity shock each period to the productivity of each entrepreneur's firm. There is no direct interaction between entrepreneurs, but every investor is part of a constant random network with 5 direct ties to other investors. Investors share the information about their average return received from their entrepreneurs within their network.

In a time step of the model the following happens:

1. If investors have not exhausted their time budget on entrepreneurs, they create new links to new entrepreneurs. The cost of a link is proportional to cultural distance.
2. Investors decide with whom of their associated entrepreneurs they want to invest this period and what amount to invest with whom.
3. Investors endow entrepreneurs with capital.
4. Entrepreneurs learn their output, which is determined by a linear production function plus a stochastic component that represents the uncertainty of the environment.
5. Entrepreneurs return the investment they have received to the investors. Then they decide how much of the profit to set aside for their private wealth, how much to give to the investors as interest, and how much to invest in their own business in the next period.
6. Investors receive their return from the entrepreneurs.
7. Investors update their trust towards the entrepreneurs.
8. If the trust to an entrepreneur is too low, the investor cuts the link.
9. If the sum of an entrepreneur's capital and private wealth is ≤ 0, he goes out of business and is replaced by a random new entrepreneur.
10. If the sum of an entrepreneur's capital and private wealth is higher than his saving target he exits the angel market segment and is replaced by a random new entrepreneur.

[2] A full description and the complete code of the model, which was built in NetLogo (Wilensky, 1999), is available at http://www.openabm.org/model/3813/version/4/view.

11. If investors have no capital left they exit the market and are replaced by a random new investor.

The entrepreneurs employ heuristics to adapt their strategy of deciding how much of their profits to return to the investors and how much to invest themselves in the firm. First, the entrepreneur computes his profit[3] $\pi_t = r_t - i_t$, where r_t is the return received and i_t is the investment which the entrepreneur has to return to the investor. If $\pi_t > 0$ and $\pi_t > \pi_{t-1}$, the entrepreneur seeks to do more of what he seems to have done right. First, if $\pi_t \geq p_3$, he sets an amount of size p_3 aside for his private wealth. p_3 is a parameter that is fixed for a simulation run and the same for all entrepreneurs. If $\pi_t < p_3$, he sets the full π_t aside. Then, if $p_{1,t-1} > p_{1,t-2}$, he attributes part of the increase in his profits[4] to the increase in p_1 (the amount paid as a return to the investors) and sets $p_{1,t} = p_{1,t-1} + a$, where a is the parameter for adaptation speed. If $\pi_t - p_3 < p_{1,t-1} + a$, he sets $p_{1,t} = \pi_t - p_3$. The rest of the profit, $\pi_t - p_3 - p_{1,t}$, if there is any, is distributed in the following way: If $\pi_t - p_3 - p_{1,t} \geq p_{2,t-1}$, the entrepreneurs sets $p_{2,t} = p_{2,t-1}$, where $p_{2,t}$ is the amount set aside for investment in his own business in the next period. Any remaining profit is split up in half and added to $p_{1,t}$ and $p_{2,t}$ in equal proportions. If $\pi_t > 0$, $\pi_t > \pi_{t-1}$ and $p_{1,t-1} < p_{1,t-2}$, he does the opposite: He increases $p_{2,t}$ in a way analogous to the one described above. If $\pi_t > 0$, but $\pi_t < \pi_{t-1}$, he increases $p_{2,t}$ if $p_{1,t-1} > p_{1,t-2}$ in the way described above, because he believes that profits are too low partly because $p_{1,t-1}$ was too high and $p_{2,t-1}$ was too low. Instead, he increases $p_{1,t}$ if $p_{2,t-1} > p_{2,t-2}$. If $\pi_t < 0$, $p_{1,t}$, $p_{2,t}$ and $p_{3,t}$ are all 0. In the very first year of existence, when entrepreneurs do not yet have any values to compare the current profit to, they split up equally what remains of their profit after subtracting p_3.

The model is calibrated in order to roughly match some stylized facts of the U.S. angel investor market as described in Wiltbank and Boeker (2007) and Shane (2012): duration of average investment 3.5 years, proportion of investments that angels lose money on 50%, average annual rate of return 31%, distribution of returns right-skewed, average number of angel investments made by an investor per year 0.43, average number of investors per start-up 4.9. The calibrated parameter values that were used as baseline values can be found in Table 1[5].

4 Results

First, I examine at which parameter combination investors maximize their return when they act as a collective, i.e. when they all follow the same behavioral rule. How critically should they evaluate the information they receive from the other in-

---

[3] For the sake of simplicity the subscript i to denote entrepreneur i was omitted.

[4] He does not know his production function and therefore does not know the size of the stochastic component.

[5] A detailed description of the calibration procedure can be found at http://www.openabm.org/model/3813/version/2/view.

Table 1 Baseline parameter values.

Parameter	Baseline value
Number of entrepreneurs	160
Number of investors	210
Time budget investors	10
Productivity	1.6
Variance of random component of production function	.8
Total investment per investor and period	70
Disappointment threshold	.6
Trust cutoff	.2
Trust decrease	1.7
Trust increase	.5
Adaptation speed of entrepreneurs a	5
Saving target of entrepreneurs	600
Minimum amount set aside for consumption	6
Length of run	200 steps
Size of two-dimensional grid	30x30

vestors? Should they be disappointed easily, or rather be more lenient? How many disappointments in a particular entrepreneur should an investor tolerate before he cuts the link? A priori the answers to these questions are not clear: Being very patient has the advantage of being able to build up a longer-term relationship with an entrepreneur that might induce the entrepreneur to increase his interest payments over time and therefore be beneficial for the investor. On the other hand, being too lenient might lead to continued support of an entrepreneur who is not well enough positioned to survive in the market and will therefore eventually go bankrupt. Investors can decide how easily they are disappointed - i.e., if they are already disappointed if their return from an entrepreneur is just below the average return of the other investors (*disappointment threshold* 1), or if they tolerate up to a return that is e.g. only 60% of the other investors' return (*disappointment threshold* .6). They can also decide how often they accept being disappointed before they eventually cut the link. This latter criterion, number of tolerated disappointments, is closely related to the value of *trust decrease*, the size of steps in which trust decreases when a disappointment occurs. Although investors cannot observe their level of trust, I use *trust decrease* here instead of the number of disappointments tolerated because it corresponds directly to a model parameter. The corresponding level of *trust decrease* can be calculated for every number of tolerated disappointments in this way:

$$td = \frac{\bar{t} - c}{\bar{nd}} \tag{1}$$

where td is the parameter level of *trust decrease*, $\bar{t}$ is the average level of trust between an investor and an entrepreneur, c is the level at which trust is cut and $\bar{nd}$ is the average number of disappointments tolerated. The level of trust cutoff c is kept constant at .2.

First, *trust decrease* and *disappointment threshold* are varied separately, keeping the other parameter fixed at its baseline value[6].

Table 2 OLS regression of investors' return on disappointment threshold.

Disappointment threshold	Average return
.2	-.0517*** (.0098)
.3	-.0635*** (.0098)
.4	-.0448*** (.0098)
.5	-.0372*** (.0098)
.6 (baseline)	1.8549***(.0069)
.7	-.04439*** (.0098)
.8	-.0478*** (.0098)
.9	-.0630*** (.0098)
1.0	-.0765*** (.0098)
N	2700
Adj R^2	.0251
Prob >F	0.000

Base category: baseline value of disappointment threshold .6. Independent variable categorical, standard errors in parentheses, *, **, *** indicate significantly different from zero at 10%, 5%, 1%.

Table 2 shows that when *trust decrease* is kept fixed at its baseline level, the level of return is highest at the baseline level of *disappointment threshold*, .6, which serves as the base category. Return is an inverted u-shaped function of the disappointment threshold. The picture is different for *trust decrease*: it is mostly not significant when varied on its own (see table 3).

However, it is evident from fig. 1 that the interaction of both behavioral parameters is important. The mean return investors receive is highest at a high level of *disappointment threshold* and a low level of *trust decrease*, that is, when investors compare their returns critically with each other but do not act on those disappointments by cutting the link until very late. Investors' return is highest - on average 90.33 percent - at a value of *disappointment threshold* of 1 and a value of *trust decrease* of .1.

Intuitively, the explanation for this result is the following: If investors are almost never disappointed, or if they are, they tolerate a lot of disappointments before cutting a link, many entrepreneurs stay in the market after several negative productivity shocks in a row. Those entrepreneurs tend to pay low returns to the investors. If, on the other hand, investors cut the link after just one or two disappointments, in particular if they are disappointed easily, even small productivity drops can end connections between investors and entrepreneurs. The effects are mainly negative for the investors as they forgo returns from entrepreneurs that are in principle well positioned and willing to return a lot. To some extent, investors can offset a higher value of *trust decrease* with a lower value of *disappointment threshold*, i.e., if in-

[6] This was also done in Roos and Klabunde (2013); more detailed results can be found there.

Table 3 OLS regression of investors' return on trust decrease.

Trust decrease	Average return
.1	-.0465*** (.0093)
.4	-.0079 (.0093)
.7	-.0028 (.0093)
1.0	.0039 (.0093)
1.3	-.0101 (.0093)
1.6 (baseline)	1.8549*** (.0066)
1.9	-.0125 (.0093)
2.2	-.0228** (.0093)
2.5	-.0055 (.0093)
2.8	-.0239** (.0093)
3.0	-.0205** (.0093)
N	3300
Adj R^2	.0112
Prob >F	0.000

Base category: baseline value of trust decrease 1.6. Independent variable categorical, standard errors in parentheses, *, **, *** indicate significantly different from zero at 10%, 5%, 1%.

vestors do not tolerate many disappointments with one entrepreneur, they should not get disappointed easily.

The following results investigate further the interaction between the two behavioral parameters. The first column of Table 4 shows that when both parameters are varied - *disappointment threshold* in steps of .1 from .2 to 1 and *trust decrease* in steps of .3 from .1 to 3 - the return-maximizing value of *disappointment threshold* is .8, but when *disapointment threshold* interacts with *trust decrease*, the latter changes the sign of *disappointment threshold* for values larger than .4. This means that when *trust decrease* is high, i.e., when investors are impatient with entrepreneurs, they harm themselves if they become disappointed very easily when comparing returns with other investors. Also when *trust decrease* is the categorical variable and interacts with a continuous *disappointment threshold* (second column of table 4), it clearly shows that as the value of *disappointment threshold* increases, it decreases returns if trust drops in large steps (e.g. when *trust decrease* = 2.8), but when trust decreases in small steps (e.g. when *trust decrease* = .1), it is better to choose a higher value of *disappointment threshold*. In this sense, *trust decrease* and *disappointment threshold* offset each other. Column 3 of table 4 confirms this: Both parameters on their own increase returns when they are set to larger values, i.e., when investors are stricter. The interaction term, however, has a significantly negative impact, showing that being too strict is disadvantageous, too.

Next, I release the assumption that all investors behave in the same way and check whether one investor can improve his result if he deviates from the collectively optimal behavioral parameters. The parameter *trust decrease* was varied from .1 to 2.9 in steps of .2 and *disappointment threshold* from .1 to 1.0 in steps of .1 for one individual investor - henceforth called investor 50 - while keeping the behavioral parameters for the 209 other investors at their collective optimum values

Table 4 OLS regression of return on disappointment threshold and trust decrease[a].

	Average return[b]	Average return[c]	Average return[d]
dis. threshold (continuous)		-.0018** (.0009)	.0096*** (.0005)
dis. threshold .2	-.0310*** (0.0057)		
.3	-.0302*** (.0057)		
.4	-.0239*** (.0057)		
.5	-.0333*** (.0057)		
.7	.0201*** (.0057)		
.8	.0340*** (.0057)		
.9	.0282*** (.0057)		
1.0	.0268*** (.0057)		
dis. threshold .2 x trust decr.	-.0001 (.0003)		
.3 x trust decr.	-.0004 (.0003)		
.4 x trust decr.	-.0007** (.0003)		
.5 x trust decr.	.0009*** (.0003)		
.7 x trust decr.	-.0025*** (.0003)		
.8 x trust decr.	-.0034*** (.0003)		
.9 x trust decr.	-.0037*** (.0003)		
1.0 x trust decr.	-.0045*** (.0003)		
trust decr. (continous)	.0000 (.0002)		.0021*** (.0002)
trust decr. .1		-.0434*** (.0082)	
trust decr. .4		-.0509*** (.0082)	
trust decr. .7		-.0151* (.0082)	
trust decr. 1.0		-.0026 (.0082)	
trust decr. 1.3		.0117 (.0082)	
trust decr. 1.9		.0126 (.0082)	
trust decr. 2.2		.0145* (.0082)	
trust decr. 2.5		.0170** (.0082)	
trust decr. 2.8		.0210** (.0082)	
trust decr. 3.0		.0073 (.0082)	
trust decr. .1 x dis. threshold		.0119*** (.0013)	
trust decr. .4 x dis. threshold		.0155*** (.0013)	
trust decr. .7 x dis. threshold		.0066*** (.0013)	
trust decr. 1.0 x dis.threshold		.0026** (.0013)	
trust decr. 1.3 x dis. threshold		-.0011 (.0013)	
trust decr. 1.9 x dis. threshold		-.0021* (.0013)	
trust decr. 2.2 x dis. threshold		-.0035*** (.0013)	
trust decr. 2.5 x dis. threshold		-.0037*** (.0013)	
trust decr. 2.8 x dis. threshold		-.0044*** (.0013)	
trust decr. 3.0 x dis. threshold		-.0028** (.0013)	
dis. threshold x trust decr.			-.0006*** (.0000)
const	1.8412*** (.0041)	1.8183*** (.0058)	1.7825*** (.0034)
N	29700	29700	29700
Adj R^2	.0457	.0368	.0297
Prob >F	0.000	0.000	0.000

[a]*, **, *** indicate significantly different from zero at 10%, 5%, 1%. Standard errors in parentheses. Base categories: baseline values of trust decrease (1.6) and disappointment threshold (0.6). [b]Disappointment threshold categorical, trust decrease continuous. [c]Disappointment threshold continous, trust decrease categorical. [d]Both continous.

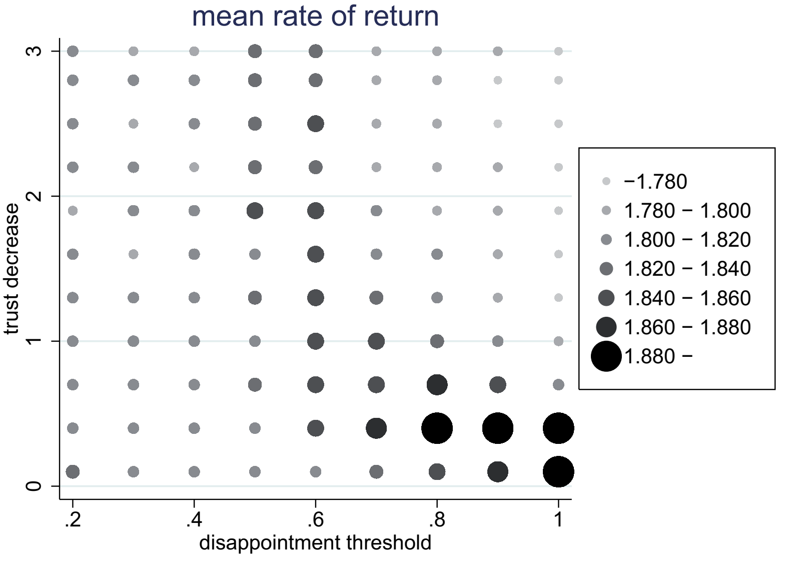

Fig. 1 Effect of parameter changes on collective return of investors, measured as (amount invested repaid + interest) / amount invested. All other parameters at their baseline value; averages over 300 runs per parameter combination, period 100 (patterns typically stable after 20–50 periods).

of .1 for the former and 1.0 for the latter. 100 runs per parameter combination were performed (i.e. a total of 15000 runs). The average return of the other investors, excluding investor 50, was 90.27 %. The investors' return at the optimal parameter combination in the previous experiment was 90.33%; the difference is not statistically significant. Quite frequently, investor 50 performs better than the others. The highest average return for a parameter combination is 131.49%, which is reached at disappointment threshold = .1 and trust decrease = 1.1. That is, an individual fares best if he is not disappointed when the return from his entrepreneurs is lower than that of the other investors. But if the return from an entrepreneur is extremely low - lower than 10% of the other investors' return - investor 50 is disappointed and his trust decreases by a fairly large amount, much larger than in the collective optimum. The average return of investor 50 at each parameter combination is shown in fig. 2.

The high average value of return at (.1, 1.1) is not due to an outlier: the variance of return is not higher than for the other combinations. Why is it possible for an individual investor to increase his return by deviating from the parameter combination that was found to be collectively optimal? Since return is calculated as amount re-

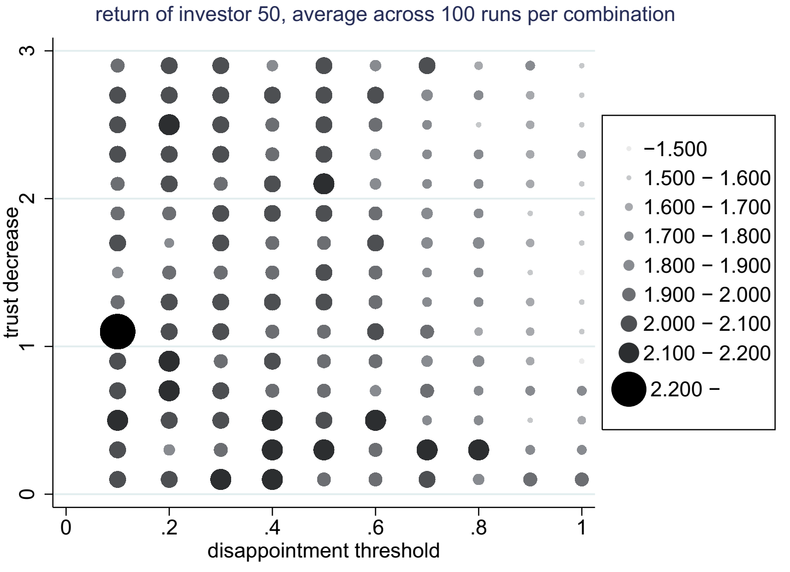

Fig. 2 Effect of parameter changes on return of individual investor when all other investors act at the collectively optimal parameter combination. Return measured as (amount invested repaid + interest) / amount invested. All other parameters at their baseline value; averages over 100 runs per parameter combination, period 100 (patterns typically stable after 20–50 periods).

ceived from the entrepreneur divided by amount invested, the higher return could be due to either a lower amount invested, or a higher payment from the entrepreneurs. The latter could be due to either a larger number of links to entrepreneurs, or a higher payment per entrepreneur. The amount invested turns out to be the same, but investor 50 has both more links and a higher interest payment per entrepreneur/link. This yields the following hypothesis: Investor 50 might be freeriding on the critical comparison that the other investors are performing. They all have a disappointment threshold of 1, that is, they are very easily disappointed. If several investors are disappointed and decrease the trust in an entrepreneur until eventually cutting a link, an entrepreneur with several negative productivity shocks in a row will be forced out of the market because he will not obtain funding anymore. If an investor is fairly far away from an entrepreneur in the cultural space so that the initital level of trust is already low, one disappointment - a return slightly lower than the average of the other investors - might suffice to cut the relation. This entrepreneur, who is not performing as badly otherwise, might pay high interest to other investors in the future, including investor 50. Therefore, only entrepreneurs that are, after a row of negative shocks, not well positioned will be forced into bankruptcy. Investor 50 is not going to connect to them. With this mechanism in place investor 50 can afford to have a low disapointment threshold himself. By not being disappointed easily he builds up long-lasting relationships with all of the entrepreneurs he is connected to, close or distant. These entrepreneurs keep paying an interest to investor 50. This interest is going to be higher if some other investors have cut the link to the entrepreneur, so that investor 50 is the only investor the entrepreneur is still connected to. In this case, investor 50 will receive all of the entrepreneur's p_1. Investor 50 is only disappointed if an entrepreneur performs really badly, and in this case his trust decreases by a large amount, i.e., he will not tolerate extremely bad performance for long.

To verify this hypothesis it is necessary to run a version of the model where *all* investors follow the individually best strategy, i.e., have a disappointment threshold of .1 and a trust decrease of 1.1 at each disappointment. Indeed it turns out that the investors as a collective perform worse if they all follow the individually best strategy. Their average return is only 80.59%. Summary statistics of all three versions - all investors perform at the collective optimum, investor 50 follows the individually optimal strategy while the others follow the collectively optimal strategy, and all investors behave according to the individual optimum - are summarized in table 5.

Table 5 Summary market characteristics when all investors follow the collectively optimal strategy, when an individual investor follows the individually optimal strategy, and when all investors follow the individually optimal strategy.

	All investors follow collectively optimal strategy[a]	Invididual investor follows individually optimal strategy[b]	All investors follow individually optimal strategy[c]
Return (percent)	90.2657 (.0933)	131.4911 (13.0211)	80.5896 (.3603)
Absolute amount received (investment plus interest)	133.1838 (.0653)	162.0438 (9.1148)	126.4081 (.2523)
Amount invested	69.9988 (.0002)	70.0000 (0.0000)	69.9973 (.0024)
Absolute amount received *per link* (investment plus interest)	40.2688 (.0222)	47.0040 (3.1937)	34.0806 (.0731)
Number of links per investor	3.3107 (.0009)	3.8000 (.0009)	3.7123 (.0039)
Average duration of an investment	3.8556 (.0059)	7.9817 (.8395)	6.6470 (.0432)
$\frac{p_1}{p_1+p_2}$	.4101 (.0001)	.3832 (.0388)	.4228 (.0005)

[a]average across 15000 runs at step 100, standard error in parentheses. [b]average across 100 runs at step 100, standard error in parentheses. [c]average across 1000 runs at step 100, standard error in parentheses.

Indeed the relations with entrepreneurs have a much longer duration for investor 50: 7.98 periods vs. 3.86 in the collective optimum. Although investor 50 has on average more links to entrepreneurs (3.80 vs. 3.31), his absolute amount received per link is higher, too (47.00 vs. 40.27). This is remarkable because the part of profit that entrepreneurs pay as interest to the investors (p_1) is lower compared to the amount entrepreneurs invest in their firms themselves (p_2) for investor 50 than for the other investors. The summary statistics for the case where all investors use the individually best strategy show the following: Although the number of links per investor and the average duration of investment is fairly close to the result for investor 50, the return of the investors is much lower because the total amount paid out to them from the entrepreneurs is lower (126.41 vs. 162.04 for investor 50) as well as the amount received per entrepreneur (34.08 vs. 47.00 for investor 50). This speaks in favour of the hypothesis above: The overall quality of entrepreneurs in the market is lower in the case where all investors have a low disappointment threshold. The fact that p_1/p_1+p_2 is larger (.42 vs. .38 for investor 50) although p_1 is smaller (126.41-69.99 = 56.42 vs. 162.04-70.00 =92.04 for investor 50) confirms this: The average p_2, i.e., the amount that entrepreneurs invest in their firms themselves, must also be smaller when all investors act according to the individual optimum.

5 Conclusion

I model a market for start-up financing where trust, which is a function of social distance, is the precondition for investment. Trust between an investor and an entrepreneur grows when the investor is satisfied with his investment and decreases when he is disappointed. An investor decides whether or not he is disappointed by comparing his return with that of other investors. How easily should an investor be disappointed, and how many disappointments should he tolerate before he ends the business relation with an entrepreneur?

I find that when we set the restriction that all investors follow the same strategy it is best for investors to compare returns critically but to lose trust slowly. Thereby investors succeed collectively in sorting out entrepreneurs with a long row of negative productivity shocks that are unlikely to recover while at the same time making sure not to cut relations too soon and forego returns because of minor productivity drops. If we release that assumption and allow a single investor to behave differently, this investor fares better if he tolerates a much lower return before being disappointed. But once the disappointment has occurred due to an extremely low return it is best for the individual investor to stop being lenient and cut the link after just one or two disappointments. This increases both his overall return as well as the return per entrepreneur. The reason for this is that he builds up long term relations with entrepreneurs who over time pay higher interest rates that the other investors miss out on. If, however, the other investors join the dissenter and mimic his strategy, they lose collectively: The interest payments from entrepreneurs and the amounts that entrepreneurs invest themselves in their firms are both lower, indicating that more unproductive firms remain in the market for longer. Therefore, the freeriding investor's strategy works only as long as there are still enough investors who are easily disappointed to make sure that entrepreneurs with many negative productivity shocks are pushed out of the market. It is left to future research to find what the critical number of investors is that can use the individually best strategy before the market slips into the low-return state described above.

References

1. Berger A, Kick T, Koetter M, Schaeck, K (2012) Does it Pay to Have Friends? - Social Ties and Executive Appointments in Banking. Available via SSRN. http://ssrn.com/abstract=2134801 or http://dx.doi.org/10.2139/ssrn.2134801.
2. Bigley G, Pearce J (1998) Straining for Shared Meaning in Organization Science: Problems of Trust and Distrust. Acad Manage Rev 23:405–421
3. Bottazzi L, Da Rin M, Hellmann TF (2011) The Importance of Trust for Investment: Evidence from Venture Capital. NBER Working Paper Series 16923. http://www.nber.org/papers/w16923.
4. Cohen L, Frazzini A, Malloy C (2008) The Small World of Investing: Board Connections and Mutual Fund Returns. J Polit Econ 116:951–979
5. Den Butter F, Mosch R (2003) Trade, Trust and Transaction Costs. Tinbergen Institute Discussion Paper TI 2003-082/3. Available via SSRN. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=459501.
6. Earle T (2009) Trust, Confidence, and the 2008 Global Financial Crisis. Risk Anal 29:785–792
7. Etang A, Fielding D, Knowles S (2011) Does trust extend beyond the village? Experimental trust and social distance in Cameroon.Exp Econ 14:15–35
8. Falcone R, Castelfranchi C (2001) Social Trust: A Cognitive Approach. In: Castelfranchi C, Tan Y (ed) Trust and Deception in Virtual Societies. Springer, Dordrecht:55-90
9. Galak J, Small D, Stephen AT (2011) Micro-Finance Decision Making: A Field Study of Prosocial Lending. J Marketing Res 48, Special Issue: 130–137
10. Gambetta D (1988) Can We Trust Trust? In: Gambetta D (ed) Trust: Making and Breaking Cooperative Relations. Basil Blackwell, Oxford:213–237
11. Giannetti M, Yafeh Y (2012) Do Cultural Differences between Contracting Parties Matter? Evidence from Syndicated Bank Loans. Manage Sci 58:365–383
12. Glaeser EL, Laibson DI, Scheinkman JA et al (2000) Measuring Trust. Q J Econ 115:811–846
13. Gorobets A, Nooteboom B (2006) Agent Based Modeling of Trust Between Firms in Markets. In: Bruun C (ed) Advances in Artificial Economics, Lecture Notes in Economics and Mathematical Systems. Springer, Berlin
14. Guiso L, Sapienza P, Zingales L (2008) Trusting the Stock Market. J Financ 63:2557–2600
15. Guiso L, Sapienza P, Zingales L (2009) Cultural Biases in Economic Exchange? Q J Econ 124:1095–1131
16. Mayer A, Puller S (2008) The old boy (and girl) network: Social network formation on university campuses. J Public Econ 92:329–347
17. Mayer C (2008) Trust in Financial Markets. Eur Financ Manag 14:617–632
18. McPherson M, Smith-Lovin L, Cook JM (2001) Birds of a Feather: Homophily in Social Networks. Annu Rev Sociol 27:415–444
19. Nooteboom B (1996) Trust, Opportunism and Governance: A Process and Control Model. Organ Stud 17:985–1010
20. Nowak M, Sigmund K (2005) Evolution of indirect reciprocity. Nature 437:1291–1298
21. Prowse S (2005) Angel investors and the market for angel investments.J Bank Financ 22:785–792
22. Ravina E (2012) Love & Loans: The Effect of Beauty and Personal Characteristics in Credit Markets. Available via SSRN. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1107307.

23. Roos M, Klabunde A (2013) Trust in a Network of Investors and Startup Entrepreneurs. Unpublished. http://economics.rub.de/fileadmin/MAKRO/pubs/2010-2020/Diverse_Dokumente/Klabunde_finalversion.pdf.
24. Roth F (2009) The Effect of the Financial Crisis on Systemic Trust.Intereconomics July/August 2009:203–208
25. Sapienza P, Zingales L (2012) A Trust Crisis. Int Rev Financ 12:123–131
26. Sapienza P, Toldra A, Zingales L (2013) Understanding Trust. Econ J, doi: 10.1111/ecoj.12036
27. Shane S (2012) The Importance of Angel Investing in Financing the Growth of Entrepreneurial Ventures. Q J Financ, doi: 10.1142/S2010139212500097
28. Sudek R (2006) Angel investment criteria. J Small Bus Strat 17:89–103
29. Tadesse B, White R (2010) Does Cultural Distance Hinder Trade in Goods? A Comparative Study of Nine OECD Member Nations. Open Econ Rev 21: 237–261
30. Tonkiss F (2009) Trust, confidence and economic crisis. Intereconomics 44:196–202
31. Wilensky U (1999) NetLogo. Center for Connected Learning and Computer-Based Modeling, Northwestern University. Evanston, IL http://ccl.northwestern.edu/netlogo/.
32. Wiltbank R, Boeker W (2007) Returns to angel investors in groups. Ewing Marion Kauffman Foundation & Angel Capital Education Foundation. Available via SSRN. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1028592.
33. Wong A, Bhatia M, Freeman Z (2009) Angel finance: the other venture capital. Strat Change 18:221–230.
34. Yamagishi T (2001) Trust as a Form of Social Intelligence. In: Cook K (ed) Trust in Society. Russel Sage Foundation, New York:121-147
35. Yuki M, Maddux WW, Brewer MB et al (2005) Cross-Cultural Differences in Relationship- and Group-Based Trust. Pers Soc Psychol B 31:48–62
36. Zak P, Knack S (2001) Trust and Growth. Econ J 111:295–321