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Using trust games to predict tree planting in Malawi

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Tillitsspill, risikoaversjon og treplanting i Malawi

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I denne studien analyserer vi treplanting blant 109 bønder fra 18 landsbyer i Malawi. Treplanting på jordbruksland er viktig som et risiko-reduserende tiltak i disse områdene, som svært utsatt for jorderosjon. Kraftige regnskyll, oversvømmelser og sterk vind kan ødelegge avlinger og vaske vekk jord. Trær som plantes på jordene, spesielt langs jordegrensene, reduserer risikoen under slike kraftige værfenomen. Trær vil imidlertid også konkurrere med med mer profitable avlinger om næring og plass, og treplanting til derfor også medføre en kostnad. Det er derfor de mer risikoaverse bøndene som bør være mest villige til å plante trær.

Vi undersøker hvorvidt det er en sammenheng mellom risikoaversjon og treplanting ved å bruke et mål på risikoaversjon fra et økonomisk eksperiment, kalt et tillitsspill. I et tilllitsspill deles deltagere opp i par, uten å kjenne identiteten til sin medspiller. Den ene spilleren får deretter utdelt 80 kwacha (den Malawiske myntenheten) og kan velge å gi noe av denne summen videre til sin medspiller. Det som blir gitt til medspilleren blir tredoblet. Medspilleren får deretter velge hvor mye av denne summen han eller hun vil gi tilbake til den første spilleren. Andelen den første spilleren velger å gi videre til sin anonyme medspiller brukes ofte som mål på generell tillit til andre mennesker. Den første spilleren må ha tillit til at den andre spilleren skal gi noe av fortjenesten tilbake. Men bidraget kan også sees på som en usikker investering, som kan gi stor eller ingen avkastning, og dermed er den første spillerens bidrag også et mål på vilje til å ta risiko. Ved å kontrollere for sosiale komponentene av dette målet får vi et renere mål på risikoaversjon.

Resultatene fra den empiriske analysen viser at de mer risikoaverse bøndene har signifikant høyere sannnsynlighet for å ha plantet trær. En økning på 20 kwacha i spillinvesteringer henger sammen med en 29% reduksjon av sannsynligheten for å ha plantet trær. Risikoaversjon ser altså ut til å være en viktig faktor for treplanting blant disse bøndene. Vi finner også at bønder som eier jorden selv har dobbel så høy sannsynlighet for å ha plantet trær. Dette støtter opp under eksisterende teorier om sammenhengen mellom selveie og investeringer.

Using trust games to predict tree planting in Malawi

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Abstract

Risk aversion may explain the low number of first-mover investments in the trust game. We investigated this proposition by relating trust game behaviour of Malawian small-scale farmers to their tree-planting behaviour. Trees reduce the negative consequences of erosion shocks and diversify income possibilities. Hence, planting trees insures farmers against bad years. We found that farmers who invested less in the trust game, i.e., were more risk averse, were more likely to plant trees. Controlling for the social components of trust game investments did not alter this result. We concluded that the degree of risk aversion was a substantial element in the decision to plant trees among these farmers.

JEL Classification: C9; D81; Q1; Q2.

Keywords: Trust game; Investment; Experiment; Risk aversion; Tree planting; Africa.

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1. Introduction

First movers' investments in anonymous trust games involve a substantial risk element. These investments tend to return only a zero or slightly positive amount, while the risk of negative returns is considerable (Fehr and Schmidt 2006). For inexperienced players, the abstract game setting and the unknown recipient probably increase the perceived element of risk in the investment. Moreover, several experimental studies have found considerable correlations between risky behaviour and trust game investments (Bohnet et al. 2008; Karlan 2005; Sapienza et al. 2007; Schechter 2007). Karlan (2005) looked at saving and repayment decisions in microcredit savings groups in Peru. He concluded that participants investing more in the trust game were more likely to default on their loans in their savings groups, and less likely to participate in voluntary saving. He thus argued that investments in the trust game predict gambling behaviour rather than trusting behaviour. Furthermore, Karlan and others (Glaeser et al. 2000; Johnson and Mislin 2008) found that the return rate of the *second mover* is actually correlated to a higher extent with other social capital variables than the investments of the first mover.

This paper used trust game investments to predict tree planting among 109 small-scale Malawian farmers in 18 villages across Malawi. Planting trees on agricultural parcels is an important risk-management strategy for these farmers, whose lands are highly exposed to erosion and weather shocks. Heavy rainfall, floods or strong winds may destroy crops and erode the land. Trees on the parcel, especially at its borders, reduce the risk and the magnitude of destruction under such shocks. However, trees also compete with more profitable food crops for land and soil nutrition. By reducing income in good years, and at the same time reducing the negative effects of natural shocks in bad years, trees work as low-cost insurance. The more risk averse farmers should be more likely to use this insurance and plant trees on their parcels.

We found that farmers who invested less as first movers in an anonymous trust game had a higher probability of planting trees. We argue that this is due to game investments being a proxy for risk aversion. Farmers face considerable economic incentives in the trust games, with initial endowments to each participant of 80 Malawian kwacha, around one day's wages, and the possibility of earning up to four times this amount. An increase in first-mover investments of 20 kwacha (the lowest possible step) was associated with a 29% decrease in the probability of tree planting on the parcel. We also found that owning the parcel more than doubled the probability of having planted trees. This is consistent with De Soto's argument regarding property rights providing investment incentives (De Soto 2000). However, it should not be interpreted as a causal relationship, as literature suggest that causality between ownership and parcel investments can run both ways (Besley 1995; Deininger and Jin 2006). We are aware of only two studies that have examined the impact of experimentally revealed risk preferences on farmers' parcel investments. Liu (2008) found that more risk averse Chinese farmers were less likely to adopt a new profitable crop, while Engle-Warnick et al. (2007) did not find the same link in Peru. Instead, they found that more ambiguity averse farmers were less likely to adopt modern crop variants. This paper adds to these findings.

Could mechanisms other than risk preferences drive the negative relationship between tree planting and trust game investment? Trust game investment is a behavioural measure of trust towards an anonymous recipient. Fehr (2009) argued that at least three important factors determine behavioural trust: (1) risk preferences, (2) beliefs about the trustworthiness of the second mover and (3) social preferences like altruistic concerns. We discussed possible impacts of the two latter concepts and controlled for them. Each trust game session was conducted with 30 participants within one village; hence, the stated trust in fellow villagers is our most relevant measure of perceived trustworthiness of the recipient. This variable had no effect on tree planting, and controlling for it did not reduce the effect of game investment. Furthermore, we predicted the influence of perceived trustworthiness of the recipient and cooperation norms on trust game investments by using survey variables. The remaining residual of game investments is termed the *risk factor*. Replacing trust game investments with this risk factor, which is a purer measure of the risk preferences in game investments, yielded the same significantly negative effect on tree planting. We also controlled specifically for fear of encroachment on land, the mechanism that might be the link between distrust in the village and tree planting, which did not reduce the impact of the risk factor of game investments to a substantial degree. This supported our conclusion that risk aversion is actually driving our result. More risk averse farmers are more likely to plant trees.

Though many studies have found risk aversion to be an important factor in reducing trust game investments, other laboratory experiments with Western university students have not found such a link (Ashraf et al. 2006; Eckel and Wilson 2004; Houser et al. 2010). Differences in experimental design may be one reason for the gap between results; another may be the sample of participants. Results from economic experiments are not necessarily replicable across cultures (Henrich et al. 2010). Specifically, poor farmers in developing countries do not necessarily behave in the same way as students at Western universities; the farmers play it safer in risk games (Akay et al. 2009; Binswanger 1980; Yesuf and

Bluffstone 2007) and invest less in trust games (Cardenas and Carpenter 2008). These differences seem reasonable, keeping in mind that people contextualise abstract experiments as a reflection of their personal experiences (Baumard and Sperber 2010; Hagen and Hammerstein 2006; Heintz 2005). Poor farmers in developing countries face substantial risks of food shortage in case of agricultural shocks and can be expected to avoid risk to a larger extent than people whose risky prospects have less severe consequences. Using the same reasoning, it might also be that the risk element of the trust game is more salient to risk-prone farmers and, thus, risk preferences play a greater role in their investment decisions.

1. Tree planting in Malawi

Landlocked Malawi has a predominantly agricultural economy, with 85% of the population living in rural areas. Population density and rapid growth[1] have resulted in heavy pressure on agricultural land and the few remaining forest resources. Forests are being cleared for timber by both commercial entrepreneurs and households striving to meet basic needs. The Malawian population not only needs more agricultural land, but it also needs more tree products for firewood due to poor access to electricity and poles for construction. The rate of deforestation has, therefore, made tree planting an important political goal.

In the context of community participation, smallholder farmers have been involved in tree planting on their croplands and in village forests since the 1970s. However, challenges still exist with regard to community participation in tree planting. Many smallholder farmers still satisfy their need for timber by collecting it from public lands, an environmentally unsound solution, as public forests are increasingly depleted. To encourage more tree planting, the Malawian government has been involved in subsidising farmers with seedlings and education on tree management. However, if one wants to encourage farmers to plant trees, one must understand the factors that explain tree planting.

Why should risk preferences affect a farmer's probability of planting a tree on his parcel of land? Planting trees on one's agricultural parcel is a risk-diversifying strategy (see Wagner (1997) for a thorough discussion of farmers' tree planting in East Africa). Trees planted on agricultural land will often compete with more valuable food crops in terms of land area, water, soil nutrition and sun. Hence, in good years, tree planting is seldom the most profitable use of scarce land. It does, however, reduce

[1] Between 1998 and 2008, the population grew by 2.8% annually, resulting in 13 million inhabitants. The population density was 139 per square kilometer for the whole country and 185 in the south. See 2008 Population and Housing Census Results at http://www.nso.malawi.net/.

agricultural risk in several ways. Most importantly, trees reduce the risk of wind and soil erosion. Gully erosion during the rainy season can suddenly wash away big areas of land and kill the crops. Heavy winds can likewise destroy the crops from one moment to the next or deplete the upper soil layers. Trees protect crops and land both against such sudden shocks and against long-term damage from slow erosion processes.

A tree is also, in a sense, a crop, though less profitable than other food crops, as it produces fruits and timber for consumption or sale. Combining food crops and trees on a parcel is therefore a risk-management strategy that diversifies income possibilities in a sector with much uncertainty and volatile production and market prices. Diversified planting also is beneficial for soil quality (Buresh and Tian 1997). Tree planting hence stabilises the long-term profitability of the parcel, though it decreases short-term production in good years.

In the Malawian context, it is important to note that trees are often used to mark the boundaries of small parcels of land. Very few have formal ownership title to their land that defines its borders. The trees then serve as a living fence, protecting crops from grazing animals, and securing the parcel's borders from encroaching neighbours. Weak property rights might be another reason to plant trees; the argument is that planting a tree strengthens the rights of the planter to use the parcel and increases his ownership rights to it. This mechanism is debated, but if true it might create extra incentive to plant trees, especially for the risk averse. We will come back to this discussion in chapter 6. However, all the reasons for tree planting we have mentioned here point towards a one-directional positive relationship between tree planting and risk aversion. The more risk averse you are, the larger is the probability that you will plant trees on your agricultural parcel. On the other hand, the argument has also been raised that tree planting is risky in itself; there is the chance that the tree will not thrive. Hence, the planter runs the risk of losing the investment costs; the seeds expenditure and the effort of planting. However, the cost of tree planting is marginal compared to the potential risk-reducing benefits outlined above. As long as the seeds are equally accessible, planting a tree is not more expensive than planting other crops on the same land, which is the main alternative. It is a small investment with great potential benefits for highly risk averse farmers. For less risk averse farmers, however, the benefits might not outweigh the investment costs. We, thus, expected a positive relationship between a farmer's risk aversion and his probability of planting trees, implying a negative relationship between trust game investment and tree planting.

2. Study design

The data were collected in 18 randomly selected villages spread across Malawi between June and August 2007. For each of Malawi's three regions, the north, central and south, two districts were selected. In each of these six districts, three villages were randomly selected, and within these villages 15 households were randomly selected (see Berge et al. (2009) for details about the sampling procedure). Survey data from the 15 respondents in each village were collected by one research assistant during a three- to four-week period. After all survey data were collected, the 15 respondents and an additional 15 randomly selected non-respondents in the village were invited to participate in an economic experiment, with the prospect of earning money.

The trust game used was the version of Berg et al. (1995) and the instructions and setup were the same as in Barr (2003). The experiment was conducted on common outside ground within the village. The procedures of the game were thoroughly explained to the 30 participants. Great care was taken to explain the trust game several times, with different examples of extreme and medium outcomes, to ensure that all participants understood the rules and the anonymity of the game[2]. After the explanation in public (lasting around 45 minutes), participants were divided into two groups: first movers and second movers. The groups were physically separated at two distinct places, such that nobody could see any of the participants in the other group. Participants were then matched randomly with participants in the other group. Everyone knew the 15 people in the other group, but they did not know which person they were matched with. Each participant was then given an envelope containing 80 kwacha (4 bills of 20 kwacha). In addition, the first movers were given an empty envelope in which to place their transfer to their matched second mover. The experimenters collected all the transfer envelopes. At a place not observable to any participant, they tripled the amount in each envelope before the envelopes were distributed to the matched second movers. The second movers then withdrew the money they wanted to keep from the envelopes, or possibly put in extra money from their initial endowment of 80 kwacha, and the envelopes were again collected. The remaining money was counted by the experimenters before the envelopes were returned to the first movers, marking the end of the game. The experimenters did not add money before delivering the envelopes back to the first movers.

This game differs from the standard trust game in one respect; namely, second movers also were given an initial endowment from the experimenters. That meant they had the possibility of returning more to the first movers than the tripled investment they received.

[2] Explanations translated to Chichewa and Chitumbuka are published in Berge et al. (2009).

3. Results

3.1 Experimental results

This section discusses the experimental results based on all 267 pairs of participants in the games. Figure 1 presents the frequencies of each of the five possible investment amounts. The average investment was 41 kwacha, 51% of the endowment. Thus, the average amount received by the second movers was 122 kwacha. The average amount returned by the second movers was 60 kwacha, which is 49.5% of the average amount received. Hence, on average, second movers split the amount received rather equally[3]. Furthermore, for the first movers, there was a positive relationship between investment and final profits, which is significantly different from zero.

Figure 1. Histogram of first movers' investments in the trust game

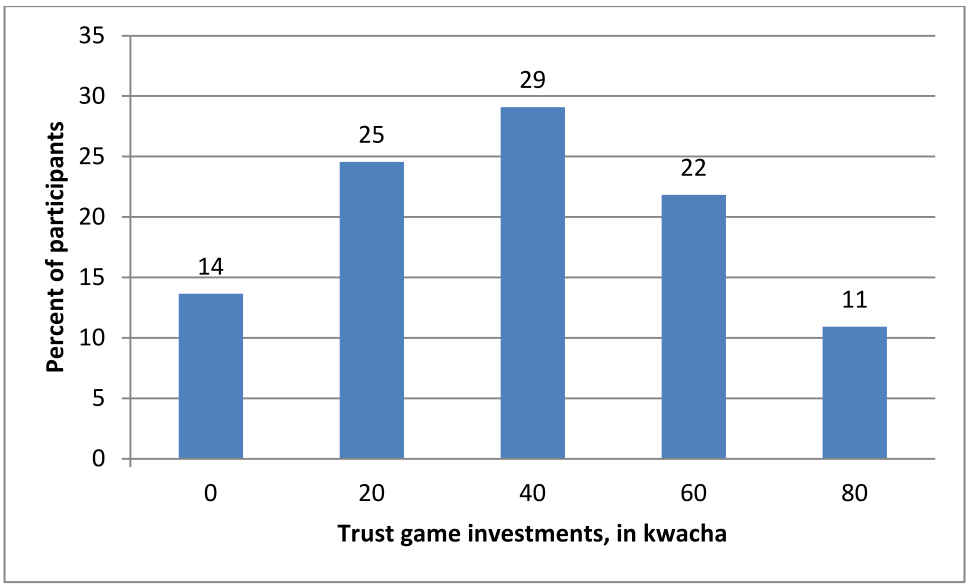


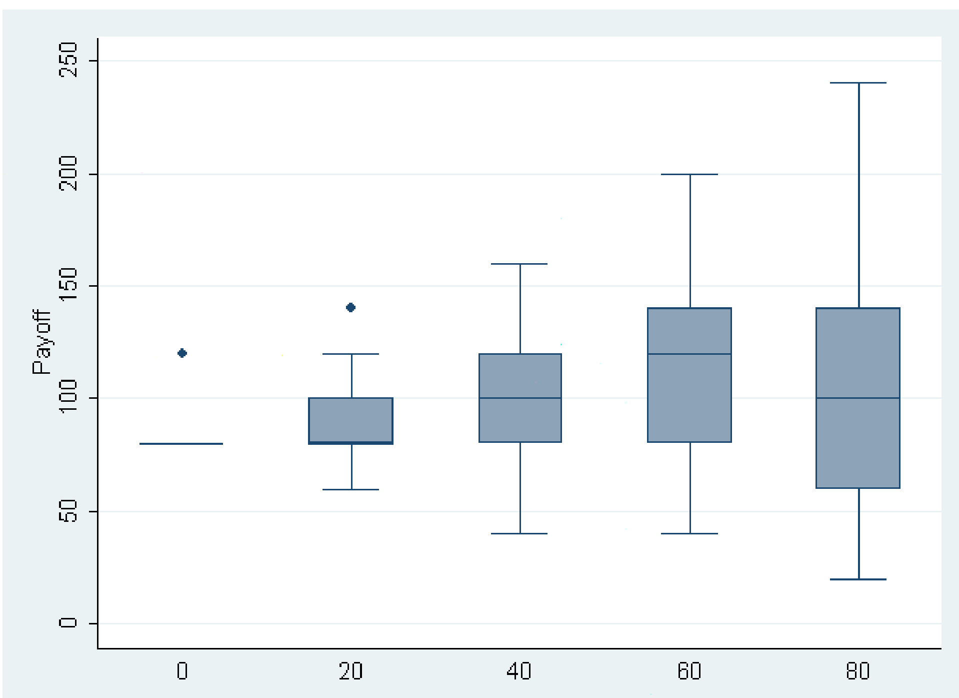
Figure 2 shows the distribution of earnings of the first movers, depending on their investments. Earnings increase with investments, but also become more dispersed. Higher investments are thus profitable in expectations, but investment is overall a risky business. The downside risk increases with every value of

[3] However, remember that the second movers also were given an 80 kwacha endowment at the start of the game; hence, they took home considerably more on average than the first movers. First movers earned on average 100 kwacha, while second movers earned 141 kwacha.

investments, except when increasing investments from 40 to 60, at which the downside stays the same while the upside increases[4].

We conclude this analysis by stating that higher investments are associated with higher expected profits, but also higher risk, in this version of the trust game. These results compare relatively well with other results from the trust games: First movers on average invest half of their endowment, but with substantial variation. Second movers tend to return the invested amount or somewhat more, such that the return on investments for first movers is zero or slightly positive. Thus, second movers make most of the profit from the investment (Fehr and Schmidt 2006). The risk element of this game is salient, and we assumed that more risk averse types would be more careful with their investments, independent of their trust in their fellow villagers.

Figure 2. Earnings of first movers plotted by investment in kwacha



Note: The boxes include observations from the 25th to the 75th percentiles, and the whiskers extend to values within another 1.5 IQR (interquartile range). The horizontal lines within the boxes show the median value. The dots represent outliers. Expected payoffs, as well as the downside risk, increase with investments.

[4] Investing 60 is not stochastically dominating an investment of 40. The chance of earning 40 or less is higher when investing 40 rather than 60.

3.2 Do trust game investments predict tree planting?

We ran logit regressions on tree planting, with agricultural parcel as the observational unit. The analysis was conducted at parcel level rather than farmer level to exploit parcel-specific variables as well as farmer-specific variables. This implies that some farmers were included in several observations. We only used parcels operated by individuals who (1) answered the survey personally and (2) played as first mover in the trust game[5]. Our sample of analysis was 184 parcels operated by 109 different farmers. Each of these operators ran between 1 and 6 parcels, and on average 1.7 parcels. The majority of farmers in the sample operated only one parcel (64 of 109). The average parcel size was 0.7 hectares. Of the sample, 53% of the farmers were men and 36% had completed primary school; only one had also completed secondary school. On average, each household had 4.4 members, and 2 of these were older than 18.

The dependent variable was a dummy for whether the operator had planted one or more of the trees that currently stood on the specific parcel. Note that the parcel-specific answers were collected while the enumerator was physically present on each parcel with the operator, making it impossible for the operator to give untruthful information about physical properties like the existence of trees on the parcel. The percentage of tree-planted parcels by game investment of the operator is shown in figure A1 in the appendix. We can see that tree planting and game investments are negatively related.

Results from different logit specifications are presented in table 1. The probabilities of one farmer planting trees on two different parcels were not believed to be independent; hence, errors clustered at the farmer level. Clustering did not affect the coefficients; it only adjusted the standard errors and thereby the significance level (Moulton 1986). The estimation results are presented as logit coefficients in table 1, and the odds ratios are presented in table A1 in the appendix.

The game investment variable had a significant negative effect on tree planting in all but estimation 1, as seen in table 1. The level of significance varied somewhat depending on the different control variables included; however, the odds ratios of game investment were rather stable, varying between 0.99 and 0.983 in the 6 specifications. We took specification 6 in table 1 as our main result, revealing an odds ratio of 0.983 from game investments. Hence, an increase in game investments of one kwacha decreased the probability of tree planting by 1.7%. It implies that a 20 kwacha increase in game

[5] Some households did not send the same person answering the survey to play in the trust game, and these were excluded.

investment, the smallest possible increase participants could make, decreased the probability of tree planting by 29%.

Table 1. Logit model: Tree planting

	1	2	3	4	5	6
Game investment	-0.0105	-0.0115*	-0.0118*	-0.0147**	-0.0170**	-0.0173**
	(-1.53)	(-1.69)	(-1.75)	(-2.11)	(-2.45)	(-2.44)
Trust people in own village		0.177	0.171	0.173	0.0709	0.0736
		(1.26)	(1.22)	(1.17)	(0.46)	(0.48)
Mountain slope (dummy)			-0.209	-0.285	-0.401	-0.401
			(-0.49)	(-0.64)	(-0.82)	(-0.82)
Owner (dummy)				0.875**	0.781**	0.765*
				(2.29)	(1.97)	(1.92)
Region south (dummy)					-0.895**	-0.866**
					(-2.53)	(-2.36)
Area per household member						0.128
						(0.74)
Constant	-0.304	-0.667	-0.608	-1.050**	-0.254	-0.291
	(-1.04)	(-1.55)	(-1.44)	(-2.15)	(-0.44)	(-0.50)
Observations	184	184	184	184	184	184

Note: Logit regression on parcel-specific tree planting, standard errors corrected for clustering at individual level. The squared roots of the Wald statistics, t-values, are listed in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

We controlled for personally stated trust in people in the village[6] to eliminate any possible effects of perceived trustworthiness from game investments. Stated trust in people in one's own village had a positive but insignificant effect on tree planting. Including this variable did not alter the coefficient or odds ratio of the game investment variable to a large degree, but it increased the significance of game investments. This indicates that trust is not driving the negative relationship between tree planting and game investments and, thus, supports the hypothesis that risk preference is the driving source of our result. We discuss further robustness checks on the influence of trust in chapter 6.

[6] The question was: "Would you say you trust all, most, some, just a few or none in your village?" Answers were coded as ordered numbers, with a higher value implying more trust.

Danger of erosion is highly plot specific. Steeply sloped mountain parcels are more prone to erosion than flat parcels and hence benefit more from tree planting. However, the dummy for parcels with mountain slope topography showed no significant effect on tree planting. One reason might be that mountain parcels are also less fertile and less profitable, and therefore farmers generally invest less in such parcels.

We also included a dummy for whether the farmer owned the parcel or not, hypothesising that owners would be more likely to plant trees than non-owners. Non-owners normally use the parcel for a shorter time horizon and do not bear the cost of parcel depreciation to the same extent as owners, leaving them with fewer benefits from tree planting. Being the owner of the parcel increased the probability of tree planting, with an odds ratio of 2.15 in the final specification. An owner was hence more than twice as likely to plant trees compared to a non-owner. Note that we do not interpret any causality in this mechanism, as it might run both ways.

The sample was drawn from three regions. Being in the south region, compared to the central and north, decreased one's probability of planting trees by 58%. The south region is much more densely populated and land is much scarcer. One might think that this decreased probability of tree planting is the result of less available land, but controlling for available land area per household member did not alter this effect. Hence, we believe that this south dummy picked up more indirect effects of population density, for example, reduced availability of tree seeds due to limited forest resources. However, it could also be the result of other cultural or geographic effects.

Due to our small sample, we limited the number of explanatory variables to 6 so that the coefficients would stay unbiased, in line with suggestions from Peduzzi et al. (1996). We also ran the same specifications using a linear probability model and a random effects logit with similar results on direction and significance levels.

Our data did not reveal whether non-planters have not planted because their parcel was already full of trees when they took it over. An otherwise "planter-type" farmer would thus show up as a non-planter in our data. We checked whether this affected the results by running the same specification on a limited sample, omitting the parcels with trees that had not been planted by the operator (80 parcels were dropped). This implies looking at differences between parcels with trees planted by the operator and parcels without trees at all. With this reduced sample, the magnitude of the game investment coefficient was unaltered, but the significance dropped. We hence concluded that the direction of our results was not affected by this data weakness.

Some commentators have suggested that time preference is an omitted variable in our model, which might influence both tree planting behaviour and revealed risk aversion. We have no variables to control for time preferences, but argue that this should not be necessary as time does not enter into the trust game. Players could not leave the experiment to spend the money before the money was returned to first movers; hence, their investments did not affect at what time they could spend the money.

3.3 Is the relationship really driven by risk aversion?

In this chapter, we study further the relationship between trust game investments and tree planting. Are there drivers of the relationship other than risk preferences? Fehr (2009) mentioned two additional important determinants of trust game investments: (1) belief in the trustworthiness of the recipient and (2) social preference for betrayal aversion or altruistic concern. An effect of any of these factors on tree planting is not obvious, but we discuss possible links in this chapter.

Most important, perceived trustworthiness of fellow villagers could theoretically influence tree planting. Trees are commonly planted along the border of a parcel to prevent erosion. Such a living fence may, however, have other benefits, such as protecting crops and land from untrustworthy neighbours . Neighbours are commonly accused of stealing crops, encroaching on land, or letting their livestock graze on the land of others. . Therefore, not trusting one's neighbour or fellow villagers might be an incentive to plant trees at the borderline to prevent theft or encroachment. If trust game investments are influenced by this kind of distrust in neighbours, low investments in the trust game might predict a higher probability of tree planting, as our results showed, making it difficult to separate the effects of distrust and risk aversion.

Specifications 2-6 in table 1 do control for stated trust in fellow villagers, without showing any significant effect on tree planting. In this chapter, we provide additional verification for the robustness of this result. We ran an OLS-regression on game investments to predict the effect of perceived trustworthiness of fellow villagers on game investments by exploiting other survey-stated measures of trust. The regression result is shown in the first column of table 2. An R-squared of nearly 0.1 indicates a limited, but noticeable explanatory power of these survey measures. The question on generalised trust—"Generally speaking, do you think most people can be trusted or that they cannot be trusted?"—was the most direct question on belief about other's trustworthiness available. It did not have any significant effect on game investment, also not when tested alone. In addition, we included dummies for all categories of the village-specific trust questions. With trusting "some" as a baseline, only trusting "most" people in the village had a significant and positive effect on game investments.

Table 2. OLS regressions: Game investment

	Game investment	Game investment
General trust in people	-2.079	
	(-0.43)	
Trust none in village	-8.174	
	(-0.48)	
Trust only a few in village	-5.975	
	(-1.00)	
Trust most in village	15.89**	
	(2.35)	
Trust all in village	-2.386	
	(-0.38)	
Days of public work last 12 months		0.0342
		(0.78)
Non-coop. sanctioned with gossip		16.05**
		(2.44)
Non-coop. sanctioned with fine		2.651
		(0.35)
Non-coop. sanctioned with threat of no help		-12.14
		(-1.62)
Non-coop. sanctioned with no help in future		6.917
		(1.01)
Non-coop. not sanctioned		8.588
		(1.21)
Sanction data missing		3.770
		(0.48)
Constant	39.21***	31.46***
	(8.50)	(4.90)
Observations	109	109
R^2	0.093	0.104

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

There is the probability that these trust questions are still interpreted as *behavioural trust*, and do not reflect only perceptions about trustworthiness. However, the main purpose of this predicted measure was to ensure that we picked up all impacts from perceived trustworthiness on game investments. If the measure also picked up some risk preferences, it should only have reduced the impact of the remaining game investment and not increased it.

We took a linear prediction from the specification in column 1 of table 2 and termed it the *perceived trustworthiness factor* of game investments, assuming that this variable picks up all effects of perceived trustworthiness of fellow villagers.

A link between social preferences and tree planting is less intuitive. We cannot think of any links between betrayal aversion and tree planting, as tree planting is an individual investment. However, more altruistic persons might be more willing to plant trees considering the public benefits of tree planting in preventing erosion in a larger area, outside the individual parcel. Altruism can increase trust game investments (Fehr, 2009)[7], and social norms on cooperation may similarly have an effect on tree planting.

In the same way as we predicted the *perceived trustworthiness factor*, we predicted the *cooperation factor* of game investment. We regressed game investments on survey-stated cooperation variables. Results are shown in column 2 of table 2. Number of days of voluntary public work during the last year was a measure of individual cooperation and did not have any predictive power on trust game investments. However, it was positively correlated with tree planting. The sanctions variables were dummies, stated by the individual, on whether these sanction types are imposed on people who do not comply in cooperative agricultural work. Only the relatively informal sanction of gossiping had a significant effect, revealing a considerable positive impact on game investments. This indicates that some sort of sanction is necessary to enforce social norms of cooperative behaviour in the village.

From the specification in column 2 of table 2, we took the linear prediction and termed it the *cooperation factor*. We now assumed that by subtracting the perceived trustworthiness factor and the cooperation factor from game investments, we would be left with a purer measure of risk aversion, termed the *risk factor*. Its graphical distribution over game investments is plotted in figure A2 in the appendix. We used this risk factor as an explanatory variable for tree planting, replacing game

[7] Fehr found a dummy on volunteering to have a significant and considerable positive correlation with trust game investments, even when controlling for sociability.

investment in the logit specifications in table 1. The results are given in column 1 of table 3 and are essentially the same as in column 6 of table 1. The risk factor had a significantly negative impact on tree planting, similarly to the whole game investment variable. The significance of the risk factor was even stronger than game investments, but the magnitude of the effect was rather stable. The odds ratio of the risk factor was 0.978, implying that a 20 kwacha increase in the risk factor of game investment decreased the probability of planting trees by 36%.

Table 3. Logit model: Tree planting

	1	2	3
Risk factor	-0.0224***	-0.0185***	-0.0204***
	(-3.14)	(-2.66)	(-2.94)
Mountain slope (dummy)	-0.395	-0.377	-0.411
	(-0.79)	(-0.78)	(-0.83)
Owner (dummy)	0.658*	0.682*	0.662*
	(1.65)	(1.73)	(1.73)
Region south (dummy)	-0.813**	-0.864**	-0.846**
	(-2.28)	(-2.48)	(-2.42)
Area per household member	0.103	0.126	0.131
	(0.63)	(0.77)	(0.79)
Fear of encroachment (dummy)		0.806**	
		(2.17)	
Fear of losing land (dummy)			0.562
			(1.46)
Constant	-1.611***	-1.647***	-1.672***
	(-2.95)	(-3.11)	(-3.41)
Observations	184	184	184

Note: Logit regression with tree planting as dependent variable, standard errors corrected for clustering at individual level. The risk factor is the residual of game investments after subtracting the trustworthiness factor and the cooperation factor, which are linear predictions from the specifications in table 2. The squared roots of the Wald statistics, t-values, are listed in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

We took this as further evidence that risk aversion increased the probability of tree planting in our sample. Removing the social factors of game investments did not alter its influence on tree planting. We also tested whether the pure trustworthiness factor alone influenced tree planting, which it did not. This suggests that tree planting was not substantially influenced by perceived trustworthiness of fellow villagers. However, our predicted factor might not pick up specific distrust in neighbours related to fear of land encroachment and fear of losing land, which is the hypothesised mechanism between distrust and tree planting. If not, some distrust-related aspects may still remain in the risk factor. Therefore, we included survey-stated measures of these two impacts in the regression to study their impact on tree planting and whether the inclusion reduced the impact of the risk factor. We discuss the effects and implications in the following two subchapters.

3.3.1 Fear of encroachment

The possible mechanism between tree planting and fear of encroachment on one's land was discussed at the beginning of this chapter. We controlled for individual stated fear of encroachment[8] and report the results in column 2 of table 3. Fear of encroachment had a strong positive effect on tree planting, in line with the argument. Including this variable did take some of the explanatory power away from the risk factor, but it was still highly significant and the magnitude was only slightly reduced. This might imply that the risk factor still picked up some distrust that affects tree planting. However, fear of encroachment might be determined not only by the objective probability of encroachment, but also to some extent by risk preferences. The more risk averse you are, the more you fear everything, including encroachment. Fear of encroachment might therefore be a second proxy for risk aversion. For this reason, we did not include fear of encroachment in our final model, but we concluded that the risk factor remained with a significantly negative impact on tree planting even after controlling for it.

3.3.2 Fear of losing land

A much debated question is how weak property rights affect farmers' investment incentives. The traditional approach is that increased security of property rights should increase incentives for investments, as argued by De Soto (2000). Here we only discuss the impact of weak property rights on tree planting that might come through distrust. In Malawi, property right to agricultural land is a continuous rather than a binary variable. In the frequent cases of land conflicts, user rights are determined by the traditional village leaders based on factors such as inheritance, use, investments and social connection to the village. Fear of losing currently used land is therefore real for both owners and non-owners. Distrust of other villagers or village leaders might increase the fear of losing land, which might in turn increase incentives for tree planting (if investments are seen to increase property rights). According to this mechanism, fear of losing land should have a positive effect on tree planting.

[8] The question posed was: "Do you fear that your own land will be encroached upon? [not rented land]"; answers coded as a dummy with positive values for yes.

We controlled for fear of losing land[9] in specification 3 of table 3, but found no significant effect on tree planting. Therefore, we did not include fear of losing land in the final model.

4. Conclusion

We have shown that farmers investing less in the trust game are more likely to plant trees, and we interpret this relationship as an effect of risk aversion. More risk averse types invest little in the trust game and are prone to use risk-reducing strategies on their agricultural parcels as well. We also tested whether removing the perceived trustworthiness part and the cooperation part from game investments changed the result, which it did not. Hence, we are more confident that it is actually risk preferences that are driving our result. Since there are no major differences in the result when using the predicted risk factor instead of game investments, we took the former and simpler model as our main result.

Knowledge about the factors pushing tree planting in rural Africa is important for the policy makers who aim to increase this activity. When evaluating the reasons behind successful and less successful tree planting policies, farmers' risk preferences, though difficult to determine, may play an important role. When other policies or events are expected to decrease farmers' exposure to erosion and land degradation risks, a side-effect may be decreased incentives for tree planting. If increased tree planting is still a goal in itself, then additional effort to counteract the decreased tree planting incentives from lower risk exposure may be beneficial. However, further research on the links between risk perception and farmers' investments is needed in order to establish these mechanisms.

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[9] The question posed was: "Do you fear that your own land will be taken away (when spouse passes away, etc.)?", with yes or no as the only possible answers.

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Appendix

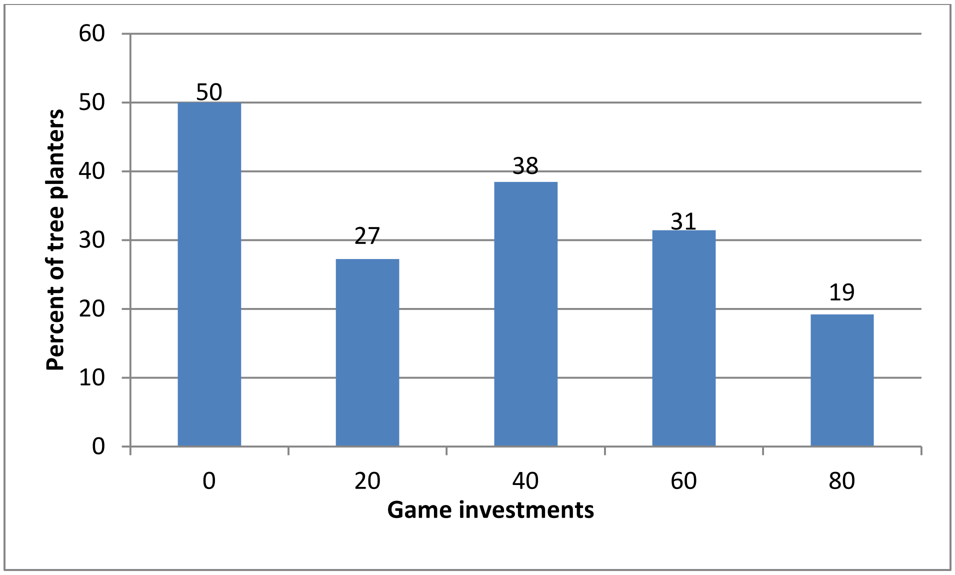
Table A1. Logit model odds ratios: Tree planting

	1	2	3	4	5	6
Game investment	0.990	0.989*	0.988*	0.985**	0.983**	0.983**

	(-1.53)	(-1.69)	(-1.75)	(-2.11)	(-2.45)	(-2.44)
Trust people in own village		1.194	1.187	1.189	1.073	1.076
		(1.26)	(1.22)	(1.17)	(0.46)	(0.48)
Mountain slope (dummy)			0.811	0.752	0.670	0.670
			(-0.49)	(-0.64)	(-0.82)	(-0.82)
Owner (dummy)				2.400**	2.184**	2.148*
				(2.29)	(1.97)	(1.92)
Region south (dummy)					0.408**	0.421**
					(-2.53)	(-2.36)
Area per household member						1.136
						(0.74)
Observations	184	184	184	184	184	184

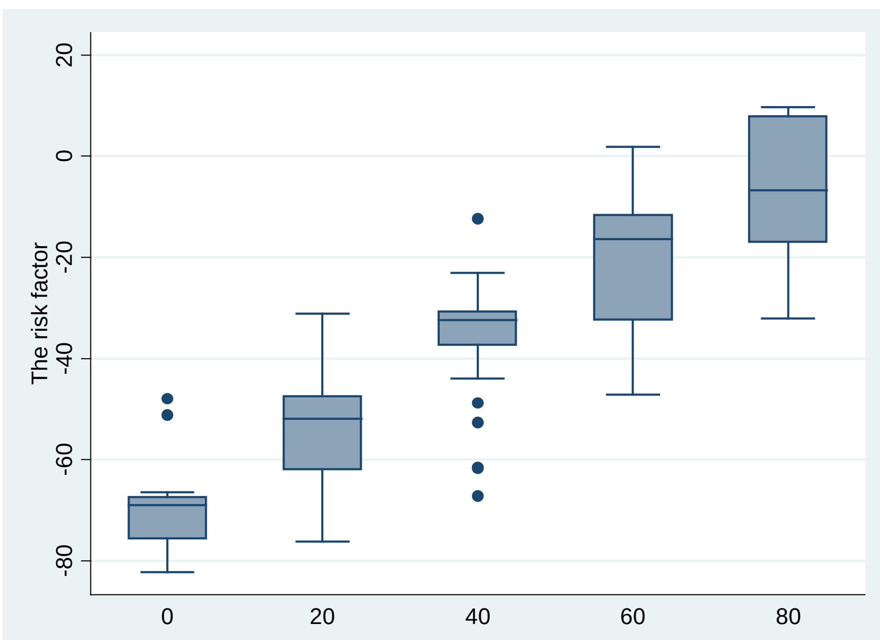
Note: Coefficients presented as odds ratios. Specifications are otherwise identical to those in table 1. The squared root of the Wald statistics, t-values, is listed in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure A1. Tree-planted parcels by game investment of the operator



Note: Data are reported at parcel level; hence, some farmers are included several times.

Figure A2. The predicted risk factor of game investment, by game investment



Note: The boxes include observations from the 25th to the 75th percentiles, and the whiskers extend to values within another 1.5 IQR (interquartile range). The horizontal lines within the boxes show the median value. Outliers are represented by dots.