Comparison of the investment behavior of Kazakhstani and German farmers: An experimental approach

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Abstract

The agricultural sectors of Kazakhstan and Germany are at different development levels. One possible explanation for this might be the different investment behavior of farmers. We experimentally analyze whether the investment behavior of farmers is consistent with the normative benchmarks of the net present value criterion or the real options approach. Furthermore, we experimentally compare the investment behavior of farmers in the two countries in an agricultural and a non-agricultural treatment. In addition, farmers were confronted with the two treatments in a different order. Our results show that both theories cannot exactly predict the investment behavior of farmers. Farmers invest later than the net present value criterion suggests and earlier than the real options approach suggests. However, German farmers invest later than Kazakhstani farmers, which mean that the investment behavior of German farmers is closer to the superior real options approach. Therefore, the different investment behavior might partly be an explanation for different development levels of the agricultural sectors of the two countries. Moreover, results are independent from the framing of an agricultural and a non-agricultural treatment. However, farmers learn from their former investment decisions and consider the value of waiting over time.

Keywords: Experimental Economics, Investment Timing, Real Options, Kazakhstan, Germany

JEL classification: C91, D03, D81, D92

1. Introduction

Kazakhstan and Germany are two representative examples for a transforming country and a Western industrialized country, respectively. The agricultural sectors of Kazakhstan and Germany are at different development levels. This fact can be substantiated by comparing some indicators: The added value per labor of the Kazakhstani agricultural sector equals $2,033, while the added value per labor of the German agricultural sector is $31,659 (World Bank, 2011a). The average yield of cereals is 1,254 kg/hectare in Kazakhstan and 7,201 kg/hectare in Germany (World Bank, 2011b). An average annual milk productivity of cows amounts to 2,241 kg/cow in Kazakhstan and to 6,643 kg/cow in Germany (Food and Agriculture Organization of the U.N., 2011).

There are several explanation concepts for the aforementioned differences. First, Kazakhstan and Germany are situated in two geographically different locations with diverse weather conditions. Kazakhstan has an extreme continental type of climate with an average annual rainfall of 400 mm, while Germany has a moderate continental climate with an average annual rainfall of 770 mm. That means that the land fertility in Germany is positively affected by high soil moisture as well as mild weather conditions. Second, the two countries have a different political and economic situation. Western Germany is considered to be a country with the predictable and stable economy, which has not experienced shocks since World War II. In contrast, Kazakhstan declared its independence only 20 years ago, as a result of the dissolution of the Soviet Union. Although the country has launched significant reforms during a short period of time, it still has a relatively young market economy in which some mechanisms still are not effectively adjusted.

A further explanation for the observed discrepancy between the development levels of the agricultural sectors of the two countries might be the different investment behavior of farmers. Investment decisions play an important role in economic development and growth of an agricultural sector. The production volume, employment rate, structural changes, and the dynamics of business cycles in agriculture are determined to a great extent by the investment decisions of farmers. Kazakhstani and German farmers could be intuitively guided by different approaches when valuing investment decisions. The net present value (NPV) is a very common and simple approach for valuing investment decisions (Mathews and Short, 2001; Vanhoucke et al., 2001). According to this approach, the value of the investment corresponds to its NPV, which is the difference between the present value of the expected incremental cash flows and the investment costs. The approach recommends conducting an investment if its NPV is positive. Another comparatively new framework is the real options approach (ROA) (Hyde et al., 2003; Seo et al., 2008; Pederson and Zou, 2009; Richards et al., 2009). From a normative point of view, the ROA is more advantageous for the valuation of investment decisions than the NPV. The ROA asserts that an investor might increase returns by postponing an irreversible investment decision instead of realizing the investment instantly even if it has a positive NPV. The ROA states that there might be an advantage in waiting to invest until the uncertainty on the future returns has cleared up since new information regarding the investment returns might occur. As long as the investment has not been realized, the investor has the flexibility to reject the investment in the case of “bad news” (Dixit and Pindyck, 1994, p. 6). Carrying out the investment “kills” the investment option. The lost option value has to be included in the investment cost and has to be covered by the expected cash flows from the investment. That means, compared to the NPV, the ROA requires a higher performance of the investment in order to accept an investment decision. In the context of our study, we suppose that German farmers are more likely to take into account the value of waiting than Kazakhstani farmers when making investment decisions. Therefore, German farmers are more likely to make optimal investment decisions resulting in more effective investments. This might partly contribute to the higher level of the development of the agricultural sector than it can be observed in Kazakhstan.

Although the benefits of real options have been presented by theoretical studies, it is not certain if investors make investment decisions in accordance with the ROA or the traditional NPV approach. There are econometric studies regarding the analysis of the investment behavior (O’Brien et al., 2003; Hinrichs et al., 2008). The observation of farmers’ investment decisions might be of little use in this context since investment decisions for a capital intensive object (such as a cow barn or a biogas plant) are relatively rare in the agricultural business (Gardebroeck and Oude Lansink, 2008). Moreover, basic conditions like financial resources differ among farms (Wale et al., 2005; Joshi and Pandey, 2006). Hence, it is hardly possible to draw meaningful conclusions from econometric analyses regarding investment behavior. An experimental analysis of the investment behavior of entrepreneurs could be used to avoid these problems.

An advantage of laboratory experiments is that they give the researcher the possibility to collect the data under controlled conditions. An experiment can be designed in a way that it allows the researcher to change desired variables and hold the other variables permanent. A review of the existing literature shows that, in spite of its relevance, experimental studies on the investment behavior are still scarce. Rauchs and Willinger (1996) were among the first who experimentally investigated the effects of the ROA. They tried to identify how irreversibility of choices influences the investment behavior of subjects under uncertainty. Howell and Jägle (1997) asked skilful managers to value a set of real options parameters encountered in their workplaces. The options were valued irregularly and optimistically. Yavas and Sirmans (2005) used an experimental methodology to test the optimal timing of an investment and found that participants invest earlier than predicted by the ROA. However, when participants competed with each other for the right to invest, their willingness to pay for an investment opportunity reflected an option value. Oprea et al. (2009) examined in experimental settings whether the optimal exercise of wait options can be closely approximated if a subject has the opportunity to learn from personal experience. Denison (2009) analyzed whether the application of the ROA in capital budgeting reduces the tendency of decision makers to continue a project after incurring losses. In a recent study, Sandri et al. (2010) carried out an experiment with students and high-tech entrepreneurs to test the applicability of the ROA for decisions to exit a business. All these aforementioned studies mainly focus on the investment behavior of students and entrepreneurs in Western industrialized countries and they do not compare the investment behavior of individuals in Western industrialized and transforming countries. It still remains widely open to what extent the results of the experiments investigating the investment behavior of entrepreneurs in Western industrialized countries are applicable to entrepreneurs in transforming countries.

Hence, the objective of our study is to experimentally examine the investment behavior of Kazakhstani and German farmers. To achieve this objective, we run an experiment on repeatedly ongoing investment opportunities in an agricultural and in a non-agricultural treatment. Within each repetition, farmers should decide to postpone or realize an investment. As the investment behavior could be influenced by the decision makers' risk attitudes (Knight et al., 2003), an additional experiment based on a Holt and Laury lottery (HLL) is carried out (Holt and Laury, 2002). We analyze whether the investment behavior of farmers is consistent with the NPV or the ROA. A further objective of our study is to test whether the investment behavior of German farmers is closer to the optimal investment behavior predicted by the ROA than those of Kazakhstani farmers. We also test the presence of a learning effect in the investment behavior of farmers. In particular, we analyze if farmers learn from their experience during the experiment and invest more in accordance to the ROA over the repetitions. In addition, we define farmer-specific variables and factors causing cognitive bias related to the design of the experiment, which might influence the investment behavior of Kazakhstani and German farmers. In the framework of factors causing cognitive bias, we test whether the framing of an investment treatment (agricultural vs. non-agricultural investment context) and the order how farmers are confronted with the treatments have an influence on their investment behavior. We suppose that this comparative study could be interesting for readers considering the fact that Kazakhstan grew up in a centrally planned administrative economy and West Germany in a market-oriented environment. Furthermore, as stated by Gardebroek and Oude Lansink (2004), it is necessary to understand investment decisions at the farm level to be able to analyze structural developments in farming.

The study closest to ours is Sandri et al. (2010) who experimentally analyzed a disinvestment problem. However, our study significantly differs from their study. First, we focus on investment decisions instead of disinvestment decisions. Second, our experimental subjects are farmers. Third, to derive our normative benchmark, we do not assume risk neutrality of decision makers. Rather individual risk propensity is explicitly taken into account when determining the normative benchmark for investment decisions. Finally, to our knowledge, this is the first study which experimentally compares investment behavior between decision makers in transforming and Western industrialized countries.

Section 2 presents the derivation of hypotheses. Section 3 describes the experimental settings, while Section 4 shows how normative benchmarks were calculated. In section 5, descriptive statistics and the approach to data analysis are presented. The results of the experiments are discussed in Section 6. Finally, the paper ends with conclusions (Section 7).

2. Derivation of hypotheses and theoretical background

The classical investment theory has been frequently used for valuing the investment behavior of entrepreneurs (Singh et al., 2010; Wu et al., 2010). It suggests that investment should be realized immediately as soon as its NPV gets a positive value; otherwise it must be cancelled. In contrast to the NPV approach, the ROA states that the investor may increase profits by deferring an investment decision instead of realizing the investment immediately, even if the NPV is positive. The value of deferring an investment decision is especially pronounced if investment is at least partially sunk or irreversible and the expected returns of the investment are uncertain (Pindyck, 1991). When the investor carries out the investment she or he loses the option to wait for new information, which might have changed the investment decision. This lost option value has to be included in the investment cost and has to be covered by the expected investment returns. As a result, this requires a higher investment trigger than that suggested by the NPV rule in order to make an investment decision (Dixit and Pindyck, 1994, p. 6-7).

In the following, we describe an investment situation to derive the NPV and the ROA related hypotheses. Imagine the rational farmer, who plans to invest in land. The investment can be realized only once - either immediately or it can be deferred up to one period. The cost of the investment I is fixed at 100,000 and must be paid immediately after realizing the investment. The costs of the investment are completely sunken once it has been implemented. The future development of the present value of the investment returns paid out one period after implementation is uncertain and modeled by a binomial approximation of the arithmetic Brownian process in discrete time. We assume that the present value of an investment in period 0 is V_0 =120,000, whereas the present value in period 1 will change. With probability p =50%, the present value in period 1 will rise by h =20,000, and with probability $1-p$, it will fall by h. In period 2, the present value can take the following values: $V_0 + 2 \cdot h$ with probability p^2; $V_0 - 2 \cdot h$ with probability $(1-p)^2$; and V_0 with probability $2 \cdot p \cdot (1-p)$. The question arises under which conditions this hypothetical investment should be realized.

To answer this question the value of the investment opportunity has to be calculated. The value of an investment $\hat{F}$ according to the NPV rule can be calculated as follows:

$$\hat{F} = \max(E(NPV_0);0), \tag{1}$$

where

$$E(NPV_0) = ((p \cdot (V_0 + h) + (1-p) \cdot (V_0 - h)) \cdot q^{-1}) - I$$

$E(\cdot)$ indicates the expectation operator and $q^{-1} = 1/(1+r^*)$ is a discount factor and r^* denotes the risk-adjusted discount rate. In the example, we assume a risk neutral decision maker with a risk-adjusted discount rate equal to the risk-free interest rate of 10%. That means for our example:

$$\begin{aligned} E(NPV_0) &= ((0.5 \cdot (120{,}000 + 20{,}000) + (1-0.5) \cdot (120{,}000 - 20{,}000)) \cdot 1.1^{-1}) - 100{,}000 \\ &= 9{,}091 \end{aligned}$$

But how high must the present value be to induce farmers to invest? To answer this question it is necessary to calculate the investment trigger, which is the critical present value of the investment returns that initiates the investment. The investment trigger $\hat{V}_0$ can be derived by equating the expected present value of the investment returns defined in equation (1) and the investment cost I:

$$\hat{V}_0 = h - 2 \cdot p \cdot h + I \cdot q \tag{2}$$

That means for our example:

$$\hat{V}_0 = 20{,}000 - 2 \cdot 0.5 \cdot 20{,}000 + 100{,}000 \cdot 1.1 = 110{,}000$$

The optimal investment behavior changes if it is taken into account that the decision to invest can be postponed up to one period. The postponement of the investment decision is valuable since new information about the expected present value may become available in the subsequent period. A rational decision maker would only invest immediately if the current expected NPV is higher than the discounted expected NPV of investing one period later. The value of an investment $\tilde{F}$ according to the ROA is defined as follows:

$$\tilde{F} = \max\left(E(NPV_0); E(NPV_1) \cdot q^{-1}\right), \tag{3}$$

where

$$E(NPV_1) = \left(p \cdot \left((p \cdot (V_0 + 2 \cdot h) + (1-p) \cdot (V_0 + h - h)) \cdot q^{-1} - I\right) + (1-p) \cdot 0\right) \cdot q^{-1}$$

The first term on the right-hand side of equation (3) is the expected NPV in period 0. The second term is the discounted expected NPV of investing one period later. For our example this means the following:

$$E(NPV_1) = \left(0.5 \cdot \left((0.5 \cdot (120{,}000 + 2 \cdot 20{,}000) + (1-0.5) \cdot (120{,}000 + 20{,}000 - 20{,}000)\right) \cdot 1.1^{-1} - 100{,}000\right) + (1-0.5) \cdot 0\right) \cdot 1.1^{-1} = 12{,}397$$

If we wait one period before deciding whether to invest in farmland or not, the discounted expected value of the NPV in period 1 is 12,397, whereas, the expected value of the NPV in period 0 is 9,091. Therefore, in our example, it is clearly better to wait one period instead of investing immediately. We receive the investment trigger $\tilde{V}_0$ by equating (1) and (3):

$$\tilde{V}_0 = \frac{q \cdot h - 2 \cdot p \cdot q \cdot h + I \cdot q^2 + 2 \cdot p^2 \cdot h - p \cdot I \cdot q}{q - p} \tag{4}$$

That means for our example:

$$\tilde{V}_0 = \frac{1.1 \cdot 20{,}000 - 2 \cdot 0.5 \cdot 1.1 \cdot 20{,}000 + 100{,}000 \cdot 1.1^2 + 2 \cdot 0.5^2 \cdot 20{,}000 - 0.5 \cdot 100{,}000 \cdot 1.1}{1.1 - 0.5}$$
$$= 126{,}667$$

The investment trigger following the NPV differs from the investment trigger following the ROA. The difference between the two triggers amounts to

$$\tilde{V}_0 - \hat{V}_0 = \frac{p \cdot h}{q - p} = \frac{0.5 \cdot 20{,}000}{1.1 - 0.5} = 16{,}667 \tag{5}$$

It can be seen that $\hat{V}_0$ is smaller than $\tilde{V}_0$ as long as $p > 0$. Against this background, we can formulate the following hypotheses:

Hypothesis H1 "NPV conformity": The investment behavior of farmers is consistent with the NPV.

Hypothesis H2 "ROA conformity": The investment behavior of farmers is consistent with the ROA.

As already mentioned in the introduction, different development levels of the agricultural sectors of Kazakhstan and Germany might be explained by different investment behavior of farmers in the two countries. It is possible that German farmers are more likely to take into account the content of the ROA than Kazakhstani farmers when making investment decisions. Therefore, we want to test the following hypothesis:

Hypothesis H3 "country differences": The investment behavior of German farmers is closer to the optimal investment behavior predicted by the ROA than those of Kazakhstani farmers.

In reality, entrepreneurs tend to perform various operations repeatedly. During these repetitions they are learning from their previous experience, which helps them to make optimal decisions. This phenomenon was studied and described by Brennan (1998), Oprea et al. (2009) and Gilbert and Harris (1981) with reference to investment decisions. In our experiment, farmers deal with repeating investment opportunities and we test the presence of a learning effect in the investment behavior of farmers. In particular, we test the following hypothesis:

Hypothesis H4 "learning effect": With increasing number of repetitions the investment behavior of farmers will approximate to the optimal investment behavior predicted by the ROA.

Farmer-specific variables also could have a considerable impact on the investment behavior of farmers. Therefore, our fifth hypothesis is:

Hypothesis H5 "farmer-specific variables": Farmer-specific variables have a significant influence on the investment behavior of farmers.

We focus on nine farmer-specific variables, which are selected from the literature related to investment behavior. They are reputed to have an influence on the investment behavior of farmers:

- The variable "farm size" measures the size of arable land of a farm. Savastano and Scandizzo (2009) found out that the larger the farmer`s present use of land is, the higher is the threshold value of the revenue per hectare to justify further land development. That means the larger the size of original land is, the later is the time at which the farmer exercises the option to invest in new land. The positive relation between land size and the threshold value was explained by the fact that larger size of farmland is associated with decreasing return to scale and increasing uncertainty. We expect that the variable “farm size” will lead to the prolongation of the investment period of farmers.

- The variable “farm type” is accounted for a series of binary variables for farm specialty. The farm type variable has a value of 1 for crop producing farms and 0 for farms specializing in animal husbandry, fodder production, processing of agricultural products and other types of agricultural activity. O`Brien et al. (2003) stated that entry into some target industries requires more irreversible investments compared to other industries. Subsequently, they argue that as the level of irreversibility of investments required to enter an industry increases, uncertainty will have a stronger negative effect on entry. We consider that crop producing farms own less assets with irreversible costs than other types of farms. Therefore, we expect that crop producing farms will invest earlier than non-crop producing farms.
- A study by Gardebroek and Oude Lansink (2004) found that age reduces the willingness of farmers to invest. The older farmer is willing to invest only if the marginal benefits of the investment are high. In the present study, we therefore expect that older farmers will invest later than younger farmers because they are more reluctant to make investments.
- The dummy variable “gender” is used as an independent variable because prior research on gender showed that women make more conservative investment decisions (Bajtelsmit and VanDerhei, 1997; Jianakoplos and Bernasek, 1998; Coleman, 2003). Based on that, we expect that female farmers are more reluctant to make investment decisions and, therefore, will invest later than male farmers.
- Considering the level of the education of farmers, we distinguish between the variables “higher education” and “economic education”. The first variable indicates whether or not the farmer has higher education, while the second variable indicates whether or not the farmer holds a degree in an economy-related subject. Managers with higher education and with a degree in a business-related subject estimate the value of a real option, and, therefore, the value of waiting higher than those who do not have higher education (Howell and Jägle, 1997). Therefore, we expect that farmers with higher education and with economic education will invest later than other farmers.
- The variable “family size” indicates the number of family members of the farmer. Lewellen et al. (1977) found that investors with many dependents stick to conservative

investment behavior. Based on their study we expect that the larger the family of the farmer is the later she or he will invest.

- The variable “farmer`s income type” is a dummy variable that measures whether or not farming is a principal income for the farmer. Adesina et al. (2000) suggested that an additional non-agricultural income may allow farmers to meet capital costs for technology implementation, which increase the likelihood to adopt new technology. Therefore, we expect that farmers with a principal income from farming are more reluctant to invest due to financial restrictions, which will lead to later investment timing.
- The variable “HLL value” is a person-specific measure of the risk preferences and equals to the number of safe choices made by farmers during the HLL experiment. Higher values of HLL correspond to a more risk-averse decision maker. Kroll and Viskusi (2011) argue that risk-averse respondents make less investment decisions. This could also be considered as the manifestation of investment reluctance. We expect that the higher level of individual risk-aversion will lead to later investment decisions.

The investment behavior of farmers during the experiment might be biased by the design of the experiment. In order to control these biases, we derive two hypotheses. Firstly, we pay attention to a framing effect based on the findings in other studies. They experimentally demonstrated that participants are more “attached” to a project, which is described in terms that are more familiar to them (Bettman and Sujan, 1987; Cronk and Wasielewski, 2008). In our study, we suppose that a treatment describing farmland investment will be closer to the perception of farmers than a treatment describing investment in a coin tossing game. Subsequently, we expect that farmers will show different investment behavior depending on the framing of a treatment. Thus, our sixth hypothesis is:

Hypothesis H6 “framing effect”: Farmers demonstrate different investment behavior if they are confronted with an agricultural or a non-agricultural investment treatment.

Secondly, responses given in a series of questions and treatments often depend on the order in which these questions and treatments are presented to a respondent (Perreault, 1975-6; Macfie et al., 1989; Legrenzi et al., 1993). With respect to our study that means that the order in which farmers are confronted with both treatments might influence their investment decision behavior. Therefore, we formulate our last hypothesis as follows:

Hypothesis H7 "order effect": Farmers demonstrate different investment behavior depending on the order how they are confronted with an agricultural and a non-agricultural investment treatment.

3. Experimental setting

The experiment consisted of three parts. The first part described two investment treatments stylizing an agricultural and a non-agricultural option to invest. In the second part, a HLL experiment was conducted in order to elicit the risk attitudes of farmers. The final part was a questionnaire gathering data about the socio-demographic characteristics of participants. There was no time constrain for participants in the experiment. Participants spent on average about 45 minutes for completing the experiment.

The first part was carried out in two treatments differing in the framing. In an agricultural investment treatment, participants had the hypothetical possibility to invest in farmland. We chose farmland as an exemplary investment object because it is a major input in world agriculture (Schmitz and Just, 2003, p. 53) and therefore we expected that farmers might be more "attached" to it. In a non-agricultural treatment, participants were given the hypothetical possibility to purchase the right to participate in a coin tossing game. The order in which participants were confronted with the treatments was randomly determined. Each participant was confronted with ten (individual) randomly determined paths of the binomial tree for each treatment. The entire binomial tree was newly determined by a random mechanism. Hence, over the course of the entire experiment, each respondent was confronted with 20 potentially different, randomly determined paths of the binomial tree. Apart from the different wording of the investment treatments, the parameters in the experiment (initial outlay, interest rate, standard deviation of returns etc.) were the same. Participants were informed about all parameters before the experiment started. To ensure that participants understood the instructions, they had to answer some control questions before the incentive compatible part of the real options experiment started. Furthermore, a trial round gave participants the opportunity to become acquainted with the experiment.

The design of the real options experiment employed the model outlined in the previous section. Within each repetition, respondents could decide to take part an ongoing investment opportunity in one of ten periods. In every repetition, participants started the experiment with a deposit of 100,000 points. The initial investment outlay was also 100,000 points. According to a binomial approximation of an arithmetic Brownian process in discrete time, the returns evolved stochastically over ten periods with no drift but with a standard deviation of 20,000 points. The probability that the returns increase or decrease for 20,000 points equaled 50%. The return in period 0 was always 100,000 points. The risk-free interest rate was fixed at 10%. The binomial tree of potential returns in figure 1 with their associated probabilities of occurrence was displayed on a screen and accordingly adjusted.

Participants had three possibilities: First, participants could pay the initial outlay of 100,000 points in period 0 and receive the return of period 1. Second, participants could decide to postpone the investment decision until period 9. Third, participants could invest in none of 10 periods and save the initial outlay of 100,000 points.

If participants realized the investment in period 0, they paid the initial outlay of 100,000 points and acquired 120,000 points or 80,000 points with probability 50% in period 1, and the first repetition ended. In an agricultural treatment, the return could be seen as the present value of an investment which participants could earn in the respective periods. The return corresponded to the present value of the gross margin, which could be achieved during

Period 0	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
										300 (0.1%)
									280 (0.2%)	
								260 (0.39%)		**260** (0.98%)
							240 (0.78%)		**240** (1.76%)	
						220 (1.56%)		**220** (3.13%)		**220** (4.39%)
					200 (3.13%)		**200** (5.47%)		**200** (7.03%)	
				180 (6.25%)		**180** (9.38%)		**180** (10.94%)		**180** (11.72%)
			160 (12.5%)		**160** (15.63%)		**160** (16.41%)		**160** (16.41%)	
		140 (25%)		**140** (25%)		**140** (23.44%)		**140** (21.88%)		**140** (20.51%)
	120 (50%)		**120** (37.5%)		**120** (31.25%)		**120** (27.34%)		**120** (24.61%)	
100		**100** (50%)		**100** (37.5%)		**100** (31.25%)		**100** (27.34%)		**100** (24.61%)
	80 (50%)		**80** (37.5%)		**80** (31.25%)		**80** (27.34%)		**80** (24.61%)	
		60 (25%)		**60** (25%)		**60** (23.44%)		**60** (21.88%)		**60** (20.51%)
			40 (12.5%)		**40** (15.63%)		**40** (16.41%)		**40** (16.41%)	
				20 (6.25%)		**20** (9.38%)		**20** (10.94%)		**20** (11.72%)
					0 (3.13%)		**0** (5.47%)		**0** (7.03%)	
						-20 (1.56%)		**-20** (3.13%)		**-20** (4.39%)
							-40 (0.78%)		**-40** (1.76%)	
								-60 (0.39%)		**-60** (0.98%)
									-80 (0.2%)	
										-100 (0.1%)

Figure 1. Binomial tree of potential investment returns
Notes: 1. The associated probabilities of occurrence are indicated in parentheses.
2. The investment returns are given in thousand points.

an infinite useful lifetime of the investment object. Moreover, it was assumed that the gross margin observed at the period after the investment realisation was guaranteed by an appropriate insurance during the entire useful lifetime. That means that the risk-free interest rate is the appropriate discount rate for determining the present value of the investment returns. This assumption of an infinite useful lifetime was described by Dixit and Pindyck (1994) (see the two-period example in Section 2). Therefore, a gross margin of e.g. 12,000 points per period resulted in a present value of 120,000 points, while a gross margin of e.g. 8,000 points per period resulted in a present value of 80,000 points. If the investment was made in period 0, the cells of the tree in the following periods were deactivated. In case participants did not invest in period 0, they faced again with the investment decision in period 1. It was randomly determined if the return in period 2 increased or decreased starting from the value of period 1. Potential return developments, which were not relevant anymore, were suppressed and probabilities for future present values were updated. This process was repeated until expiration of the investment option in period 9. The deposit and the returns less the initial outlay realized before period 10 increased by an interest rate of 10% for every period left in the tree.

The design of the HLL carried out in the second part of the experiment, is illustrated in Table I. In this lottery, participants could choose between two alternatives: The first alternative provided the opportunity to win 4,000 tenge[1] or 3,200 tenge with probabilities of 10% and 90%, respectively. The second alternative provided the opportunity to win 7,700 tenge or 200 tenge with the same probabilities as in the first alternative. The probabilities varied systematically creating 10 possible combinations: In the first combination, participants could win 4,000 tenge or 7,700 tenge with probability 10% and 3200 tenge and 200 tenge with probability 90%. In the second combination, the probabilities raised to 20% and 80%. Until the fourth combination, the expected value of the less risky alternative 1 was higher. When achieving the fifth combination, the expected value of the second alternative exceeded the expected value of the first alternative.

[1] €1 = 200 tenge

Table I.
Structure of the HLL

	Alternative 1 (A_1)	Alternative 2 (A_2)	Expected value A_1	A_2	Critical constant relative risk aversion coefficient
1	with 10% gain of **4,000 tenge** with 90% gain of **3,200 tenge**	with 10% gain of **7,700 tenge** with 90% gain of **200 tenge**	3,280 tenge	960 tenge	-1.71
2	with 20% gain of **4,000 tenge** with 80% gain of **3,200 tenge**	with 20% gain of **7,700 tenge** with 80% gain of **200 tenge**	3,360 tenge	1,700 tenge	-0.95
…	…	…	…	…	…
9	with 90% gain of **4,000 tenge** with 10% gain of **3,200 tenge**	with 90% gain of **7,700 tenge** with 10% gain of **200 tenge**	3,920 tenge	6,960 tenge	1.37
10	with 100% gain of **4,000 tenge** with 0% gain of **3,200 tenge**	with 100% gain of **7,700 tenge** with 0% gain of **200 tenge**	4,000 tenge	7,700 tenge	-

Notes: 1. The last three columns were not displayed in the experiment.
2. A power risk utility function is assumed.

Participants were asked to choose between two alternatives in each of the ten combinations. The observation of the choices of participants regarding the question when they opted for a riskier alternative allowed us to determine their individual risk attitude. A risk neutral decision maker would always decide in favor of the alternative with the higher expected value. Therefore, the decision maker would have had to prefer alternative 1 four times before switching to alternative 2. A HLL value (=number of safe choices) between 0 and 3 expressed risk-preference, a HLL value of 4 implied risk neutrality, whereas a HLL value between 5 and 9 expressed risk aversion of a decision maker. The last combination was used to test the comprehension of the HLL experiment by participants. If participants understood the terms of the lottery, it was supposed that even the most risk-averse decision makers should switch to alternative 2 as it yields a secure winning of 7,700 tenge.

The experiments were conducted in Kazakhstan and Germany between the end of 2010 until the beginning of 2011. Farmers were recruited through alumni networks of Kazakhstani and German universities. The alumni provided us with addresses of active farmers who were invited to participate in the computer-based experiment. Farmers were also asked to suggest other farmers who might be willing to participate in the experiment. In both countries, participants received a fixed amount for participating in the experiment (2,000 tenge in Kazakhstan and €10 in Germany). The target was to recruit around 100 farmers in each country with an acceptable deviation of 10% in both directions. We randomly spoke to approximately 500 farmers, if they would like to participate in our experiment. In total, 100 Kazakhstani and 106 German farmers participated in the computer-based experiment. That means 4,120 (2·10 repetitions for each of 206 farmers) investment decisions and 206 HLL values were given by participants. The hypothetical decisions were related to real winnings of participants to ensure incentive compatibility of the experiment. After all experiments had been carried out, two winners were randomly selected in each experiment carried out for Kazakhstani and German farmers. The chance to be the winner in one of the experiments amounted to approximately 1%. The winning of the farmer in the first part of the experiment was based on her individual scores earned on a randomly chosen repetition of the treatments. The Kazakhstani winner received 2,000 tenge for each 25,000 points, i.e., the potential winnings varied between 4,000 tenge and 36,000 tenge. In the second part of the experiment, the farmer received a payoff dependent on her expressed preference for or aversion against different alternatives. The potential winnings varied between 200 tenge and 7,700 tenge.

Financial incentives in experiments have been subject to controversial discussions. Ideally, all participants should be paid for their performance during an experiment in order to provide a maximal consequentiality of participants` decisions. Unfortunately, the introduction of a sufficient financial incentive for each participant is too costly. Ding (2007) carried out an experiment in which only a fraction of winners was received the reward based on their decisions. Despite this fact, he revealed that the experiment was able to elicit true preferences of participants. In addition, Camerer and Hogarth (1999) revealed that higher incentives often improve participants' performance during an experiment. Furthermore, they mentioned that it might be more motivating to pay one out of N participants if participants overweigh their chances of being selected.

The winnings in the experiment intended for German farmers were ten times higher than those in the experiment with Kazakhstani farmers. This adjustment was done on the basis of the ratio of the average salaries in agriculture in both countries, which is ten times higher in Germany than in Kazakhstan (Agency of Statistics of the Republic of Kazakhstan, 2011a; Federal Statistical Office, 2011).

4. Normative benchmark

We have to derive normative benchmarks, which reflect the NPV approach and the ROA for valuing the investment behavior observed in the experiments and for testing our hypotheses. For this purpose, equations (2) and (4) can be used; in view of the experimental design, however, an extension is necessary. Especially, the equations need to be adapted to the number of potential investment times of ten instead of two. In addition, the risk-adjusted discount rate r^* must be calculated on the basis of the results of the HLL. The solutions of these two tasks are expounded in this section.

Calculation of the risk-adjusted discount rate

The risk-adjusted discount rate is calculated using the results of the HLL. In accordance with Holt and Laury (2002), we assume a power risk utility function, which implies declining absolute risk aversion and constant relative risk aversion:

$$U(V) = V^{1-\theta}, \tag{6}$$

where U is utility and θ denotes the relative risk aversion coefficient. Based on equation (6), we can match θ for each farmer based on their choices given in the HLL. On the basis of this information the certainty equivalent CE of a risky prospect is formulated as:

$$CE = V(E(U(V))) = E(U(V))^{\frac{1}{1-\theta}} = E(V) - RP \tag{7}$$

Here, $E(V)$ is the expected value of the investment returns and RP is a risk premium. The present value of the certainty equivalent CE_0 of an uncertain payment V_T at time T can be defined as follows:

$$CE_0 = CE_T \cdot (1+r)^{-T} = (E(V_T) - RP_T) \cdot (1+r)^{-T} \tag{8}$$

where r is the risk free interest rate. An equivalent risk-adjusted discount rate $r^* = r + v$ can be derived from equation (8) using the following equation:

$$(E(V_T) - RP_T) \cdot (1+r)^{-T} = E(V_T) \cdot (1+r+v)^{-T} \tag{9}$$

$$\Rightarrow v = (1+r) \cdot \left(\left(\frac{E(V_T)}{E(V_T) - RP_T} \right)^{1/T} - 1 \right)$$

Obviously, the risk loading v and thus the risk-adjusted discount rate $r+v$ depend on the risk premium RP as well as on the length of the discounting period T .

Calculation of the exercise frontiers

The calculation of the exercise frontier according to the NPV is presented in equation (2). As you can see in Figure 2 the exercise frontier according to the NPV amounts to a value of 110,000 points and does not change over the periods. That is explained by the fact that the NPV approach does not consider the value of entrepreneurial flexibility to postpone an investment.

The exercise frontier according to the ROA is determined by dynamic stochastic programming (Trigeorgis, 1996, p. 312). However, it is problematic to apply dynamic programming to the binomial tree depicted in Figure 1 by using the risk-adjusted discount rates following equation (9), because the problem of non-recombining binomial tree for the expected net present value of the project may arise. That means the amount of potential states increases exponentially as the number of time periods rises (Longstaff and Schwartz, 2001). In the following, we suggest a simplification, which makes the calculation of the exercise frontier tractable. First, we fix the level of the returns at its initial value when calculating the risk-adjusted discount rate by equation (9). Second, we fix T at one period in equation (9). Finally, we derive nine discount rates representing different risk attitudes. The risk-adjusted discount rate varies in the range from 6.8% (HLL value = 0-1) to 13.1% (HLL value = 9-10). Figure 2 depicts the normative benchmarks obtained for the NPV approach and the ROA for a risk neutral decision maker.

The exercise frontiers of the ROA decrease exponentially reflecting the diminishing

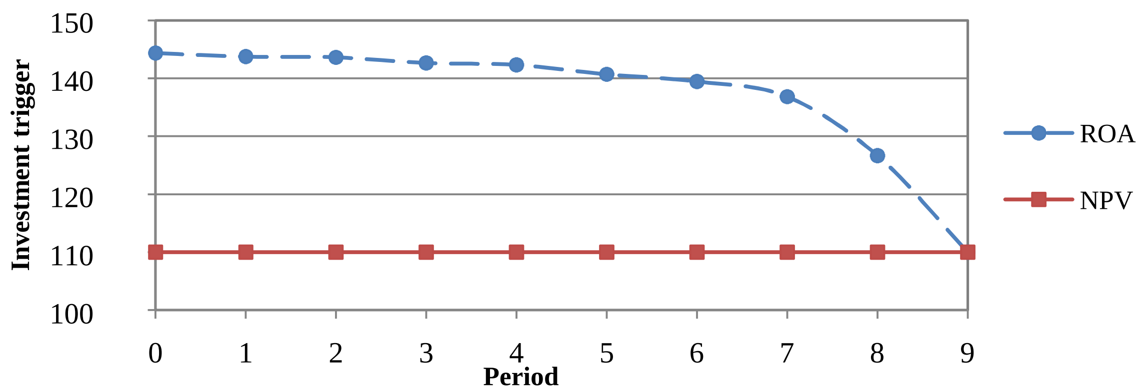

Figure 2. Investment trigger for a risk neutral decision maker
Note: The investment triggers are given in thousand points.

time value of the investment option. The trigger value starts at 144,000 in period 0. The curves coincide with the NPV approach at 110,000 points in period 9 because there is no more time to wait with the investment decision in period 9. The curve shape of the ROA and the NPV would change slightly according to different risk attitudes of participants, whereas the basic structure is maintained. The investment trigger in period 8 corresponds to the trigger derived in equation (4) of Section 2.

5. Descriptive statistics and approach to data analysis

Descriptive statistics

As it is shown in Table II, the average agricultural land size of Kazakhstani participants is much larger than that of German participants. This is not surprising because according to statistical data from the Agency of Statistics of the Republic of Kazakhstan (2011b) and the Federal Ministry of Food, Agriculture and Consumer Protection (2011), the average Kazakhstani farmer has a larger area of agricultural land than the average German farmer. Furthermore, the proportion of Kazakhstani farmers engaged in crop production reaches 52% and exceeds an analogous parameter of German farmers (32%). This is explained by the prevalence of the number of grain producing farms in the Kazakhstani agricultural sector. More than half of Kazakhstani farmers are female, while only 19.8% of the German farmers are female. This difference results from the different structural features of farms in the two countries. The Kazakhstani farms consist of several divisions lead by managers who were also involved in the experiment together with the head of the farm. Most of these managers were female in our experiment. In Germany, family farms with a simple organizational structure, are prevailing in the agricultural sector. Another considerable discrepancy between Kazakhstani and German participants is in the proportions of farmers with higher education. The proportion of Kazakhstani farmers with higher education exceeds the proportion of the German farmers with higher education. A reason for this might be the fact that it takes more time to get a university degree in Germany than in Kazakhstan. For example, in Germany two more years in school are required for university entrance than in Kazakhstan. According to the characteristics of farmers, the sample was unrepresentative for Kazakhstani as well as for German farmers.

The period of investment of Kazakhstani farmers is about 0.4 periods longer than the period of investment of German farmers. However, compared to Kazakhstani farmers, German farmers have a higher percentage of non-investment decisions. That means that German farmers decided not to invest in any of the 10 periods provided by the design of the experiment more often than Kazakhstani farmers. The average periods of investment presented in Table II do not take into account the cases of non-investment. Normative benchmarks derived for the NPV and the ROA were applied to 2,000 (Kazakhstan) and 2,120 (Germany) random realizations of the discrete approximation of an arithmetic Brownian process generated during the experiment. As it can be seen in Table II, the average periods of investment according to the ROA benchmark are considerably later than suggested by the NPV benchmark. In addition, the ROA benchmark has a higher percentage of non-investment decisions than the NPV benchmark. Kazakhstani and German farmers invest later than suggested by the NPV approach and earlier than suggested by the ROA.

Table II.
Descriptive statistics

	Kazakhstan		Germany	
	Agricultural treatment with 1,000 decisions	Non-agricultural treatment with 1,000 decisions	Agricultural treatment with 1,060 decisions	Non-agricultural treatment with 1,060 decisions
Average farm size	11,685 ha (12,956 ha)		304 ha (570 ha)	
Crop producers	52.0%		32.0%	
Average age of farmers	37.5 years (11.1 years)		30.1 years (10.3 years)	
Female farmers	53.0%		19.8%	
Farmers with higher education	70.0%		37.7%	
Farmers with economic education	55.0%		34.9%	
Principal income farmers	88.0%		81.7%	
Average risk attitude of farmers (HLL value)	5.3 (2.6)		4.8 (2.4)	
Average period of investment of farmers without non-investment periods	3.5 (2.8)	3.4 (2.8)	3.0 (3.0)	3.2 (3.0)
Percentage of non-investment of farmers	8.5%	7.4%	12.1%	9.5%
Average period of investment according to NPV without non-investment periods	2.2 (2.1)	2.3 (2.0)	2.3 (2.1)	2.4 (2.1)
Normative percentage of non-investment following NPV	27.3%	26.8%	27.8%	27.8%
Average period of investment according to ROA without non-investment periods	6.0 (2.2)	6.3 (2.1)	6.1 (2.2)	6.0 (2.1)
Percentage of non-investment according to ROA	46.6%	47.1%	48.3%	46.7%

Note: Standard deviations are indicated in parentheses.

Approach to data analysis

In order to test the hypotheses *H1* and *H2,* we have to define whether there is dependence between the periods of investment of farmers and the periods of investment according to the forecast following the NPV approach or the ROA. For this purpose, it is necessary to regress the periods of investment of farmers against the periods of investment according to the NPV approach or the ROA. The regression is complicated by the fact that, both the dependent variable (the periods of investment of farmers) and the independent variable (the periods of investment according to the NPV approach or the ROA) have observations which are censored. Censoring takes place because both the dependent variable and the independent variable are interval-censored and measures the time of investment between 0 and 9. Therefore investment decisions made after these investment periods provided by the experimental design are not observable. Given that the dependent variable and the independent variable are subject to censoring, an appropriate way to estimate the dependence parameter between them is a modified Theil-Sen estimator (Akritas et al., 1995). A modified Theil-Sen estimator is a non-parametric regression based on Kendall`s tau correlation coefficient. We now describe the application of a modified Theil-Sen estimator in the context of our two hypotheses.

X_i^t and Y_i^t, $i=1,...N$, are the investment periods according to the normative benchmarks and the investment periods of farmers, correspondingly. Both variables are not censored. The variables X_i^c and Y_i^c are censoring variables. The observed values X_i and Y_i are defined as the minimum of the non-censored variables and the censoring variables $X_i = \min(X_i^t, X_i^c)$ and $Y_i = \min(Y_i^t, Y_i^c)$. Censoring indicators, $\delta_i^x = I(X_i = X_i^t)$ and $\delta_i^y = I(Y_i = Y_i^t)$ are observed. I is an indicator function for an event. We need to estimate an unknown dependence parameter β in the following regression model:

$$Y_i^t = \beta X_i^t + u_i^t, \tag{10}$$

where β measures the change in Y_i^t associated with a one-period change in X_i^t.

In the uncensored case, the Theil-Sen estimator of the parameter β (Theil, 1950; Sen, 1968) is obtained as the value of b that makes Kendall`s τ statistics between the residuals $y_i - bx_i$ and x_i (approximately) equal to zero. But if both the dependent variable and the independent variable are subject to censoring, the residuals can be right censored, left censored, or both. Akritas et al. (1995) proposed a modification of the Theil-Sen estimator for doubly censored data, which is defined as the solution of b of the equation:

$$T_n(b) = \sum_{i<j} \delta_i^x \delta_j^x \left(I\{X_i < X_j\} - I\{X_j < X_i\} \right)$$
$$\cdot \left(\delta_i^y I\{r_i(b) < r_j(b)\} - \delta_j^y I\{r_j(b) < r_i(b)\} \right) \quad (11)$$

where $r_i(b)$ is the (possibly) censored analog of $r_i(b)^t = Y_i^t - bX_i^t$.

The modified Theil-Sen estimator of the slope (dependence) parameter with doubly censored data is:

$$\hat{\beta} = \frac{(\hat{b}_1 + \hat{b}_2)}{2}, \quad (12)$$

where $\hat{b}_1 = \sup\{b : T_n(b) > 0\}$ and $\hat{b}_2 = \inf\{b : T_n(b) < 0\}$.

Furthermore, a tobit model (Tobin, 1958) is used in order to test *H3* to *H7*, i.e. to analyze the impact of different independent variables on the investment behavior of farmers. Independent variables are not censored, whereas the dependent variable, i.e., the time of investment of farmers, is subject to censoring. It could be observed only when it falls between 0 and 9. For values below 0, we observe 0; for values above 9, we observe 9. Denoting the time of investment of farmers as Y_i,

$$Y_i = \beta X_i + u_i, \text{ with } i = 1,2,..., N \quad (13)$$

where N is the number of observations, Y_i is the dependent variable, X_i is a vector of independent variables, β is a vector of unknown regression parameters to be estimated, and u_i is a normal random variate with a mean of 0 and a variance of σ^2. The model for the dependent variable Y_i under interval censoring can be presented as follows:

$$Y_i = \begin{cases} 0 & \beta X_i + u_i < 0, \\ 9 & \beta X_i + u_i > 9, \\ \beta X_i + u_i & \text{otherwise}, \end{cases} \quad (14)$$

where 0 and 9 are the censoring interval endpoints. The equation (14) presents a tobit model with double censoring (Maddala, 2006, p. 150-151).

6. Experimental results

In this section, we test the aforementioned hypotheses.

Hypotheses H1 "NPV conformity" and H2 "ROA conformity"

In order to test *H1* and *H2*, we compare the investment behavior of farmers with the benchmark prediction given by the NPV and the ROA in an agricultural and a non-agricultural treatment. Results are shown in Table III. Around 45% of both Kazakhstani and German farmers invest earlier than suggested by the NPV approach in both treatments.

Around 40% of Kazakhstani and German farmers invest later than suggested by the NPV approach in both treatments. Regarding the ROA benchmark, around 75% of investment decisions are made earlier than suggested by the ROA. The proportion of optimal investment decisions exceeds the proportion of the investment decisions which are made later than predicted by the ROA benchmark. This applies to Kazakhstani and German farmers in both treatments.

Table III.
Hit ratio of the investment behavior of farmers and investment behavior according to the normative benchmarks

	Kazakhstan		Germany	
	Agricultural treatment with 1,000 decisions	Non-agricultural treatment with 1,000 decisions	Agricultural treatment with 1,060 decisions	Non-agricultural treatment with 1,060 decisions
Earlier investment than predicted by the NPV	44.2%	46.8%	49.3%	47.2%
Optimal investment as predicted by the NPV	13.2%	12.3%	13.3%	16.0%
Later investment than predicted by the NPV	42.6%	40.9%	37.4%	36.8%
Earlier investment than predicted by the ROA	76.5%	77.5%	74.8%	76.7%
Optimal investment as predicted by the ROA	13.1%	11.6%	15.1%	13.5%
Later investment than predicted by the ROA	10.4%	10.9%	10.1%	9.8%

Table IV illustrates the p-values of a dependence parameter $\hat{\beta}$ between the investment timing of farmers and the optimal investment timing according to the NPV approach or the ROA for Kazakhstan and Germany. The value of a dependence parameter $\hat{\beta}$ equals -6.7055e-08, which is identical for both benchmarks and both countries. The p-values of the dependence parameter are not significant. That means that there is no dependence between the investment timing of farmers and the investment timing according to the normative benchmarks for both countries. Consequently, neither the NPV approach nor the ROA is able to predict the investment timing of farmers. Thus, the hypotheses *H1 "NPV conformity"* and *H2 "ROA conformity"* are rejected.

Table IV.
p-values of modified Theil-Sen estimators

Approach	Kazakhstan	Germany
NPV	0.700	0.294
ROA	0.680	0.792

For testing the hypotheses *H3* to *H7*, we run a tobit model in which we regress the investment timing of farmers in an agricultural as well as in a non-agricultural treatment on different independent variables. The results of the tobit regression are presented in Table V.

Hypothesis H3 "country differences"

The results of the tobit model show that the estimated coefficient of the variable "country" is highly significant and has a positive sign (p-value < 0.001), i.e. on average, German farmers invest 0.946 periods later than Kazakhstani farmers. That means that in contrast to Kazakhstani farmers, German farmers time their investment decisions closer to the optimal investment periods predicted by the ROA. Hence, we fail to reject *H3 "country differences"*. At the same time this might imply that German farmers are more likely to consider the value of waiting than Kazakhstani farmers and, therefore, make more effective investment decisions.

Hypothesis H4 "learning effect"

For testing *H4 "learning effect"*, we insert the variable "repetition" in the tobit model. The variable "repetition" corresponds to the number of paths of the binomial tree discussed in Section 3. The estimated coefficient of the variable "repetition" is highly significant and has a positive sign (p-value < 0.001), i.e., with each repetition of an investment treatment, Kazakhstani and German farmers invested 0.067 periods later. Therefore, we fail to reject *H4*

Table V.
Tobit regression of the individual investment period of farmers (N=4,120)

	Coefficient	Robust standard error	p-value	
Constant	0.131	0.450	0.771	
Country (1: Germany, 0:Kazakhstan)	0.946	0.172	<0.001	***
Repetition (from 1 to 20 repetitions)	0.067	0.010	<0.001	***
Farm size	4.1281e-05	7.4307e-06	<0.001	***
Farm type (1: crop producer, 0: other)	0.324	0.125	0.010	***
Age	0.019	0.006	0.003	***
Gender (1: male, 0: female)	0.830	0.133	<0.001	***
Higher education (1: with, 0: without)	0.650	0.126	<0.001	***
Economic education (1: economic, 0: other)	-0.225	0.133	0.091	*
Family size	0.054	0.035	0.116	
Farmer`s income type (1: principal income, 0: sideline)	1.238	0.182	<0.001	***
HLL value (from 0 to 10)	-0.023	0.025	0.359	
Framing (1: non-agricultural, 0: agricultural)	-0.061	0.120	0.611	
Order (1: first agricultural; second non-agricultural, 0: first non-agricultural; second agricultural)	-0.575	0.122	<0.001	***

Note: Chi2 = 249.25, Log-Likelihood = -9411.27. Asterisk (*), double asterisk (**) and triple asterisk (***) denote variables significant at 10%, 5% and 1%, respectively.

"learning effect". That means that with an increasing number of repetitions the investment timing of farmers will approximate to the optimal periods predicted by the ROA.

Hypothesis H5 "farmer-specific variables"

As we can see from Table V, the estimated coefficients of the variables "farm size", "age", "higher education" and "farmers' income type" are significant and have a positive sign. This implies that farmers with a larger size of farmland, older farmers, farmers with higher education and farmers earning a principal income from farm business invest later. All these findings meet our expectations described in Section 2. It can be seen from Table V that crop producing farmers and male farmers invest later, which contradicts to our expectations. The variable "economic education" has a negative sign, which implies that farmers with economic education invest earlier. This finding also runs counter to our expectation. There is no statistically significant effect of the variables "family size" and "HLL value". In general, based on these results, we fail to reject *H5 "farmer-specific variables"*.

Hypothesis H6 "framing effect"

As it can be seen in Table V, coefficient "framing" is not significant. That means that the framing of the investment experiment has no impact on the investment behavior of farmers in an agricultural context as well as in a non-agricultural context. Farmers demonstrate similar investment behavior in an agricultural as well as in a non-agricultural investment treatment. Therefore, a framing effect is not revealed and *H6 "framing effect"* is rejected. However, we have to consider that the opportunities to invest in farmland and to participate in a coin tossing game were only hypothetical in our experiment. Framing might be helpful in making a laboratory experiment more realistic and thereby increases its external validity.

Hypothesis H7 "order effect"

As already mentioned, a framing effect has no influence on the investment behavior of farmers. But it could be possible that farmers who are first confronted with an agricultural treatment and afterwards with non-agricultural treatment show different investment behavior than farmers who were faced with the two treatments in a reverse order. We test this assumption by means of the variable "order" included in the tobit model. The variable "order" is a dummy variable, which takes the value of 1 if the farmer was at first confronted with an agricultural treatment and then with a non-agricultural treatment and 0 if the farmer was confronted with both treatments in a reverse order. The coefficient of the parameter "order" is significant. That means that the investment behavior of farmers regarding the two variations of the order is different. Farmers, who are first confronted with an agricultural treatment, invest 0.575 periods earlier than farmers who are first confronted with a non-agricultural treatment. Therefore, we fail to reject *H7 "order effect"*.

7. Discussion and conclusions

The agricultural sectors of Kazakhstan and Germany have significantly different levels of development. We hypothesized that the different investment behavior of farmers in the two countries could be one of the explanations for this fact. In order to test this, we experimentally analyzed whether the investment behavior of Kazakhstani or German farmers is more consistent with the NPV approach or with the ROA.

We could not indicate that the NPV approach or the ROA can exactly predict the investment behavior of Kazakhstani as well as German farmers. Both groups invested later than predicted by the NPV approach but earlier than predicted by the ROA. That means farmers failed to completely recognize the value of waiting provided by the ROA. However, we found that the investment behavior of German farmers is closer to the predictions of the ROA than those of Kazakhstani farmers. This might be one explanation for the fact that German farmers make more effective investments than Kazakhstani farmers and, therefore, the level of development of the agricultural sector in Germany is higher than in Kazakhstan. As well, this result shows that it is not acceptable to apply the results of the experiments investigating the investment behavior of entrepreneurs in Western industrialized countries to entrepreneurs in transforming countries. Based on the findings of other experimental economic researchers we tested if the investment behavior of farmers improves with an increasing number of repetitions of investment treatments. We found out that with each repetition farmers invest later. That means with each repetition farmers approximate to the optimal investment periods predicted by the ROA. We also expected that farmers would demonstrate different investment behavior in an agricultural treatment and in a non-agricultural treatment because they might be more "attached" to a project that is explained to them by using familiar terminology. However, results show that the investment behavior of farmers in an agricultural treatment does not differ significantly from that in a non-agricultural treatment. An important aspect is the order in which the two treatments were allocated to farmers. Farmers, who are first confronted with an agricultural treatment, invest earlier than farmers who are first confronted with a non-agricultural treatment.

Further findings are that a number of farm- and farmer-specific variables have an influence on the investment behavior of farmers. In particular, an increase in the values of the variables "farm size" and "age" leads to a later investment. Farmers with higher education and farmers, whose major source of income is farming, also invest later. These findings meet our expectations. Nevertheless, in our opinion, it is somehow surprising that crop producing farmers and male farmers make later investment decisions as this is a finding that is contradictory to those of many other studies. Farmers who completed an economic education invest earlier. This might be explained by the fact that in both countries, these farmers are more familiar with the NPV approach than with the ROA as the latter is a relatively new theory and, thus, has not found its way yet into the study program of most economic schools.

We have found that both Kazakhstani and German farmers invest later than predicted by the NPV approach but earlier than predicted by the ROA. The result implies that farmers only partly consider the value of waiting inherent in the ROA when making investment decisions. That means that there is still a room for improvement for the farmers in order to achieve the ROA benchmark. This could be achieved via training (human capacity building). This implication is consonant with another research by Howell and Jägle (1997), who also suggested training for managers in order to reduce the noise or bias of intuitive option valuations. From a policy-maker’s viewpoint, our results are relevant insofar as they not only draw attention to the generally known determinants of an investment decision (e.g. the level of the returns and their uncertainty or the level of the conversion costs), but also to the influence of temporal flexibility with regard to the investment timing in the case of uncertainty. An exclusive reliance on NPV models generates the risk that both the pace and the type of behavioral adaptations to changing institutional environments are misjudged. Since it is not possible to provide an exact prediction of farmers’ investment behavior by using ROA benchmarks, experimental methods should be included in the tool kit of policy impact analysis. This allows to take into account the bonded rationality of farmers and the fact that real actors normally pursue multiple goals including non-monetary motivations.

There are some directions of future research for explaining the deviation of observed investment behavior from the normative predictions given by the superior ROA. It would make sense to measure the impact of loss aversion on premature investment. As it is stated in the literature, gains tend to cause the risk-aversion, whereas losses tend to cause risk-seeking behavior (Kühberger et al., 2002; Cullis et al., 2012). In addition, it was found that losses influenced preferences of a decision-maker stronger than gains (Tversky and Kahneman, 1991; Epley and Gneezy, 2007). Further research in the vein of this study should investigate why the variables “farm type” and “gender” resulted in a later investment decision. It is also interesting to observe how the investment decisions of farmers would change if another asset was taken in the experiment instead of land investment (i.e. cow barn, pig-fattening barn, irrigation technology etc.). Researchers also may compare disinvestment decisions in transforming and Western industrialized countries. Finally, it is worth pursuing if farmers from other transforming countries would show different investment behavior compared to a Western industrialized country.

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