The comparison of investment behaviors of Kazakhstani and German farmers: An experimental approach

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Abstract

Kazakhstan and Germany have different development levels of the agricultural sector. One of the explanations for this fact might be the different investment behavior of farmers in the two countries. In this study, we experimentally compare the investment behavior of farmers in the two countries in a farmland investment treatment and a coin tossing game investment treatment. In addition, farmers were confronted with the two treatments in a different order. Results demonstrate that German farmers are more reluctant to make investment than Kazakhstani farmers. Moreover, results are independent from the framing of a farmland investment and a coin tossing game investment treatment. Furthermore, the investment behaviors of farmers were contrasted with normative benchmark of the classical investment theory and the real options theory. Our results show that both theories cannot exactly explain the investment behavior of farmers. However, farmers learn from former investment behavior and consider the value of waiting over time.

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

JEL code C91, D03, D81, D92

1. INTRODUCTION

The agricultural sectors of Kazakhstan and Germany have different levels of development. 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 (FAO, 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 a predictable and stable economy, which has not experienced shocks since the Second World War. 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 behavior plays an important role in the 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 behavior of farmers. 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. Therefore, this paper focuses on comparing and explaining the investment behavior of the farmers in Kazakhstan and Germany with regard to timing of investment decisions.

There are different investment theories that could be used to analyze investment decisions of farmers. The real options approach (ROA) is a comparatively new framework, which provides a microeconomic explanation for investment timing decisions (Luong and Tauer, 2006; Odening et al., 2005; Richards, Nganje and Acharya, 2009; Seo et al., 2008). The net present value (NPV) is another very common approach for evaluating investment decisions (Mathews and Short, 2001; Vanhoucke, Demeulemeester and Herroelen, 2001). From a normative point of view, the ROA is more advantageous for the valuation of investment decisions than the NPV. This approach 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. Consequently, the investment trigger according to the ROA must be significantly higher than according to the NPV criterion in order to realize an investment project (Dixit and Pindyck, 1994).

Furthermore, there are econometric studies regarding the analysis of the investment behavior (Bokusheva et al., 2007; O'Brien et al., 2003). 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 (Joshi and Pandey, 2006; Wale et al., 2005). 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 a possibility to the researcher to keep under the review the data. An experiment can be designed so 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 how irreversibility of choices influences investment behavior of subjects. Yavas and Sirmans (2005) used an experimental methodology to test the optimal timing of an investment. Oprea, Friedman and Anderson (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 to allocate resources to 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 decision behavior of student participants.

Hence, the objective of our study is to experimentally analyze if the investment behavior of German farmers differs from that of Kazakhstani farmers. A further objective of our study is to define farmer-specific and behavioral factors, which influence the investment behavior of Kazakhstani and German farmers. In the framework of behavioral factors, we test whether the framing of the investment treatment (farmland investment vs. coin tossing game investment context), the order how farmers face with treatments as well as farmers' personal experience during the experiment have an influence on their investment behavior. We also examine whether investment behavior of Kazakhstani and German farmers can be predicted better by the NPV or the ROA. We suppose that this comparative study could be interesting for readers considering the differences in economies, culture, and other spheres of public life of the two countries. Furthermore, improved policy impact analysis is possible when investment decisions are well understood at farm level.

These objectives are achieved by running experiments on repeatedly ongoing investment opportunities in a farmland investment and in a coin tossing game investment 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).

The contribution of this article to the existing literature is threefold. First, to our knowledge, this is the first study which experimentally compares investment behavior between decision makers in a developing and a developed country. Second, it is the first time that this type of experiment has been conducted with agricultural entrepreneurs. Third, we do not assume risk neutrality of decision makers. Rather individual risk propensity is explicitly taken into account when determining the normative benchmark for the investment decision.

Section 2 presents the derivation of hypotheses. Section 3 describes the experimental settings, In section 4 descriptive statistics is presented. The results of the experiments are discussed in Section 5. Finally, the paper ends with conclusions (Section 6).

2. DERIVATION OF HYPOTHESES AND THEORETICAL BACKGROUND

As already mentioned in the introduction, Kazakhstan and Germany differ significantly in the level of development of the agricultural sector. As stated by Gardebroek and Oude Lansink (2004), analysis of structural developments in farming needs a transparent understanding of investment decisions at the farm level. Therefore, we want to test whether the investment behavior of the farmers in the two countries is different.

Hypothesis H1 "country differences": Kazakhstani and German farmers show a different investment behavior.

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

Hypothesis H2 "farmer-specific variables": Farmer-specific variables have a significant influence on the investment behavior of farmers.

We focus on nine farmer-specific variables, which were analyzed in previous research related to investment behavior: farm size (Feder et al., 1992; LaDue, Miller and Kwiatkowski, 1991), farm type (Daberkow and McBride, 2003), age (Engstroem and Westerberg, 2003), gender (Hira and Loibl, 2008), university degree (Nilsson, 2007), economic education (Rahm and Huffman, 1984), farmer's income type (Adesina et al., 2000), individual perception of profitability of farming (Cary and Wilkinson, 1997) and person-specific measures of the risk preferences (Kroll and Viskusi, 2011).

In the present study, we pay attention to the framing effect based on the findings of researchers from other fields. They have experimentally demonstrated that participants are more "attached" to a project, which is described in terms that are more familiar to them (Cronk and Wasielewski, 2008; Kuhberger, 1998; Levin and Gaeth, 1988; Patel and Fiet, 2010). Thus, our third hypothesis is:

Hypothesis H3 "framing effect": Farmers behave differently if they are confronted with a farmland investment treatment and a coin tossing game investment treatment.

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 (Legrenzi, Girotto and Johnson-Laird, 1993; Macfie et al., 1989; Perreault, 1975-6). With respect to our study this means that a farmer could show a different investment behavior in each treatment depending on the order of a farmland investment and a coin tossing game investment treatment. We therefore formulated our fourth hypothesis as follows:

Hypothesis H4 "order effect": The investment behavior of farmers differs depending on the order how they are confronted with a farmland and a coin tossing game investment treatment.

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 occurrence was studied and described by Brennan (1998), Oprea, Friedman, and Anderson (2009) and Gilbert and Harris (1981) with reference to investment decisions. In our experiment, the participants deal with repeating investment opportunities and we test the presence of the learning effect in the investment behavior of farmers:

Hypothesis H5 "learning effect": Farmers learn from their previous investment behavior.

The NPV has been frequently used for evaluating investment behavior in various spheres of agriculture (Singh et al., 2010; Wu, Sperow, and Wang, 2010). It assumes that the investment is reversible; otherwise, the irreversible investment cannot be postponed but must be made immediately or needs to be cancelled (Dixit and Pindyck, 1994: 6). In contrast to the NPV approach, the ROA takes into account three features which are inherent in many real-life investment decisions, i.e. the irreversibility, uncertainty and flexibility of investment decisions (Kogut and Kulatilaka, 2001). The ROA requires a higher investment trigger than that suggested by the NPV rule in order to realize an investment decision (Dixit and Pindyck, 1994: 6-7). In the following, we test if the investment behavior of farers is more in line with the NPV approach or the ROA.

Hypothesis H6 "NPV conformity": The investment behavior of farmers corresponds with the NPV.

Hypothesis H7"ROA conformity": The investment behavior of farmers corresponds with the ROA.

3. EXPERIMENTAL SETTING

The experiment was divided into three parts. The first part described two investment treatments stylizing a farmland investment and a coin tossing game investment. In the second part, a HLL experiment was conducted in order to elicit the risk attitudes of participants. Both parts were followed by a questionnaire gathering data about the socio-demographic characteristics of the participants. There was no time constrain for participants in the experiment. Participants spent on average about 45 minutes for the experiment.

The first part was carried out in two treatments differing in their investment framing. In the coin tossing game investment treatment, a farmer was given the hypothetical possibility to purchase the right to participate in a coin tossing game. The order in which farmers were confronted with the treatments was randomly determined. Each treatment consisted of ten repetitions. Apart from the different wording of the investment treatments, the parameters in the experiment (initial outlay, interest rate, standard deviation of the present values etc.) were the same.

In every repetition, a farmer started the experiment with a deposit of 100,000 points. The initial investment outlay was 100,000 points. According to a discrete arithmetic Brownian motion, the present values of the investment returns evolved stochastically over ten periods with no drift but with a standard deviation of 20,000 points. The probability that the present values of the investment returns increase or decrease for 20,000 points equaled 50%. The paths of the binomial tree in each of the ten repetitions were randomly determined. As shown in Figure 1, the tree starts with the present value of the investment returns of 100,000 points. At the beginning of the experiment, a participant had two possibilities: First, the participant could pay the initial outlay of 100,000 points in period 0 and receive the present value of the investment returns of period 1. Second, a participant could decide to postpone the investment decision and save the initial outlay of 100,000 points and invest later until period 9.

If a participant realizes the investment in period 0, he or she would pay the initial outlay of 100,000 points and acquire 120,000 points or 80,000 points with a probability of 50% in period 1 and the first repetition ends. In the farmland investment treatment, the return can be seen as the present value of the investment which the participant could earn in the respective periods. The return corresponds to the present value of the gross margin, which could be achieved during 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 would result in a present value of 80,000 points. If investment was made in period 0, the cells of the tree in the following periods were deactivated. If a participant did not invest in period 0, the return for period 1 is randomly determined. Then the participant would be confronted with the investment decision in period 1. It would be randomly determined if the present value of the investment returns in the following period 2 increased or decreased starting from the value of the former period. This process was repeated until period 9 unless the participant invested earlier. The deposit and the present values of the investment returns less the initial outlay realized before period 10 increased by an interest rate of 10% for every period left in the tree. They were informed about all parameters before the experiment started. To ensure that the participants understood the instruction, they had to answer some control questions.

According to the design of the HLL carried out in the second part of the experiment, two alternatives are given in each line. The first alternative provides the opportunity to win 4,000 tenge[1] or 3,200 tenge with probabilities of 10% and 90%, respectively. The second alternative provides the opportunity to win 7,700 tenge or 200 tenge with the same probabilities as in the first alternative. The probabilities vary systematically creating 10 possible combinations. In the first combination there is a 10% probability of winning 4,000 tenge or 7,700 tenge, whereas in the second situation the probability

Figure 1. Binomial tree of the potential present values of the investment returns

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%)

Note: The associated probabilities of occurrence are indicated in parentheses. The present values of the investment returns are given in thsnd. points.

raises to 20%. Until the fourth combination, the expected value of the less risky alternative 1 is higher. When achieving the fifth combination, the expected value of the second alternative exceeds the expected value of the first alternative.

According to the requirements of the experiment, the participants had 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, he or she would choose 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 session by

[1] €1 = 200 tenge

the participants. If a participant understood the terms of the lottery, it is supposed that even the most risk-averse decision maker should switch to alternative 2 as it yields a secure winning of 7,700 tenge.

The experiments were conducted in Kazakhstan and in Germany between the end of the year 2010 until the beginning of the year 2011. 100 Kazakhstani and 106 German farmers participated in the computer-based experiment. In order to encourage farmers to participate in the experiment, 2,000 tenge were paid to each participant. In total, 4,120 (2·10 repetitions for each of the 206 participants) investment decisions and 206 HLL values were given by the farmers. The hypothetical decisions were related to real winnings of participants to ensure incentive compatibility of the experiment. Two winners were chosen in each experiment carried out for Kazakhstani and German farmers. The winning in the first part of the experiment was based on his or her individual score attained during the experiment, i.e., the amount of points that had been accumulated 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. The Kazakhstani winner of the second part of the experiment was also randomly selected. The participant would also receive a payoff dependent on his or her expressed preference for or aversion against different alternatives. The potential winnings varied between 200 tenge and 7,700 tenge. The chance to be the winner in one of the experiments amounts to approximately 1%.

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 in comparison to Kazakhstan.

4. DESCRIPTIVE STATISTICS

As it is shown in Table 1, the average agricultural land size is much larger in Kazakhstan than in Germany. According to statistical data from the Agency of Statistics of the Republic of Kazakhstan (ASRK, 2011) and the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV, 2011), an average Kazakhstani farmer has a larger agricultural land area than an average German farmer. More than half of Kazakhstani participants are female, while only 19.8% of the German participants 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, which do not have several divisions, are prevailing in the agricultural sector. The majority of the functions in family farms are performed by the head of a farm that is a man in most cases. Another considerable discrepancy between Kazakhstani and German participants is the proportion of studied farmers (farmers with higher education). The proportion of farmers with higher education is lower in Germany than in Kazakhstan. A reason for this might be the fact that it takes more time to complete a career in higher education in Germany.

The average period in the farmland investment treatment without consideration of the non-investment cases is for Kazakhstani farmers 0.5 periods longer than for German farmers. Kazakhstani farmers have a lower percentage of non-investment decisions than German farmers. Normative benchmarks derived for the NPV and the ROA were applied to 2,000 (Kazakhstan) and 2,120 (Germany) random realizations of the discrete arithmetic Brownian motion generated during the experiment.

The optimal investment period following the NPV and the ROA must be derived in order to have normative benchmarks for the investment behavior of farmers. We derived normative benchmarks using the risk-adjusted discount rate, which is calculated using the critical risk aversion coefficient derived for each participant during the HLL (Holt and Laury, 2002). As it can be seen in Table 1, the average periods of investment following the ROA benchmark are later than suggested by the NPV benchmark. 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 criterion and earlier than suggested by the ROA.

Table 1. Descriptive statistics

Parameter	Kazakhstan		Germany	
	Farmland treatment with 1,000 decisions	Coin treatment with 1,000 decisions	Farmland treatment with 1,060 decisions	Coin 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 participants	37.5 years (11.1 years)		30.1 years (10.3 years)	
Female participants	53.0%		19.8%	
Farmers with university degree	70.0%		37.7%	
Farmers with economic education	55.0%		34.9%	
Principal income farmers	88.0%		81.7%	
Average farm profitability assessment	73.2 points (20.3 points)		65.9 points (26.2 points)	
Average risk attitude of participant (HLL value)	5.31 (2.57)		4.79 (2.38)	
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)
Percentage of non-investment according to 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.

5. EXPERIMENTAL RESULTS

In this section, we test the aforementioned hypotheses. For testing the hypotheses *H1* to *H5*, we run a tobit model (Tobin, 1958) in which we regress the investment periods of farmers in the farmland investment treatment as well as in the coin tossing game investment treatment on different independent variables. Investment period is the interval-censored dependent variable, which measures investment time between period 0 and period 9. According to the design of the investment experiment, the participants had the option to reject the offer to invest until period 9. The results of the tobit regression are presented in Table 2.

Table 2. Tobit regression of the individual investment period of farmers (N=4,120)

Parameter	Coefficient	Robust standard error	p-value	
Constant	-0.640	0.433	0.139	
Country (1: Germany, 0:Kazakhstan)	0.878	0.170	<0.001	***
Farm size	4.1281e-05	0.000	<0.001	***
Farm type (1: crop producer, 0: other)	0.177	0.126	0.160	
Age	0.018	0.006	0.003	***
Gender (1: male, 0: female)	0.723	0.131	<0.001	***
University degree (1: with, 0: without)	0.584	0.126	<0.001	***
Economic education (1: economic, 0: other)	-0.272	0.131	0.038	**
Farmer`s income type (1: principal income, 0: sideline)	1.078	0.182	<0.001	***
Profitability assessment (from 0 to 100 points)	0.022	0.003	<0.001	***
HLL value (from 0 to 10)	-0.038	0.025	0.132	
Framing (1: coin treatment, 0: farmland treatment)	-0.060	0.119	0.617	
Order (1: first coin treatment; second farmland treatment, 0: first farmland treatment; second coin treatment)	-0.676	0.122	<0.001	***
Repetition (from 1 to 20 repetitions)	0.068	0.010	<0.001	***

Note: Chi^2 = 326.14, Log-Likelihood = -9268.14. Asterisk (*), double asterisk (**) and triple asterisk (***) denote variables significant at 10%, 5% and 1%, respectively.

Hypothesis H1 "country differences"

As we can see from Table 2, 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 0.878 periods later than Kazakhstani farmers. This confirms *H1 "country differences"* saying that the investment behaviors of Kazakhstani and German farmers differ significantly. Hence, *H1* cannot be rejected.

Hypothesis H2 "farmer-specific variables"

While there is a significant effect of the variable "farm size", the impact on the investment period is quantitatively small because the estimated coefficient is nearly zero. The estimated coefficient of the variable "age" is significant and has a positive sign. This implies that the older a farmer is, the later he or she invests. In addition, the dummy variables "gender", "university degree", "farmers' income type" and the variable "profitability assessment" are significant and have a positive sign. That means that female participants, participants with a university degree and participants earning a principal income from farm business invest later. In addition, the higher a farmer assesses the profitability of his or her farm, the later he or she invests. In contrast, a variable “economic education” has a negative sign. This implies that a farmer with economic education invests earlier. Although the coefficients of the variables “HLL value” and “farm type” are not significant, these results support *H2* stating that selected farmer-specific variables have a significant influence on investment decisions.

Hypothesis H3 “framing effect”

As it can be seen in Table 2, the coefficient of a variable “framing” is not significant. That means that framing has no impact on the individual investment period of farmers in our experiment. Farmers demonstrate similar investment behavior in the farmland investment as well as in the coin tossing game investment treatments. Therefore, the framing effect is not revealed and *H3 “framing effect”* must be rejected.

Hypothesis H4 “order effect”

Both treatments were presented to the participants in a different order. For example, in one survey group, participants had the opportunity to take part in a coin tossing game. After ten repetitions of this coin tossing game investment treatment they had ten times the opportunity to invest in farmland. In another survey group, farmers were confronted with both treatments in reverse order. In the scope of *H4 “order effect”*, we want to test whether the participants who are first confronted with the coin tossing game investment treatment and second with the farmland investment treatment (a dummy variable with the value of 1) show a different investment behavior than farmers who are confronted with the two treatments in reverse order. The tobit model in Table 2 shows that the coefficient of the variable “order” is significant. Farmers, who are first confronted with the coin tossing game investment treatment, invest 0.676 periods earlier than farmers who are first confronted with the farmland investment treatment. Therefore, *H4 “order effect”* is supported.

Hypothesis H5 “learning effect”

For testing *H5 “learning effect”*, we insert the variable “repetition” (Table 2) in the tobit model. 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 the investment treatment Kazakhstani and German famers invested 0.068 periods later. This result confirms *H5* stating that farmers learn from their experiences in the previous investment treatments and invest later.

Hypotheses H6 and H7 “NPV conformity” and “ROA conformity”

In order to test *H6* and *H7*, we compare the investment behavior of farmers with the benchmark prediction given by the NPV and the ROA. The hit ratio of the investment behavior of farmers and investment timing according to the normative benchmarks are shown in Table 3. On average, farmers invest earlier than suggested by the NPV criterion. The proportion of early investment decisions is higher for German farmers.

As far the ROA benchmark around 75% of investment decisions are given 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 both Kazakhstani and German farmers in both treatments.

Table 3. Hit ratio of the investment behavior of farmers and investment timing according to the normative benchmarks

Parameter	Kazakhstan		Germany	
	Farmland treatment with 1,000 decisions	Coin treatment with 1,000 decisions	Farmland treatment with 1,060 decisions	Coin 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%

Furthermore, in order to test the hypotheses *H6* and *H7*, we have to define whether the periods of investment of farmers correspond with the periods of investment according to the forecast following the NPV criterion 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 criterion or the ROA. The regression is complicated by the fact that both the response variable (the periods of investment of farmers) and the covariate (the periods of investment according to the NPV criterion or the ROA) are censored. Thus, in some cases of the 4,120 investment decisions a defined period of investment is not observable. There are unobservable periods of investment according to the NPV criterion and the ROA because these two approaches also provided non-investment decisions. In such cases, it is known that the period of investment exceeded the expiration of the investment opportunity. That means that the data point is above a certain value, the data is right-censored. The response variable and the covariate are subject to censoring. An appropriate way to estimate the dependence parameter in a simple regression is a modified Theil-Sen estimator (Akritas et al., 1995). Table 4 illustrates the p-values of dependence parameters between the investment periods of farmers and the investment periods according to the NPV criterion or the ROA for Kazakhstan and Germany. The value of the dependence parameter equals -6.7055e-08, which is identical for both countries and both benchmarks. The p-values show that there is no significant dependence between the investment periods of farmers and the investment periods according to the normative benchmarks in both treatments for both countries. Consequently, neither the NPV criterion nor the ROA is able to predict the investment behavior of farmers. Thus, we have to reject hypotheses *H6 "NPV conformity"* and *H7 "ROA conformity"*.

Table 4. p-values of modified Theil-Sen estimators

Investment criterion	Kazakhstan	Germany
NPV	0.700	0.294
ROA	0.680	0.792

6. DISCUSSION AND CONCLUSIONS

The agricultural sectors of Kazakhstan and Germany have significantly different levels of development. A possible explanation might be the different investment behavior of farmers in the two countries. We therefore examined and compared the investment behavior of farmers in Kazakhstan and Germany. Furthermore, we also aimed to identify whether factors such as farmer-specific determinants, framing, order, and learning influence the investment behavior of farmers. Another objective of our study was to test if the investment behavior of farmers is consistent with the NPV criterion or with the ROA, which are two criterions commonly applied in investment analysis.

One of the main findings of this experimental study is that the investment behavior of Kazakhstani and German farmers is significantly different, i.e., German farmers invest later than Kazakhstani farmers. That means that German farmers take into account the value of waiting more often than Kazakhstani farmers when making an investment decision. This might be one of the explanations of the higher investment performance of German farmers which, in turn, might at least partially explain the difference between the stages of development of the agricultural sectors of the two countries. Further findings are that a number of farmer-specific variables influence the investment behavior of farmers. In particular, variable as "age", "gender", "university degree", "farmers' income type” and “profitability assessment” result in a later investment period, whereas a variable “economic education” results in an earlier investment period.

We expected that farmers will show another investment behavior in a more familiar investment situation, i.e., in the farmland investment treatment. However, results show that the investment behavior in the farmland investment treatment of both Kazakhstani and German farmers does not differ significantly from that in the coin tossing game investment treatment. An important aspect is the order in which the two treatments were allocated to the participants. Moreover, we found out that Kazakhstani as well as German participants learn from their experience: The investment behavior of the participants diverges from the predictions of the NPV and approximates to the predictions of the ROA with an increasing number of repetitions. Despite this fact, the investment behavior of Kazakhstani and German farmers is neither predictable with the NPV criterion nor with the ROA. To improve the prediction of the investment behavior of farmers, the NPV and the ROA need to be extended to behavioral economic aspects as, for example, endowment and escalation-of-commitment effect.

The conclusion that neither the NPV criterion nor the ROA are able to predict the investment behavior of farmers was made on the basis of the results obtained by applying the estimation procedure proposed by Akritas et al. (1995). In the framework of this procedure, a dependence parameter between the investment periods of farmers and the investment periods according to the NPV criterion (the ROA) was estimated in a simple regression model, which considers censored data in both the response variable and the covariate. In our opinion, it would provide further insights if we could estimate the dependence parameter in a multiple regression model which also considers bivariate censored data. That would allow us to adjust the dependence parameter for other covariates in the model. How to extend the currently applied simple regression model to a multiple regression model should be studied further.

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