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## Institutions, competitiveness and cognitive ability

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# Institutions, competitiveness and cognitive ability

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**cemmap** working paper CWP31/20

# Institutions, Competitiveness and Cognitive Ability<sup>\*</sup>

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## **Abstract**

We investigate whether growing up in a socialist country affects the development of competitiveness by comparing three Korean groups in South Korea, born and raised in three countries with distinct institutional environments: South Korea, North Korea, and China. We examine the effect of home country experiences on competitiveness using laboratory experiments. Results show that North Korean refugees are significantly less competitive than South Koreans or Korean-Chinese immigrants. Ultimately, we find that the lower cognitive ability of North Koreans is a crucial determinant for the deficiency of competitiveness, while we fail to find evidence for direct effects of socialist institutions. Analysis through the lens of a choice model with probability weighting uncovers the effects of cognitive ability not only on expected performance but also on subject belief about winning and aversion for competition.

**JEL Classification:** C92, P20.

**Keywords:** Piece Rate; Tournament; North Korea; Institution; Laboratory Experiment.

# 1 Introduction

Institutions affect economic performance in both direct and indirect ways. The direct effects of property rights and contracting institutions have been attracting much attention and there is now a large body of literature suggesting their primary role in long-run growth (e.g., North, 1991; Acemoglu and Johnson, 2005; Besley and Ghatak, 2010; Acemoglu, Gallego, and Robinson, 2014). At the same time, institutions affect social norms such as trust, preferences on social policies, and giving behavior, which may subsequently influence economic performance (e.g., Alesina and Fuchs-Schündeln, 2007; Guiso, Sapienza, and Zingales, 2004, 2008; Kim, Choi, Lee, Lee, and Choi, 2017). Competitiveness, that is, an inclination toward competition, is a social norm that may vary across different institutions. Indeed, the literature finds that discrepancies in competitiveness between males and females are nurtured by the societal culture on the appropriate roles of each gender, and result in gender gaps in economic outcomes (e.g., Croson and Gneezy, 2009; Niederle and Vesterlund, 2011; Buser, Niederle, and Oosterbeek, 2014; Zhang, 2020). This indicates that the long-run performance of a country harnessing competitiveness is better than that of a nation failing to do so.

There is a widespread belief that the deficiency of competitiveness caused by state ownership of productive assets contributed to the failure of socialism (Gregory and Stuart, 2004). Similarly, one may claim that socialism emphasizing egalitarianism and workers' unity is in stark contrast to capitalism in terms of emphasis on competitiveness. Indeed, Stalin (1929) wrote, "The principle of competition is defeat and death of some competitors, the victory and domination of others." Nevertheless, it is known that socialism also utilized competition in various forms to maximize the performance of individuals and production units. The examples include the shock work in the form of the Stakhanovite movement in the Soviet Union, which encouraged to work harder and more efficiently following Alexey Stakhanov, who mined coal by 14 times of his quota. Races for fulfilling production targets set by central planners had been encouraged in the socialist countries. Speed battles have been used in China's Great Leap Forward and constantly in North Ko-

rea to maximize the efforts of workers for production (Kim, 2017). Hence, it is unclear whether socialism lagged behind capitalism in developing competitiveness *per se*. In this paper, we ask the following questions: would growing up in a socialist country affect the development of competitiveness?; if it is such a case, what is a factor that generates such a difference?

Answering these questions generates two critical challenges. First, it is difficult to find comparable groups of people who were exposed to different institutions. This is due to the fact that people with different institutional backgrounds are also different in many other regards. Second, we need to define and measure competitiveness quantitatively. In our study, we attempt to overcome the first challenge by comparing three Korean groups in South Korea, born and raised in three countries with distinct institutional environments: South Korea, North Korea, and China. These three groups are ethnically identical, possess the same historical origin, use a common language, and currently live in South Korea. However, their origin countries are starkly different. South Korea is the country based on a market economy and democracy, while North Korea is based on a centrally planned economy and dictatorship. China is politically a one-party communist country but economically based on a market economy. Despite of other differences among three countries, the contrasts in economic and political institutions are so significant that any differences in attitudes and behaviors may be at least partially attributed to institutional differences. Therefore, these three groups are close to ideal comparison groups for the purpose of our study.

To address the second challenge of measuring competitiveness as a distinct trait, we adapt the design of Niederle and Vesterlund (2007) with the addition of a random bonus. This type of experimental design is further used by Bartling, Fehr, Marechal, and Schunk (2009) and Dohmen and Falk (2011) among others; however, the random bonus is a novel feature in our experimental design. Because there are likely to be non-negligible differences in performance among the three Korean groups, we introduce an *exogenous* individual-level variation via a random bonus that helps low performers select into the tournament. The purposes of the random bonus are two-fold: (i) it balances the performance distribu-

tion among the three groups, and (ii) it serves as a subsidy for the disadvantaged North Korean subjects.<sup>1</sup> From their choice of a compensation scheme, we are able to elicit their preferences for competition after controlling for a set of potentially confounding factors.

To explore the mechanisms in which different factors translate into competitiveness, we measure standard determinants for entry to the tournament: namely, subjective winning probability, risk aversion, and cognitive ability. First, upon completing the three rounds of the real-effort experiment, we elicit subjects' beliefs of winning probability under the tournament. The method of belief elicitation is based on the binarized scoring rule of Hossain and Okui (2013). Next, we elicit subjects' risk preferences using the multiple price list design of Holt and Laury (2002). Then, we measure the cognitive skills of subjects using an abbreviated version of the Raven's Progressive Matrices Test.<sup>2</sup> The three subject groups in our experiments have substantially different life experiences and received completely different schooling. In view of that, the Raven test is appropriate for our study since it is a classical and leading test of analytic intelligence.<sup>3</sup>

In summary, we find that North Korean refugees are significantly less likely to select into the tournament scheme. The unconditional probability of North Korean subjects' selecting into tournament is about 20 percentage points lower than that for South Korean natives. The gap remains substantial (about 10 percentage points) even after controlling for the degree of risk aversion and their task performance measured prior to the choice of compensation scheme. Similarly, we find that North Koreans hold a significantly lower expectation of winning the competition. On the contrary, it turns out that Korean-Chinese immigrants are not significantly different from South Korean natives in terms of selection into the tournament as well as subjective expectation about winning the competition. Remarkably, we find that the South-North Korean gap becomes statistically and economi-

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<sup>1</sup>We found a substantial score gap in the Raven test between North Korean and South Korean subjects in our previous work (Choi, Kim, Lee, and Lee, 2020).

<sup>2</sup>In economics, Raven test scores have been previously used in, for example, Burks, Carpenter, Goette, and Rustichini (2009), Charness, Rustichini, and van de Ven (2011) and Gill and Prowse (2016) among others.

<sup>3</sup>In psychology, analytic intelligence is referred to as "the ability to reason and solve problems involving new information without relying extensively on an explicit base of declarative knowledge derived from either schooling or previous experience" (Carpenter, Just, and Shell, 1990; Nisbett, Aronson, Blair, Dickens, Flynn, Halpern, and Turkheimer, 2012).

cally insignificant once we control for the cognitive ability measured by the Raven test. In fact, it turns out that once the Raven test is controlled for, North Korean refugees are more competitive than South Korean natives in terms of point estimates.

We do not find any kind of experience in North Korea, such as educational attainment in North Korea or the Communist party membership which is proxy for a socioeconomic status in North Korea, to have any significant effect on competitiveness. Our results suggest that institutions affect competitiveness only through cognitive ability. We find little direct effects of socialist institutions on competitiveness, implying that socialism is not free of competition. Furthermore, we analyze how cognitive ability is associated with performance, subject beliefs about winning competition and aversion for competition through the lens of a choice model with probability weighting. We instrument subjective winning probability with the random bonus to deal with measurement errors. Our results suggest that lower cognitive ability may be associated with lower levels of expected performance, more pessimistic subject beliefs and greater aversion for competition. Finally, our findings suggest that failed socialism in North Korea, which is frequently mentioned in the popular book by Acemoglu and Robinson (2012), might be the underlying cause of the lower cognitive ability of North Korean subjects.

The remainder of the paper proceeds as follows. In Section 2, we briefly review distinct characteristics of three groups of Koreans. In Section 3, we describe the sampling and experimental design of our study. In Section 4, we firstly provide the summary statistics of baseline variables and Raven test scores across the three groups and then present experimental results. In Section 5, we develop a choice model between the piece-rate and tournament schemes and examine different channels through which the Raven score can matter for selection into competition. In Section 6, we relate our study to several stands of the literature. Section 7 concludes.



## 2 Background

In our study, we compare native-born South Koreans with two groups of immigrants living in South Korea: North Korean refugees and Korean Chinese. These two groups are similar to native-born Koreans in their shared language and long-lasting cultural intersections. In this section, we review their distinct characteristics.

**North Korean Refugees** One critical contrast between South and North Koreans may amount to differences in institutions, that is, capitalism and democracy in the South and socialism and dictatorship in the North, which were exogenously installed in the late 1940s and intensified after the end of the Korean War (Acemoglu, Johnson, and Robinson, 2005; Kim, Choi, Lee, Lee, and Choi, 2017).

Socialist institutions, based on state ownership of productive assets and cooperation-oriented ideology, are believed to repress competition. The theorists powering these institutions viewed capitalist competition as a cause of anarchy and self-destruction (Marx, 1993; Hilferding, 1910). This ideology suggests a hypothesis claiming that North Korean refugees are less competitive than South Koreans because of little exposure to a market economy and anti-competition ideology. However, some scholars claim that socialism succeeded in harnessing competition by using shock-worker movement, speed battles, and races in achieving production targets (Prokhorov, 1981). In principle, it is difficult to accept that socialism, an egalitarian society, had competitive elements. However, from the beginning of socialism, it was found that harnessing competition was indispensable for economic growth. Socialism responded this dilemma by asserting that socialist competition is different from capitalist one. The former is motivated by unselfish commitment to building socialism and the latter by the pursuit of own self-interest. As mentioned in Introduction, the Stakhanovite movement in the Soviet Union during the late 1930s was one example. The Soviet authorities utilized this case to start a movement of breaking this record and to urge to build a great socialist country as fast as possible. A North Korean version of such a movement is called Chullima (a horse running 400 kilo meters without a break) movement. Such competition in the form of speed battles has continued until

today (Kim, 2017). In a socialist society, competition might be for the sake of the state, which might not be as potent as individual competition, but it nevertheless might serve as a basis for productive competition. Ultimately, it is an empirical question as to whether North Korean refugees shy away from competition.

Naturally, South and North Koreans should differ along important observed and unobserved dimensions other than their institutional backgrounds. Therefore, it is difficult to causally attribute any inter-Korean differences in competitiveness to the differences in their institutional experiences. To mitigate this concern, we oversample low-income South Koreans to match them as much as possible to North Koreans in terms of incomes and control for a rich set of demographic and socioeconomic characteristics in regression analyses.

North Korean refugees are a selected sample of the North Korean population, thereby implying that our sample is unlikely to be a representative sample of North Koreans living in North Korea. Consequently, in the paper, we do not intend to reach a decisive conclusion about North Koreans in general. See our previous work (Kim, Choi, Lee, Lee, and Choi, 2017) for details on comparison between North Korean refugees and the North Korean population.

**Korean-Chinese Immigrants** Korean-Chinese immigrants living in South Korea are the descendants of Korean emigrants into China from the late 19th and the first half of the 20th century. Most of the Korean-Chinese spent their childhood and received education in China but came to South Korea during the last twenty years mainly for economic opportunities. Therefore, they are influenced by Chinese institutions which can be characterized as being politically centralized but economically decentralized (Xu, 2011). This means that while Korean-Chinese immigrants, like North Korean refugees, are immigrants in South Korea, they should be closer to native-born South Koreans in terms of their institutional background, especially regarding the exposure to a market economy. Moreover, the Korean-Chinese are almost indistinguishable from North Koreans in terms of their accent or appearances. If past experiences of economic institutions in the home country matter

for competitiveness, we expect to find that the Korean-Chinese are similarly competitive to South Koreans.

### **3 Sampling and Study Design**

#### **3.1 Sampling**

Our study involved three distinct groups of Korean people in terms of their countries of origin. We used the stratified sampling method to recruit 191 North Korean refugees who were representative of the population of North Korean refugees in South Korea in terms of gender, age (at least 20 years old), and year of entry.<sup>4</sup> In addition, we recruited 193 South Korean adults and 72 Korean Chinese in South Korea to match the composition of North Korean refugee subjects with regard to gender and age. To reduce income differences between South Korean and North Korean subjects, we oversampled low-income South Korean subjects by restricting the one-third of all South Korean subjects to those from low-income households making less than about 2,200 USD in terms of monthly income.

In recruiting these three subject groups and implementing our experiments, we collaborated with a branch of a global survey company, the Nielsen Company in Korea, which had accumulated experiences in conducting surveys with a representative sample of South Korean adults and North Korean refugees in South Korea.

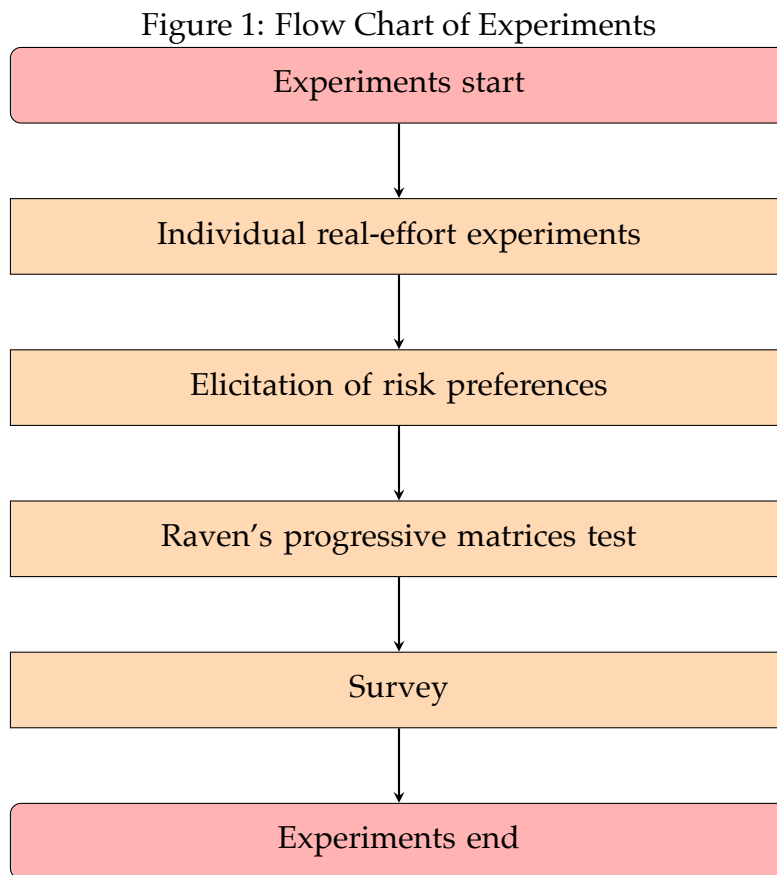
#### **3.2 Study Design**

We ran 12 experimental sessions in June 2015 at the Nielsen Company in Korea. In each session, all three Korean groups were proportionally invited to the total number of subjects. That is, in each session, the number of North Korean refugees was about the

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<sup>4</sup>According to the 2014 official statistics of the Ministry of Unification in South Korea, the population of North Korean refugees consists of about 28% in their twenties, 30% in their thirties, 16% in their forties, and 10% in their fifties or above. About 28% of them entered at South Korea prior to 2005, 27% between 2006 and 2008, 29% between 2009 and 2011, and the rest since 2012.

same magnitude as that of native-born South Koreans and was larger than that of Korean-Chinese immigrants. Our study design is broadly depicted in Figure 1.



### 3.2.1 Individual Real-Effort Experiments

**Individual Real-Effort Tasks** At the first stage, subjects conducted a series of individual real-effort tasks under two different payment schemes. The task in each scheme involved counting 0's in a  $7 \times 7$  table of containing 0's and 1's (see, e.g., Abeler, Falk, Goette, and Huffman, 2011). Specifically, subjects received 20 of these tables in an envelope, counted 0's and input answers in a computer within 5 minutes.

Subjects performed this task under a noncompetitive piece-rate incentive scheme as well as under a competitive tournament scheme. In the piece-rate incentive scheme, the

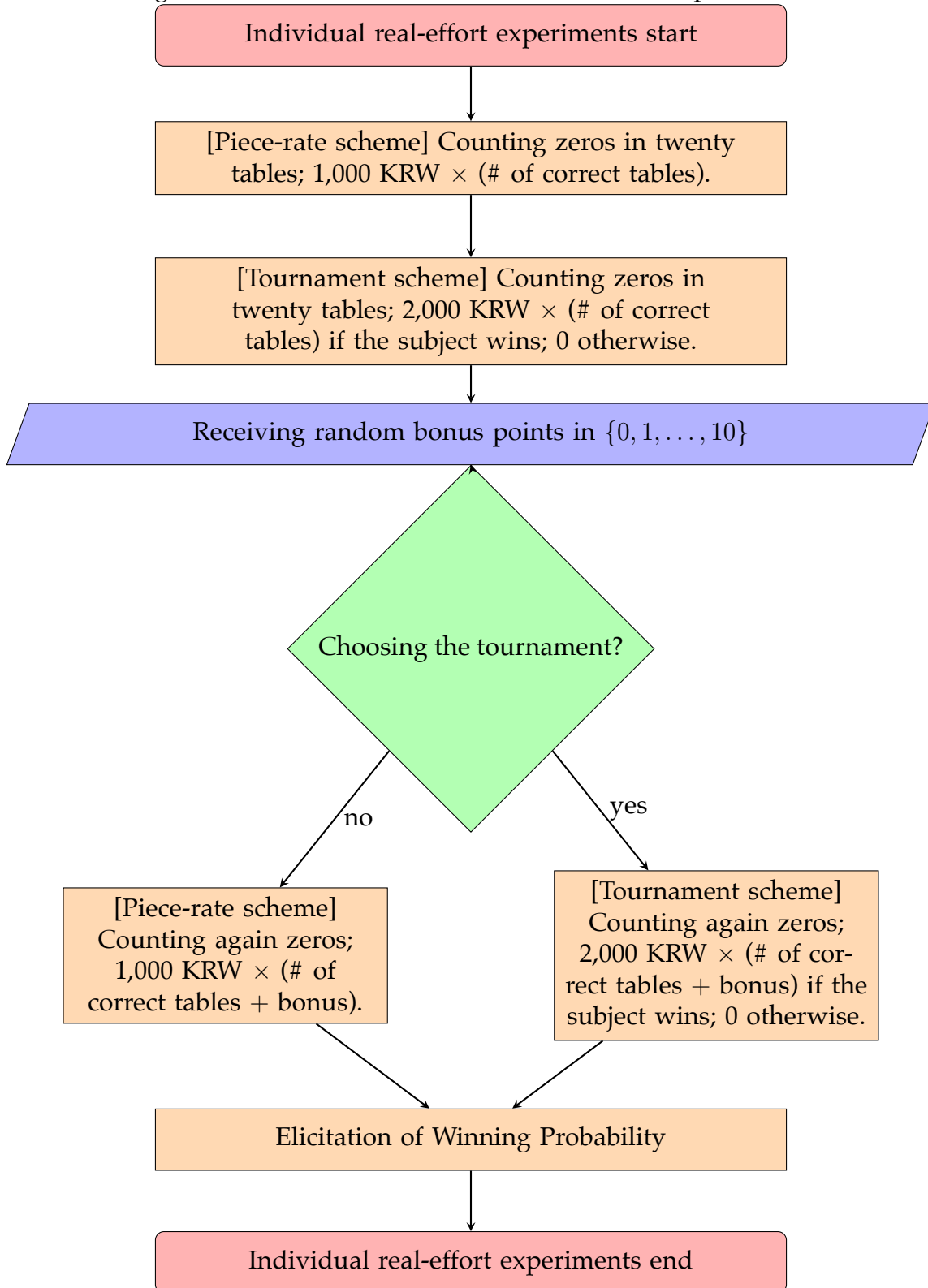
subject was paid 1,000 KRW (about one USD) for each correct table. For example, the subject was paid 12,000 KRW if the answers for 12 tables were correct. Under the tournament incentive scheme, subjects were informed that each person would be randomly matched with an anonymous partner at the end of the session and would earn 2,000 KRW for each correct table if the number of correct tables made by the subject was higher than that by his/her partner or if the subject was randomly selected in case of a tie. Otherwise, the subject received nothing. For example, suppose that subject A answered 9 tables correctly. If partner B had 8 correct tables, then A earned 18,000 KRW and B nothing; if B had 10 correct tables, then A earned nothing and B 20,000 KRW; if B had 9 correct tables, then a random winner (A or B) earned 18,000 KRW.

We randomized the order of the two schemes among subjects. At the end of the task under each payment scheme, individual subjects were informed of the number of correct answers they made. Under the tournament scheme, whether the individual won or not was revealed after they finished all tasks, including the post-experimental survey.

**Choice of Incentive Schemes** After completing the real-effort tasks under the two incentive schemes, subjects were asked to choose an incentive scheme under which they performed the same task of counting 0's with a new set of 20 such tables as in the first two rounds. Since there might have been performance differences among three Korean groups, we introduced an exogenous variation in the task performance by randomly giving an individual an integer bonus point between 0 and 10. If the piece-rate scheme was selected, the individual obtained total earnings as the sum of the number of correct answers and the bonus point, multiplied by 1,000 KRW. If the tournament was selected, the individual received the total earnings of the sum of the number of correct answers and the bonus point, multiplied by 2,000 KRW, if the individual won and nothing otherwise. Under the tournament incentive scheme, the individual with a bonus point competed with the opponent matched in the previous round under tournament. In deciding the winner, the opponent did not have a bonus point. Subjects were informed of this information.

One of the main research questions in the paper is whether North Korean refugees shy

Figure 2: Flow Chart of Individual Real-Effort Experiments



away from competition. They may choose the piece-rate scheme not only because they are unwilling to undertake competition (that is, due to competition aversion) but also because they are on average low performers relative to South Koreans or Korean-Chinese (that is, due to low skills). The random allocation of bonus points allows us to separate the former from the latter in the choice experiment.

**Elicitation of Winning Probability** Upon completing the three rounds of the real-effort experiment, we elicited subjects' beliefs of winning probability using the method of Hossain and Okui (2013). Subjects were reminded of the number of correct answers under the incentive scheme they chose as well as the bonus point assigned to themselves, and that their opponent in the stage of belief elicitation was another participant who was matched under the tournament scheme and had no bonus point. In the case where the piece-rate scheme was chosen, the subject was asked for his or her beliefs of the winning probability if he or she had chosen the tournament instead. Subjects were asked to choose beliefs of their winning probability in the range between 0% and 100% with 10% increments. We computed a prediction error based on whether they won and their elicited beliefs. The computed prediction error was compared with a random number generated between 0 and 1. If the prediction error was lower than a random number, the subject received 2,000 KRW and nothing otherwise. Figure 2 presents the flow chart of individual real-effort experiments.<sup>5</sup>

### 3.2.2 Other Measurements

**Elicitation of Risk Preferences** After team-level experiments, we elicited subjects' risk preferences. Specifically, we used the multiple price list design of Holt and Laury (2002) for the elicitation of risk preferences. The design involves ten choices between the paired lotteries. One lottery in the pair ('safe' choice) involves 5,000 KRW with probability

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<sup>5</sup>After elicitation of winning probability, we had team-level real efforts experiments. Specifically, we formed random groups of three subjects each of which conducted a joint real-effort task under an exogenously given payment scheme. The details of the experimental results at the team level will be reported in a separate outlet since they are not directly related to the main research question in the current paper.

$p$  and 4,000 KRW with probability  $1 - p$ , whereas the other lottery ('risky' choice) entails 10,000 KRW with probability  $p$  and 0 KRW with probability  $1 - p$ . The probability of the high-payoff outcome begins with  $p = 0.1$  and increases by 0.1 as the decision goes down along the list. The expected payoff difference between the safe and risky lotteries is  $4 - 9p$  in 1,000 KRW; therefore, as a benchmark, a risk-neutral subject's optimal behavior is to make the first four safe choices and then to switch to six risky lotteries.

**Raven's Progressive Matrices Test** At the end of experiments, we measure the cognitive ability of subjects using an abbreviated version of the Raven's Progressive Matrices Test. Subjects solved 24 questions within 15 minutes. We did not provide any monetary incentives for completing the Raven test, which is conventional in the psychology and psychometric literature (Gill and Prowse, 2016).

**Survey** At the end of each session, the participants completed a survey which collected information on their demographic and socioeconomic characteristics. We asked several additional questions for North Korean refugees and Chinese Korean participants.

## 4 Empirical Results

In this section, we firstly provide the summary statistics of baseline variables and Raven test scores across the three groups and then present experimental results. For brevity, we will abbreviate native-born South-born Koreans, North Korean refugees and Korean-Chinese immigrants to SK, NK and KC, respectively.

### 4.1 Summary Statistics of Baseline Variables

The basic sociodemographic characteristics of the three subject groups are reported in Tables 1, disaggregated by the country of origin (SK, NK, and KC). A significant majority of each group are female: 66% of the NK subjects and about 71% of each of the SK and KC



Table 1: Summary Statistics

	NK	SK	KC	p-value
Female*	.66	.71	.708	.533
Age	37.5	34.8	33.6	.00376
Post-secondary education*	.262	.85	.597	<.001
Married*	.298	.425	.306	.0246
Subject health status: not healthy*	.304	.14	.125	<.001
Religious affiliation*	.597	.585	.417	.023
Number of household members	2.38	3.15	2.9	<.001
Employed*	.639	.798	.792	.00126
Unemployed*	.136	.0777	.111	.174
Out of labor force*	.225	.124	.0972	.00884
Stock market participation*	.0838	.275	.139	<.001
Credit card holding*	.382	.705	.333	<.001
Online shopping*	.429	.933	.611	<.001
Monthly household income	1.5	4.42	2.12	<.001
Monthly household income per person	.794	1.64	1.01	<.001
Monthly household expenditure	1.05	3.34	1.54	<.001
Household wealth	133	352	185	.0577

Notes: The table shows the mean of each variable for North Korean refugees (NK), native-born South Koreans (SK) and Korean-Chinese immigrants (KC) separately. The last column shows the p-value for testing the joint significance of group indicators in regressing each variable on group indicators. The omitted group is SK in the regression. Household income, expenditure and wealth are measured in 1 million KRW. The variables with \* are binary indicator variables. The labor force status consists of employed, unemployed and out of labor force.

subjects. The NK subjects are on average 38 years old, while the SK subjects and the KC subjects are 35 years old and 34 years old, respectively.

The three Korean groups are different on many observables. Less than 30 percent of the NK subjects were post-secondary educated in contrast to 85 percent for the SK subjects and 60 percent of the KC subjects. Compared to SK, the NK and KC subjects were less likely to be married. About 30 percent of the NK subjects assessed subjectively that they were unhealthy—much higher than SK and KC. The KC subjects are noticeably less affiliated with religion than both NK and SK. The NK subjects had fewer household members. In terms of labor force status, NK were least likely to be employed while there was no difference between SK and CK. Relative to SK, both NK and KC were less likely to participate in the stock market, to hold a credit card and to shop online. In short, as immigrants, both NK and KC were less engaged with various economic aspects than the native SK. Although we oversampled lower-income SK, their average household income, expenditure and wealth were significantly higher than those of NK and KC.

## 4.2 Raven Test Results

All subjects took the Raven test at the end of experiments. Test results are presented in Table 2 and Figure 3. Specifically, the summary statistics are given in Table 2; Panel A of Figure 3 plots the histograms of the test scores and Panel B shows the age profiles that are obtained by local linear estimates. The results reveal that there exists a staggering gap between the NK and SK subjects in terms of cognitive ability. The average z-score of the SK subjects is 0.724, whereas the average score of the NK subjects is only -0.771. The average score of the KC subjects is between those of SK and NK—slightly above zero. The Raven test results for SK and NK are quantitatively similar to those reported in our previous work (Choi, Kim, Lee, and Lee, 2020), where the Raven test is used as source of income in dictator games. Some works based on data from Germany suggest that the cognitive ability of East Germans lagged behind that of West Germans before the German unification. The average intelligence quotient (IQ) of military recruits from West Germany

was 101 while that from East Germans was 95; nevertheless, East German military recruits gained by 0.66 points in IQ in each year after the unification (Roivainen, 2012). In a similar vein, the difference between Raven test scores between West and East Germans was substantial: the former recorded 70 on average but the latter did only 50 (Brouwers, Van de Vijver, and Van Hemert, 2009).

Table 2: Summary Statistics for Raven Test Z-Scores

	mean	SD	min	max
NK	-.771	.79	-1.96	1.13
SK	.724	.572	-1.52	1.57
KC	.104	.904	-1.82	1.43
Total	0	1	-1.96	1.57

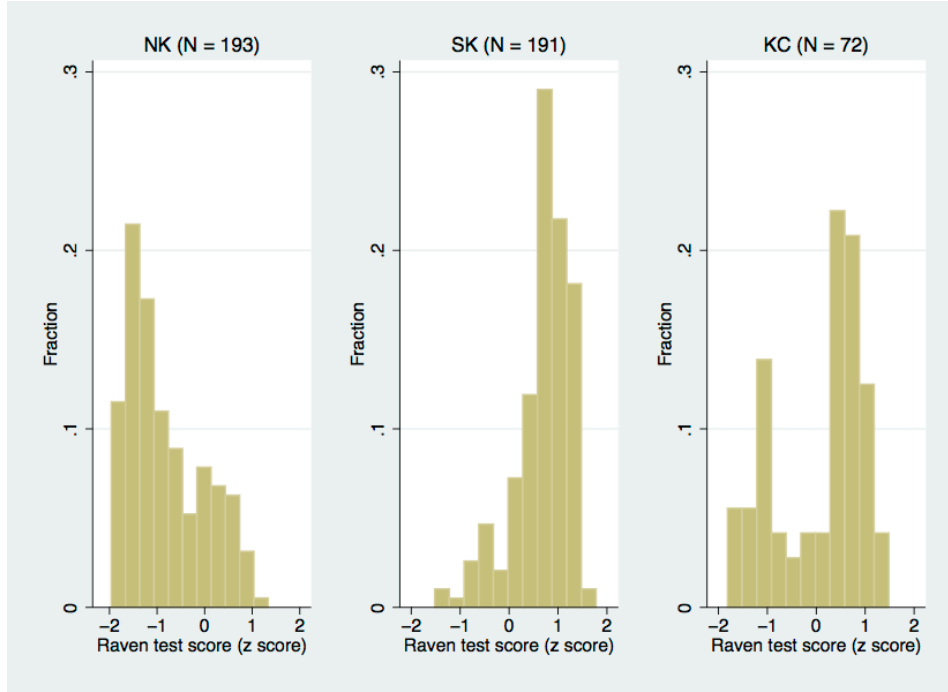
In Figure 3, the estimated age profiles exhibit that the SK-NK gap is uniformly persistent across different ages and the KC subjects are again between the NK and SK subjects. Interestingly, the gradient for KC seems steeper. This could be due to the fact that economic development in China occurred mainly after 1990s. Improvement in Chinese’s cognitive ability might be accounted for by better nutrition, expansion in education, and heightened quality of education. Economic growth influences cognitive ability through more nutritious diets. Increases in enrollment ratio in secondary and tertiary education might have played an important role in higher cognitive ability. Education quality has improved not only in the areas of better infrastructure and teacher-pupil ratios but also in the form of curriculum reform (Wu, 2010; Jianjun, 2012). In addition, labor market reform has increased return to education and thus motivated individuals to pursue better and higher education (Heckman, 2002).

### 4.3 Experimental Results

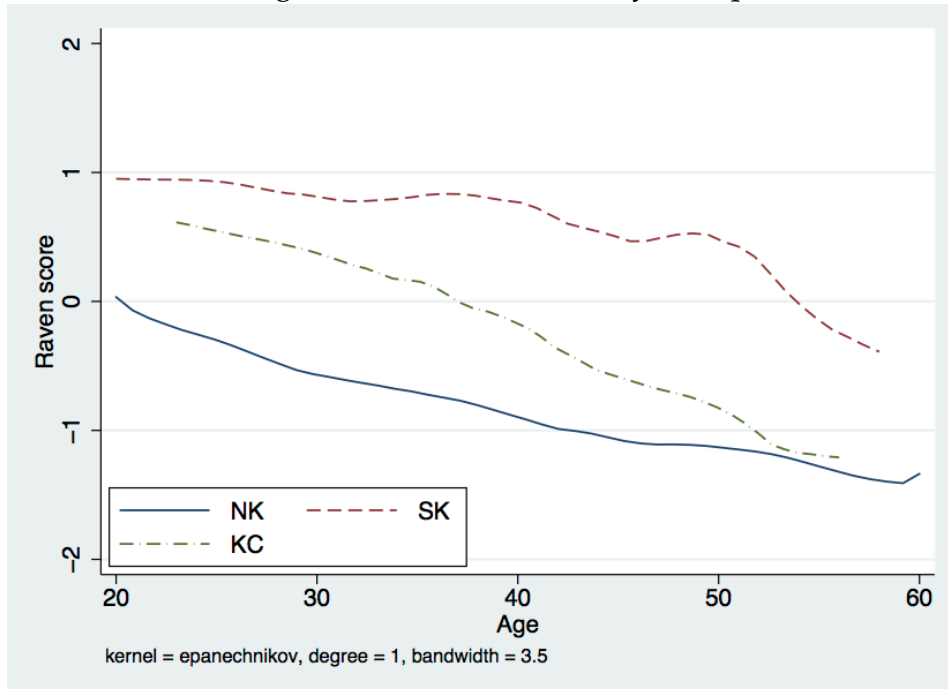
Table 3 gives central empirical results at the individual level. Panel A of Table 3 summarizes individual performance by compensation scheme. Subjects performed the real-effort task twice under two alternative compensation schemes. We randomized the order

Figure 3: Raven Test Z-Scores

A. Histogram of Test Scores by Group



B. Age Profile of Test Scores by Group



of the compensation schemes by session; therefore, about 50% of subjects of each country of origin performed under the piece rate scheme first and under the tournament scheme later (54% for NK, 50% for KC and 49% for SK). Under the piece rate scheme, on average, the NK subjects scored about 11 out of 20, which was 2 points below the average scores of SK and KC. Under the tournament scheme, the NK subjects performed slightly better; however, the SK subjects scored above 13, keeping the gap between SK and NK at about 2 points. Under both schemes, on average, the SK subjects performed best, while the NK subjects performed worst. The KC subjects are between SK and NK. The difference between NK and SK is statistically significant at the 1% significance level. The performance gap is about 18% in both schemes. There is no significant gap between SK and KC under the piece rate scheme (less than 0.5%); however, the gap becomes marginally significant (7%) under the tournament scheme.

Panel B of Table 3 presents the compensation scheme choice results and task performance outcomes under the selected scheme. As explained above, subjects were randomly given some bonus points before choosing a compensation scheme. The bonus point is a random integer between 0 and 10. Thus, the average is 5 for all three groups, and there is no statistical difference. The most important finding in Panel B is that the NK subjects were less likely to choose the tournament scheme than the SK or KC subjects. 45% of the NK subjects selected the tournament scheme, whereas 65% of SK subjects and 63% of KC subjects chose the tournament scheme. The difference between SK and NK or between NK and KC is significantly different from zero at the 1% significance level. If we interpret the choice of tournament as a measure of competitiveness, the results are consistent with the hypothesis that the NK subjects are less competitive than the SK or KC subjects. Panel B also shows how well subjects performed in their selected compensation scheme. It is found that subjects performed better in the selected scheme, compared to the results in Panel A. This is partly because of learning as they repeated the same kind of the task and partly because of self-selection into the preferred compensation scheme. As in Panel A, the NK subjects performed worst, while the SK and KC subjects scored 15 and 14 on average, respectively.

Table 3: Empirical Results at the Individual Level

	NK	SK	KC	p-value-NK	p-value-KC
A. Real effort task performance					
Piece rate first	.539	.487	.5	.307	.852
Score at piece rate	10.8	12.9	12.9	2.16e-08	.905
Score at tournament	11.4	13.6	12.7	9.37e-10	.0507
B. Compensation scheme choice					
Bonus	4.91	4.74	5.13	.616	.358
Choice of tournament	.45	.648	.625	.0000898	.735
Score at the chosen scheme	12.4	15.2	14	3.75e-13	.0176
C. Belief elicitation					
Subjective winning probability	.601	.781	.749	6.41e-10	.356
Subjective–empirical prob. gap	-.119	-.0449	-.0844	.0116	.264
D. Lottery choice					
Number of safe lottery choices	4.62	5.51	4.74	.000498	.0291
Inconsistent lottery choices	.429	.104	.236	7.06e-14	.0161
E. Cognitive ability					
Raven test score	-.771	.724	.104	7.25e-70	8.53e-08

Notes: The table shows the mean of each variable for North Korean refugees (NK), native-born South Koreans (SK) and Korean-Chinese immigrants (KC) separately. The p-value-NK and p-value-KC are p-values for testing the significance of NK and KC indicators, respectively, in regressing each variable on group indicators. The omitted group is SK in the regression.

Panel C of Table 3 reports elicited subjective winning probability across three groups. The NK subjects, on average, assessed their chance of winning with a bonus point at 60%; whereas the average winning probability was 78% and 75% for SK and KC, respectively. The average gap between the subjective and ex post empirical winning probability was negative for all the groups; NK showed the most pessimistic self-evaluation of the likelihood of winning. It is interesting to note that NK are less likely to select into tournament and gauge the odds of winning more unfavorably: that is, aversion to competition seems linked to a doubtful view of winning.

Panel D of Table 3 summarizes the empirical results of the elicitation of risk preferences. Out of ten choices between paired lotteries, all three groups selected about 5 safe lotteries with a bit higher number for SK. The more noticeable difference is that the incidence of inconsistent lottery choice due to multiple switching is much more frequent for NK than SK and KC: 82 out of 191 NK subjects made an inconsistent lottery choice—only 57% of NK were consistent—whereas, only 20 out of 193 SK subjects made an inconsistent lottery choice. Like many other variables, the result for KC is somewhat between SK and NK. In view of the Raven test results reported in the previous subsection, the prevalence in inconsistency for the NK subjects might be due to their low level of cognitive ability. The results for the Raven test score is reproduced in Panel E for the sake of simple comparison.

#### **4.4 Determinants for Selection into Tournament**

In view of the experiments in the previous subsection, the key question now is: *What explains the differences in selection into tournament across the three Korean groups?* As mentioned earlier and shown in Table 1, the three Korean groups, particularly, SK and NK, differed along important observed and unobserved dimensions. To address this concern, in the regression analysis below, we controlled for some demographic and socioeconomic characteristics. Furthermore, we elicited or measured some unobservable characteristics which were presumably relevant for the compensation scheme selection, such as risk aversion and ability. We tested for the differences in competitiveness after controlling for these

Table 4: Determinants for Selection into Tournament

	(1)	(2)	(3)	(4)	(5)
NK	-.171 (.0384)	-.156 (.0346)	-.11 (.0441)	.0893 (.0561)	.122 (.0647)
KC	-.0513 (.0901)	-.0525 (.0823)	-.0285 (.0777)	.0644 (.07)	.107 (.0799)
Age	-.0139 (.0032)	-.0131 (.00325)	-.0112 (.00329)	-.00659 (.00302)	-.00582 (.0027)
Female	-.109 (.054)	-.0862 (.0551)	-.0925 (.0543)	-.0757 (.0504)	-.0971 (.0555)
Bonus	.0321 (.00529)	.0308 (.00506)	.0306 (.00491)	.0327 (.00503)	.0348 (.00556)
Number of safe lottery choices		-.0219 (.00859)	-.0216 (.00824)	-.0198 (.00794)	-.0198 (.00706)
Inconsistent lottery choices		-.107 (.0504)	-.103 (.0547)	-.0532 (.0561)	-.0403 (.06)
Pre-choice tournament score			.0231 (.00589)	.0161 (.00606)	.0135 (.00681)
Raven test score				.162 (.0359)	.16 (.0351)
Further sociodemographic variables	No	No	No	No	Yes
Observations	456	456	456	456	423
R-squared	.165	.185	.211	.25	.29

Notes: Linear probability models. The dependent variable is an indicator of whether the subject selects the tournament scheme. Further sociodemographic variables include post-secondary education, marital status, subjective health status, religious affiliation, number of household members, labor force status, stock market participation, credit card holding, online shopping, log monthly household income, log monthly household expenditure, and log household wealth. Robust standard errors, clustered by session, are presented in parentheses.



characteristics.

Table 4 presents the regression results. In column (1), we controlled for age, female, and bonus points only. Then we added more and more control variables to check the robustness of the inter-group differences. Column (1) shows that the NK subjects were about 17 percentage points less likely to select the tournament scheme than the SK subjects while there was no significant difference between the SK and KC subjects. In column (2), we controlled for risk aversion; the number of safe choices and whether they made any inconsistent choices (more than one switching point). The SK-NK difference became slightly smaller to 15.6 percentage points but was still statistically significant. This result holds in column (3) where we controlled for the level of pre-choice task performance.

The SK-NK gap became statistically insignificant in column (4) once we controlled for Raven's test score, which was a measure of general cognitive ability. In fact, the sign of the estimate for NK was reversed. It now suggests that NK refugees were *more* competitive than SK. The negative age effect is diluted approximately by half and insignificant with controlling for the Raven score, suggesting that the apparent age effect in columns (1)-(3) are mainly driven by cognitive ability. There was no difference between SK and KC across the board in Table 4, regardless of control variables. The results in column (4) are similar to those in column (5) where further sociodemographic variables are included additionally.

In the post-experiment survey, we asked a question about preference for competition. The exact question was "What do you think about competing with others in a usual day?" The response was from 1 (hate it very much) to 10 (like it very much).<sup>6</sup> The survey results show that the average was highest for NK subjects (6.6) and lowest for SK subjects (5.5). KC subjects' average was around the middle, 6.2. This means that NK subjects did not mind or even *enjoyed* competing with others. We checked whether the result holds after controlling for individual characteristics. It turns out that the result that NK subjects had a more favorable attitude toward competition holds with control variables including gen-

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<sup>6</sup>A general question on competition is adopted here to avoid any potential bias against NK or KC. In a different context, a general question about risk taking resulted in the best versatile predictor of risky behavior (Dohmen, Falk, Huffman, Sunde, Schupp, and Wagner, 2011).

eral cognitive ability. This corroborates our experimental finding about competitiveness and is consistent with the claim that socialism aims to harness competition in achieving production targets, as was discussed in Section 2. The survey results show that the KC subjects were more favorable to competition than the SK subjects.

## 4.5 Determinants for Subjective Winning Probability

Table 5: Determinants for Subjective Winning Probability

	(1)	(2)	(3)	(4)	(5)
NK	-.167 (.0244)	-.154 (.0264)	-.106 (.0273)	-.00794 (.0279)	-.0236 (.0279)
KC	-.0515 (.0266)	-.0469 (.0238)	-.0217 (.0215)	.024 (.0261)	.0251 (.0255)
Age	-.00768 (.00152)	-.00737 (.00157)	-.00537 (.00155)	-.00311 (.00134)	-.00291 (.00192)
Female	-.0631 (.0178)	-.057 (.0183)	-.0636 (.018)	-.0554 (.0162)	-.0608 (.0165)
Bonus	.0255 (.00397)	.0255 (.00396)	.0252 (.00327)	.0263 (.00351)	.027 (.00381)
Number of safe lottery choices		-.00273 (.00422)	-.0024 (.00387)	-.00152 (.0044)	-.00157 (.00452)
Inconsistent lottery choices		-.0477 (.0354)	-.0439 (.0349)	-.0192 (.0334)	-.0157 (.0378)
Pre-choice tournament score			.0244 (.00263)	.0209 (.00256)	.0209 (.00278)
Raven test score				.0794 (.0186)	.0763 (.0184)
Further sociodemographic variables	No	No	No	No	Yes
Observations	456	456	456	456	423
R-squared	.248	.253	.339	.367	.366

Notes: Linear probability models. Further sociodemographic variables are the same as those in Table 4. Robust standard errors, clustered by session, are presented in parentheses.

As shown in Panel C of Table 3, the NK subjects expected to win the tournament 18

percentage points less than the SK subjects, while the KC subjects displayed no significant respective difference to the SK subjects. There are at least two possible explanations. The first explanation is based on rational expectation. Since subjects have carried out the same task under the tournament scheme, they should have good expectation about their own performance levels. That is, those who did not performed well in the previous tournament were more likely to choose the piece-rate scheme rather than the tournament scheme.<sup>7</sup> Since the NK subjects performed below average, they might have had a lower expectation about winning and were less likely to choose the tournament scheme. The second explanation is based on factors beyond rational expectation, such as self-confidence and aversion to competition among other things. There exists a substantial amount of heterogeneity in self-confidence (Barber and Odean, 2001). It is likely that minority groups such as women and immigrants are less confident about themselves. If the NK subjects are less self-confident or intrinsically averse to competition, then despite the probability of winning the tournament being the same, they should be less likely choose the tournament scheme. In this subsection, we report reduced-form results on the determinants of subjective winning probability. We will look into different explanations more systematically in Section 5.

In Table 5, we attempt to examine which individual characteristics can account for the NK-SK difference in their subjective winning probability. Column (1) presents the differences among the three Korean groups conditional on basic variables: age, female and bonus points. NK subjects' subjective winning probability was on average 17 percentage points lower than SK subjects'. KC subjects' probability was 5.2 percentage points lower but it was only marginally significant. In column (2), we controlled for two variables of risk aversion. The NK-SK gap became a bit smaller, 15.4 percentage points. In column (3), we added the variable of pre-choice task performance in view of rational expectation explanation. As expected, this variable was significant and explains a part of the NK-SK

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<sup>7</sup>They are limited to guess their winning probability accurately because they have little information about the distribution of ability among other subjects in their session.

gap. After controlling for it, the gap reduced to 10.6 percentage points.<sup>8</sup> However, it is still significant, indicating that factors beyond rational expectation may affect subjective winning probability.

In column (4), we controlled for the Raven test score and found that the variable explained the whole NK-SK gap in subjective winning probability. The gap became statistically insignificant and virtually zero in magnitude. It is intriguing to find that general cognitive ability plays a key role in explaining why the NK subjects had a lower expectation about winning given our previous finding that the Raven test score was also a crucial factor for explaining the NK-SK difference in tournament entry decision. As before, the inclusion of further sociodemographic variables in column (5) gives results similar to those in column (4).

#### **4.6 Do Experiences in North Korea and in South Korea Matter?**

In this subsection, we focus on the NK subjects and examine whether any experiences in North Korea and in South Korea matter for the willingness to compete. After the experiments, we conducted a detailed survey for North Korean refugees about their economic activities and experiences in North Korea. Although the North Korean society is an extremely uniform society, there exists some extent of individual heterogeneity in terms of economic and social experiences. This is partly because it is also a class society that places extreme limitations on social mobility. Therefore, the extent to which they are captured by the standard rules and social norms of North Korea might be varying across individuals.

Table 6 gives descriptive statistics for NK specific variables. Almost 80% of the NK subjects were born in border provinces, 15% of them participated in military service, 13% of them were communist party members, 40% of them had a secondary job—the aver-

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<sup>8</sup>We tried to control for two additional variables: own group strongest and own group weakest. In the post-experimental survey, we asked which group among NK, SK and KC was expected to perform best in the task and which group would perform worst, respectively. Based on the responses to the questions, we created the two variables which indicated that their own group was expected to be the best or the worst. We interpret that these variables measured the extent of group-level confidence. The results show that those who believed that their own group was the most inferior were less likely to select into the tournament. However, it turns out that these variables did not explain the NK-SK difference.

Table 6: Descriptive Statistics for NK Specific Variables

	mean	SD	min	max
Border provinces	.791	.408	0	1
Military service in NK	.147	.355	0	1
Communist party member in NK	.131	.338	0	1
Secondary job in NK	.408	.493	0	1
Years of secondary job in NK	1.4	3.12	0	30
Years in SK	7.12	3.78	.75	15
Education in SK	.45	.499	0	1
Monthly household income	1.5	1.48	.1	12

age year of secondary job experience was 1.4 including those who had no experience at all. Specifically, a secondary job refers to income-generating activities mostly at markets: trading, production of basic consumer goods, smuggling, repair, private services, feeding the cattle and cultivating private plots (Kim, 2017). Furthermore, on average, they spent about 7 years in South Korea, 45% of them received some education in South Korea, and their average monthly household income was 1.5 million KRW.

Table 7 presents the results which are basically replications of Table 4. We begin with the baseline specification in column (4) in Table 4 and add interactions between the NK indicator variable and NK-specific variables. The results in column (2) of Table 7 show that no variables representing the experiences in North Korea are significant. Not only are none of the estimated coefficients significantly different from zero but they are also jointly insignificant.<sup>9</sup> The indicator for the Communist party membership should be correlated with socioeconomic status in North Korea. It is therefore somewhat intriguing to find that the party membership variable is not significant. Those from border provinces or those who had a secondary job should be more exposed to markets, but still none of them turn out to be significant for competitiveness. In column (3), we include NK refugees' experiences in South Korea: the duration of residence in SK, education in SK and monthly household income. We find that the longer they live in South Korea, the more competi-

<sup>9</sup>As Abadie (2018) advocate, statistical non-significance in our empirical result can be viewed as an informative result. That is, when we designed the experiment, it was largely unexpected that none of variables representing the experiences in North Korea would be insignificant.

Table 7: Determinants for Selection into Tournament Using NK Specific Variables

	(1)	(2)	(3)	(4)
NK	.0893 (.0561)	.0537 (.106)	.0188 (.0629)	-.071 (.104)
KC	.0644 (.07)	.0653 (.0688)	.0538 (.0728)	.0541 (.0708)
Age	-.00659 (.00302)	-.00745 (.00266)	-.00722 (.00302)	-.00835 (.00277)
Female	-.0757 (.0504)	-.0693 (.0494)	-.0583 (.0475)	-.0428 (.0493)
Bonus	.0327 (.00503)	.0327 (.0054)	.0359 (.0046)	.0361 (.00517)
Number of safe lottery choices	-.0198 (.00794)	-.0193 (.0082)	-.0208 (.00843)	-.0205 (.00888)
Inconsistent lottery choices	-.0532 (.0561)	-.0588 (.055)	-.0545 (.0558)	-.0616 (.056)
Pre-choice tournament score	.0161 (.00606)	.0166 (.0061)	.0142 (.00634)	.0149 (.0065)
Raven test score	.162 (.0359)	.162 (.0373)	.152 (.033)	.151 (.0342)
NK × (Border provinces)		.0562 (.0693)		.0734 (.0695)
NK × (Military service in NK)		-.105 (.141)		-.0739 (.147)
NK × (Communist party member in NK)		.178 (.156)		.211 (.165)
NK × (Secondary job in NK)		-.08 (.0735)		-.0692 (.0648)
NK × (Years of secondary job in NK)		.0162 (.0131)		.0235 (.0116)
NK × (Years in SK - 7)			.0258 (.00725)	.0278 (.00786)
NK × (Education in SK)			.0762 (.0533)	.0992 (.0583)
NK × (log(household income in SK) - log(1.5))			-.0544 (.0491)	-.0796 (.0488)
Observations	456	456	456	456
R-squared	.25	.258	.271	.283

Notes: Robust standard errors, clustered by session, are presented in parentheses.

tive they become. This could be driven by North Korean refugees' assimilation into the South Korean society (time effect) or by the difference in the ages at which they arrive in South Korea (cohort effect). For subjective winning probability, no variables related to experiences in NK and SK are not significant.

#### **4.7 Why do North Korean refugees have lower cognitive skills?**

We have found that the deficiency of competitiveness among NK refugees can be attributed to their lower cognitive abilities. Therefore, a natural question to ask is why they have lower cognitive abilities than their SK or KC comparison groups. One possible reason can be found in education. Kim and Lee (2018) compared years of schooling and Raven's test scores across countries and found that NK's cognitive skills are lower than comparable less-developed countries, although their length of schooling is much longer. The education system is made to cultivate the skills that people need to make their living and live as citizens in their country. It is therefore not surprising that the education in North Korea is focused on ideological indoctrination. Teachers are not incentivized to teach students mathematics or reading but make them memorize the words from their supreme leader. Also, students in North Korea are often mobilized for some collective labor work instead of regular classes, from agriculture ("weeding battle" or "fall battle" of harvesting) to construction (Institute for Unification Education, 2014).

Another reason for NK refugees' lower abilities is malnutrition in childhood or even during their prenatal period. Kim and Lee (2018) showed that heterogeneity in cognitive abilities among NK refugees is not explained by their demographic or socioeconomic characteristics and concluded that their lower abilities are likely originated from more macro factors such as lower economic development or food shortage at the national level.

There has been a growing body of the literature finding the long-term impacts of early childhood conditions on human capital development (Currie and Almond, 2011). The living environments of NK refugees should be much worse than those of SK or KC comparison groups. There have been some attempts to collect anthropometric data on people

who were born and raised in North Korea, given that height and weight are strongly correlated with childhood conditions. The data have shown some substantial gaps between South Korea and North Korea. For example, Schwekendiek and Pak (2009) found that North Korean pre-school children are about 6-7 cm shorter and 3 kg lighter than South Korean children. Also, they found that NK refugee children and adolescents are about 3-4 cm shorter and weighed less by 1 kg than their SK counterparts. Pak (2010) found that the duration in South Korea or a third country after escape from North Korea has a positive effect, suggesting a catch-up effect, although it is not large enough to cancel the disparity with SK peers.

## 5 Understanding the Experimental Results through the Lens of a Choice Model with Probability Weighting

In the previous section, we find that the Raven test score is a strong predictor of selecting the tournament. The Raven score can affect competitiveness because (i) it is a strong predictor of individual performance, (ii) it affects subjective beliefs about winning the tournament, as shown in Section 4.5, (iii) it could affect risk aversion, and (iv) it may have a direct effect on preference for competition, not explained through performance, beliefs or risk aversion. To understand which channels matter and how they contribute to the overall competitiveness, in this section, we analyze experimental data using a simple choice model between the piece-rate scheme (*PS*) and the tournament scheme (*TS*).

Assume that subject  $i$  estimates his/her performance upon observing a random bonus by

$$x_i = p_i + b_i,$$

where  $x_i$  is the predicted score for competition that is the sum of the two terms:  $p_i$  his/her expected performance and  $b_i$  the random bonus.



Suppose that subject  $i$ 's utility of choosing the piece-rate scheme is given by

$$U_i(PS) = u_i(x_i) - c(x_i), \quad (5.1)$$

where the utility function over money is  $u_i(x) = x^{\alpha_i}$  and  $c(x_i)$  denotes an individual's disutility of making an effort to solve  $x_i$ . Here,  $u_i(\cdot)$  allows for individual heterogeneity via  $\alpha_i$ , which represents subject  $i$ 's risk aversion or preference, whereas  $c(\cdot)$  is assumed to be homogeneous across subjects. Our choice of model specification mainly comes from the fact that we have measurements of risky lotteries but none of disutility of making the effort.

We consider the following specification for the expected utility of choosing the tournament scheme:

$$U_i(TS) = u_i(2x_i) \times w_i \left( \Pr\{x_i > p_j\} + \frac{\Pr\{x_i = p_j\}}{2} \right) - c(x_i) + \phi_i, \quad (5.2)$$

where  $u_i(\cdot)$  and  $c(\cdot)$  are the same as in the piece-rate scheme,  $p_j$  is the expected performance of opponent  $j$ ,  $w_i(\cdot)$  is a probability weighting function, and  $\phi_i$  is subject  $i$ 's preference for or against competition. Just like  $u_i(\cdot)$ , we allow individual heterogeneity for both  $w_i(\cdot)$  and  $\phi_i$ . In evaluating the probability in (5.2),  $p_j$  is compared to  $x_i$  because the random bonus is applied only to subject  $i$ —but not to opponent  $j$ —to determine a winner in the tournament. Finally, subject  $i$ 's choice, say  $d_i$ , is determined by

$$d_i = TS \text{ iff } U_i(TS) > U_i(PS),$$

equivalently

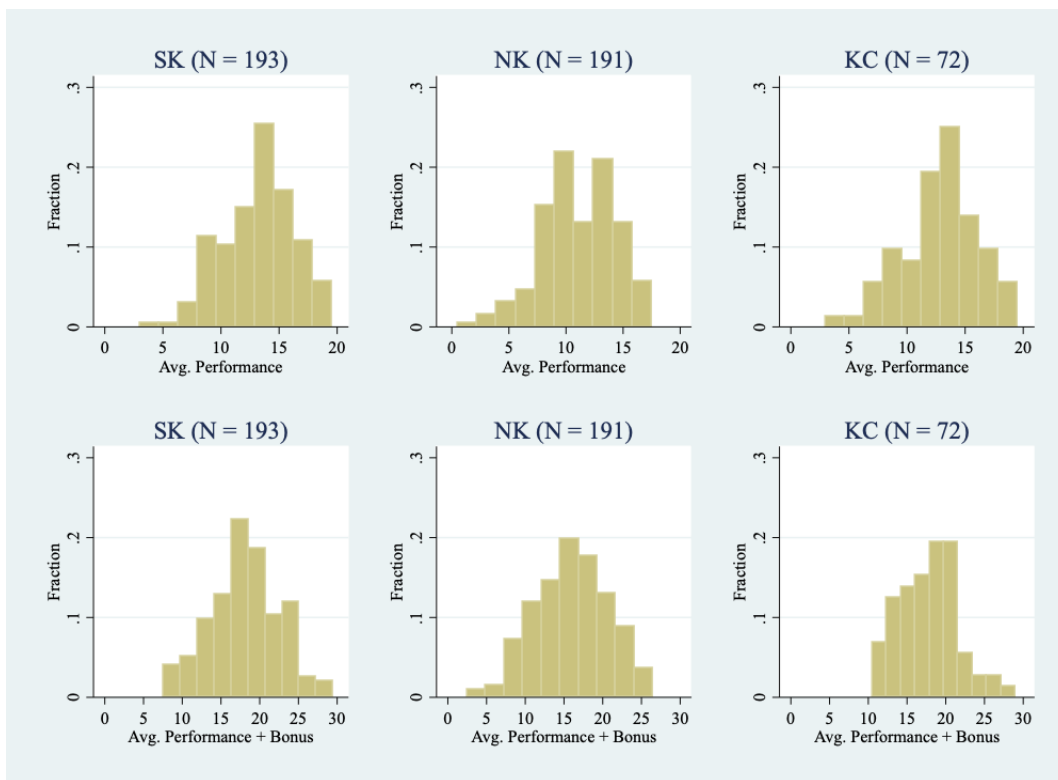
$$d_i = TS \text{ iff } u_i(2x_i) \times w_i \left( \Pr\{x_i > p_j\} + \frac{\Pr\{x_i = p_j\}}{2} \right) - u_i(x_i) + \phi_i > 0. \quad (5.3)$$

In what follows, we describe detailed specifications of the choice model and how to estimate them.

## 5.1 Expected performance

To measure  $p_i$  for each subject, we use the average number of correct answers during the first two individual real-effort tasks. The top panel of Figure 4 shows histograms of the average performance by group, while the bottom panel depicts histograms of the average performance plus the random bonus. It can be seen from the top panel that the SK and CK subjects performed noticeably better than the NK subjects. Adding the random bonus substantially diluted differences across groups.

Figure 4: Average Performance and Random Bonus by Group



Notes: The average performance refers to the average number of correct answers during the first two individual real-effort tasks. The top panel shows histograms of the average performance by group, while the bottom panel depicts histograms of the average performance plus the random bonus by group.

Before we move to measurements of other components in the model, in Table 8, we report regression results for the average performance. In column (1), the regressors in-

Table 8: Average Performance before Selecting an Incentive Scheme

	(1)	(2)	(3)
Piece rate first	-.498 (.318)	-.234 (.312)	-.248 (.305)
NK	-2.17 (.313)	-1.95 (.293)	-.271 (.316)
KC	-.499 (.688)	-.6 (.63)	.185 (.546)
Age		-.0847 (.0178)	-.0442 (.0147)
Female		.166 (.24)	.315 (.254)
Raven test score			1.19 (.137)
Constant	13.5 (.228)	16.2 (.624)	13.8 (.486)
Observations	456	456	456
R-squared	.1	.158	.21

Notes: The dependent variable is the average number of correct answers in the first two individual real-effort tasks. Robust standard errors, clustered by session, are presented in parentheses.

clude group dummies and an indicator variable whether the first task was the piece-rate scheme. In column (2), age and female are added and in column (3), the Raven test score is included. The NK subjects score about two less correct answers on average in columns (1) and (2) but this difference disappears once we control for the Raven test score.

## 5.2 Probability weighting

The crucial component in the specification of (5.2) is subject  $i$ 's subjective winning probability:

$$w_i \left( \Pr \{x_i > p_j\} + \frac{\Pr \{x_i = p_j\}}{2} \right). \quad (5.4)$$

To operationalize probability weighting, we build on Goldstein and Einhorn (1987)'s functional form:

$$w_i(p) = \frac{\delta_i p^\gamma}{\delta_i p^\gamma + (1-p)^\gamma} \quad (5.5)$$

for  $\delta_i \geq 0$  and  $\gamma \geq 0$ . Here,  $\delta_i$  captures the degree of optimism and  $\gamma$  the parameter of likelihood insensitivity. We assume that  $\delta_i$  can be heterogenous but  $\gamma$  is the same across subjects. When  $\delta_i = \gamma = 1$  for each  $i$ , the model reduces to the expected utility without probability weighting.

Let  $\text{SWP}_i$  denote subject  $i$ 's winning probability measured by the method of Hossain and Okui (2013). We regard  $\text{SWP}_i$  as a noisy measurement of subject  $i$ 's subjective winning probability in (5.4). Now the *objective* winning probability for subject  $i$  is

$$\Pr\{x_i > p_j\} + \frac{\Pr\{x_i = p_j\}}{2},$$

which can be estimated for each  $i$  using our experimental data. Specifically, define

$$\text{EWP}_i = \frac{1}{n} \sum_{j=1}^n \left\{ \mathbb{I}(p_j < p_i + b_i) + \frac{1}{2} \mathbb{I}(p_j = p_i + b_i) \right\},$$

where  $\mathbb{I}(\cdot)$  is the usual indicator function and  $n$  is the sample size. Note that  $\text{EWP}_i$  is the empirical winning probability using the average performance of all the subjects. The form of probability weighting in equation 5.5 suggests the following regression model:

$$\log \left( \frac{\text{SWP}_i}{1 - \text{SWP}_i} \right) = \log \delta_i + \gamma \log \left( \frac{\text{EWP}_i}{1 - \text{EWP}_i} \right). \quad (5.6)$$

The term  $\log \delta_i$  is further decomposed into the two parts: observed heterogeneity ( $z_i' \theta$ ) and unobserved heterogeneity ( $u_i$ ), where  $z_i$  is a vector of covariates and  $\theta$  is the corresponding vector of parameters and  $u_i$  is the idiosyncratic component. For some subjects,  $\text{SWP}_i$  or  $\text{EWP}_i$  can be zero or one. To have well-defined log odds, we truncate  $\text{SWP}_i$  and  $\text{EWP}_i$  to be always between 0.01 and 0.99. The unknown parameters  $\gamma$  and  $\theta$  are estimated via

median regression to mitigate the effect of truncation.

Table 9: Determinants of Probability Weighting

	(1)	(2)	(3)
Log odds of $EWP_i$	.565 (.0835) [.445,.717]	.501 (.0517) [.416,.591]	.543 (.0561) [.425,.612]
NK	-1.9 (.528) [-2.4,-.767]	-1.29 (.28) [-1.84,-.958]	-.463 (.393) [-.979,.249]
KC	-1.43 (.6) [-2.4,-.379]	-1.04 (.393) [-1.74,-.432]	-.558 (.432) [-1.2,.187]
Age		-.0465 (.0117) [-0.0688,-.0297]	-.0235 (.0125) [-.0456,-.00426]
Female		-1.08 (.249) [-1.38,-0.564]	-.813 (.283) [-1.22,-.26]
Raven test score			.613 (.181) [.397,.971]
Observations	456	456	456

Notes: Median regression. The dependent variable is the log odds of subjective winning probability ( $SWP_i$ ) and the first covariate is the log odds of empirical winning probability ( $EWP_i$ ). Bootstrap standard errors and 90% percentile confidence intervals are presented in parentheses and brackets, respectively.

Table 9 reports estimation results. Since the  $EWP_i$  is constructed from the sample, we bootstrap the entire estimation procedure 1,000 times to obtain the standard errors and confidence intervals. In column (1), the coefficient for the log odds of empirical winning probability is 0.565, which corresponds to  $\gamma$  in (5.6). The coefficients for NK and KC are significantly negative, respectively, indicating that the NK and KC subjects are less optimistic about their chance of winning the tournament. In column (2), age and female are

controlled for additionally and their coefficients are also significantly negative; however, in column (3) where the Raven test score is added, we can see that only female and the Raven score have large significant effects. In summary, the estimation results suggest that (i) individuals' subjective beliefs about their chance of winning the tournament is aligned with the empirical winning probability; (ii) the SK subjects exhibit more optimistic patterns than the NK and KC subjects but the differences seem to be explained by the Raven score; (iii) women shy away from competition mainly because of their pessimistic view on the chance of winning the tournament. It is striking that women's pessimism is still large even after controlling for the Raven score.

### 5.3 Separating competition aversion from risk aversion

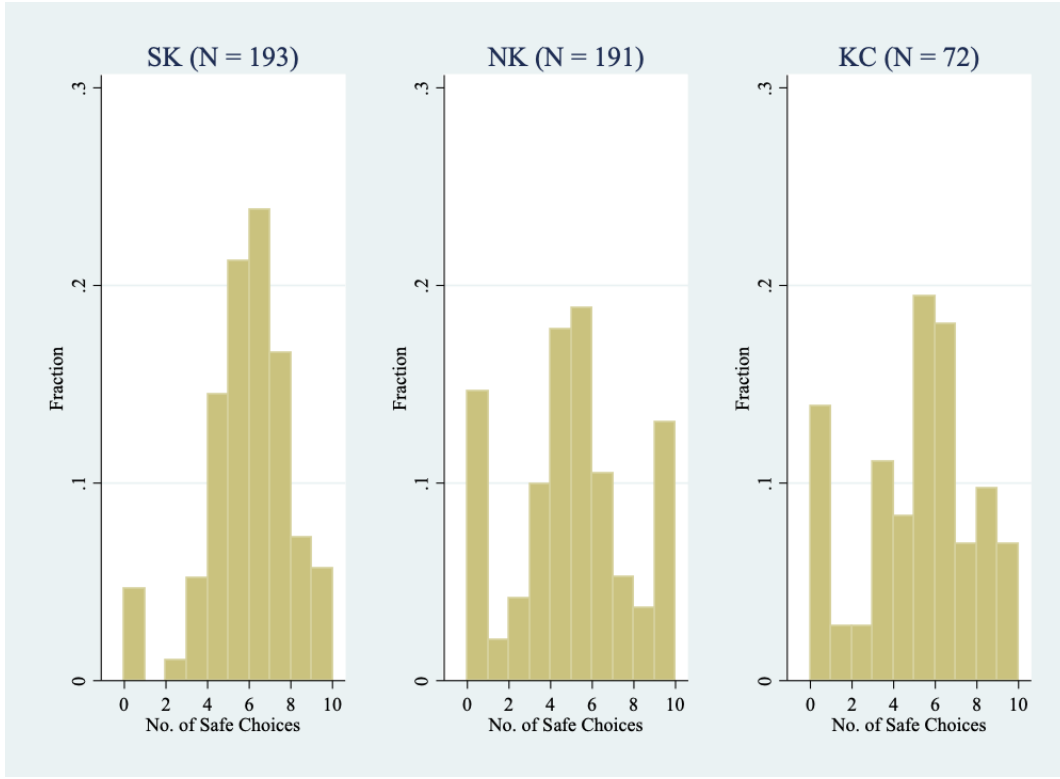
We now estimate the choice model in (5.3). To capture individual heterogeneity for risk aversion or preference, we use data on ten lottery choices.

Figure 5 shows the histograms of the number of safe choices out of the ten pairs of lotteries. In each group, there is substantial heterogeneity across subjects. There are more extreme types among the NK subjects than the SK subjects: 28 NK subjects (respectively, 9 SK subjects) selected none of safe choices, while 19 NK subjects (respectively, 1 SK subject) chose all of safe choices. The KC subjects also show a high proportion of choosing all risky options (10 out of 72 KC subjects). Table 10 confirms the patterns observed in Figure 5. It is interesting to observe that the negative NK coefficient becomes even larger in the absolute value after controlling for the Raven score. In general, none of age, female and the Raven score explain the number of safe choices, resulting in the R-squared of only 0.04.<sup>10</sup> Recall that the utility function over money is  $u_i(x) = x^{\alpha_i}$ . In what follows, we do not attempt to

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<sup>10</sup>In the literature, Dohmen, Falk, Huffman, and Sunde (2010) find that greater risk aversion is associated with lower cognitive ability, whereas Andersson, Holm, Tyran, and Wengström (2016) report evidence suggesting that this relation might be spurious. In Table 10, we do not find any evidence that the Raven test score is negatively correlated with the number of safe options. When we regress the extreme lottery choice (equals one if either  $\text{Safe}_i = 0$  or  $\text{Safe}_i = 10$  is true; zero otherwise) on the same covariates as in column (3) of Table 10, the estimated coefficient for the Raven score is  $-0.061$  with a standard error of  $0.024$ , hinting that lower cognitive ability may be associated with extreme choice. However, our experimental design does not allow us to determine whether it is mainly due to mistakes from lower cognitive ability or genuine differences in the underlying preferences.

Figure 5: Number of Safe Options by Group



Notes: The histograms show the number of safe options in the ten paired lottery choices by group.

estimate  $u_i(x)$  in an elaborate way, but we simply classify subjects based on the number of safe lottery choices by assigning different values of  $\alpha_i$ :

$$\begin{aligned}
 u_i(x) = & x^2 \times \mathbb{I}(\text{Safe}_i \leq 1) + x^{1.5} \times \mathbb{I}(2 \leq \text{Safe}_i \leq 3) + x \times \mathbb{I}(\text{Safe}_i = 4) \\
 & + x^{0.5} \times \mathbb{I}(5 \leq \text{Safe}_i \leq 6) + \ln(x) \times \mathbb{I}(7 \leq \text{Safe}_i \leq 8) + x^{-0.5} \times \mathbb{I}(9 \leq \text{Safe}_i \leq 10),
 \end{aligned} \tag{5.7}$$

where  $\text{Safe}_i$  is the number of safe choices for subject  $i$ . This utility specification is broadly in line with Holt and Laury (2002)'s risk-aversion classifications based on lottery choices (see Table 3 in their paper). The main purpose of adopting the heterogeneous utility function via (5.7) is to alleviate the misspecification issues of using a homogeneous utility function, thereby allowing us to estimate preference for competition more credibly.

Table 10: Patterns in the Number of Safe Options

	(1)	(2)	(3)
NK	-.89 (.212)	-.886 (.183)	-1.13 (.281)
KC	-.772 (.299)	-.76 (.303)	-.875 (.368)
Age		.00908 (.0111)	.0032 (.0136)
Female		.57 (.285)	.548 (.297)
Raven test score			-.173 (.17)
Constant	5.51 (.187)	4.79 (.459)	5.13 (.717)
Observations	456	456	456
R-squared	.0278	.0399	.0418

Notes: The dependent variable is the number of safe choices in the ten pairs of lotteries. Robust standard errors, clustered by session, are presented in parentheses.

In view of (5.3), the systematic component of determining the incentive scheme is

$$u_i(2x_i) \times w_i \left( \Pr\{x_i > p_j\} + \frac{\Pr\{x_i = p_j\}}{2} \right) - u_i(x_i),$$

which can be approximated by the following utility difference:

$$\text{UDiff}_i = u_i(2x_i) \times \text{SWP}_i - u_i(x_i). \quad (5.8)$$

Furthermore, we decompose  $\phi_i$  into the two parts: observed heterogeneity ( $z_i'\beta$ ) and unobserved heterogeneity ( $v_i$ ). This leads to a regression model of  $\mathbb{I}(d_i = TS)$  on  $\text{UDiff}_i$  and  $z_i$ . We instrument  $\text{UDiff}_i$  with the random bonus ( $b_i$ ) or the empirical winning probability ( $\text{EWP}_i$ ) because it is highly likely that  $\text{UDiff}_i$  is measured with error.

Table 11 reports the resulting estimation results. In column (1), the OLS estimates are



Table 11: Selection into Tournament: Instrumental Variable Estimation

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV-1	IV-2	OLS	IV-1	IV-2
UDiff <sub><i>i</i></sub> /1000	.298 (.0634)	3.16 (1.37)	3.54 (.899)	.278 (.0664)	3.33 (1.43)	3.21 (.904)
NK	-.174 (.0339)	-.257 (.0832)	-.268 (.08)	.0759 (.054)	-.0848 (.114)	-.0787 (.0964)
KC	-.0527 (.0902)	-.184 (.202)	-.202 (.21)	.065 (.0758)	-.109 (.206)	-.103 (.189)
Age	-.0135 (.00354)	-.00924 (.00462)	-.00867 (.00478)	-.00749 (.00339)	-.00474 (.00516)	-.00484 (.00507)
Female	-.107 (.0569)	.00337 (.11)	.018 (.105)	-.0856 (.0511)	.0253 (.112)	.0211 (.0977)
Raven test score				.177 (.0355)	.125 (.0439)	.127 (.0429)
Constant	1.17 (.134)	.785 (.24)	.733 (.226)	.825 (.123)	.513 (.268)	.525 (.246)
Observations	456	456	456	456	456	456

Notes: Linear probability models. The dependent variable is an indicator of whether the subject selects the tournament scheme. UDiff<sub>*i*</sub> is defined in (5.8) and instrumented with the random bonus ( $b_i$ ) in IV-1 or with the empirical winning probability (EWP<sub>*i*</sub>) in IV-2. Robust standard errors, clustered by session, are presented in parentheses.

reported when the group dummies, age, female are included as regressors in addition to UDiff<sub>*i*</sub>. In columns (2) and (3), the IV estimates are given. The coefficient for UDiff<sub>*i*</sub> is about ten times larger when UDiff<sub>*i*</sub> is instrumented, indicating that its OLS coefficient is attenuated towards zero. The coefficient of  $-0.257$  for NK in column (2) implies that the NK subjects' probability of selecting into the tournament goes down by 26 percentage points due to aversion to competition. This magnitude is larger than the reduced-form estimates reported in Table 4. This difference may come from the fact that the risk-loving behavior of some of NK subjects is reflected in computing UDiff<sub>*i*</sub>, thus resulting in a higher degree of aversion to competition for the NK subjects in Table 11. Women do not show any difference in columns (2) and (3), suggesting that there is little gender-specific aversion to

competition beyond the subjective utility difference measured by  $UDiff_i$ . This finding resonates well with the reduced-form findings in Tables 4 and 5 where we find a negative but insignificant coefficient for female in terms of selection into tournament but a significantly negative coefficient for subjective winning probability. When the Raven score is added in columns (4)-(6), the coefficients for NK become small and insignificant, echoing the reduced-form estimation results in Tables 4.

The choice model we have developed in this section allows us to disentangle between different channels through which the Raven score can matter for selection into competition. Our estimation results suggest that an individual with a high Raven test score favors competition through (i) a high level of performance in the real-effort task, (ii) optimism in assessing the chance of winning the tournament, and (iii) preference for competition. Quantitatively, one standard deviation increase in the Raven score is associated with (i) an increase of 1.2 correct answers in the real-effort task (see column (3) of Table 8), (ii) an increase of 1.85 in optimism, measured by the odds of subjective probability ( $1.85 \approx \exp(0.613)$ ; see column (3) of Table 9), and (iii) an increase of 13 percentage points in preference for competition, measured by the change in the probability of selecting into the tournament (see columns (5) and (6) of Table 11). The reduced-form impact of the Raven score—net of the effect of pre-choice tournament score—is 16 percentage points in terms of choice probability (see column (4) and (5) of Table 4). Therefore, a rough comparison implies that the reduced-form effect is due to pure preference for competition as well as optimism in assessing the chance of winning. This conclusion bodes well with the finding that the Raven score explains less winning probability than probability into the tournament in the previous section.

## 6 Relation to the Literature

Our paper is most closely related to recent literature in economics suggesting that the cultural, economic and political environments in which individuals grow up affect their preference and belief formation, such as their trust in financial institutions, stock market

participation, preferences over social policies, willingness to take financial risks, and anti-Semitic violence. See, for instance, Alesina and Fuchs-Schündeln (2007), Guiso, Sapienza, and Zingales (2004, 2008), Osili and Paulson (2008), Malmendier and Nagel (2011), and Voigtländer and Voth (2012) among others. It is also related to a strand of research on the importance of early stage of the life cycle. The literature on immigration finds that immigrants' home-country institutions matter for their success in the host country; the social norms in their origin country are carried over and dissimilarity from those in the host country retards economic assimilation (Friedberg, 2000; Casey and Dustmann, 2010; Bénabou and Tirole, 2011). The long-term influences of economic and political institutions can also be found in inter-generational differences over the course of history within a country. People embody different attitudes mostly during their school ages. (Cantoni, Chen, Yang, Yuchtman, and Zhang, 2017) find that political attitudes are instilled by textbook reforms in China. Fuchs-Schündeln and Masella (2016) compare between East Germans and West Germans after the reunification and find that longer exposure to communism is associated with lower investment in human capital and lower wages in the labor market. Fuchs-Schündeln and Schündeln (2020) analyze the long-lasting effects of communism in Eastern Europe. Becker, Mergele, and Woessmann (2020) critically examine the selection problems in the context of the separation and reunification of Germany.

Our study is also related to a growing body of the literature examining differences in competitiveness of different groups in a society or across cultures. Much attention has been paid to gender differences since women tend to underperform in the labor market relative to men with similar ability. It has been found that women are on average less competitive than men in most societies (Gneezy, Niederle, and Rustichini, 2003; Gneezy and Rustichini, 2004; Niederle and Vesterlund, 2007, 2011). However, the opposite phenomenon is observed in a matriarchal society (Gneezy, Leonard, and List, 2009). This indicates that competitiveness is a trait that is not biological but shaped by social institutions. Another piece of evidence supporting the "nurture" hypothesis is that seamen are found to be less inclined toward competition than fishermen at a lake since the former needs cooperation while the latter tends to work alone (Gneezy, Leibbrandt, and

List, 2016). Furthermore, communist reforms promoting a gender egalitarian society may increase female competitiveness in China (Booth, Fan, Meng, and Zhang, 2020; Zhang, 2020) and affect women's attitudes toward career success in West Germany (Campa and Serafinelli, 2019).

This paper also contributes to the literature that combines traditional lab experiments with historical contexts. Ockenfels and Weimann (1999) and Brosig-Koch, Helbach, Ockenfels, and Weimann (2011) examine East-West comparison in the context of German unification. Callen, Isaqzadeh, Long, and Sprenger (2014) conduct experiments on a sample of Afghanistan civilians to investigate the relationship between violence and economic risk preferences. In our previous work (Kim, Choi, Lee, Lee, and Choi, 2017; Choi, Kim, Lee, and Lee, 2020), we find that the North Korean refugees behave very differently from South Korean natives in terms of preferences for giving in the context of the dictator games.

## 7 Conclusions

The role of institutions in economic development is widely acknowledged but the channels through which the former affects the latter are not fully understood. Using contrasting institutions between capitalism and socialism, this paper first investigated whether socialist institutions instill a social norm different from that shaped by capitalist ones. Particularly it focused on competitiveness, which may vary among the three groups of ethnic Koreans: native South Koreans, North Korean refugees born in North Korea but recently settled down in South Korea, and ethnic Koreans born in China but has been residing in South Korea mainly for the purposes of job and living. Moreover, it addressed factors influenced on competitiveness among the three groups of Koreans.

We have found that North Korean refugees are significantly less competitive than South Koreans or Korean-Chinese immigrants, and that their lower cognitive ability measured by Raven test scores is a crucial determinant for the deficiency of competitiveness. This indicates that socialism failed due to not only the direct effects of institutions such as lack of property rights but also their indirect effects on development. It lagged behind

capitalism in terms of individual competitiveness and thus missed an opportunity to fully harness economic efficiencies. Yet such dissimilarity in competitiveness among the three groups of ethnic Koreans is accounted for largely by cognitive ability. We have further discovered that such low cognitive ability of North Korean refugees result in low expectation on performance and winning probability together with increased aversion for competition. In this sense, this paper suggests that one fundamental weakness of socialism lies in failure in improving cognitive abilities as a form of human capital. A question on why socialism, in comparison with capitalism, was less successful in developing cognitive abilities still remains, which will be our agenda for future research.

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**For Online Publication**

**Online Appendices**

**Institutions, Competitiveness and Cognitive Ability**

**Syngjoo Choi, Byung-Yeon Kim, Jungmin Lee, and Sokbae Lee**

## Experimental Instructions in Korean and English

### 의사결정에 관한 경제학 실험 및 설문조사

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본 연구는 경제 의사결정 과정에 대해 알아보고자 하는 목적으로 서울대학교가 한국연구재단의 지원을 받아 실시하는 경제학 실험 연구입니다. 대한민국에 거주하는 다양한 성인 그룹을 대상으로 경제 의사결정 과정에 대해 실험과 설문조사를 통해 알아보고, 관련 연구의 기초자료로 활용하고자 합니다.

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**2) 설문파트** : 선생님의 경제활동과 인식 등을 묻으며, 약 40~50분 정도 소요가 예상됩니다.

귀하께서 설문조사까지 마치면, 기본 답례금에 실험을 통해 확보하신 금액을 덧붙여 나가실 때 지급해 드립니다.  
구체적인 실험 내용과 방법은 각 단계별로 설명을 드리도록 하겠습니다.

**개인정보보호**

실험 참석 확인을 위해 보유한 선생님의 정보(이름, 전화번호, 성, 연령 등)와 이 자리에서 응답하신 선생님의 모든 정보는 실험 종료와 동시에 모두 폐기되며, 통계법 제33~34조에 의해 통계적 목적으로만 사용되고, 비밀은 엄격히 보호됩니다.

본 연구는 서울대학교 생명윤리심의위원회의 승인을 받았습니다. (IRB No. 1506/002-001, 승인날짜 2015.6.3)

### Purpose of study

This study is conducted by a research team at Seoul National University with the support of the National Science Foundation of Korea to understand economic decision making. We recruit a variety of South Korean residents to take part in economics experiments about decision making and survey. The collected data will be served as basic materials for academic research.

### Procedure and method

This study consists of the following two parts and will take approximately 2.5 hours to complete. The experiments and survey will be computer-based and paper-based. Please follow instructions given by the experimenter.

1) Experiment part: It consists of four stages. Your earnings in this study will depend on your performance and choices in the first three stages. The last stage will not affect your earnings.

2) Survey part: You will answer survey questions of economic activities and attitudes, it will take about 40~50 minutes to complete.

If you have completed the study, you will receive your earnings and a show-up fee before you leave. We will give you specific instructions about each stage of the study when it starts.

### Privacy

All the personal information, including name, phone number, gender, age, etc., and the responses you give in this study will be discarded when this research is completed. In accordance with the Article 33-34 of the Statistics Act, all confidential information is strictly protected and used only for the purpose of statistics.

This research has been approved by the Institutional Review Board at Seoul National University (IRB No. 1506/002-001, Approval date: June 3, 2015).

## PART A

# 보수책정 1단계

- ❖ 개인 실험은 총 3개의 실험으로 이루어집니다.
- ❖ 각 단계별로 문제를 풀어 맞춘 개수와 각 단계별 차별적인 보수선택 방식에 따라 단계별 선생님의 보수가 결정되며, 3개 실험으로 결정된 보수 중 무작위로 한 개를 선택해 선생님의 최종 보수가 결정됩니다.



- ❖ 최종 보수가 결정되면 그 금액에 기본 참가비(5만원)를 덧붙여 모든 설문이 끝나고 나가실 때 지급됩니다.
- ❖ 각 단계별 실험과 보수 결정 방식은 순서대로 단계 시작 전에 설명 드리겠습니다.

### Part A: Earnings

The experiment will consist of 3 stages. Your earnings in each stage will depend on the number of correct answers in problem solving and an incentive scheme. Your final earnings will be determined by a random selection of your earnings in the three stages. You will receive this randomly selected final earnings together with a participation fee (50,000 KRW) when you leave after completing the study.

We will give you an information of the detail of each stage experiment and an incentive scheme when it starts.

# 실험 A1 성과제

- ❖ 보수책정 1단계 모든 실험은 선생님이 맞추신 퀴즈의 정답 수에 따라 보수액이 결정됩니다.
- ❖ 다만 보수책정 방식에 있어 차이가 있으며 첫번째는 맞추신 수 그대로 보수가 결정되는 **성과제**입니다.
- ❖ 선생님께서 앞으로 받으실 봉투 안에는 **총 20개의 숫자표**가 들어 있습니다.
- ❖ **총 5분** 동안 각 숫자표에 있는 “0”의 개수를 맞추는 것이 문제이며, 맞추신 개수에 따라 **보수액이 결정**됩니다.

## Experiment A1: Piece rate scheme

In all stages of the experiment, your earnings will depend on the number of your correct answers in a task. In the first stage, your earnings will depend solely on the number of your correct answers.

You will receive an envelope containing 20 tables and will be asked to answer the number of “0” in each table.

- ❖ 아래 숫자 표에서 0의 개수를 맞춰주세요.
- ❖ 총 20개의 숫자 표가 있습니다.

[숫자 표 A1-1]

0	1	0	1	0	0	0
1	1	1	0	0	1	0
0	1	0	1	1	0	0
1	0	1	0	1	0	1
0	0	1	1	1	0	0
0	1	0	0	0	1	0
1	1	0	1	1	0	0

- ❖ 답을 컴퓨터의 화면 응답란에 입력해주세요.
- ❖ 숫자표 순서가 틀리지 않도록 주의해주세요. 순서가 틀리면 오답이 됩니다.
- ❖ 옆의 숫자표의 0의 개수는 27개입니다.

27

Q8. '숫자표 [A1-1]'에서 숫자 '0'의 개수를 맞춰주세요.  
선생님의 응답  개

As an example, please count the number of zeros in the table below [Number Table A1-1]. You will then be asked to submit your answer. Please bear in mind the order of Number Table. The answer in this example is 27.

You will face such 20 tables.

## 실험 A1의 보수 결정

- ❖ 첫 번째 단계의 보수는 선생님께서 맞추신 정답 \* 1천원을 받게 됩니다.
- ❖ 3개를 맞추면 3천원, 12개를 맞추면 1만 2천원 등이며, 다 맞추면 2만원, 하나도 맞추지 못하면 0원입니다.

정답의 개수 \* 1천원

3개 맞출 경우 3,000원

12개 맞출 경우 12,000원

- ❖ 문제를 한 개씩 푸실 때마다 문제의 정답이 공개되며,  
모든 문제를 다 풀고 나면 선생님께서 맞추신 정답 개수와 첫 번째 보수 금액을 확인할 수 있습니다.

### Earnings in Experiment A1

You will receive 1,000 KRW for each correct answer. For instance, if you solved 3 tables correctly, you will receive 3,000 KRW. If you solved 12 tables correctly, you will receive 12,000 KRW. If you did not solve any table correctly, you will earn nothing.

Once you submit your answer in each table, you will be informed of a correct answer. After you solved all the tables, you will be informed of the number of your correct answers and your earnings in this stage.



진행요원들은 연습 숫자표를 수거해 주세요.

(반납이 끝나면)

- ❖ 잠시 후 숫자표 20개가 들어 있는 문제 봉투를 나누어 드리겠습니다.
- ❖ 진행자가 '시작'을 외치면 총 5분 동안 문제를 푸시고 정답을 입력해주세요.  
시작을 외치기 전 봉투를 미리 개봉하면 실격 처리 됩니다.
- ❖ 숫자표에 정답을 적어 두셨다가 컴퓨터에 입력하셔도 관계 없으며,  
다만 시간 안에, 반드시 정답을 컴퓨터에 입력해야 점수가 계산됩니다.
- ❖ 진행자 화면에 시간이 보일 예정이며, 1분이 남으면 알려드릴 예정이니 입력을 반드시 완료해주세요.
- ❖ 5분이 모두 지나면 봉투는 한꺼번에 모두 회수하겠습니다.



진행요원들은 숫자표 봉투 A1을 나눠주세요.

- ❖ 먼저, 봉투에 본인 이름과 ID를 정확히 적어주세요.
- ❖ 그럼, 이제 시작을 외치면 '다음'을 누르시고 봉투를 개봉해 5분간 문제풀이를 시작하게 됩니다.

## “시작”

You will soon be given an envelope containing 20 tables. If the experimenter announces “Start”, you can start counting zeros and submitting your answers in 5 minutes.

You will be disqualified if you open your envelope before the experimenter announces “Start.” Answers you submit within 5 minutes in the computer will be only counted.

The experimenter will show you a timer through a beam projector and will announce “one minute remaining” when 4 minutes pass.

[The experimental assistants distribute envelopes to subjects]

Please write down your name and ID on the envelope. The experimenter is about to announce “Start.”



실험A1을 종료합니다.

진행자에게 문제지와 봉투를 제출해주세요.



진행요원들은 담당구역의 봉투를 신속하게 걷어주세요.  
앞에 비치된 A1 수거 상자에 모아주세요.

아래 “다음” 버튼을 누르시면 **정답의 총 개수**와

선생님의 개인실험 1단계 **보수 금액이 공개** 됩니다.

Experiment A1 has just ended. Please submit your envelope and tables to the experimenter.

If you press “Next” button in your computer, you will be informed of the number of correct answers and your earnings in this stage.

## 실험 A2 경쟁제

- ❖ 두 번째 단계인 경쟁제도 첫 단계와 동일하게 5분 안에 20개의 문제를 풀게 됩니다.
- ❖ 그러나 보수는 첫 단계처럼 선생님이 맞추신 금액에 따라 결정되지 않습니다.
- ❖ 선생님과 실험에 참여하고 있는 다른 사람과 무작위로 짝을 지어 드리며, 선생님과 짝은 동일한 문제를 풀게 됩니다.
- ❖ 그 중 더 많이 맞춘 이긴 사람에게만 보수를 지급하며, 진 사람은 아무런 보수가 책정되지 않습니다.

### Experiment A2: Tournament scheme

In the second stage you will be again asked to solve 20 tables within 5 minutes. You will be randomly paired with another subject in the experiment. Each of you and your partner will receive an envelope containing the same set of 20 tables. One who solves a higher number of correct answers will become a winner and receive earnings. The other who loses (that is, solves a lower number of correct answers) will receive nothing.

- ❖ 아래 숫자 표에서 0의 개수를 맞춰주세요.
- ❖ 총 20개의 숫자 표가 있습니다.

[숫자 표 A1-1]

0	1	0	1	0	0	0
1	1	1	0	0	1	0
0	1	0	1	1	0	0
1	0	1	0	1	0	1
0	0	1	1	1	0	0
0	1	0	0	0	1	0
1	1	0	1	1	0	0

- ❖ 답을 컴퓨터의 화면 응답란에 입력해주세요.
- ❖ 숫자표 순서가 틀리지 않도록 주의해주세요. 순서가 틀리면 오답이 됩니다.
- ❖ 옆의 숫자표의 0의 개수는 27개입니다.

27

Q8. '숫자표 [A1-1]'에서 숫자 '0'의 개수를 맞춰주세요.  
선생님의 응답  개

As an example, please count the number of zeros in the table below [Number Table A1-1]. You will then be asked to submit your answer. Please bear in mind the order of Number Table. The answer in this example is 27.

You will face such 20 tables.

## 실험 A2 보수 결정

- ❖ 두 번째 단계의 보수는 선생님께서 다른 누군가와 경쟁을 해 이길 경우만 받을 수 있습니다.
- ❖ 맞춘 개수가 적어 경쟁에서 진 경우는 아무런 보수도 책정되지 않습니다(0원).
- ❖ 단, 이긴 사람은 맞춘 정답 \* 2천원으로 첫 단계의 두 배를 받게 됩니다.
- ❖ 단, 정답의 개수가 같으면 이긴 사람과 진 사람은 무작위로 결정됩니다.

내가 이길 경우

내 정답 12개



상대 정답 9개

내 보수 12개 \* 2,000원 ⇨ 24,000원  
상대 보수 0원

내가 질 경우

내 정답 7개



상대 정답 10개

내 보수 0원  
상대 보수 10개 \* 2,000원 ⇨ 20,000원

- ❖ 다만, 이기고 지고는 모든 실험이 끝나고 프로그램을 통해 짝짓기가 이루어져 결정되며, 모든 설문이 끝나고 밖으로 나가서 답례금을 받으실 때 상황판에서 확인하실 수 있습니다.

### Experiment A2: Earnings

In this stage, you will receive earnings only if you win the competition against another subject. If you solve less tables correctly, you will receive nothing. If you win, you will receive 2,000 KRW for each correct answer, which is twice compared to 1,000 KRW earning in the first stage. When the number of correct answers is equal between you and your partner, a winner will be randomly selected.

You will be informed of whether you are a winner in this stage when you complete the study.

- ❖ 잠시 후 문제 봉투를 나누어 드리겠습니다.
- ❖ 진행자가 '시작'을 외치면 총 5분 동안 문제를 푸시고 정답을 입력해주세요.  
시작을 외치기 전 봉투를 미리 개봉하면 실격 처리 됩니다.
- ❖ 5분이 모두 지나면 봉투는 한꺼번에 모두 회수하겠습니다.



진행요원들은 숫자표 봉투 A1-2를 나눠주세요.

- ❖ 먼저, 봉투에 본인 이름과 ID를 정확히 적어주세요.
- ❖ 그럼, 이제 시작을 외치면 '다음'을 누르시고 봉투를 개봉해 5분간 문제풀이를 시작하게 됩니다.

## “시작”

You will soon be given an envelope containing 20 tables for this stage. If the experimenter announces “Start”, you can start counting zeros and submitting your answers in 5 minutes.

You will be disqualified if you open your envelope before the experimenter announces “Start.” Answers you submit within 5 minutes in the computer will be only counted.

The experimenter will show you a timer through a beam projector and will announce “one minute remaining” when 4 minutes pass.

[The experimental assistants distribute envelopes to subjects]

Please write down your name and ID on the envelope. The experimenter is about to announce “Start.”

실험A2를 종료합니다.

진행자에게 문제지와 봉투를 제출해주세요.



진행요원들은 담당구역의 봉투를 신속하게 걷어주세요.  
앞에 비치된 A2 수거 상자에 모아주세요.

아래 “다음” 버튼을 누르시면 **정답의 총 개수**가 **공개** 됩니다.

무작위로 결정된 상대보다 맞춘 개수가 많아 **이길 경우는 정답 개수\*2천원**이 확보되며,

**질 경우(0원)**는 아무런 보수도 확보되지 않습니다.

Experiment A2 has just ended. Please submit your envelope and tables to the experimenter.

If you press “Next” button in your computer, you will be informed of the number of correct answers.  
If you solve more tables correctly than your partner, you will earn 2000 KRW times the number of correct answers. If you lose, you will earn nothing.

## 실험 A3

# 선택 : 성과제 vs 경쟁제

- ❖ 세 번째 단계도 이전 두 단계와 동일하게 5분 안에 20개의 문제를 풀게 됩니다.
- ❖ 여기서 보수 제도는 1단계 성과제와 2단계 경쟁제 중 선생님께서 선택하신 방법에 따라 결정됩니다.
- ❖ 주목하실 것은 보수제도 선택 전에 선생님께 보너스 점수를 제공합니다.  
보너스는 선생님의 선택에 따라 무작위로 결정되며, 선생님께서 맞추신 개수에 보너스 점수를 합산한 것이 선생님께서 맞춘 최종 개수가 됩니다.
- ❖ 이후 선생님께서 선택하신 성과제, 경쟁제 방법에 따라 이후 3단계 보수가 책정됩니다.

### Experiment A3: Choice between piece-rate scheme and tournament scheme

In the third stage, you will again solve 20 tables in 5 minutes as before. You will be asked to select an incentive scheme between the piece-rate scheme (A1) and the tournament scheme (A2).

Note that you will receive a bonus point before making a choice of an incentive scheme. Your bonus point will be randomly selected. The final number of correct answers in this stage is the number of correct answers you make plus your bonus point.

After observing your bonus point, you will be asked to choose between the piece-rate scheme and the tournament scheme.

## 보너스 점수의 결정

- ❖ 보너스 점수는 선생님의 선택에 따라 무작위로 결정됩니다.
- ❖ 아래 예에서 보시는 것처럼 컴퓨터에는 0~10까지 각각의 번호에 보너스 점수가 부여되어 있습니다.  
(아래의 점수들은 설명을 위한 예시이며 실제와는 다릅니다.)

### [보너스 예시]

가)	나)	다)	라)	마)	바)	사)	아)	자)	차)	카)
10점	8점	7점	2점	4점	0점	1점	9점	3점	5점	6점

- ❖ 예를 들어, 선생님께서 ②번을 선택하시면, 8점의 보너스 점수가 부여됩니다.
- ❖ 아래 문항에 선생님께서 뽑고 싶으신 번호를 뽑아주세요.  
각 번호에 따라 결정되는 보너스 점수는 아무도 모르며,  
선생님 선택이 완료되면 몇 점의 점수가 부여되는지 공개됩니다.

### Selection of a bonus point

Your bonus point will be randomly selected.

As shown below as an example, the computer randomly assigns bonus points from 0 to 10. (Note that it is an illustrative example and is different from the actual selection of your bonus point.)

For instance, if you selected number (2), you will be given the bonus point 8.

Please select a number between 0 and 10 as you wish. No one knows which number is linked to a particular bonus point. Once you select a number, the computer will inform you of your bonus point.



### A3 보수 결정 : ① 성과제 선택 시

❖ 성과제를 선택하게 되면, 선생님께서(맞춘 개수+보너스 점수) \* 1천원을 받게 됩니다.

(보너스 점수+정답의개수) \* 1천원

보너스 3점, 정답 3개면 총 6개 6,000원

보너스 3점, 정답 12개면 총 15개 15,000원

### A3 보수 결정 : ② 경쟁제 선택 시

❖ 무작위로 선택된 상대방과 경쟁해 이기면 점수 \* 2천원을 받고, 지면 보수가 책정되지 않습니다.

경쟁자는 2단계에서 결정된 사람과 동일하며, 그 상대방이 2단계에서 맞춘 정답의 수로 경쟁합니다.

❖ 결국, 상대방은 보너스 점수가 없고 선생님만 보너스 점수가 있습니다.

❖ 단, 2단계 결과에는 아무런 영향을 주지 않습니다. 2단계의 승패와 금액은 모두 동일하며,

2단계 상대방의 점수는 현재 단계 선생님 점수와 비교 대상으로만 사용이 됩니다.

내 점수  
이번에 맞춘 개수 + 보너스 점수

VS

상대 점수  
2단계에서 짝지어진 상대방의 2단계 점수

#### Experiment A3: Earnings when you selected the piece-rate scheme

If you chose the piece-rate scheme, your earnings will be given by the number of correct answers times 1000 KRW.

#### Experiment A3: Earnings when you selected the tournament scheme

If you won against your randomly assigned partner, you will receive 2000 KRW for each correct answer. If you lost, you will earn nothing.

Your partner is the same person matched to you in Experiment A2. Your partner will compete with you with the number of correct answers that your partner solved in Experiment A2. That is, your partner will have no bonus point, whereas you have a bonus point.

Note that this stage will not affect the earnings of Experiment A2 for you and your partner. The number of correct answers that your partner solved in Experiment A2 is only used to determine who wins if you selected the tournament scheme.

- ❖ 잠시 후 문제 봉투를 나누어 드리겠습니다.
- ❖ 진행자가 '시작'을 외치면 총 5분 동안 문제를 푸시고 정답을 입력해주세요.  
시작을 외치기 전 봉투를 미리 개봉하면 실격 처리 됩니다.
- ❖ 5분이 모두 지나면 봉투는 한꺼번에 모두 회수하겠습니다.



진행요원들은 숫자표 봉투 A3을 나눠주세요.

- ❖ 먼저, 봉투에 본인 이름과 ID를 정확히 적어주세요.
- ❖ 그럼, 이제 시작을 외치면 '다음'을 누르시고 봉투를 개봉해 5분간 문제풀이를 시작하게 됩니다.

## “시작”

You will soon be given an envelope containing 20 tables for this stage. If the experimenter announces "Start", you can start counting zeros and submitting your answers in 5 minutes.

You will be disqualified if you open your envelope before the experimenter announces "Start." Answers you submit within 5 minutes in the computer will be only counted.

The experimenter will show you a timer through a beam projector and will announce "one minute remaining" when 4 minutes pass.

[The experimental assistants distribute envelopes to subjects]

Please write down your name and ID on the envelope. The experimenter is about to announce "Start."

실험A3을 종료합니다.

진행자에게 문제지와 봉투를 제출해주세요.



진행요원들은 담당구역의 봉투를 신속하게 걷어주세요.  
앞에 비치된 A3 수거 상자에 모아주세요.

아래 “다음” 버튼을 누르시면 **정답의 총 개수**가 **공개** 됩니다.

Experiment A3 has just ended. Please submit your envelope and tables to the experimenter.

If you press “Next” button in your computer, you will be informed of the number of correct answers.



진행요원들은 칸막이를 제거해주세요.

보수책정 1단계 실험을  
모두 완료하셨습니다.

3개의 결과 중 최종 보수는  
다음 추가 실험 진행 후 선생님의 제비뽑기를  
통해 확정됩니다.

보수책정  
1

실험 A1  
실험 A2  
실험 A3

성과제 결과  
경쟁제 결과  
성과제 or 경쟁제 결과

제비  
뽑기

1단계  
최종보수

The experiment has ended.

You will make a lottery to select one of the three stages—A1, A2, and A3. It will be counted for your final earnings.

## 추가 Track ① 기대측정 실험

- ❖ 이번에는 선생님께서 경쟁을 했을 때 본인이 이겼을 가능성을 예측하시고, 그 결과가 얼마나 정확한지에 따라 추가 보수를 지급하는 실험입니다.
- ❖ 이 결과에 따라 **2천원의 추가 보수**가 확정될 수 있습니다.

Extra track (1): Elicitation of winning probability

You will now be asked to guess your winning probability when you compete with your partner. You will earn 2000 KRW depending on how accurate your guess is.

## 경쟁에서 이길 확률

- ❖ 앞서 개인실험 3단계(선택: 성과제 vs 경쟁제)에서 선생님의 정답 수와 보너스 숫자는 아래와 같습니다.
- ❖ 해당 단계에서 보너스를 합친 선생님의 숫자가 경쟁 상대가 되는 2단계 상대방(보너스가 없이 맞춘 개수만 있는)을 이길 확률이 얼마나 될지 아래 문항에서 선택해 주세요.



- ❖ 이 중에는 해당 단계에서 경쟁제를 선택하신 분들도 있고, 경쟁 없이 성과제를 선택하신 분들도 있습니다. 후자의 경우는 '만약 경쟁을 했으면, 이길 확률이 얼마나 됐을까' 가정으로 응답해 주시면 됩니다.
- ❖ 이 단계는 선생님의 예측이 실제 결과와 얼마나 가까운가가 중요한 기준입니다. 따라서, 최선의 방식은 이길 수 있었을까라는 기대치를 정확히 입력하는 것이 가장 중요합니다.

### Probability of winning in the tournament

In the previous experiment A3, the number of correct answers and your bonus point are as below.

Please guess your winning probability in that experiment. Please note that you competed against your partner with the number of correct answers you solved in that experiment plus your bonus point, while the number of correct answers your partner solved in the experiment A2 was used.

You may have chosen the piece-rate scheme. In that case, please guess your winning probability if you have chosen the tournament.

It is important how close your guess is to the real outcome. Therefore, you are asked to guess as accurately as possible your winning probability.

## 기대의 예측 오류 계산

- ❖ 방금 선생님께서 이겼을 것이라고 예측하신 것이 틀릴 가능성을 **예측 오류**라고 합니다.
- ❖ 예측 오류는 아래와 같이 이긴 경우는  $(1-\text{예측치})$ 의 제곱으로, 진 경우는  $(\text{예측치})$  제곱으로 계산됩니다.

	이길 확률	→	실제로 이긴 경우	실제는 진 경우
수식	x%	→	(1-x) <sup>2</sup>	x <sup>2</sup>
예시	20%	→	(1-0.2) <sup>2</sup> =0.64	0.2 <sup>2</sup> =0.04

- ❖ 선생님의 예측오류는 상대방이 결정되어야 할 수 있으므로, 실험 종료 후 상황판에 공개됩니다.
- ❖ 이후 컴퓨터의 무작위 프로그램을 통해 0부터 1까지 숫자가 하나 결정되며, 이것보다 선생님의 **예측오류가 작으면 2천원**을 추가로 받고, **높으면 0원**을 받게 됩니다.

### Computing prediction error

The prediction error is referred to as a chance of your guess being wrong. Given  $x\%$  as your winning probability guess, the prediction error is computed as  $(1 - x)^2$  if you actually won and as  $(x)^2$  if you lost.

Your prediction error will be announced after your partner is determined.

The computer will randomly select a real number between 0 and 1. If your prediction error is smaller than a randomly selected number, you will receive 2000 KRW. Otherwise, you will receive nothing.

## PART C

# 보수책정 3단계

- ❖ 지금부터는 이제까지 선택한 것과 전혀 다른 실험이 진행되며, 개인 과제입니다.
- ❖ 이 단계에서는 확률에 따라 금액이 다른 두 개의 복권 중 한 개의 복권을 선택하는 의사결정 실험입니다.
- ❖ 이 단계에서 선생님이 받아가실 금액은 선생님의 의사결정에 따라 달라지며,  
역시 실험과 설문이 모두 끝나고 나가실 때 기본 답례금과 앞서 받으신 보수에 더해 받아가시게 됩니다.
- ❖ 그럼, 실험 요령을 순서대로 설명 드리겠습니다.

### Part C: Lottery choice experiment

You will participate to a different experiment in which you are asked to choose between two lotteries. You will receive additional earnings from this part of the experiment. We will explain the detail of the experiment.



## 첫 단계 : 복권의 선택

- ❖ 선생님께서 두 개의 복권 중 하나의 복권을 선택하게 됩니다.
- ❖ 복권1을 택하면 5천원 혹은 4천원을 받을 수 있으며, 해당 금액이 선택될 확률은 10% : 90%입니다.  
반대로, 복권2를 택하면 1만원을 받거나 하나도 못 받으며, 해당 금액이 선택될 확률은 1:9로 동일합니다.

		복권1		복권2	
C1	받을 금액	5,000	4,000	VS	10,000    0
	받을 확률	10%	90%		10%    90%

복권1 선택시	5천원 받을 확률이 10%, 4천원 받을 확률이 90%
복권2 선택시	1만원 받을 확률이 10%, 하나도 못받을 확률이 90%

- ❖ 이러한 복권의 선택을 총 10번하게 되는데, 각 복권의 금액은 동일하며 확률만 달라집니다.  
아래의 경우는 확률이 100%이기때문에 반드시 복권 1을 택하면 5천원, 2를 택하면 1만원을 받습니다.

		복권1		복권2	
C10	받을 금액	5,000	4,000	VS	10,000    0
	받을 확률	100%	0%		100%    0%

### Lottery choice experiment

You will be asked to choose between two lotteries in each of 10 lottery choice problems. For instance, if you select Lottery 1, you will earn 5000 KRW with 10% probability or 4000 KRW with 90% probability. If you select Lottery 2, you will earn 10000 KRW with 10% probability or nothing with 90% probability.

You will make choices in such 10 problems where money amounts are fixed and probabilities change. For instance, in the following problem where one of the outcomes is given with 100% probability, you will earn for sure 5000 KRW if you select Lottery 1 and 10000 KRW if you select Lottery 2.

## 첫 단계 : 복권의 선택

❖ 아래가 실제 문제지입니다.

복권1을 선택하면 받을 수 있는 금액은 5천원, 4천원 두 가지로 모두 동일하고,

복권2를 선택하면 받을 수 있는 금액은 1만원, 0원 두 가지로 모두 동일합니다.

❖ 다만 다음 문항일수록 5천원 혹은 1만원을 받을 수 있는 확률이 높아지고, 반대는 낮아집니다.

받을 금액	복권1		복권2	
	5,000	4,000	10,000	0
C1. 받을 확률	10%	90%	10%	90%
C2. 받을 확률	20%	80%	20%	80%
C3. 받을 확률	30%	70%	30%	70%
C4. 받을 확률	40%	60%	40%	60%
C5. 받을 확률	50%	50%	50%	50%
C6. 받을 확률	60%	40%	60%	40%
C7. 받을 확률	70%	30%	70%	30%
C8. 받을 확률	80%	20%	80%	20%
C9. 받을 확률	90%	10%	90%	10%
C10. 받을 확률	100%	0%	100%	0%

### Lottery choice problem

The following is the list of binary lottery choices that you will face. Note that Lottery 1 always uses (5000 KRW, 4000 KRW) and Lottery 2 always uses (10000 KRW, 0 KRW).

Please note that a lottery choice problem further down in the list involves a higher probability of winning 5000 KRW or 10000 KRW.

## 두번째 단계 : 받을 확률의 추첨

❖ 다음 단계는 선생님께서 선택한 10개의 복권 중 한 개의 복권을 추첨하는 단계입니다.

앞서와 마찬가지로 번호를 고르면, 컴퓨터에 입력된 번호에 따라 선생님이 받을 복권이 결정됩니다.

### [C1~C10 복권 결정 예시]

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
C3의 선택복권	C7의 선택복권	C10의 선택복권	C8의 선택복권	C4의 선택복권	C5의 선택복권	C1의 선택복권	C2의 선택복권	C9의 선택복권	C6의 선택복권

❖ 예를 들어, 선생님께서 ②번을 선택하시면, C7 단계에서 선택하신 선생님의 복권이 확정됩니다.

❖ 아래처럼 복권2를 이전 단계에서 고르셨다면, 만원 받을 확률이 70%, 받지 못할 확률이 30%입니다.

	복권1		복권2	
받을 금액	5,000	4,000	10,000	0
C7. 받을 확률	70%	30%	70%	30%

### Selection of a lottery choice problem that counts

Once you completed your choices in the 10 lottery choice problems of the list, you will be asked to participate in the random selection of one of the problems that will count for your earnings.

For instance, if the seventh problem is randomly selected, your choice in the seventh problem will count for the determination of your earnings in this experiment.

### 세번째 단계 : 최종 복권 추첨

- ❖ 이제 최종적으로 복권을 추첨합니다.
- ❖ 다시 한 번 무작위로 번호를 뽑게 되며, 1~10까지 숫자가 아래처럼 무작위로 입력되어 있습니다.

[복권 추첨 예시]

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
6	5	10	2	4	8	7	3	9	1

- ❖ 각 번호는 당첨의 확률을 의미하며, C1 단계 복권1(5천원 10%, 4천원 90%)을 선택하였다면, 1이 당첨되면, 5천원, 2~10이 당첨되면 4천원을 받게 됩니다.
- ❖ 앞선 예에 이어, C7 단계의 복권 2를 앞 단계에서 선택했고,
- ❖ 이 단계에서 선생님께서 ②번을 선택해 5번(50%)이 결정되었다면, 70%이내로 당첨되어 1만원을 받습니다.

#### Determination of your earnings

Given the random selection of a decision problem that counts for your earnings, your earnings will be randomly determined by your lottery choice of that problem. For instance, if the lottery of 5000 KRW with 10% probability and 4000 KRW with 90% probability is considered for your final earnings, you will participate in a random draw to determine your actual earnings.

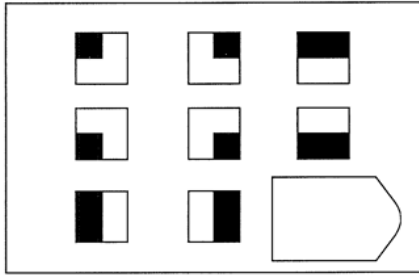
## 추가 Track ② 인지력 퀴즈

- ❖ 지금부터 총 10분 동안 도형과 관련된 24개 문제를 푸시게 됩니다.
- ❖ 앞서 진행하신 실험과 다르게, 지금부터 문제를 푸신 결과는 선생님의 답례금 책정에 영향을 주지 않습니다.

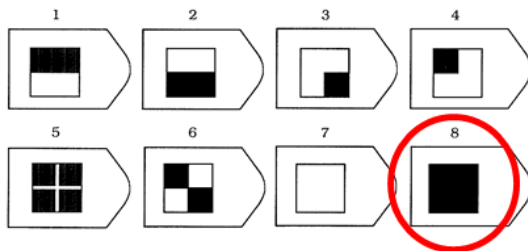
Extra Track (2): cognitive test quiz

You are about to solve 24 figural reasoning quizzes in 10 minutes. Differently from the experiment to which you participated just before, you will not receive any earnings from this part.

## 인지력 퀴즈 예시



- ❖ 선생님께서 받게 되실 조사표에서 왼쪽 상단과 같은 9개의 도형으로 이루어진 그림을 보시게 됩니다.
- ❖ 각 도형은 왼쪽에서 오른쪽, 그리고 위에서 아래로 일정한 규칙을 가지고 있고, 이 규칙을 이해하셔서 오른쪽 하단 빈 칸에 들어갈 도형을 맞춰야 합니다.



- ❖ 보기는 8개가 제시되며, 그 중 정답을 골라주시면 됩니다.
- ❖ 왼쪽 예시 문항의 정답은 8번입니다.

Example of cognitive test

You will see a picture of 9 diagrams as shown in the upper left corner.

Each diagram follows a certain rule, from left to right and from top to bottom. You will be asked to figure out this rule and match a shape that fits into the lower right empty space.

You will be presented with 8 possible choices. Please select the correct answer.

The answer to this example is 8.