Producer Attitudes toward Output Price Risk: Experimental Evidence from the Lab and from the Field*

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Abstract

In a seminal article, Sandmo (1971) showed that when faced with a risky output price, a risk-averse producer would in theory hedge against price risk by producing less than she would if she instead had been faced with a certain price equal to the mean of the risky price distribution. A number of policy instruments—for instance, administrative pricing, buffer stocks, marketing boards, and variable tariffs—as well as a substantial amount of research contributions are predicated on the idea that producers dislike price volatility. We test Sandmo's prediction experimentally, both in the lab with US college students and in the field with Peruvian farmers. We find no support for Sandmo's prediction, either in the restricted sample of risk-averse subjects when eliciting our subjects' risk preferences by way of Holt and Laury's (2002) list experiment, or in the whole sample. Moreover, we find that our subjects increase their production in response to price risk at the extensive margin but decrease it in response to price risk at the intensive margin. Looking at alternative explanations for our subjects' behavior, we find no support for the safety-first decision criterion or for the hypothesis that our subjects maximize expected profit rather than expected utility, but we find evidence in support of prospect theory.

Keywords: Price Risk, Risk and Uncertainty, Experiments

JEL Classification Codes: D80, C91, C93

1 Introduction

How do producers respond to output price risk? In a seminal article, Sandmo (1971) showed that, starting from a situation of price certainty, a risk-averse producer will in theory hedge against price risk by producing less than she would were she faced with a certain output price equal to the mean of the risky output price distribution.[1] Consistent with this, many policy instruments (e.g., administrative pricing, buffer stocks, marketing boards, and variable tariffs) are predicated on the idea that price risk causes producers to underproduce relative to a situation of price certainty.

We apply experimental methods to Sandmo's prediction. Specifically, we study how experimental subjects whom we put in the role of producers for whom storage and insurance are not available behave in the face of output price risk.[2,3] To do so, we use a two-stage randomized design to determine (i) whether our subjects face a certain or a risky output price, and (ii) conditional on the price being risky, how much risk they face by taking a randomly

[1] In concurrent research, Baron (1970) had reached a conclusion similar to Sandmo's. For better or for worse, a comparison of citation counts shows that history mostly remembers that conclusion as being Sandmo's. For brevity, we talk of Sandmo's prediction in the remainder of this article when referring to this Baron-Sandmo result.

[2] This is similar to production conditions for the majority of agricultural producers throughout the developing world. On the lack of storage and the consequences thereof in developing countries, see Wright and Williams (1982, 1984) and Gouel (2013). On insurance market failures in developing countries, see Cole et al. (2013), Karlan et al. (2014), and Clark (2016).

[3] Price risk is generally seen as distinct from income risk. This is best seen in the case of a consumer, whose indirect utility function $V(p, w)$ is defined over both income w and prices p. Stiglitz (1969) initially explored the relationship between expected utility (EU) theory and utility maximization over multiple commodities, but as was shown by Karni (1979) and Turnovsky et al. (1980), the Hessian of the indirect utility function relates to the consumer's attitudes relative to fluctuations in her income (via V_{ww}) and the prices she faces (via V_{pp}), with the diagonal elements capturing preferences relative to fluctuations in a given variable (e.g., the variance of income or of a given price) and the off-diagonal elements capturing preferences relative to co-fluctuations in a pair of variables (e.g., the covariance between two prices, or between income and a given price). Though the problem we study analytically can be viewed equivalently as income risk, we will talk of "price risk" throughout this article.

chosen mean-preserving spread of the certain price (degenerate) distribution from among four potential such mean-preserving spreads. This allows disentangling the effects of output price risk on production at both the extensive and intensive margins of risk, i.e., it allows disentangling the effect of output price risk relative to output price certainty as well as the effect of more relative to less output price risk.

In doing so, we develop an experimental protocol that mimics the theoretical framework developed by Sandmo (1971) to study the behavior of individual producers in the face of price risk. We then use this protocol to test the aforementioned theoretical prediction in three distinct contexts. In the first two contexts, we run our experiments with college students in labs at two US research universities, viz. Cornell University and the University of Minnesota. In the third context, we run our artefactual experiments in the field, with farmers in Peru's Lima province.

Our work is in the same vein as a number of experimental lab and field studies conducted over the years to study behavior in the face of risk or to elicit risk preferences, going back as far as Binswanger (1981), who sought to elicit attitudes toward risk with a lab-in-the-field experiment in rural India. More recently, Tanaka et al. (2010) developed a series of list experiments aimed at eliciting risk and time preferences, Bombardini et al. (2012) studied a large-stake experiment to estimate a structural model exploring risk aversion both locally and globally, and Callen et al. (2014) studied the relationship between exposure to violence and risk preferences. Because we run our experiments both in the lab and in the field, our work is close in spirit to work by Harrison et al. (2007), who compare risk aversion in lab and field settings. Moreover, because we ultimately test whether prospect theory explains the behavior of our subjects, our work is related to Sprenger's (2015), who tests experimentally for stochastic reference points. Finally, because we study production decisions in the face of risk, our work is related to a recent study by Cole et al. (2017), who study how the introduction of rainfall insurance affects producer behavior in rural India.

We find little to no support for Sandmo's prediction that price risk causes risk-averse producers to decrease their production. At best, we find that subjects classified as risk-averse on the basis of Holt and Laury's (2002) list experiment do not sensibly adjust their output level in response to price risk. At worst, we find that they actually increase their production in response to price risk at the extensive margin, only to decrease it in response to price risk at the intensive margin. This not only holds true in the restricted sample of subjects classified as risk-averse, but also in the whole sample. These findings are only consistent with EU theory if our subjects are actually risk-loving and if their preferences exhibit decreasing absolute risk aversion (DARA), the former stemming from Sandmo's theoretical framework, and the latter stemming from follow-up work by Batra and Ullah (1973).

Because it is both unlikely and inconsistent with our Holt-Laury results that the average subject in our sample should be risk-loving, we expore three alternative theories of decision in the face of risk. We find no support for safety-first behavior (Roy, 1952) or for expected profit maximization, but we find suggestive evidence in favor of prospect theory (Kahneman and Tversky 1979). Specifically, we find evidence that suggests that (i) expected losses lead our subjects to take on more risk, and thus act as if risk-loving over losses, (ii) subjects react more strongly to expected losses than to expected gains, suggesting loss aversion, and (iii) subjects react more strongly to small probability events (i.e., the likelihood of extreme prices, or tail risk) than to events that have a higher probability of happening, which suggests that they may overweight small probabilities.

Our contribution is thus threefold. First, this is to our knowledge the first experimental test of the theory of producer behavior in the face of output price risk. Second, we bring credible evidence to a question of considerable importance for policy in that our experiments reproduce the production conditions faced by many producers in rural areas of developing countries, who lack access to storage technology and face missing insurance markets while nevertheless having to sink resources into production well ahead the resolution of price risk. Finally, we provide suggestive evidence that prospect theory might provide a better description of producer behavior in the face of output price risk than EU theory.

The remainder of this paper is organized as follows. In section 2, we present the theoretical framework from which we derive our experimental protocol. Section 3 describes our experimental design, paying particular attention to how we ensured that we ran the same experiment in the lab as well as in the field as well as the the differences across contexts. In section 4, we discuss the simple empirical framework we rely on to test the predictions of the theory. Section 5 presents the data and briefly discusses descriptive statistics. In section 6, we present our core results, which test the theoretical model developed in section 2. Because we find no support for the predictions of EU theory, we next explore alternative theories of behavior in the face of price risk. Section 7 summarizes our findings and concludes with directions for future research.

2 Theoretical Framework

Because we focus here on reproducing the theoretical conditions in Sandmo (1971), we reproduce his original theoretical framework here, before using it to test his result that price risk at the extensive margin will lead a risk-averse producer to decrease her level of production.

Assume that a firm manager's preferences over profit π are represented by a utility function $u(\pi)$, where $u'(\pi) > 0$ and $u''(\pi) < 0$. Profit is such that $\pi = px - c(x) - F$, where output price $p > 0$ is risky, with $E(p) = \mu$ and $Var(p) > 0$, and where $x > 0$ is the firm manager's output choice, $c(x)$ is an increasing and convex function representing the firm's variable costs, i.e., $c'(x) > 0$ and $c''(x) > 0$, and F is a constant representing the firm's fixed costs.

The firm manager's objective is to maximize the utility she derives from her firm's profit by choosing how much to produce *ex ante* of the realization of the risky output price p. That is, the firm manager chooses her quantity produced x so as to

$$\max_{x} E\left\{u(px - c(x) - F)\right\}, \tag{1}$$

the first-order necessary and second-order sufficient conditions of which are such that

$$E\{u'(\pi)(p - c'(x))\} = 0, \tag{2}$$

and

$$E\{u''(\pi)(p - c'(x))^2 - u'(\pi)c''(x)\} < 0 \tag{3}$$

Given the foregoing, we can establish the following result.

Proposition 1 (Sandmo, 1971) *Under the assumptions made so far, the presence of output price risk causes an income risk-averse firm manager to underproduce relative to the case where output price is certain and equal to the mean of the price distribution.*

Proof. Equation 2 can be rewritten as

$$E\{u'(\pi)p\} = E\{u'(\pi)c'(x)\}. \tag{4}$$

Subtracting $E\{u'(\pi)\mu\}$ from both sides of equation 4 yields

$$E\{u'(\pi)(p - \mu)\} = E\{u'(\pi)(c'(x) - \mu)\}. \tag{5}$$

Expected profit is $E(\pi) = \mu x - c(x) - F$, which can be rearranged to express profit as a function of expected profit and the difference between expected and realized prices such that $\pi = E(\pi) + (p - \mu)x$. Intuitively, this means that the difference between expected and realized profit is only due to the difference between the *ex post* realization of the stochastic output price p and the firm manager's expectation μ of that price.

The firm manager takes her decision on the basis of his expectation of what price will look like *ex post*; if the realized price is exactly equal to the expected price, i.e., if $\mu = p$, then $E(\pi) = \pi$. But if $\mu \neq p$, there will be a discrepancy between expected and realized profit.

It follows from the foregoing that $u'(\pi) \leq u'(E(\pi))$ if $p \geq \mu$, so

$$u'(\pi)(p - \mu) \leq u'(E(\pi))(p - \mu), \tag{6}$$

a relationship which holds for all values of $p \geq \mu$. Taking the expectations on both sides of equation 6 implies

$$E\left\{u'(\pi)(p - \mu)\right\} \leq u'(E(\pi))E(p - \mu), \tag{7}$$

where the right-hand side is equal to zero given that $E(p - \mu) = E(p) - \mu$, and $E(p) = \mu$, which means that the left-hand side is negative. Substituting into equation 5, this in turn means that $E\left\{u'(\pi)(c'(x) - \mu)\right\} \leq 0$, which means that $c'(x) \leq \mu$, or the firm manager's marginal cost of producing x is less than his marginal benefit of doing so. In other words, the firm manager produces less than she would when output price is certain, which establishes the result. ■

The next section discusses the experimental protocol we develop to mimic the conditions just described in the lab as well as in the field.

3 Experimental Design

We design an experimental protocol to study producer behavior in the face of price risk following the theoretical framework in section 2. In this section, we thus begin by describing the design of the experimental game we use to elicit behavior in the face of price risk.

Because Sandmo's prediction only holds for risk-averse individuals, we also briefly discuss the design of the experimental game we use to elicit risk preferences, which was developed by Holt and Laury (2002), and which allows conditioning our core estimation results on the sub-sample of risk-averse subjects.

Finally, we describe the differences, where applicable, among the three contexts wherein we conducted our experiments, viz. in lab settings at Cornell University and the University of Minnesota, and in a lab-in-the-field setting in rural areas of Peru's Lima province.[4]

3.1 Price Risk Game

In the output price risk game, each subject assumes the role of a producer (or firm manager) producing a single commodity. To focus on the effect of output price risk, we assume away all other forms of risk and uncertainty (e.g., production, technological, or demand shocks). We also abstract from strategic interactions in that a subject's behavior has no effect on another subject's payoff. Lastly, we abstract from general equilibrium effects in that every subject is a price taker, i.e., her production decisions have no effect on the price drawn.

[4]The field component of our study was the subject of a pre-analysis plan filed with the American Economics Association's trial registry at `https://www.socialscienceregistry.org/trials/1497`. Part of what we label our core analysis—specifically, equation 9—is in the pre-analysis plan. The specifications in equations 8 and 10 and our exploration of alternatives to EU theory were not in the pre-analysis plan.

To mimic the theoretical framework in section 2, we choose simple cost and profit functions. We assume that the fixed cost F is such that $F = 15$ and the variable cost function $c(x)$ is such that $c(x) = 2x^{1.4}$, which is an increasing and convex function of output. We picked this specific functional form in accordance with both the theoretical framework in section 2 and the payoff structure we use, which we describe below. Accordingly, the profit function $\pi = px - 2x^{1.4} - 15$ is a concave function of output. Our experimental subjects' monetary reward from this price risk game is directly tied their profits.

The level of output x that a subject can choose ranges from 0 to 20. It must be determined *ex ante* of the realization of output price. Once experimental subjects have made their production decisions, the price per unit is drawn and is one of five values in the set $\{5, 6, 7, 8, 9\}$. We made sure that subjects could not cheat by changing their production level in response to the price drawn by closely monitoring them in our US lab experiments and by having production decisions recorded by the enumerators before prices were drawn in our Peruvian framed experiments.[5]

To facilitate decision making, subjects are given charts that describe the relationship between output level, price, cost, and profit, along with graphs of the profit function under each of the five different possible prices in the set $\{5, 6, 7, 8, 9\}$. A combined chart summarizing the relationship between output and profit under all five price scenarios is also provided to facilitate comparisons and, ultimately, decision-making. Exhibit B1 in Appendix B shows those charts for the US experiments, and exhibit C1 in Appendix C shows those charts for the Peruvian experiments. The charts in exhibits B1 and C1 only differ in the language in which they are written; their payoff structure is identical.

To determine the price of the output in each round, we follow a two-stage

[5] In List's (2018) terminology, our lab-in-the-field experiments are framed field experiments because they are on an application that our subjects, who are all farmers, are familiar with.

randomization strategy which goes as follows:

1. In the first stage, we determine whether there is any price risk, i.e., the extensive margin of the price risk. In expectation, in one third of the cases, subjects are presented with a certain price of \$7 per unit, which is the mean of the five possible prices. We refer to this as experimental setting 1 in the US and *escenario* 0 in Peru, wherein the standard deviation σ of the price distribution is such that $\sigma = 0$. Figure 1a shows the chart shown to our subjects in cases of price certainty.

2. The foregoing means that in expectation subjects are presented with a risky price in two thirds of the cases.[6] Conditional on facing a risky price in stage 1, in stage 2, the level of price risk is determined by randomly selecting one of four price distributions which are all mean-preserving spreads of one another. We refer to these as experimental settings 2 to 5, wherein the standard deviation σ of the price distribution respectively takes on the values $\sigma = 0.795$, $\sigma = 1.17$, $\sigma = 1.451$, and $\sigma = 1.58$. Because we are taking mean-preserving spreads, the mean of the price distribution is always equal to 7, so in terms of coefficients of variation, our subjects face price risk ranging from $\frac{\sigma}{\mu} = 0$ in setting 1 to $\frac{\sigma}{\mu} = 0.23$ in setting 5. Figures 1b to 1e show the charts shown to our subjects in cases of price risk. Exhibit C6 shows the Spanish version of those charts. The difference between the US and Peruvian contexts is that setting 1 in the US becomes *escenario* 0 in Peru, setting 2 in the US becomes *escenario* 1 in Peru, and so on until setting 5 in the US becomes *escenario* 4 in Peru.

Exhibit C5 shows the Spanish version of our randomization strategy, which was shown to our Peruvian subjects to make it easier to understand the

[6]We settled upon a one third—two thirds breakdown of situations of price certainty versus price risk to guarantee that we would have enough variation to study the effect of price risk at the extensive margin.

structure of the game. Randomization is done publicly in the US, where sessions involved approximately 24 participants, by showing subjects the Excel spreadsheet used to randomize the presence of price risk (i.e., the extensive margin of price risk). Conditional on there being price risk, the price is drawn from a bag filled with balls marked with prices (i.e., the intensive margin of price risk). In Peru, where we conducted experiments individually, this is done subject-by-subject by the successive throw of a six-sided die to determine whether the price is certain or risky (rolling a 1 or a 2 means facing a certain price, and rolling a 3, 4, 5, or 6 means facing a risky price) and, in cases of a risky price, that of a four-sided die to determine which risky distribution the price is drawn from, as shown in exhibit C5. Subjects are told explicitly that there are no strategic interactions or general equilibrium effects.

A possible objection to our design might be that the mean of the price distributions we use should also have been randomized instead of being held constant at 7. Though it would certainly be interesting to also randomize the mean of the price distribution so as to eliminate possible anchoring at a price of 7, we chose to keep the mean price across all settings the same in order to study the effect of mean-preserving spreads, which is what Sandmo (1971) focused on.

In each round, once we determined the applicable setting from the two-stage randomization process, subjects are shown the shape of the price distribution of the corresponding setting or *escenario*. Again, those are shown in exhibit C6.

Subjects choose how much to produce in each round *ex ante* of the resolution of price risk by looking at the picture of the randomly drawn price distribution and the profit charts they are given. Once all subjects have recorded their output choice, we draw a ball from the bag with the corresponding setting to determine the *ex post* market price and to give each subject a chance to figure out how she has done in terms of profit before moving on to the next round.

Recall that we were especially careful that our subjects could not change their answers. In the US, in each round, we had them fill out a note card indicating their output choice for that round,[7] which we then collected before prices were drawn and profits realized to prevent our subjects from cheating. In Peru, a subject's output choice in a given round was recorded by the enumerator in charge of recording that subject's answers before the price was drawn, and it was not possible to change one's output choice *ex post* of the resolution of price risk.

In each context, subjects played 10 practice rounds and 20 actual rounds of this price game. During the practice rounds, subjects were explicitly encouraged to ask questions to ensure that they properly understood the structure of the game. Profits from the actual rounds were mapped into a monetary reward function. At the end of each experimental session, we randomly chose one of the 20 actual rounds for each subject using a 20-sided die thrown by the subject herself in order to determine which round we would base that subject's experimental payout on. In the US, the experimental payoff from the production game was determined by adding a $25-base payoff plus a half of the subject's profit or loss in the randomly selected price game round, her proceeds from the Holt-Laury list experiment, which we describe below, and a $45 payment for showing up to the experiment. The average payoff for our US subjects was thus on the order of $75, which we felt was high enough to make our subjects treat their decision seriously.

In Peru, subjects received a PEN 45 payment for showing up to the experiment,[8] a 25 PEN base payoff for the price risk game plus half of a subject's profit or loss in the randomly selected price game round, and her proceeds from the Holt-Laury list experiment (ranging from PEN 0.30 to 11.55), as presented in exhibit C3. The average payoff for our Peruvian

[7] We then used the information on those cards to fill out the answer sheet in the appendix.

[8] As of writing, USD 1 $\approx$ PEN 3.22.

subjects was about $20, which represents two to three times the daily wage of a farmer or low-skilled worker in Peru, i.e., a substantial amount of money for our Peruvian subjects.

Because our subjects do not know *ex ante* which of the 20 actual rounds will be chosen for their payoff, they are induced to truthfully reveal their preference in every round, and this allowed us to economize on the transactions costs involved with compiling individual earnings over 20 rounds, given the pencil-and-paper nature of the experiment.

3.2 Holt-Laury List Experiment

Recall that Sandmo's prediction is that *risk-averse* producers respond to price risk by decreasing how much they produce, which means that we need a means of determining which of our subjects are risk-averse. Along with the price risk game, we thus had our subjects play the list game developed by Holt and Laury (2002), which we use here to elicit our subjects' risk preferences.[9] We do this to make sure that we can control for risk preferences and to explore different behaviors for different degrees of risk aversion. The list of choices used in the Holt-Laury game is shown in exhibit B4 in the appendix, under Set II, for the US context. For the Peruvian context, what was shown to our subjects is in exhibit C4, and the sheet where their answers were recorded is shown in exhibit C3, under the sixth heading.[10]

In the Holt-Laury game, subjects are shown a list of ten rows. Each row contains two options, A and B, which are both different specifications of a lottery. Option A is always less risky than option B. The expected value of the payoff starts off higher for option A than for option B in the top row,

[9]Although Drichoutis and Lusk (2017) show that the Holt and Laury (2002) method is better suited to elicit the shape of the probability weighting function than it is to measure the curvature of the utility function, the findings in Drichoutis and Lusk were not yet published when we initially developed our experimental protocol.

[10]Some subjects played the price risk game first, and others played it second. We discuss the order of games in the next sub-section.

but the difference between the two decreases as the row number increases.

Subjects choose which option to take starting from the top row. The game is designed so that most subjects will eventually switch from A to B. Switching to B at later rows means that a subject is more risk-averse. Once a subject switches to B, the game ends. In other words, in order to make sure that our setup satisfies the axioms of EU theory, we enforce monotonic switching. This is common practice when conducting list experiments (Liu, 2013).

To determine the payoff in the Holt-Laury lottery game, each subject rolled a 10-sided die twice: first to randomly select the row number on which we based that subject's payout, and then to actually play the lottery in that row to determine her payoff for this part of the experiment. The monetary payoff in this case was identical to the dollar amount shown in the table.

3.3 Differences across Contexts

The preceding section already highlights some of the differences between the US and Peruvian contexts. This section describes the remainder of those differences.

Recall that we conducted our experiments in three contexts. In the first two contexts, we conducted our experiments in lab settings at Cornell University and at the University of Minnesota. In the third context, we conducted our experiments in lab-in-the-field settings with farmers in rural areas of Peru's Lima province.

The Cornell lab experiments were conducted in December 2014 and March 2015. The Minnesota lab experiments were conducted in October 2015. The Peruvian lab-in-the-field experiments were conducted in August and September 2016. We conducted the lab experiments at Cornell and Minnesota ourselves; the lab-in-the-field experiments in Peru were contracted out to Innovations for Poverty Action (IPA), a New Haven, CT-based organization with offices throughout the developing world whose expertise lies in implementing field experiments and surveys, usually for economists. Prior to IPA conducting the lab-in-the-field experiments in Peru, we spent three full days training the enumerators on the right implementation of our experimental design.

At Cornell and Minnesota, experimental subjects were undergraduate students. At Cornell, subjects were recruited from the general undergraduate population via the lab listserv. At Minnesota, subjects were recruited via listserv from the population of undergraduates enrolled in one of two majors offered by the Department of Applied Economics. In Peru, subjects were recruited by IPA staff from among a population of farmers in rural Lima province who were numerate and literate enough to take part in the experimental games discussed above.

An important difference between the lab experiments conducted at Cornell and Minnesota and the lab-in-the-field experiments conducted in Peru lies in the variation off of which we identify parameters of interest. At both Cornell and Minnesota, where the per-subject costs of conducting experiments were relatively high, prices vary within each subject across rounds, but not across subjects within a round, i.e., we draw a single price for all 23 or 24 subjects (depending on enrollment, which we discuss below) in each round, because subjects participated group sessions. In Peru, where the per-subject cost of conducting the experiments are relatively lower, we had the luxury of being able to conduct the experiments one-on-one with each subject, and so each subject faces her own price in each round, i.e., prices vary across subjects within each round and within subject across all rounds.

Another important difference between contexts is the order in which the price risk and the Holt-Laury games were played. At Cornell in December 2014, the price risk game was played first and the Holt-Laury game was played second. At Cornell in March 2015 and at Minnesota in October 2015, the order of games was inverted, with the Holt-Laury game played first and the price risk game played second. In Peru, the order of games was randomly determined for each respondent by the throw of a die. Across contexts, this provides us with enough variation to determine whether the order in which the games are played matters. Within contexts, this is only possible at Cornell and in Peru.

The notional commodities subjects are told to imagine they are producing differ as well. In the US, we talk of bushels of wheat. Because wheat is uncommon in Peru, and because we wanted to run a framed field experiment, we asked our Peruvian subjects to imagine they are producing potatoes. This also has the added advantage of making the prices we drew overlap with the price of potatoes Peruvian farmers actually receive for similar quantities of potatoes.

Finally, one last difference across contexts has to do with the randomization method. At both Cornell and Minnesota, we determined both the extensive and intensive price risk margins by means of public randomization via an Excel spreadsheet projected on a screen for all to see. These were used to select the distribution. Once a distribution was selected, the price was drawn from a bag with appropriately labeled ping pong balls. In Peru, the extensive and intensive price risk margins were respectively determined by throwing a six- and a four-sided dice. On the former, rolling 1 or 2 meant a certain price, and rolling anything between 3 and 6 meant a risky price. On the latter, the four sides of the die mapped to settings 2, 3, 4, and 5. Across all contexts, prices were drawn for settings 2 to 5 from bags containing 20 balls marked with prices in the relevant proportions for each setting. Subjects were told they could—and were encouraged to—inspect those bags after the experiment was concluded in order to see that the actual price distributions we drew from reflected what was on the charts we showed them, and that there was no deception involved in the experiment.

As regards deception, Cornell's Lab for Experimental Economics and Decision Research (LEEDR), where we conducted our experiments, does not allow deception. Since the Minnesota subjects were recruited from a departmental listserv, and not as part of a lab's pool of subjects, it is impossible to know whether they had been exposed to lab experiments with deception before participating in our experiment, but it seems unlikely. As for the Peruvian subjects, they had never been part of a lab-in-the-field experiment before our experiment. Therefore, we are confident that the vast majority of our subjects had never been exposed to deception in the context of an experiment before. Finally, although we conducted two group sessions at Cornell, subjects were not allowed to participate in our experiment twice, and so there was no overlap between the two Cornell groups.

4 Empirical Framework

To test Sandmo's prediction, we first estimate the following equation

$$y_{it} = \alpha_0 + \beta_0 I(\sigma_{it} > 0) + \delta_0 R_i + \tau_0 t_t + \theta_0 x_i + \nu_{0i} + \epsilon_{0it}, \tag{8}$$

where y_{1it} denotes the subject i's output choice in round $t \in \{1, ..., 20\}$, $I(\sigma_{it} > 0)$ is an indicator variable equal to one if subject i has to make her output choice in the face of price risk and equal to zero otherwise,[11] R_i denotes subject i's Arrow-Pratt coefficient of relative risk aversion obtained from the Holt-Laury lottery game,[12] x_i is a vector of controls specific to subject i, ν_{0i} is a fixed or random effect specific to subject i, and ϵ_{0it} is an error term with mean zero.

To test Sandmo's hypothesis that output price risk at the extensive mar-

[11] Strictly speaking, this only varies at the subject level in Peru. Recall that in the US, we ran group experiments and drew a single price for all subjects in a given round. We maintain this somewhat abusive notation for the remainder of this article.

[12] Following Holt and Laury's recommendations (2002), we assume constant relative risk aversion (CRRA), and thus DARA, by ascribing $R = -0.95$ to subjects who switch in the first line of the Holt-Laury list experiment; $R = -0.49$ to subjects who switch in the second line; $R = -0.15$ to subjects who switch in the third; $R = 0.15$ to subjects who switch in the fourth line; $R = 0.41$ to subjects who switch in the fifth line; $R = 0.68$ to subjects who switch in the sixth line; $R = 0.97$ to subjects who switch in the seventh line; $R = 1.37$ to subjects who switch in the eighth line; $R = 1.50$ to subjects who switch in the ninth or tenth line.

gin causes producers to decrease their level of output, we test the null hypothesis $H_0 : \beta_0 = 0$. Rejecting the null in favor of the alternative hypothesis that $\beta_0 < 0$ would constitute evidence in favor of Sandmo's hypothesis. Strictly speaking, however, this would only really need to hold in cases where our subjects are risk-averse, i.e., for subjects for whom $R > 0$. We thus start by estimating equation 8 for the restricted sample of subjects classified as risk-averse on the basis of the Holt-Laury experiment, before moving on to the sample as a whole.

In addition to equation 8, we estimate two additional specifications of our estimable equation. The first is such that

$$y_{it} = \alpha_1 + \beta_1 I(\sigma_{it} > 0) + \gamma_1 \sigma_{it} + \delta_1 R_i + \tau_1 t_t + \theta_1 x_i + \nu_{1i} + \epsilon_{1it}, \tag{9}$$

where σ_{it} denotes the standard deviation of the price distribution used in round t and all other variables are defined as before. Equation 9 allows studying the effects of price risk at the extensive and intensive margins, or the effect of going from a situation of price certainty to a situation of price risk, and then effect of increases in price risk conditional on there being some price risk, respectively. This latter phenomenon was explored theoretically by Batra and Ullah (1973), who showed that producers decrease the quantity they produce in response to further mean-preserving spreads of the output price distribution if their preferences exhibit DARA.

The last specification is

$$y_{it} = \alpha_2 + \sum_{j=2}^{5} \gamma_{2j} \sigma_{ijt} + \delta_2 R_i + \tau_2 t_t + \theta_2 x_i + \nu_{2i} + \epsilon_{2it}, \tag{10}$$

where σ_{ijt} is a dummy variable equal to one if setting $j \in \{2, ..., 5\}$ was randomly drawn for subject i in round t and equal to zero otherwise. Equation 10 allows studying the effect of various levels of price risk separately from the others.

Although the dependent variable in equations 8 to 10 is a nonnegative integer and thus lends itself to the estimation of count data models such as Poisson or negative binomial regressions, we present throughout the results of ordinary least squares (OLS) regressions as our preferred specifications. We favor OLS results because, with likelihood-based procedures like Poisson or negative binomial regressions, there is a small possibility that a coefficient might be identified off of the specific functional form imposed on the error term. Moreover, the coefficients from an OLS regression are directly interpretable as marginal effects.

Additionally, because our data are longitudinal and we follow each subject over the course of 20 rounds, we cluster standard errors everywhere at the subject level, following the recommendations in Abadie et al. (2017).

Lastly, we estimate random effects versions of equations 8 to 10. We do so for two reasons: First, because random effects are in principle superior to fixed effects when dealing with experimental data given that the variables of interest are clearly orthogonal to the error term, and because the fixed effects estimator is inefficient. Second, we do so based on the results of Hausman tests which we discuss in section 6, and which fail to reject the null that the coefficients from random and fixed effects specifications are statistically equal.

5 Data and Descriptive Statistics

The experiments for this paper were conducted at the Lab for Experimental Economics and Decision Research in the Dyson School of Applied Economics and Management at Cornell University in December 2014 and March 2015, in the Department of Applied Economics at the University of Minnesota in October 2015, and in rural areas of Peru's Lima province in August and September 2016.

Subjects in the US were undergraduate students at the universities where we ran our experiments; subjects in Peru were farmers who were literate and numerate enough, as determined from survey data on that population, to understand the experimental materials used as part of our experiments.

Our sample consists of 24 subjects at Cornell in December 2014, 24 subjects at Cornell in March 2015, 23 subjects at Minnesota in October 2015, and 48 subjects in Peru in August and September 2016, for a total of 119 subjects across all three contexts. Because each subject played 20 actual rounds (after playing 10 practice rounds) of the price game, our pooled sample size consists of 2,380 subject-round observations for the price risk game. In some cases, we lose a subject-round or all of a subject's rounds due to missing data, so our pooled estimation sample consists of $N = 2,339$ observations encompassing data on 119 subjects for 19 or 20 rounds each. The 41 missing observations were due to two subjects (i.e., 40 subject-round observations) whose Holt-Laury switch point was mistakenly entered as zero—an impossible value—when the data were entered and one subject-round observation for which the production level was missing.

Table 1 presents summary statistics for our pooled sample of experimental subjects (column 1) as well as for our Cornell (column 2), Minnesota (column 3), and Peru (column 4) sub-samples. Both in the pooled sample and across all three sub-samples, the mean price drawn does not differ significantly from the mean price of 7 in all distributions, nor does the mean output chosen differ significantly from 10, the profit-maximizing output choice when the price is equal to 7. Likewise, on average, subjects face a risky output price in about two thirds of cases, as one would expect given our randomization strategy.

Consistent with the *ex ante* odds of observing a certain versus a risky price, the price is certain in about one third of cases and risky in about two thirds of cases, where it is spread out relatively uniformly across settings 2 to 5.

Our subjects are on average relatively risk-averse, though that average for the pooled sample masks some heterogeneity: the average Cornell and

Minnesota subjects is risk-averse, but the average Peruvian subject is risk-neutral. This latter finding is surprising; in her study combining experimental and survey data to estimate price risk preferences, Schechter (2007), for instance, finds that the average subject in her Paraguayan data has a coefficient of relative risk aversion equal to 1.92 when considering expected utility of consumption.

We have already discussed the order between our price risk game and the Holt-Laury game above. Because we only ran one experimental session at Minnesota, wherein the order of games was the same for everyone, we do not report a descriptive statistic for the dummy for whether Holt-Laury was played first in that sub-sample. Lastly, the proportion of women in our sample was almost everywhere close to one half, except at Minnesota, where it was closer to 30 percent. This is likely be because the majors we recruited our subjects from both tend to attract more men than women.

Figures 2 and 3 show histograms of the output choices made by our subjects. In figure 2a, we show the frequency of each output choice for all rounds indiscriminately. In figure 2b, we show the frequency of each output choice for those rounds where the price is certain. In figure 2c, we show the frequency of each output choice for those rounds where the price is risky.

The high frequency of output choice $y = 10$ in figure 2a is due to the fact that this is the profit- (and thus utility-) maximizing choice in cases where the price is certain. The high frequency of profit-maximizing choices in the certainty case, shown in figure 2b, indicates that our subjects largely understood the price risk game. It is nevertheless interesting to see in figure 2b that some subjects still make mistakes in cases where the optimal choice is *a priori* unambiguous.

Figure 2c shows that even when we consider only the rounds in which the price is risky, there is still a tendency to choose to produce $y = 10$. Figure 3 takes the results of figure 2a and disaggregates them by context, with the Cornell, Minnesota, and Peru sub-samples respectively in figures 3a to 3c.

6 Experimental Results

This section proceeds in two parts. In the first part, we discuss our core results (i.e., the estimation results for equations 8 to 10), which aim at testing Sandmo's (1971) prediction that price risk at the extensive margin causes producers to decrease how much they produce.

Finding little to no support for Sandmo's prediction, we then test three alternative theories which might explain the patterns we observe in the data, viz. safety-first, expected profit maximization, and prospect theory.

6.1 Core Results and Tests of the Theory

Table 2 presents estimation results for equations 8 to 10 for the sub-sample of subjects who are classified as risk-averse according to their choice in the Holt-Laury game.[13] Column 1 constitutes our main test of Sandmo's prediction that price risk at the extensive margin causes risk-averse subjects to decrease how much they produce. In this case, we find that price risk at the extensive margin causes no detectable change in how much our risk-averse subjects produce, which contradicts Sandmo's prediction.

In column 2, we differentiate between price risk at the extensive and intensive margins, finding that price risk at the extensive margin causes our subjects to produce more—not less—than in situations of price certainty, but price risk at the intensive margin causes them to produce less. This latter finding is not inconsistent with Batra and Ullah's (1973) theoretical prediction that with preferences exhibiting DARA, producers respond to price risk at the intensive margin by decreasing the quantity they produce.

In column 3, we treat each level of price risk as a separate treatment, omitting the price certainty case for comparison. The results in column 3

[13]Hausman tests pitting the full-sample fixed effects specifications of equations 8 to 10 against the random effects specifications of the same equations failed to reject the null with p-values of 1.00, 1.00, and 0.90. We thus estimate random effects specifications throughout.

show that the results in columns 1 and 2 are driven by our subjects' behavior in response to setting 2 relative to price certainty.

In appendix tables A1 to A3, we estimate the specifications in table 2 for the sub-samples of Cornell, Minnesota, and Peruvian risk-averse subjects. The Cornell and Minnesota results are consistent with the pooled results—indeed, they appear to drive them altogether, as the Peru results are somewhat different. In column 2 of table A3, subjects do not seem to respond to price risk at either the extensive or the intensive margin.

From the sub-sample of risk-averse subjects, we move to the full sample of all subjects in table 3. In terms of signs, the results in table 3 are similar to those in table 2, with the difference being that those coefficients that are significant in the shaded portion of table 3 are a bit smaller in magnitude than the equivalent coefficients in table 2. This suggests that risk-averse subjects respond more strongly to price risk than subjects in the full sample, albeit in the wrong direction, if one takes EU theory at face value. Given that column 2 of tables 2 and 3 shows that our subjects respond to price risk at the extensive margin by producing *more*, not less, than they do in situations of price certainty, this compounds the lack of support we find for Sandmo's prediction with the puzzling fact that the inclusion of risk-loving subjects makes the full sample appear more risk-averse, in light of Sandmo's prediction, than the sub-sample of risk-averse subjects when it comes to exposing oneself to price risk.

In appendix tables A4 to A6, we estimate the specifications in table 3 for the sub-samples of Cornell, Minnesota, and Peruvian subjects. The reader might have noticed that tables A4 and A5 are identical to tables A1 and A2. This is not a mistake, as neither the Cornell nor the Minnesota sample included any risk-neutral or risk-loving subjects. The results in table A6 suggest that in the broader sample of Peruvian subjects, only the last *escenario*, or setting, causes subjects to take on more risk.

One concern here might be that our subjects might feel like they are playing with "house money," and thus be more willing to gamble that money and take risks with it. To mitigate this possibility, we gave our subjects a substantial payment just for showing up to the experiment, as we have discussed above, and we clearly told them what they would get on average from the variable-payoff part of the experiment, and that they could either win *or lose* some of their endowment. Moreover, the fact that our subjects decrease how much risk they expose themselves to at the intensive margin in column 2 of tables 2 and 3 suggests that they are not inclined to gamble with our money.

6.2 Alternative Theories

Taken together, our core results seem to reject Sandmo's (1971) prediction. More generally, and given that our experimental setup exactly mimics the theoretical conditions laid out by Sandmo, our core results suggest that expected utility (EU) theory is likely poorly suited to explain our subjects' behavior in the face of price risk. In the next few sections, we explore three alternative theories which we feel might explain behavior in our data.

6.2.1 Safety First

One possible explanation for why the average subject in our data chooses to expose herself to more risk in response to price risk at the extensive margin might be that she exhibits safety-first behavior (Roy, 1952).

Recall that under safety first, individuals attempt to avoid some return falling below a certain threshold (Telser, 1995). In this context, we define that threshold as the point where profit equals zero. This means that we are assuming that under this decision criterion, our subjects avoid experiencing a loss. We are fully aware that this threshold is arbitrary; this arbitrariness is a weakness of the safety-first approach.

Econometrically, we thus regress a dummy variable equal to one if, in a given round, a given subject makes a choice that minimizes the likelihood of experiencing a loss and equal to zero otherwise on the variables on the RHS of equations 8 to 10, thereby estimating a linear probability model.[14]

The results of those regressions are shown in table 4. In column 1, rather than causing our subjects to seek to minimize the probability that they incur a loss, price risk causes them to do just the opposite. The results in column 2 show that this is driven by price risk at the intensive margin, and the results in column 3 show that every setting where the price is risky causes our subjects to do the opposite of what safety-first would predict relative to cases of price certainty. We interpret these results as showing little to no support for safety-first in this context. Appendix tables A7 to A9, which estimate the safety-first specification in table 4 for the Cornell, Minnesota, and Peru sub-samples, also show that safety-first finds support in none of those sub-samples.

The only variable that appears roughly consistent with safety-first behavior in table 4 is the Arrow-Pratt coefficient of relative risk aversion, whose coefficient suggests that as subjects become more relatively risk-averse, they are more likely to choose their output level so as to minimize the probability of experiencing a loss. This result is not causal, however, given that our subjects' Holt-Laury switch point cannot be argued to be strictly exogenous to their output choice.

6.2.2 Expected Profit Maximization

Another possible explanation for why the average subject in our data chooses to expose herself to more risk in response to price risk at the extensive margin is that she might an expected profit maximizer. Under expected revenue maximization, subjects seek to maximize $E(\pi)$ instead of maximizing

[14]Given the charts in appendix figures A1 to A6, the probability of incurring a loss is always minimized when $y \in [5, 15]$, so the dependent variable for our test of safety-first is equal to one if $y \in [5, 15]$ and equal to zero otherwise.

$E[u(\pi)]$.[15]

To test this decision-making framework, we regress a dummy variable equal to one if the output choice made by a subject is profit maximizing and equal to zero otherwise. Given the charts in appendix figures A1 to A6, profit is always maximized when $y = 10$, so our dependent variable for our test of expected profit maximization is equal to one if $y = 10$ and equal to zero otherwise. Note, however, that because the baseline of price certainty implies that a rational subject will always choose $y = 10$, we can only reject the null in one direction if our subjects are all rational. Though this would normally mean that we should run one-sided tests for the price risk coefficients we estimate under this decision criterion, we choose to go with critical values from two-sided tests, since figure 2b shows that some subjects do not always behave rationally in cases of price certainty.

The results of this regression are shown in table 5. Results show that the presence of price risk (column 1) causes subjects to do the opposite of maximizing expected profit, and that this is due to price risk at the extensive margin (column 2). Consistent with this, every price risk setting (column 3) makes subjects less likely to maximize expected profit relative to situations of price certainty. Tables A10 to A12 disaggregate the results in table 5 by sub-sample, and show that the results in table 5 are similar across all the contexts we study.

Again, the only variable that appears roughly consistent with expected profit maximization in table 5 is the Arrow-Pratt coefficient of relative risk aversion, whose coefficient suggests that as subjects become more relatively risk-averse, they are more likely to choose their output level so as to maximize expected profit. This result is not causal, however, given that our subjects' Holt-Laury switch point cannot be argued to be strictly exogenous to their output choice.

[15]Here, note that risk neutrality implies expected profit maximization, but that the converse is note true. This means that finding support for expected profit maximization would not be tantamount to finding support for risk neutrality.

6.2.3 Prospect Theory

One last possible explanation why the behavior of the average subject in our data is at odds with the predictions of the canonical model is that prospect theory (Kahneman and Tversky, 1979) might be better suited than EU theory to explain their behavior.

Recall that prospect theory differs from EU theory in three important ways. First, subjects have a reference point above which they act as if risk-averse and below which they act as if risk-loving. Second, subjects are loss-averse, so that a loss is felt more strongly than the equivalent gain. Finally, subjects tend to react more strongly to small-probability events.

Given that we fully expected to find support for the canonical predictions of Sandmo (1971) when we began work for this project, our experimental protocol was not designed to test prospect theory. Yet, we can nevertheless conduct a test of prospect theory with the data we have. Specifically, by assuming that our subject's reference point is the point where they make zero profit, we can look at whether subjects expose themselves to less risk (i.e., act as if risk-averse) over gains, whether they expose themselves to more risk (i.e., act as if risk-loving) over losses, whether they are loss-averse by testing whether they react more strongly to expected losses than to expected gains, and we can look at whether they respond more strongly to small-probability events.

To do so, we define five new variables on which we regress quantity produced:

1. A variable $P(p = 5)$ capturing the likelihood that the price drawn will be equal to 5. By symmetry of all price distributions in this paper, this is identical to the likelihood that the price drawn will be equal to 9. We also refer to this likelihood as "tail risk,"

2. A variable $P(p = 6)$ capturing the likelihood that the price drawn will be equal to 6. By symmetry of all price distributions in this paper, this

is identical to the likelihood that the price drawn will be equal to 8,

3. A variable $P(p = 7)$ capturing the likelihood that the price drawn will be equal to 7,

4. A variable g equal to the expected gain if expected profit is positive and equal to zero otherwise, and

5. A variable ℓ equal to the expected loss if expected profit is negative and equal to zero otherwise.

Note that by definition, $P(p = 5)$, $P(p = 6)$, and $P(p = 7)$ are not collinear. Similarly, by definition, g and ℓ are also not collinear.

This leads us to estimate the following equation:

$$y_{it} = \alpha_2 + \sum_{k \in \{5,6,7\}} \pi_{2k} P(p = k)_{it} + \kappa_2 g_{it} + \lambda_2 \ell_{it} + \delta_2 R_i + \tau_2 t_t + \theta_2 x_i + \nu_{2i} + \epsilon_{2it}, \quad (11)$$

For each distribution, $P(p = 5) \leq P(p = 6) \leq P(p = 7)$, so our test that subjects respond more sharply to small-probability events tests the null of the joint hypothesis that $H_0 : \pi_{25} = \pi_{26}$ and $\pi_{25} = \pi_{27}$. Under the assumption that a change in the probability of observing a tail event (i.e., a price of 5 or 9) should not have an effect different than a change in the probability of observing other events (i.e., a price of 6, 7, or 8), *ceteris paribus*, rejection of the null in favor of finding that both $\pi_{25} > \pi_{26}$ and $\pi_{25} > \pi_{27}$ would suggest that our subjects react more strongly to small-probability events (i.e., tail risk) than to more likely—and more central, from a distributional perspective—events.

Our test that subjects act as if risk-averse over gains consists in testing the null $H_0 : \kappa_2 = 0$. Because a decrease in quantity produced translates into a decrease in one's exposure to price risk, rejecting that null in favor of the alternative that the coefficient on expected gains is negative suggests that our subjects expose themselves to less risk in response to greater expected gains, i.e., it supports the hypothesis that subjects act as if risk-averse over gains.

Similarly, our test that subjects act as if risk-loving over losses consists in testing the null $H_0 : \lambda_2 = 0$. Because an increase in quantity produced translates into an increase in one's exposure to price risk, rejecting that null in favor of the alternative that the coefficient on expected losses is positive suggests that our subjects expose themselves to more risk in response to greater expected losses, i.e., it supports the hypothesis that subjects act as if risk-loving over losses.

Lastly, a test comparing the magnitude of the latter two coefficients by testing the null $H_0 : |\kappa_2| = |\lambda_2|$ allows testing for loss-aversion. A rejection in favor of the alternative hypothesis that $|\lambda_2| > |\kappa_2|$ would support the hypothesis that our subjects are loss-averse, as it would indicate that they respond more strongly to (expected) losses than to (expected) gains.

Table 6 shows estimation results for equation 11. Here, the reader should keep in mind that the coefficients κ_2 and λ_2 are not causal, given that they depend on the value of the dependent variable, and so they suffer from bias due to reverse causality.

The results in table 6 show that our subjects respond more strongly to the likelihood that the price drawn will be equal to 5 (which is identical to the likelihood that the price drawn will be equal to 9, i.e., a measure of tail risk) than to the likelihood that the price drawn will be equal to 6 (which is identical to the likelihood that the price drawn will be equal to 8) or than to the likelihood that the price drawn will be equal to 7, a result that is causal (since those probabilities are randomly assigned) and significant at less than the 1 percent level. Because our subjects seem to over-react to tail risk (i.e., they adjust their production level more to tail risk than to more central risk), this supports the notion that they tend to overweight small-probability events.

The results in table 6 also support the notion that our subjects are risk-loving over losses, given the positive association between expected loss and output choice. The same results, however, do not support the notion that our subjects are risk-averse over gains. Again, these results are not causal, and so they are only suggestive.

Lastly, the results in table 6 support the notion that our subjects are loss-averse. A test of equality of the estimated coefficient for expected gains and the absolute value of the coefficient on expected losses rejects the null at less than the 5 percent level.

Appendix tables A13 to A15 estimate equation 11 respectively for the Cornell, Minnesota, and Peru sub-samples. There is considerable heterogeneity across context. At Cornell, we find evidence in favor of our subjects overweighting small-probability events, in favor of loss aversion, and in favor of our subjects being risk-loving over losses. At Minnesota, we find no evidence of loss aversion, but we find evidence that our subjects appear to overweight small-probability events, and we again find evidence in favor of risk-loving behavior over losses. Finally, in Peru, we find no evidence of loss aversion or overweighting of small probability events, but we find evidence in favor of both risk-loving behavior over losses and risk-averse behavior over gains. Ultimately, the only part of prospect theory that is consistently supported across all three contexts is the notion that subjects act as if risk-loving over losses.

7 Summary and Concluding Remarks

We have conducted an experimental test—the first, to our knowledge—of the theory of producer behavior in the face of output price risk. To do so, we have developed an experimental protocol that exactly mimics the theoretical framework in Sandmo (1971) to test the prediction that risk-averse producers respond to the presence of price risk by decreasing how much they choose to produce.

Our core results offer little to no support for Sandmo's prediction. Because that prediction is rooted in EU theory, we then explore whether alternative models of decision-making in the face of risk could explain our subjects' behavior. Testing in turn whether safety-first, expected profit maximization, or prospect theory explain our subjects' behavior, we find no support for either safety-first or expected profit maximization, but we find suggestive evidence in favor of some components of prospect theory.

Because we conducted the same experiments in the lab with US college students and in the field with Peruvian farmers, our results have more external validity than the usual experiment, which tends to focus on a relatively homogeneous group of subjects (often students at a single university) in a single country. If one were to take our results at face value as having full external validity—admittedly, a big if—one would need to rethink a number of policies aimed at stabilizing prices. Indeed, a number of such programs are based on the belief that producers respond to the presence of price risk by decreasing how much they produce,[16] whereas our findings show that price risk has no effect on how much they produce, a finding which masks the fact that price risk at the extensive margin causes them to produce more but price risk at the intensive margin causes them to produce less.

Our work suggests that the theory of producer behavior in the face of output price risk—as well as the policies used to protect producers from price risk— might need to be rethought along the lines of prospect theory, or perhaps even more complex behavioral rules. Likewise, our experiments only considered producers facing output price risk in situations without storage or

[16] On this, Binswanger-Mkhize (2012) discusses the low uptake of index insurance schemes in developing countries. Even in the US, where insurance markets tend to be more complete than in developing countries, the demand for agricultural insurance tends to be low. Glauber (2004) writes: "Participation in the [US crop insurance] program grew slowly in the 1980s, reaching only 55.6 million acres in 1988, about 25% of eligible acreage. Participation reached 40% in 1989 and 1990, largely because of disaster legislation that required recipients of disaster payment in 1988 and 1989 to buy crop insurance in the subsequent crop year. By 1993, participation had fallen to 32% of eligible area."

insurance. This suggests that running similar experiments aimed at studying producer behavior in the face of price risk with access to storage or insurance might be a fruitful avenue for future research in this area.

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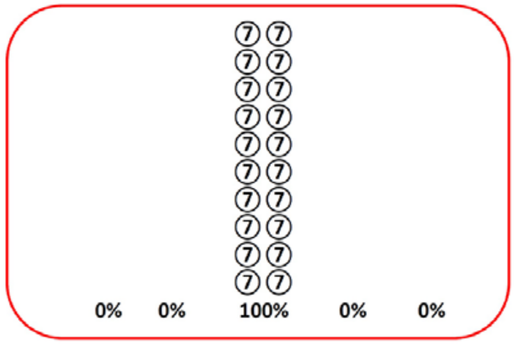
Setting 1

- There are 20 balls in the bag marked with prices $5, $6, $7, $8, and $9. The number of balls marked with each price are shown in the following picture.

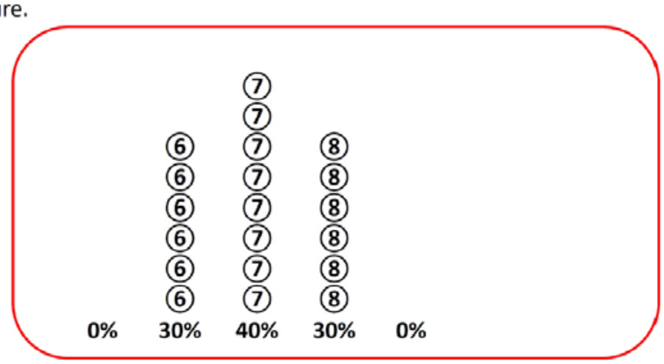


- Write down your choice of input (0-20) on the answer sheet.

Figure 1a. Setting 1, or Price Certainty Case.

Setting 2

- There are 20 balls in the bag marked with prices $5, $6, $7, $8, and $9. The number of balls marked with each price are shown in the following picture.

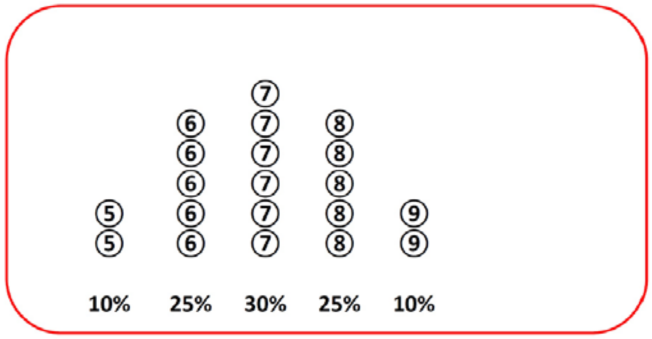


- Write down your choice of input (0-20) on the answer sheet.

Figure 2a. Setting 2.

Setting 3

- There are 20 balls in the bag marked with prices $5, $6, $7, $8, and $9. The number of balls marked with each price are shown in the following picture.

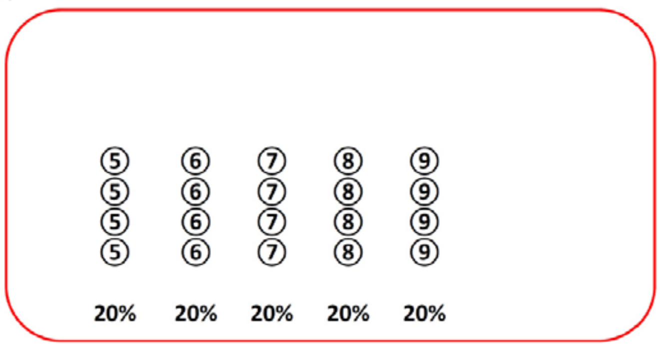


- Write down your choice of input (0-20) on the answer sheet.

Figure 1c. Setting 3.

Setting 4

- There are 20 balls in the bag marked with prices $5, $6, $7, $8, and $9. The number of balls marked with each price are shown in the following picture.

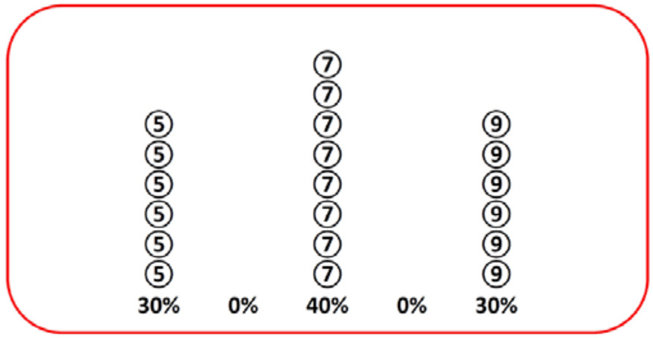


- Write down your choice of input (0-20) on the answer sheet.

Figure 1d. Setting 4.

Setting 5

- There are 20 balls in the bag marked with prices \$5, \$6, \$7, \$8, and \$9. The number of balls marked with each price are shown in the following picture.



- Write down your choice of input (0-20) on the answer sheet.

Figure 1e. Setting 5.

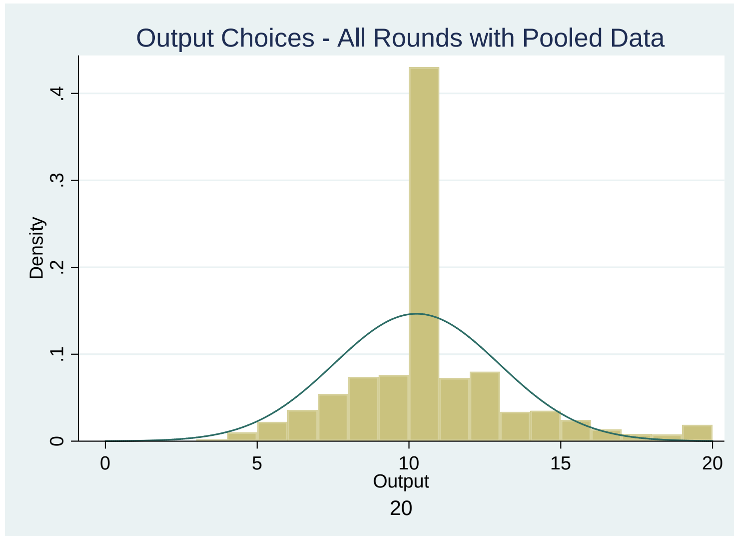


Figure 2a. Frequency of Output Choices for All Rounds, Pooled Data.

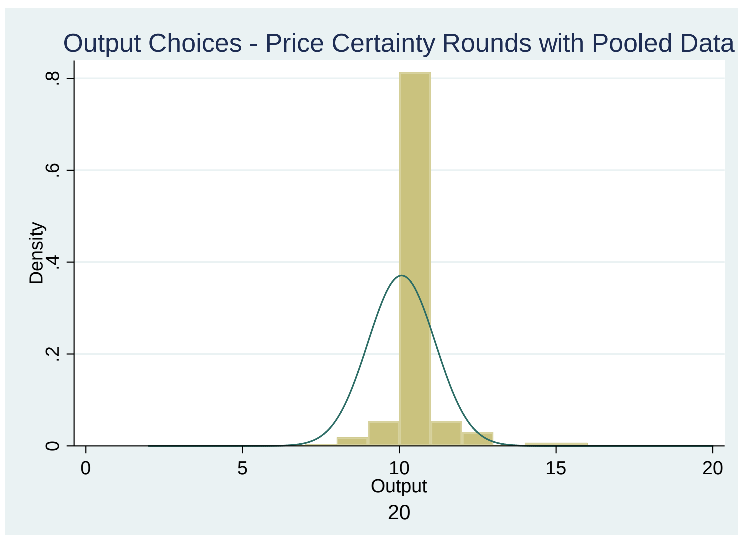


Figure 2b. Frequency of Output Choices for Price Certainty Rounds, Pooled Data.

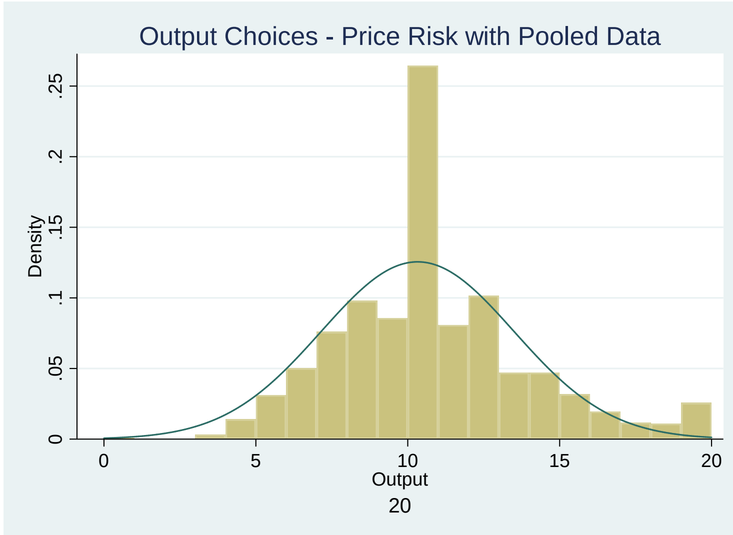


Figure 2c. Frequency of Output Choices for Price Risk Rounds, Pooled Data.

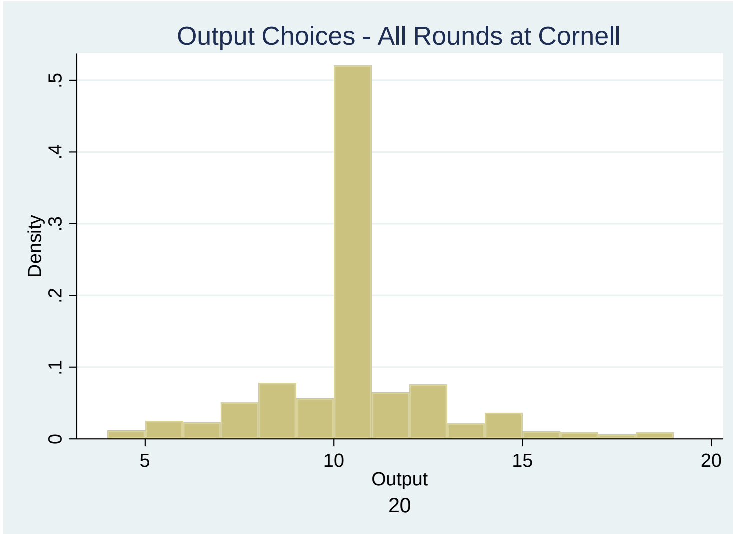


Figure 3a. Frequency of Output Choices for All Rounds, Cornell Sample.

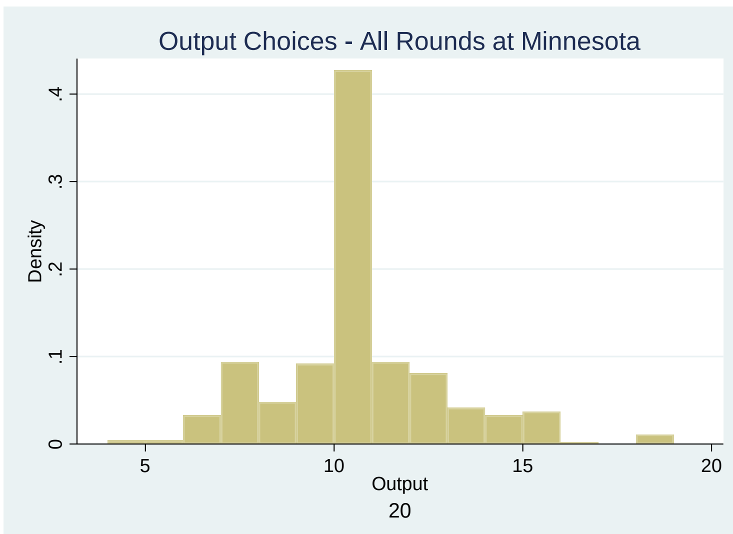


Figure 3b. Frequency of Output Choices for All Rounds, Minnesota Sample.

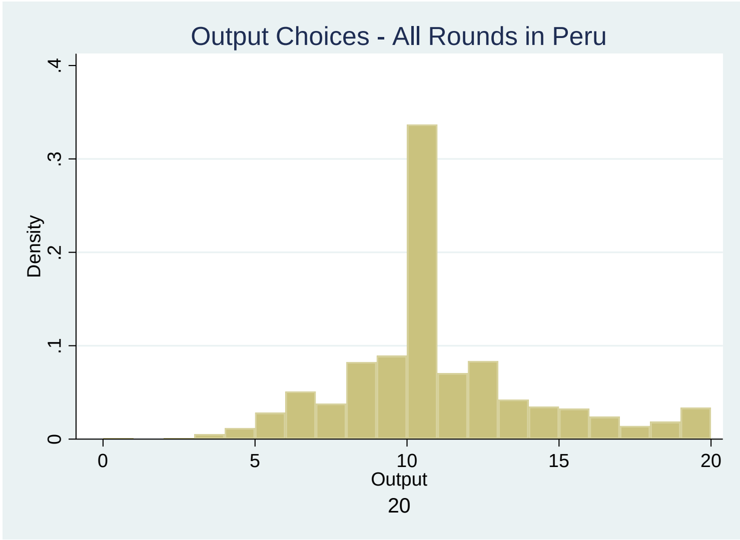


Figure 3c. Frequency of Output Choices for All Rounds, Peru Sample.

Table 1. Descriptive Statistics

Variables	Pooled	Cornell	Minnesota	Peru
Output (Units)	10.247	10.009	10.159	10.535
	(0.057)	(0.074)	(0.105)	(0.109)
Price Per Unit (Experimental Currency)	6.944	6.874	6.902	7.037
	(0.024)	(0.035)	(0.069)	(0.033)
$I(\sigma > 0)$, or Price Risk Dummy	0.698	0.676	0.850	0.646
	(0.010)	(0.015)	(0.017)	(0.016)
σ, or Standard Deviation of the Price Distribution	0.909	0.913	1.127	0.797
	(0.013)	(0.022)	(0.025)	(0.021)
$I(\sigma = 0.795)$, or Setting 2 Dummy	0.151	0.124	0.148	0.180
	(0.007)	(0.011)	(0.017)	(0.013)
$I(\sigma = 1.17)$, or Setting 3 Dummy	0.110	0.076	0.100	0.151
	(0.007)	(0.009)	(0.014)	(0.012)
$I(\sigma = 1.451)$, or Setting 4 Dummy	0.235	0.199	0.451	0.163
	(0.009)	(0.013)	(0.023)	(0.012)
$I(\sigma = 1.58)$, or Setting 5 Dummy	0.202	0.277	0.150	0.152
	(0.008)	(0.015)	(0.017)	(0.012)
Arrow-Pratt Coefficient of Relative Risk Aversion	0.593	0.983	1.050	-0.033
	(0.016)	(0.013)	(0.018)	(0.025)
Holt-Laury Played First Dummy	0.551	0.489	-[†]	0.391
	(0.010)	(0.016)	(0.000)	(0.016)
Female	0.474	0.553	0.305	0.478
	(0.010)	(0.016)	(0.022)	(0.016)
Observations	2,318	940	459	919

Standard errors in parentheses

[†] The Holt-Laury game was always played first at Minnesota.

Table 2. Core Random Effects Regression Results for the Pooled Sample, Risk-Averse Subjects Only

Variables	(1)	(2)	(3)
	Dependent Variable: Output		
$I(\sigma > 0)$, or Price Risk	0.223	1.824***	
	(0.219)	(0.340)	
σ, or Standard Deviation		-1.212***	
		(0.285)	
$I(\sigma = 0.795)$, or Setting 2			0.924***
			(0.192)
$I(\sigma = 1.17)$, or Setting 3			0.360
			(0.261)
$I(\sigma = 1.451)$, or Setting 4			-0.111
			(0.271)
$I(\sigma = 1.58)$, or Setting 5			0.084
			(0.301)
Arrow-Pratt Coefficient of RRA	-0.297	-0.286	-0.289
	(0.387)	(0.388)	(0.388)
Holt-Laury Played First	0.463	0.450	0.499*
	(0.286)	(0.285)	(0.281)
Female	-0.186	-0.189	-0.199
	(0.280)	(0.279)	(0.280)
Round	-0.016	-0.019*	-0.023*
	(0.012)	(0.011)	(0.012)
Constant	10.450***	10.504***	10.570***
	(0.435)	(0.432)	(0.437)
Observations	1,739	1,739	1,739

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3. Core Random Effects Regression Results for the Pooled Sample, All Subjects

Variables	(1)	(2)	(3)
Dependent Variable: Output			
$I(\sigma > 0)$, or Price Risk	0.252	0.982***	
	(0.199)	(0.354)	
σ, or Standard Deviation		-0.563*	
		(0.291)	
$I(\sigma = 0.795)$, or Setting 2			0.550***
			(0.195)
$I(\sigma = 1.17)$, or Setting 3			0.397
			(0.267)
$I(\sigma = 1.451)$, or Setting 4			-0.042
			(0.253)
$I(\sigma = 1.58)$, or Setting 5			0.262
			(0.278)
Arrow-Pratt Coefficient of RRA	-0.327*	-0.308	-0.304
	(0.190)	(0.189)	(0.188)
Holt-Laury Played First	0.401	0.394	0.441*
	(0.266)	(0.265)	(0.262)
Female	-0.259	-0.262	-0.272
	(0.264)	(0.264)	(0.264)
Round	-0.021**	-0.021**	-0.023**
	(0.010)	(0.010)	(0.011)
Constant	10.598***	10.595***	10.620***
	(0.312)	(0.313)	(0.318)
Observations	2,319	2,319	2,319

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Safety-First Random Effects Regression Results for the Pooled Sample

Variables	(1)	(2)	(3)
Dependent Variable: = 1 if Probability of Loss is Minimized, = 0 Otherwise			
$I(\sigma > 0)$, or Price Risk	-0.087***	0.014	
	(0.015)	(0.036)	
σ, or Standard Deviation		-0.078***	
		(0.029)	
$I(\sigma = 0.795)$, or Setting 2			-0.046***
			(0.017)
$I(\sigma = 1.17)$, or Setting 3			-0.086***
			(0.022)
$I(\sigma = 1.451)$, or Setting 4			-0.093***
			(0.020)
$I(\sigma = 1.58)$, or Setting 5			-0.112***
			(0.023)
Arrow-Pratt Coefficient of RRA	0.045***	0.048***	0.048***
	(0.014)	(0.014)	(0.014)
Holt-Laury Played First	0.015	0.014	0.013
	(0.019)	(0.019)	(0.019)
Female	0.006	0.005	0.006
	(0.018)	(0.018)	(0.018)
Round	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Constant	0.948***	0.947***	0.948***
	(0.023)	(0.023)	(0.023)
Observations	2,320	2,320	2,320

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5. Expected Profit Maximization Random Effects Regression Results for the Pooled Sample

Variables	(1)	(2)	(3)
Dependent Variable: = 1 if Expected Profit is Maximized, = 0 Otherwise			
$I(\sigma > 0)$, or Price Risk	-0.556***	-0.494***	
	(0.034)	(0.062)	
σ, or Standard Deviation		-0.048	
		(0.042)	
$I(\sigma = 0.795)$, or Setting 2			-0.526***
			(0.040)
$I(\sigma = 1.17)$, or Setting 3			-0.560***
			(0.038)
$I(\sigma = 1.451)$, or Setting 4			-0.578***
			(0.039)
$I(\sigma = 1.58)$, or Setting 5			-0.554***
			(0.041)
Arrow-Pratt Coefficient of RRA	0.078***	0.080***	0.080***
	(0.027)	(0.027)	(0.027)
Holt-Laury Played First	0.065	0.065	0.068
	(0.043)	(0.043)	(0.043)
Female	-0.042	-0.042	-0.043
	(0.041)	(0.041)	(0.041)
Round	0.003*	0.003*	0.003
	(0.002)	(0.002)	(0.002)
Constant	0.692***	0.691***	0.696***
	(0.057)	(0.057)	(0.058)
Observations	2,320	2,320	2,320

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6. Prospect Theory Random Effects Regression Results for the Pooled Sample

Variables	(1)
Dependent Variable: Output	
Pr(Price = 5) or Pr(Price = 9)	-28.359**
	(12.847)
Pr(Price = 6) or Pr(Price = 8)	-23.876**
	(11.906)
Pr(Price = 7)	-12.434**
	(6.073)
Expected Gain Conditional on Output Level	-0.235
	(0.154)
Expected Loss Conditional on Output Level	0.936***
	(0.250)
Arrow-Pratt Coefficient of RRA	-0.098
	(0.148)
Holt-Laury Played First	0.415*
	(0.227)
Female	-0.215
	(0.228)
Round	-0.017*
	(0.010)
Constant	23.883***
	(6.049)
p-value (Overweighting of Small Probabilities, or H_0: $\pi_{25} = \pi_{26}$ and $\pi_{25} = \pi_{27}$)	0.001
p-value (Loss Aversion, or H_0: $\kappa_2 = -\lambda_2$)	0.049
Observations	2,319

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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Appendix A: Additional Results

Table A1. Core Random Effects Regression Results for the Cornell Sample, Risk-Averse Subjects Only

Variables	(1)	(2)	(3)
	Dependent Variable: Output		
$I(\sigma > 0)$, or Price Risk	0.039	2.041***	
	(0.243)	(0.423)	
σ, or Standard Deviation		-1.491***	
		(0.352)	
$I(\sigma = 0.795)$, or Setting 2			0.874***
			(0.238)
$I(\sigma = 1.17)$, or Setting 3			0.117
			(0.261)
$I(\sigma = 1.451)$, or Setting 4			0.029
			(0.320)
$I(\sigma = 1.58)$, or Setting 5			-0.386
			(0.347)
Arrow-Pratt Coefficient of RRA	-0.437	-0.437	-0.437
	(0.426)	(0.427)	(0.427)
Holt-Laury Played First	0.301	0.237	0.201
	(0.346)	(0.345)	(0.341)
Female	-0.084	-0.084	-0.084
	(0.335)	(0.335)	(0.336)
Round	-0.004	-0.002	-0.002
	(0.015)	(0.014)	(0.015)
Constant	10.399***	10.386***	10.407***
	(0.583)	(0.588)	(0.592)
Observations	940	940	940

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A2. Core Random Effects Regression Results for the Minnesota Sample, Risk-Averse Subjects Only

Variables	(1)	(2)	(3)
	Dependent Variable: Output		
$I(\sigma > 0)$, or Price Risk	0.361	1.810***	
	(0.341)	(0.551)	
σ, or Standard Deviation		-1.184**	
		(0.499)	
$I(\sigma = 0.795)$, or Setting 2			0.824***
			(0.313)
$I(\sigma = 1.17)$, or Setting 3			0.934**
			(0.427)
$I(\sigma = 1.451)$, or Setting 4			-0.448
			(0.406)
$I(\sigma = 1.58)$, or Setting 5			0.743
			(0.576)
Arrow-Pratt Coefficient of RRA	-0.613	-0.618	-0.618
	(0.882)	(0.886)	(0.888)
Female	-1.302**	-1.304**	-1.304**
	(0.646)	(0.647)	(0.648)
Round	0.022	0.006	-0.006
	(0.020)	(0.019)	(0.021)
Constant	10.456***	10.889***	11.214***
	(1.340)	(1.335)	(1.361)
Observations	459	459	459

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A3. Core Random Effects Regression Results for the Peru Sample, Risk-Averse Subjects Only

Variables	(1)	(2)	(3)
	Dependent Variable: Output		
$I(\sigma > 0)$, or Price Risk	0.741	0.939	
	(0.677)	(1.063)	
σ, or Standard Deviation		-0.160	
		(1.051)	
$I(\sigma = 0.795)$, or Setting 2			1.029**
			(0.520)
$I(\sigma = 1.17)$, or Setting 3			0.341
			(0.679)
$I(\sigma = 1.451)$, or Setting 4			0.803
			(1.025)
$I(\sigma = 1.58)$, or Setting 5			0.810
			(1.012)
Arrow-Pratt Coefficient of RRA	0.044	0.043	0.057
	(0.655)	(0.655)	(0.643)
Holt-Laury Played First	1.901***	1.908***	1.902***
	(0.671)	(0.658)	(0.651)
Female	0.579	0.581	0.544
	(0.747)	(0.746)	(0.743)
Round	-0.080***	-0.081***	-0.081***
	(0.029)	(0.029)	(0.029)
Constant	10.912***	10.920***	10.920***
	(0.848)	(0.848)	(0.856)
Observations	340	340	340

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4. Core Random Effects Regression Results for the Cornell Sample, All Subjects

Variables	**(1)**	**(2)**	**(3)**
	Dependent Variable: Output		
$I(\sigma > 0)$, or Price Risk	0.039	2.041***	
	(0.243)	(0.423)	
σ, or Standard Deviation		-1.491***	
		(0.352)	
$I(\sigma = 0.795)$, or Setting 2			0.874***
			(0.238)
$I(\sigma = 1.17)$, or Setting 3			0.117
			(0.261)
$I(\sigma = 1.451)$, or Setting 4			0.029
			(0.320)
$I(\sigma = 1.58)$, or Setting 5			-0.386
			(0.347)
Arrow-Pratt Coefficient of RRA	-0.437	-0.437	-0.437
	(0.426)	(0.427)	(0.427)
Holt-Laury Played First	0.301	0.237	0.201
	(0.346)	(0.345)	(0.341)
Female	-0.084	-0.084	-0.084
	(0.335)	(0.335)	(0.336)
Round	-0.004	-0.002	-0.002
	(0.015)	(0.014)	(0.015)
Constant	10.399***	10.386***	10.407***
	(0.583)	(0.588)	(0.592)
Observations	940	940	940

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5. Core Random Effects Regression Results for the Minnesota Sample, All Subjects

Variables	(1)	(2)	(3)
Dependent Variable: Output			
$I(\sigma > 0)$, or Price Risk	0.361	1.810***	
	(0.341)	(0.551)	
σ, or Standard Deviation		-1.184**	
		(0.499)	
$I(\sigma = 0.795)$, or Setting 2			0.824***
			(0.313)
$I(\sigma = 1.17)$, or Setting 3			0.934**
			(0.427)
$I(\sigma = 1.451)$, or Setting 4			-0.448
			(0.406)
$I(\sigma = 1.58)$, or Setting 5			0.743
			(0.576)
Arrow-Pratt Coefficient of RRA	-0.613	-0.618	-0.618
	(0.882)	(0.886)	(0.888)
Female	-1.302**	-1.304**	-1.304**
	(0.646)	(0.647)	(0.648)
Round	0.022	0.006	-0.006
	(0.020)	(0.019)	(0.021)
Constant	10.456***	10.889***	11.214***
	(1.340)	(1.335)	(1.361)
Observations	459	459	459

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6. Core Random Effects Regression Results for the Peru Sample, All Subjects

Variables	(1)	(2)	(3)
Dependent Variable: Output			
$I(\sigma > 0)$, or Price Risk	0.472	-0.612	
	(0.387)	(0.637)	
σ, or Standard Deviation		0.878	
		(0.561)	
$I(\sigma = 0.795)$, or Setting 2			0.120
			(0.360)
$I(\sigma = 1.17)$, or Setting 3			0.416
			(0.476)
$I(\sigma = 1.451)$, or Setting 4			0.460
			(0.542)
$I(\sigma = 1.58)$, or Setting 5			0.957*
			(0.552)
Arrow-Pratt Coefficient of RRA	0.049	0.045	0.046
	(0.269)	(0.270)	(0.270)
Holt-Laury Played First	0.772	0.767	0.775
	(0.515)	(0.516)	(0.515)
Female	-0.050	-0.050	-0.058
	(0.503)	(0.502)	(0.502)
Round	-0.051***	-0.053***	-0.053***
	(0.019)	(0.018)	(0.018)
Constant	11.012***	11.052***	11.041***
	(0.524)	(0.525)	(0.527)
Observations	920	920	920

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7. Safety-First Random Effects Regression Results for the Cornell Sample

Variables	(1)	(2)	(3)
Dependent Variable: = 1 if Probability of Loss is Minimized, = 0 Otherwise			
$I(\sigma > 0)$, or Price Risk	-0.056***	0.051	
	(0.019)	(0.037)	
σ, or Standard Deviation		-0.079**	
		(0.034)	
$I(\sigma = 0.795)$, or Setting 2			-0.023
			(0.016)
$I(\sigma = 1.17)$, or Setting 3			-0.024
			(0.018)
$I(\sigma = 1.451)$, or Setting 4			-0.053***
			(0.020)
$I(\sigma = 1.58)$, or Setting 5			-0.087***
			(0.029)
Arrow-Pratt Coefficient of RRA	0.006	0.006	0.006
	(0.028)	(0.028)	(0.028)
Holt-Laury Played First	0.007	0.004	0.002
	(0.025)	(0.026)	(0.026)
Female	0.054*	0.054*	0.054*
	(0.028)	(0.028)	(0.028)
Round	0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)
Constant	0.951***	0.950***	0.944***
	(0.041)	(0.042)	(0.043)
Observations	940	940	940

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A8. Safety First Random Effects Regression Results for the Minnesota Sample

Variables	(1)	(2)	(3)
Dependent Variable: = 1 if Probability of Loss is Minimized, = 0 Otherwise			
$I(\sigma > 0)$, or Price Risk	-0.019	0.030	
	(0.013)	(0.044)	
σ, or Standard Deviation		-0.040	
		(0.039)	
$I(\sigma = 0.795)$, or Setting 2			-0.010
			(0.016)
$I(\sigma = 1.17)$, or Setting 3			0.015
			(0.012)
$I(\sigma = 1.451)$, or Setting 4			-0.002
			(0.005)
$I(\sigma = 1.58)$, or Setting 5			-0.064
			(0.046)
Arrow-Pratt Coefficient of RRA	-0.004	-0.004	-0.004
	(0.025)	(0.025)	(0.025)
Holt-Laury Played First	-0.003	-0.003	-0.003
	(0.018)	(0.018)	(0.018)
Female	0.001	-0.000	0.001
	(0.001)	(0.001)	(0.001)
Round			
Constant	0.991***	1.005***	0.967***
	(0.042)	(0.048)	(0.039)
Observations	460	460	460

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A9. Safety First Random Effects Regression Results for the Peru Sample

Variables	(1)	(2)	(3)
Dependent Variable: = 1 if Probability of Loss is Minimized, = 0 Otherwise			
$I(\sigma > 0)$, or Price Risk	-0.143***	0.019	
	(0.027)	(0.074)	
σ, or Standard Deviation		-0.131**	
		(0.063)	
$I(\sigma = 0.795)$, or Setting 2			-0.072**
			(0.032)
$I(\sigma = 1.17)$, or Setting 3			-0.152***
			(0.040)
$I(\sigma = 1.451)$, or Setting 4			-0.200***
			(0.047)
$I(\sigma = 1.58)$, or Setting 5			-0.153***
			(0.047)
Arrow-Pratt Coefficient of RRA	0.020	0.021	0.021
	(0.021)	(0.021)	(0.021)
Holt-Laury Played First	-0.024	-0.023	-0.022
	(0.036)	(0.035)	(0.035)
Female	-0.023	-0.023	-0.025
	(0.036)	(0.035)	(0.035)
Round	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)
Constant	0.986***	0.980***	0.978***
	(0.039)	(0.038)	(0.036)
Observations	920	920	920

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A10. Expected Profit Maximization Random Effects Regression Results for the Cornell Sample

Variables	(1)	(2)	(3)
Dependent Variable: = 1 if Expected Profit is Maximized, = 0 Otherwise			
$I(\sigma > 0)$, or Price Risk	-0.717***	-0.631***	
	(0.046)	(0.105)	
σ, or Standard Deviation		-0.064	
		(0.068)	
$I(\sigma = 0.795)$, or Setting 2			-0.677***
			(0.060)
$I(\sigma = 1.17)$, or Setting 3			-0.699***
			(0.063)
$I(\sigma = 1.451)$, or Setting 4			-0.743***
			(0.053)
$I(\sigma = 1.58)$, or Setting 5			-0.719***
			(0.057)
Arrow-Pratt Coefficient of RRA	-0.099	-0.099	-0.099
	(0.093)	(0.093)	(0.093)
Holt-Laury Played First	0.111*	0.108*	0.112*
	(0.063)	(0.063)	(0.062)
Female	-0.020	-0.020	-0.020
	(0.059)	(0.059)	(0.059)
Round	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)
Constant	0.995***	0.994***	0.996***
	(0.093)	(0.093)	(0.094)
Observations	940	940	940

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A11. Expected Profit Maximization Random Effects Regression Results for the Minnesota Sample

Variables	(1)	(2)	(3)
Dependent Variable: = 1 if Expected Profit is Maximized, = 0 Otherwise			
$I(\sigma > 0)$, or Price Risk	-0.620***	-0.532***	
	(0.069)	(0.154)	
σ, or Standard Deviation		-0.072	
		(0.106)	
$I(\sigma = 0.795)$, or Setting 2			-0.579***
			(0.090)
$I(\sigma = 1.17)$, or Setting 3			-0.664***
			(0.104)
$I(\sigma = 1.451)$, or Setting 4			-0.650***
			(0.080)
$I(\sigma = 1.58)$, or Setting 5			-0.635***
			(0.079)
Arrow-Pratt Coefficient of RRA	-0.011	-0.011	-0.011
	(0.161)	(0.161)	(0.161)
Female	-0.161*	-0.161*	-0.161*
	(0.089)	(0.089)	(0.090)
Round	0.007	0.006	0.005
	(0.005)	(0.004)	(0.004)
Constant	0.864***	0.891***	0.924***
	(0.242)	(0.229)	(0.239)
Observations	460	460	460

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A12. Expected Profit Maximization Random Effects Regression Results for the Peru Sample

Variables	(1)	(2)	(3)
Dependent Variable: = 1 if Expected Profit is Maximized, = 0 Otherwise			
$I(\sigma > 0)$, or Price Risk	-0.371***	-0.440***	
	(0.049)	(0.085)	
σ, or Standard Deviation		0.056	
		(0.053)	
$I(\sigma = 0.795)$, or Setting 2			-0.379***
			(0.060)
$I(\sigma = 1.17)$, or Setting 3			-0.404***
			(0.048)
$I(\sigma = 1.451)$, or Setting 4			-0.368***
			(0.056)
$I(\sigma = 1.58)$, or Setting 5			-0.327***
			(0.058)
Arrow-Pratt Coefficient of RRA	0.028	0.028	0.029
	(0.042)	(0.042)	(0.042)
Holt-Laury Played First	-0.001	-0.002	-0.001
	(0.063)	(0.063)	(0.062)
Female	-0.022	-0.022	-0.023
	(0.059)	(0.059)	(0.060)
Round	0.005	0.005	0.005
	(0.003)	(0.003)	(0.003)
Constant	0.494***	0.496***	0.496***
	(0.082)	(0.082)	(0.082)
Observations	920	920	920

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A13. Prospect Theory Random Effects Regression Results for the Cornell Sample

Variables	**(1)**
Dependent Variable: Output	
Pr(Price = 5) or Pr(Price = 9)	-21.257
	(20.348)
Pr(Price = 6) or Pr(Price = 8)	-15.076
	(19.099)
Pr(Price = 7)	-8.948
	(9.701)
Expected Gain Conditional on Output Level	0.107
	(0.258)
Expected Loss Conditional on Output Level	1.821***
	(0.262)
Arrow-Pratt Coefficient of RRA	-0.288
	(0.423)
Holt-Laury Played First	0.088
	(0.280)
Female	0.046
	(0.281)
Round	0.001
	(0.016)
Constant	18.633*
	(9.611)
p-value (Overweighting of Small Probabilities, or H_0: $\pi_{25} = \pi_{26}$ and $\pi_{25} = \pi_{27}$)	0.001
p-value (Loss Aversion, or H_0: $\kappa_2 = -\lambda_2$)	0.000
Observations	940

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A14. Prospect Theory Random Effects Regression Results for the Minnesota Sample

Variables	**(1)**
Dependent Variable: Output	
Pr(Price = 5) or Pr(Price = 9)	-76.275***
	(17.317)
Pr(Price = 6) or Pr(Price = 8)	-67.254***
	(16.017)
Pr(Price = 7)	-35.114***
	(8.256)
Expected Gain Conditional on Output Level	-0.191
	(0.458)
Expected Loss Conditional on Output Level	1.424***
	(0.371)
Arrow-Pratt Coefficient of RRA	-0.639
	(0.790)
Female	-1.358**
	(0.619)
Round	-0.014
	(0.020)
Constant	47.489***
	(7.664)
p-value (Overweighting of Small Probabilities, or H_0: $\pi_{25} = \pi_{26}$ and $\pi_{25} = \pi_{27}$)	0.000
p-value (Loss Aversion, or H_0: $\kappa_2 = -\lambda_2$)	0.129
Observations	459

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A15. Prospect Theory Random Effects Regression Results for the Peru Sample

Variables	**(1)**
Dependent Variable: Output	
Pr(Price = 5) or Pr(Price = 9)	-13.816
	(19.965)
Pr(Price = 6) or Pr(Price = 8)	-13.755
	(18.235)
Pr(Price = 7)	-6.215
	(9.351)
Expected Gain Conditional on Output Level	-0.419**
	(0.201)
Expected Loss Conditional on Output Level	0.706***
	(0.269)
Arrow-Pratt Coefficient of RRA	0.051
	(0.217)
Holt-Laury Played First	0.579
	(0.414)
Female	-0.030
	(0.421)
Round	-0.040**
	(0.017)
Constant	18.863**
	(9.330)
p-value (Overweighting of Small Probabilities, or H_0: $\pi_{25} = \pi_{26}$ and $\pi_{25} = \pi_{27}$)	0.440
p-value (Loss Aversion, or H_0: $\kappa_2 = -\lambda_2$)	0.481
Observations	920

Standard errors clustered at the subject level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

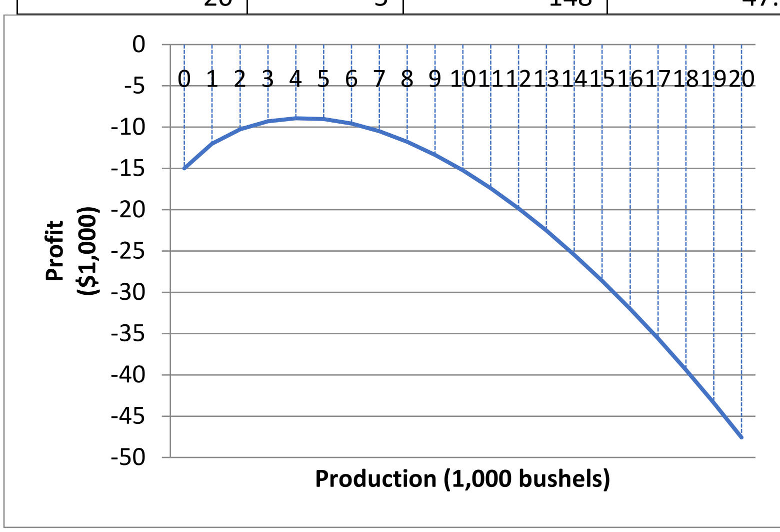
FOR ONLINE PUBLICATION

Appendix B: Experimental Protocol and Answer Sheets for Experiments in the US

Exhibit B1. Production, Price, Cost, and Profit Charts

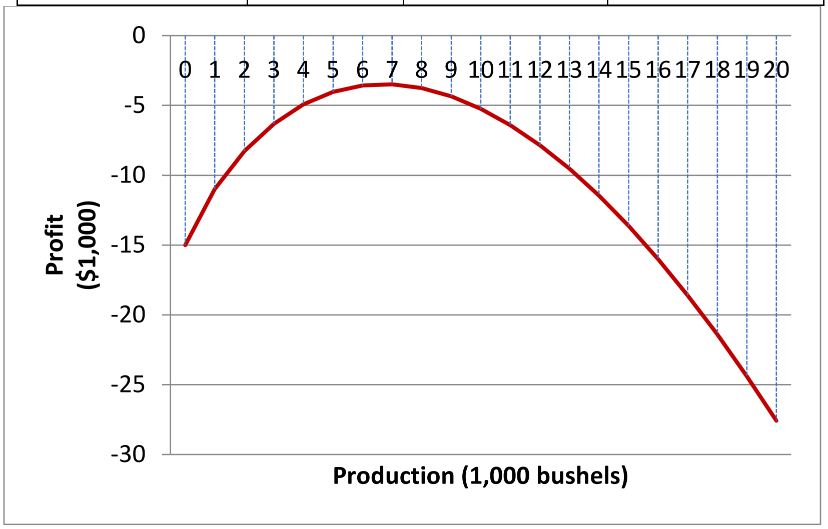
1. Wheat production, cost, and profit when price of wheat is **$5/bushel**.

(1) Wheat Production (1,000 bushels)	(2) Price ($/bushel)	(3) Cost = 2 X $(1)^{1.4}$+15 ($ 1,000)	(4) Profit = (1)X(2)-(3) ($1,000)
0	5	15	-15.00
1	5	17	-12.00
2	5	20	-10.28
3	5	24	-9.31
4	5	29	-8.93
5	5	34	-9.04
6	5	40	-9.57
7	5	45	-10.49
8	5	52	-11.76
9	5	58	-13.35
10	5	65	-15.24
11	5	72	-17.41
12	5	80	-19.85
13	5	88	-22.54
14	5	95	-25.47
15	5	104	-28.63
16	5	112	-32.01
17	5	121	-35.60
18	5	129	-39.40
19	5	138	-43.39
20	5	148	-47.58



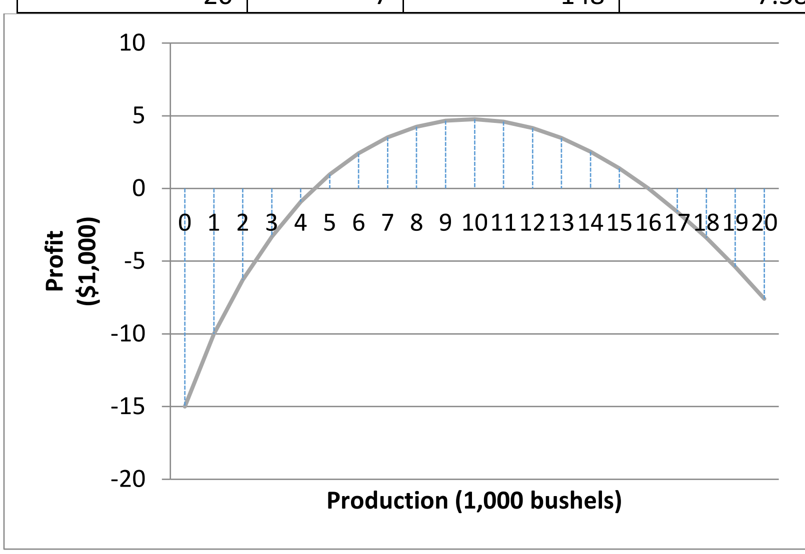
2. Wheat production, cost, and profit when price of wheat is <u>$6/bushel</u>.

(1) Wheat Production (1,000 bushels)	(2) Price ($/bushel)	(3) Cost $= 2 \times (1)^{1.4} + 15$ ($ 1,000)	(4) Profit = (1)X(2)-(3) ($1,000)
0	6	15	-15.00
1	6	17	-11.00
2	6	20	-8.28
3	6	24	-6.31
4	6	29	-4.93
5	6	34	-4.04
6	6	40	-3.57
7	6	45	-3.49
8	6	52	-3.76
9	6	58	-4.35
10	6	65	-5.24
11	6	72	-6.41
12	6	80	-7.85
13	6	88	-9.54
14	6	95	-11.47
15	6	104	-13.63
16	6	112	-16.01
17	6	121	-18.60
18	6	129	-21.40
19	6	138	-24.39
20	6	148	-27.58



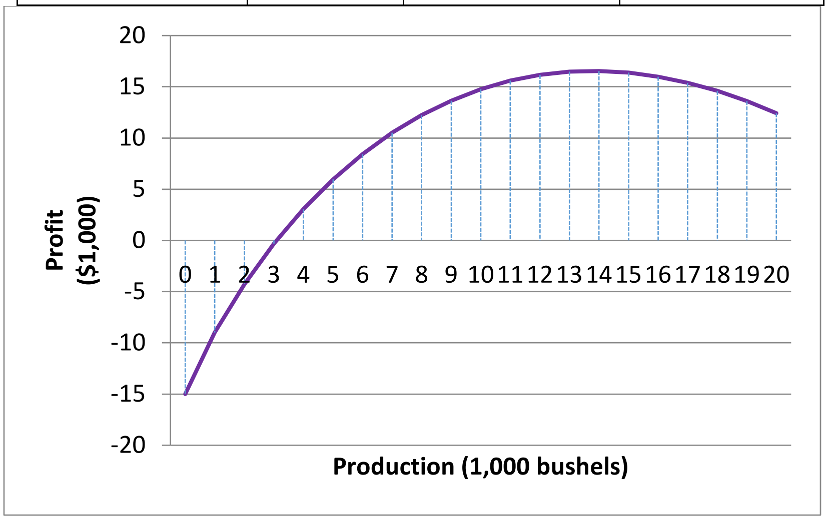
3. Wheat production, cost, and profit when price of wheat is **<u>$7/bushel</u>**.

(1) Wheat Production (1,000 bushels)	(2) Price ($/bushel)	(3) Cost = 2 X $(1)^{1.4}$+15 ($ 1,000)	(4) Profit = (1)X(2)-(3) ($1,000)
0	7	15	-15.00
1	7	17	-10.00
2	7	20	-6.28
3	7	24	-3.31
4	7	29	-0.93
5	7	34	0.96
6	7	40	2.43
7	7	45	3.51
8	7	52	4.24
9	7	58	4.65
10	7	65	4.76
11	7	72	4.59
12	7	80	4.15
13	7	88	3.46
14	7	95	2.53
15	7	104	1.37
16	7	112	-0.01
17	7	121	-1.60
18	7	129	-3.40
19	7	138	-5.39
20	7	148	-7.58



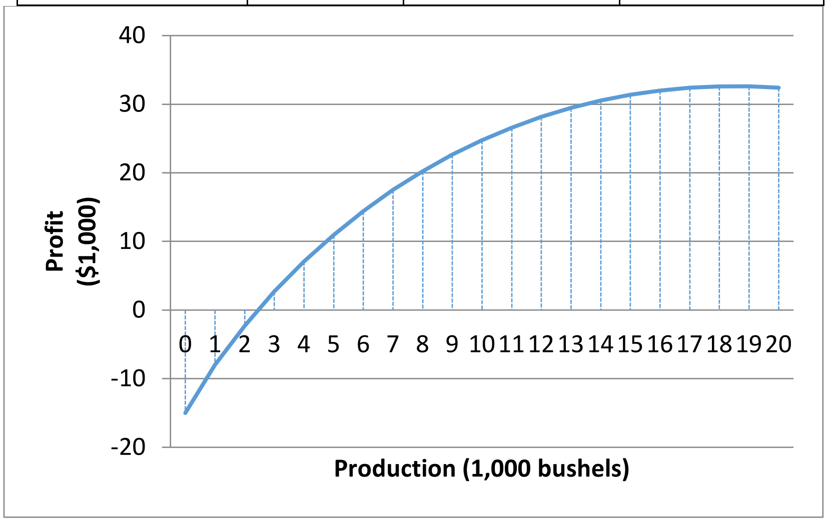
4. Wheat production, cost, and profit when price of wheat is **<u>$8/bushel</u>**.

(1) Wheat Production (1,000 bushels)	(2) Price ($/bushel)	(3) Cost = 2 X $(1)^{1.4}$+15 ($ 1,000)	(4) Profit = (1)X(2)-(3) ($1,000)
0	8	15	-15.00
1	8	17	-9.00
2	8	20	-4.28
3	8	24	-0.31
4	8	29	3.07
5	8	34	5.96
6	8	40	8.43
7	8	45	10.51
8	8	52	12.24
9	8	58	13.65
10	8	65	14.76
11	8	72	15.59
12	8	80	16.15
13	8	88	16.46
14	8	95	16.53
15	8	104	16.37
16	8	112	15.99
17	8	121	15.40
18	8	129	14.60
19	8	138	13.61
20	8	148	12.42



5. Wheat production, cost, and profit when price of wheat is **$9/bushel**.

(1) Wheat Production (1,000 bushels)	(2) Price ($/bushel)	(3) Cost $= 2 \times (1)^{1.4}+15$ ($ 1,000)	(4) Profit = (1)X(2)-(3) ($1,000)
0	9	15.00	-15.00
1	9	17.00	-8.00
2	9	20.28	-2.28
3	9	24.31	2.69
4	9	28.93	7.07
5	9	34.04	10.96
6	9	39.57	14.43
7	9	45.49	17.51
8	9	51.76	20.24
9	9	58.35	22.65
10	9	65.24	24.76
11	9	72.41	26.59
12	9	79.85	28.15
13	9	87.54	29.46
14	9	95.47	30.53
15	9	103.63	31.37
16	9	112.01	31.99
17	9	120.60	32.40
18	9	129.40	32.60
19	9	138.39	32.61
20	9	147.58	32.42



6. Profits when price of wheat is **<u>$5/bushel-$9/bushel</u>**.

Wheat Production	Profit				
	P = $5	P = $6	P = $7	P = $8	P = $9
0	-15.00	-15.00	-15.00	-15.00	-15.00
1	-12.00	-11.00	-10.00	-9.00	-8.00
2	-10.28	-8.28	-6.28	-4.28	-2.28
3	-9.31	-6.31	-3.31	-0.31	2.69
4	-8.93	-4.93	-0.93	3.07	7.07
5	-9.04	-4.04	0.96	5.96	10.96
6	-9.57	-3.57	2.43	8.43	14.43
7	-10.49	-3.49	3.51	10.51	17.51
8	-11.76	-3.76	4.24	12.24	20.24
9	-13.35	-4.35	4.65	13.65	22.65
10	-15.24	-5.24	4.76	14.76	24.76
11	-17.41	-6.41	4.59	15.59	26.59
12	-19.85	-7.85	4.15	16.15	28.15
13	-22.54	-9.54	3.46	16.46	29.46
14	-25.47	-11.47	2.53	16.53	30.53
15	-28.63	-13.63	1.37	16.37	31.37
16	-32.01	-16.01	-0.01	15.99	31.99
17	-35.60	-18.60	-1.60	15.40	32.40
18	-39.40	-21.40	-3.40	14.60	32.60
19	-43.39	-24.39	-5.39	13.61	32.61
20	-47.58	-27.58	-7.58	12.42	32.42

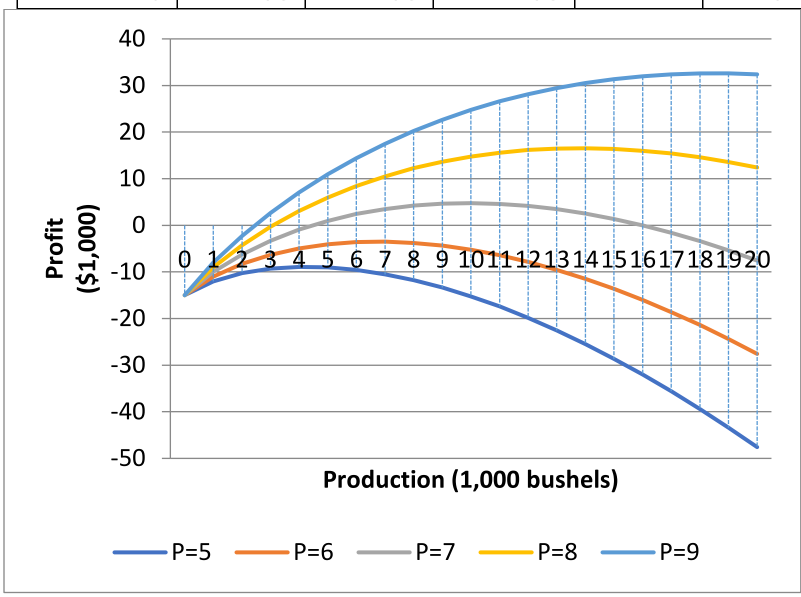


Exhibit B2. Consent Form

This study involves research in economics and it is being conducted by researchers from the University of Minnesota and from Cornell University. The purpose of this study is to test some of the predictions of economic theory. You will spend 60 to 90 minutes in the laboratory playing economic games for money. We will "endow" you with an amount of money ($45 plus $25) which you will use in playing the economic games you will be playing as part of this experiment. Depending on your performance as part of those experimental games, you may win additional money or lose some of the $25 portion of your endowment. You will, however, go home with at least $45 to compensate you for your time. Note, however, that you might go home with an additional $1.31 to $45.16 depending on your performance. Beyond that, there is no direct benefit to participation.

You will face minimal risk by participating in this experiment: the risks include loss of confidentiality and potential embarrassment associated with losing money. You will feel no discomfort at all.

The benefits of this research will be to validate an important and hitherto neglected aspect of economic theory as well as to inform policy makers about an important area of economic policy.

In the interest of confidentiality, we will not be recording your name, but we will be recording some demographic information about you (e.g., age, gender, level of education), and we will obviously be recording your actions in the experimental economic games we will have you play. It will not be possible from the data to tell who you are, and so all the data provided here today is confidential in its strictest sense.

For more information, please contact the Principal Investigator, Professor Marc F. Bellemare, Department of Applied Economics, University of Minnesota, by writing to him at mbellema@umn.edu or calling him at 612-624-1692. You may also contact Ms. Yu Na Lee, PhD student, Department of Economics, University of Minnesota, by writing to her at leex5244@umn.edu or calling her at 213-393-6712, or Professor David R. Just, Dyson School of Applied Economics and Management, Cornell University, by writing to him at drj3@cornell.edu or calling him at 607-255-2086.

Your participation is voluntary, and your refusal to participate will involve no penalty or decrease in benefits to which you are otherwise entitled outside of this experiment. Moreover, you may discontinue participation at any time without penalty or loss of benefits to which you are entitled outside of this experiment.

Name (please print): ____

Date: ____

Signature: ____

Exhibit B3. Instructions Given and Read to the Subjects

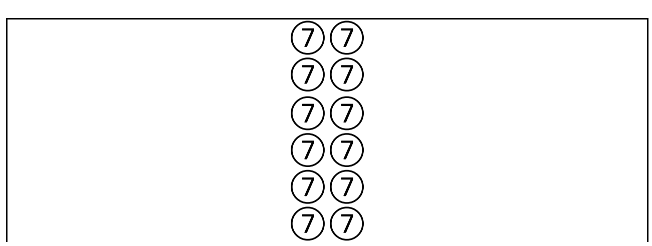
General Instructions

- This is an experiment in the economics of individual decision making. We are trying to understand how people make production decisions when they are unsure of the price they will receive. We have designed simple decision-making games in which we will ask you to make choices in a series of situations.
- There are two sets of games. In the first set of games, you will be making decisions assuming that you are a farmer producing a single commodity, wheat. In the second set of games, you will be given a series of lotteries to choose from. More detailed explanations will follow in each set.
- You will spend 90 to 120 minutes in this study playing economic games. You will automatically receive $45 for participation and in addition may earn between $1.31 and $45.16 depending on your performance and also on the luck on the experiment.

- You should make your own decision and should not discuss your decisions or the decision scenarios with other participants. Also, please turn off your cell phones.
- You need to have a good understanding on how your decisions affect your payoff. Please raise your hand at any time during the session if you have any question.

Set I: Single-Commodity Production Game

- You are a farmer who produces and sells only one commodity, wheat.
- The selling price of wheat in dollars per bushel will be one of the five possible values: $5, $6, $7, $8, and $9, and it will be realized *after* you make your production decision to reflect the real-world output price uncertainty.
- You will be given charts 1 through 5 which document the amount of cost to be incurred according to production levels 0 through 20 (in 1,000 bushels), and the corresponding profit (in $1,000) that will occur *under the five different price scenarios*. These charts contain all the information about how your production decision, cost of production, and your profit relate to one another. Chart 6 is a summary of charts 1 through 5 and shows only the relationship between the production level and the profit.
- Prices will be determined in the following way: In each round, you will be presented a picture of a bag with 20 balls. Each of the 20 balls have different prices (⑤, ⑥, ⑦, ⑧, and ⑨) marked. There are five bags with different composition of balls. In each round, a bag will be selected randomly. The average of the prices marked on the 20 balls will always be $7, but the composition of balls marked with different prices will change each round.
- Given a picture of a bag, you decide how much wheat to produce, knowing *only the composition of prices marked in the bag, not the actual price that will be drawn*.
- Here is an example:



		⑦⑦		
		⑦⑦		
		⑦⑦		
		⑦⑦		
0%	0%	100%	0%	0%

In the bag depicted above, all the balls are marked with price $7. Therefore, you are 100% sure that the wheat price will be $7 per bushel.

		⑦		
	⑥	⑦	⑧	
	⑥	⑦	⑧	
	⑥	⑦	⑧	
⑤	⑥	⑦	⑧	⑨
⑤	⑥	⑦	⑧	⑨
10%	25%	30%	25%	10%

In the bag depicted above, among the 20 balls, there are 2 balls each with $5 and $9 marked, 5 balls each with $6 and $8 marked, and 6 balls with $7 marked. There is a 10% probability that a random draw from this bag will be the price of $5, and a 25% probability for the price of $6, etc. Here is another example.

⑤	⑥	⑦	⑧	⑨
⑤	⑥	⑦	⑧	⑨
⑤	⑥	⑦	⑧	⑨
⑤	⑥	⑦	⑧	⑨
20%	20%	20%	20%	20%

In this bag, we can see that all possible wheat prices are equally likely to occur. In comparison to the last given situation, it is more likely to have more extreme prices than the first round.

- Given such information, you will be asked to choose any integer between 0 and 20 as your production level. You may refer to the charts 1-6 to facilitate your decision.
- Your goal is to maximize the profit (price times quantity produced minus cost of production), since maximizing profit is identical to maximizing your payoff.
- Note that there is no subsistence constraint, meaning that there is no minimum required level of production for your survival. Nor is there a requirement to make a positive profit in order for you to survive. Negative profits mean that you lose some of the money that you are endowed with.
- *After* you have chosen how much to produce, a ball will be drawn randomly from the bag which will determine your selling price. You will sell your wheat at that price, which will determine your profit.
- You will first play 10 rounds of practice games. After the practice games, you will play 20 rounds of the real games. In the real games, your profits will affect your actual payoffs from the games.
- In this set of the games, you start from base payoff of $25. In a given round, your profit will be between -47.58 and 32.61. After the 20 actual rounds, we will randomly select a round. Your payoff from these games will be determined in the following way: $25 base payoff + a half of your profit in the randomly selected round. For example, if you have made a loss of 30 in the

selected round, your final payoff will be $25 + (-$30 X 0.5) = $10. If you have made a profit of 28, your final payoff will be $25 + ($28 X 0.5) = $39.

- Your final payoff in this set of the games will range between $1.21 and $41.31.

Set II: Lottery Choice Game

- In this set of games, you will be presented a table of ten paired lotteries, A and B, from which you are asked to choose one that you prefer.
- Below is an example of the options that you will be given:

Option A	Option B
1/10 of $2.00, 9/10 of $1.60	1/10 of $3.85, 9/10 of $0.10

If you choose option A, there is a probability of 0.1 that you will be receiving $2.00, and a probability of 0.9 that you will be receiving $1.60. If you choose option B, there is a probability of 0.1 that you will be receiving $3.85 which is much bigger than $2.00 in option A. However, there is also a 0.9 probability that you will be receiving only $0.10.

- Stop once you have chosen the option B.
- Your payoff from this round of game will be determined in the following way: A random number will be drawn to determine the row number of one of your choices. Then, according to the probability that the row of the choice dictates, either option A or B will be drawn, which will determine your payoff.
- Your payoff from this round will range between $0.1 and $3.85.

Exhibit B4. Answer Recording Sheet

Set I: Single-Commodity Production Game

- **Practice Rounds**

Round	Choice of Production Level (1,000 bushels)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

- **Actual Rounds**

Round	Choice of Production Level (1,000 bushels)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Set II: Lottery Choice Game

	Option A	Option B	Your Choice (circle one)
1	1/10 of $2.00, 9/10 of $1.60	1/10 of $3.85, 9/10 of $0.10	A , B
2	2/10 of $2.00, 8/10 of $1.60	2/10 of $3.85, 8/10 of $0.10	A , B
3	3/10 of $2.00, 7/10 of $1.60	3/10 of $3.85, 7/10 of $0.10	A , B
4	4/10 of $2.00, 6/10 of $1.60	4/10 of $3.85, 6/10 of $0.10	A , B
5	5/10 of $2.00, 5/10 of $1.60	5/10 of $3.85, 5/10 of $0.10	A , B
6	6/10 of $2.00, 4/10 of $1.60	6/10 of $3.85, 4/10 of $0.10	A , B
7	7/10 of $2.00, 3/10 of $1.60	7/10 of $3.85, 3/10 of $0.10	A , B
8	8/10 of $2.00, 2/10 of $1.60	8/10 of $3.85, 2/10 of $0.10	A , B
9	9/10 of $2.00, 1/10 of $1.60	9/10 of $3.85, 1/10 of $0.10	A , B
10	10/10 of $2.00, 0/10 of $1.60	10/10 of $3.85, 0/10 of $0.10	A , B

Please stop once you have chosen the option B.

❖ **Demographics**

- Age:__________
- Sex: M / F
- Ethnicity/Race:
  (1) Hispanic or Latino
  (2) American Indian or Alaska Native
  (3) Asian
  (4) Black or African American
  (5) Native Hawaiian or Other Pacific Islander
  (6) White
- Nationality: ____________

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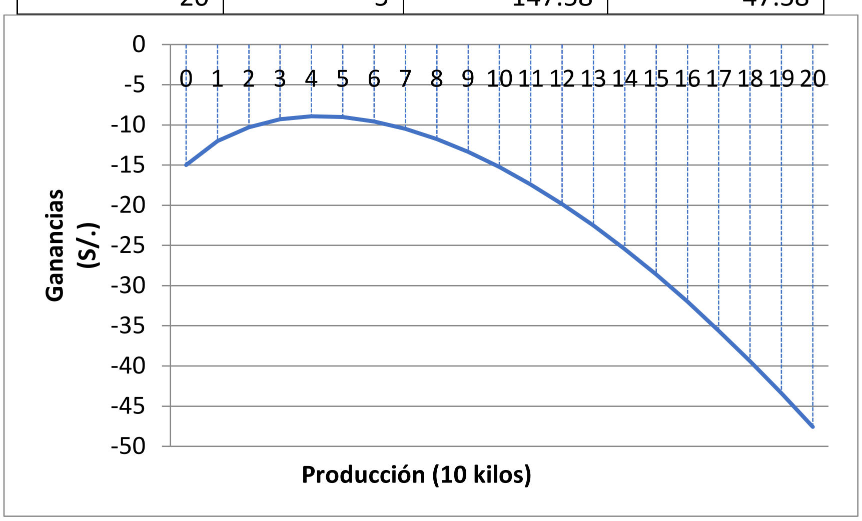
Appendix C: Experimental Protocol and Answer Sheets for Experiments in Peru

Exhibit C1. Production, Price, Cost, and Profit Charts

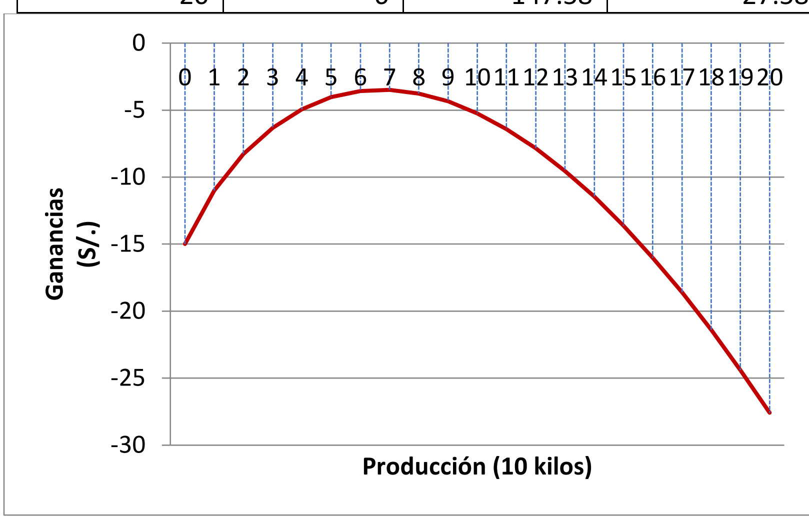
1. La producción de papas, el costo y las ganancias cuando el precio del papas es de S/. 5 / 10 kilos.

(1) Producción de papas (10 kilos)	(2) Precio (S/./10 kilo)	(3) Costo = 2 X $(1)^{1.4}$+15 (S/.)	(4) Ganancias = (1)X(2)-(3) (S/.))
0	5	15.00	-15.00
1	5	17.00	-12.00
2	5	20.28	-10.28
3	5	24.31	-9.31
4	5	28.93	-8.93
5	5	34.04	-9.04
6	5	39.57	-9.57
7	5	45.49	-10.49
8	5	51.76	-11.76
9	5	58.35	-13.35
10	5	65.24	-15.24
11	5	72.41	-17.41
12	5	79.85	-19.85
13	5	87.54	-22.54
14	5	95.47	-25.47
15	5	103.63	-28.63
16	5	112.01	-32.01
17	5	120.60	-35.60
18	5	129.40	-39.40
19	5	138.39	-43.39
20	5	147.58	-47.58



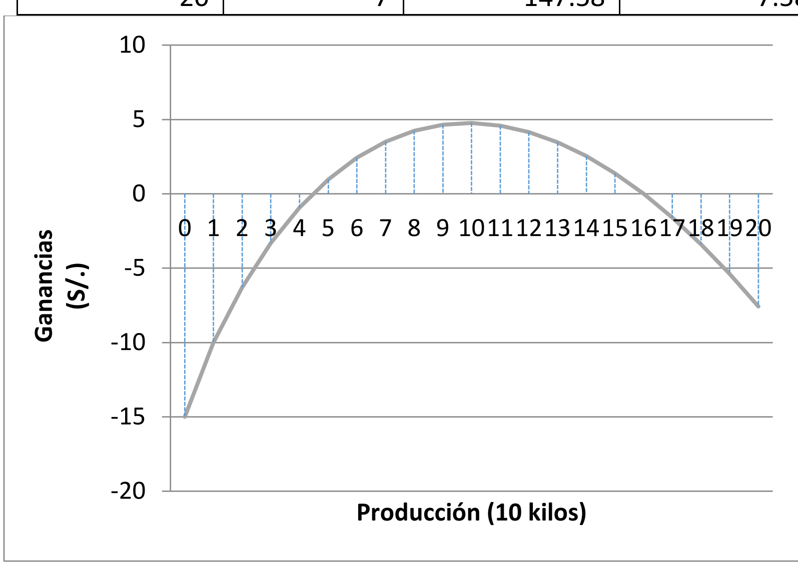
2. **La producción de papas, el costo y las ganancias cuando el precio del papas es de S/. 6 / 10 kilos.**

(1) Producción de papas (10 kilos)	(2) Precio (S/./10 kilo)	(3) Costo = 2 X $(1)^{1.4}$+15 (S/.)	(4) Ganancias = (1)X(2)-(3) (S/.))
0	6	15.00	-15.00
1	6	17.00	-11.00
2	6	20.28	-8.28
3	6	24.31	-6.31
4	6	28.93	-4.93
5	6	34.04	-4.04
6	6	39.57	-3.57
7	6	45.49	-3.49
8	6	51.76	-3.76
9	6	58.35	-4.35
10	6	65.24	-5.24
11	6	72.41	-6.41
12	6	79.85	-7.85
13	6	87.54	-9.54
14	6	95.47	-11.47
15	6	103.63	-13.63
16	6	112.01	-16.01
17	6	120.60	-18.60
18	6	129.40	-21.40
19	6	138.39	-24.39
20	6	147.58	-27.58



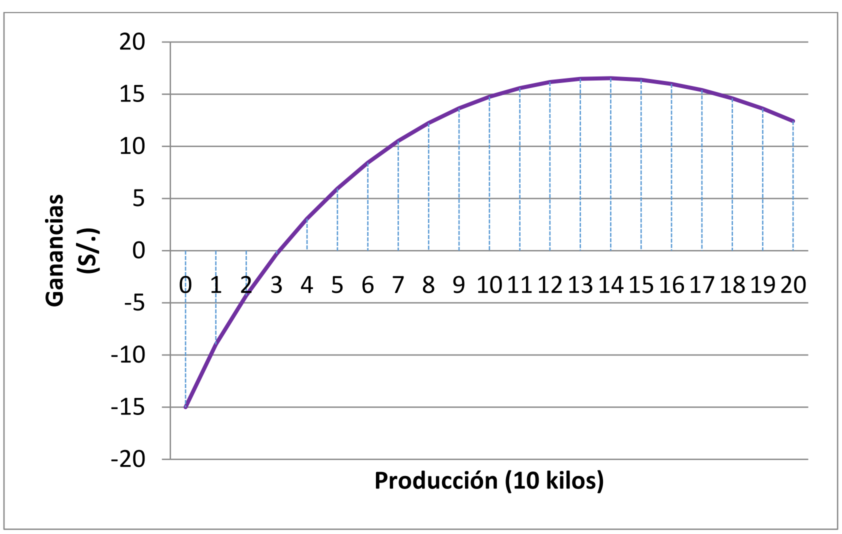
3. La producción de papas, el costo y las ganancias cuando el precio del papas es de S/. 7 / 10 kilos.

(1) Producción de papas (10 kilos)	(2) Precio (S/./10 kilo)	(3) Costo $= 2 X (1)^{1.4}+15$ (S/.)	(4) Ganancias = (1)X(2)-(3) (S/.))
0	7	15.00	-15.00
1	7	17.00	-10.00
2	7	20.28	-6.28
3	7	24.31	-3.31
4	7	28.93	-0.93
5	7	34.04	0.96
6	7	39.57	2.43
7	7	45.49	3.51
8	7	51.76	4.24
9	7	58.35	4.65
10	7	65.24	4.76
11	7	72.41	4.59
12	7	79.85	4.15
13	7	87.54	3.46
14	7	95.47	2.53
15	7	103.63	1.37
16	7	112.01	-0.01
17	7	120.60	-1.60
18	7	129.40	-3.40
19	7	138.39	-5.39
20	7	147.58	-7.58



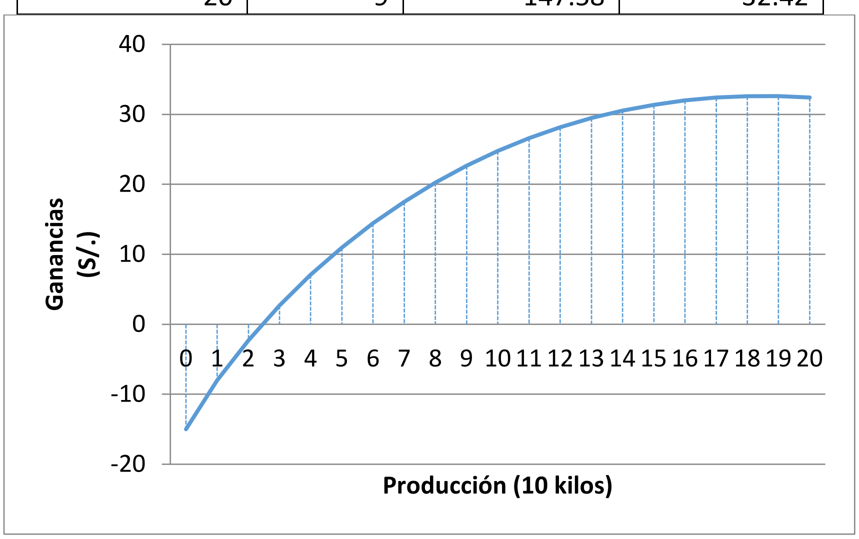
4. **La producción de papas, el costo y las ganancias cuando el precio del papas es de S/. 8 / 10 kilos..**

(1) Producción de papas (10 kilos)	(2) Precio (S/./10 kilo)	(3) Costo $= 2 \text{ X } (1)^{1.4}+15$ (S/.)	(4) Ganancias = (1)X(2)-(3) (S/.))
0	8	15.00	-15.00
1	8	17.00	-9.00
2	8	20.28	-4.28
3	8	24.31	-0.31
4	8	28.93	3.07
5	8	34.04	5.96
6	8	39.57	8.43
7	8	45.49	10.51
8	8	51.76	12.24
9	8	58.35	13.65
10	8	65.24	14.76
11	8	72.41	15.59
12	8	79.85	16.15
13	8	87.54	16.46
14	8	95.47	16.53
15	8	103.63	16.37
16	8	112.01	15.99
17	8	120.60	15.40
18	8	129.40	14.60
19	8	138.39	13.61
20	8	147.58	12.42



5. La producción de papas, el costo y las ganancias cuando el precio del papas es de S/. 9 / 10 kilos.

(1) Producción de papas (10 kilos)	(2) Precio (S/./10 kilo)	(3) Costo $= 2 \text{ X } (1)^{1.4}+15$ (S/.)	(4) Ganancias = (1)X(2)-(3) (S/.))
0	9	15.00	-15.00
1	9	17.00	-8.00
2	9	20.28	-2.28
3	9	24.31	2.69
4	9	28.93	7.07
5	9	34.04	10.96
6	9	39.57	14.43
7	9	45.49	17.51
8	9	51.76	20.24
9	9	58.35	22.65
10	9	65.24	24.76
11	9	72.41	26.59
12	9	79.85	28.15
13	9	87.54	29.46
14	9	95.47	30.53
15	9	103.63	31.37
16	9	112.01	31.99
17	9	120.60	32.40
18	9	129.40	32.60
19	9	138.39	32.61
20	9	147.58	32.42



6. Las ganancias cuando los precios van desde S/. 5 a S/. 9 por 10 kg

Producción de papas (en 10 kilos)	Ganancias				
	P = S/.5	P = S/.6	P = S/.7	P = S/.8	P = S/.9
0	-15.00	-15.00	-15.00	-15.00	-15.00
1	-12.00	-11.00	-10.00	-9.00	-8.00
2	-10.28	-8.28	-6.28	-4.28	-2.28
3	-9.31	-6.31	-3.31	-0.31	2.69
4	-8.93	-4.93	-0.93	3.07	7.07
5	-9.04	-4.04	0.96	5.96	10.96
6	-9.57	-3.57	2.43	8.43	14.43
7	-10.49	-3.49	3.51	10.51	17.51
8	-11.76	-3.76	4.24	12.24	20.24
9	-13.35	-4.35	4.65	13.65	22.65
10	-15.24	-5.24	4.76	14.76	24.76
11	-17.41	-6.41	4.59	15.59	26.59
12	-19.85	-7.85	4.15	16.15	28.15
13	-22.54	-9.54	3.46	16.46	29.46
14	-25.47	-11.47	2.53	16.53	30.53
15	-28.63	-13.63	1.37	16.37	31.37
16	-32.01	-16.01	-0.01	15.99	31.99
17	-35.60	-18.60	-1.60	15.40	32.40
18	-39.40	-21.40	-3.40	14.60	32.60
19	-43.39	-24.39	-5.39	13.61	32.61
20	-47.58	-27.58	-7.58	12.42	32.42

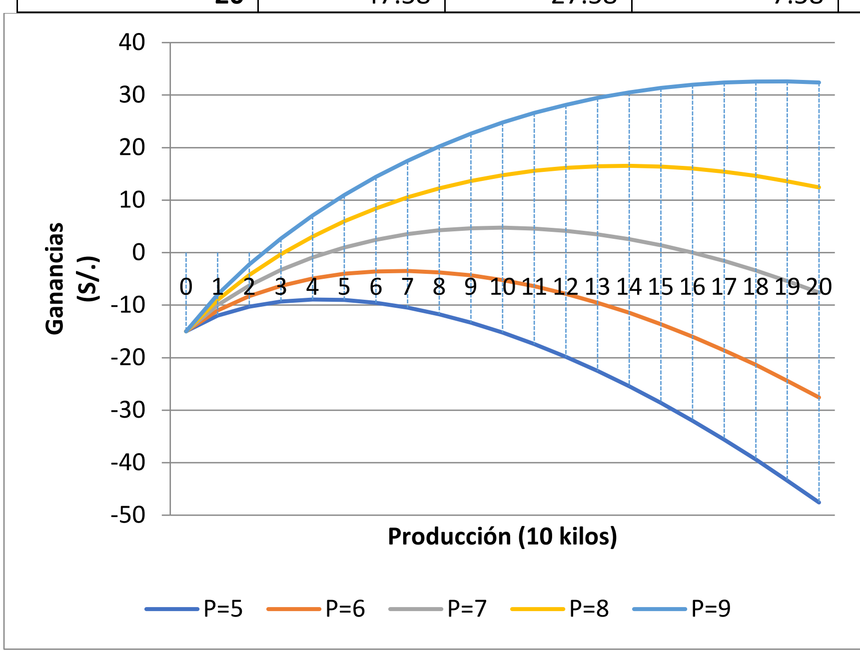


Exhibit C2. Consent Form

Formulario de consentimiento

Usted está siendo invitado a ser parte de un estudio de investigación en el área económica que está conducido por investigadores de la University of Minnesota y Cornell University. El objetivo del estudio es probar algunas teorías económicas que esperaríamos encontrar. Su tiempo de compromiso esperado para este estudio es de 60 a 90 minutos en el cual usted estaría practicando algunos juegos experimentales con el uso del dinero. Les corresponderíamos un monto de S/. 45 + un promedio de S/. 25 que usted utilizará para participar a los juegos de economía y que son parte del estudio. Dependiendo de su rendimiento en estos juegos experimentales, usted podrá ganar o perder una parte de los S/. 25 que se le va a corresponder para el juego. De toda forma, usted recibirá un mínimo de S/. 45 como compensación de su tiempo con nosotros. Además, usted puede recibir un monto adicional entre S/. 1.51 y S/. 52.86 dependiendo de su rendimiento en los juegos. A parte esto, no hay beneficios directos asociados a este estudio.

Usted enfrentará un riesgo mínimo en participar en esta investigación: falta de confidencia y potencial vergüenza asociada en perder algo de dinero. No habrá ningún tipo de incomodidad. Los beneficios de esta investigación serán particularmente relevante para validar algunos aspectos que hasta ahora no han sido debidamente explorados en la teoría económica e informar los hacedores de política en poner más atención a temas de políticas económicas.

Todos los datos registrados en este estudio serán confidenciales y sus respuestas serán privadas: no estaremos registrando su nombre, pero si alguna información demográfica (edad, sexo, nivel de educación), además de sus acciones en este juego económico experimental. No incluiremos ninguna información que pueda hacer posible identificarlo/a.

Para mayores informaciones, por favor contactarse con el Investigador Principal, el Profesor Marc F. Bellemare, Departamento de Economía Aplicada, University of Minnesota, a su correo mbellema@umn.edu o llamarle a su número +1-612-624-1692. También puedes contactarte con Ms. Yu Na Lee, estudiante de Doctorado, en el Departmento de Economía Aplicada, University of Minnesota, a su correo leex5244@umn.edu o llamandola al +1-213-393-6712, o el Professor David R. Just, Dyson School of Applied Economics and Management, Cornell University, a su correo drj3@cornell.edu o a su teléfono +1-607-255-2086.

Su participación es totalmente voluntaria: usted puede decidir si participar o no en la encuesta y no hay problemas si es que decide no participar. También, puede detenerla en cualquier momento o no responder preguntas que no te gusten. No estará recibiendo ninguna penalidad o pérdida de beneficios en todo lo que no concierne este estudio.

Nombre (en mayúscula): ____

Fecha: ____

Firma: ____

Exhibit C3. Instructions for Enumerators

Hoja de respuesta individual

1. Código del encuestador:	_____	(1 = Marcela; 2 = Nadesca).
2. Código del encuestado:	_____	(1-24 = Juego Risk encuestado por Marcela;
		25-48 = Juego Risk encuestado por Nadesca;
		49-72 = Juego Ambiguity encuestado por Marcela;
		73-96 = Juego Ambiguity encuestado por Nadesca).

<u>Instrucciones</u>: Empieza leyendo el consentimiento informado al encuestado. Asegúrate que escribió bien su nombre, su firma y puso la fecha.

Preguntas de revisión

<u>Instrucciones</u>: Hágale al encuestado las siguientes 2 preguntas. Si se equivoca en más de <u>una</u> respuesta, agradécele de su disponibilidad y sigues con otro encuestado.

2. 1. ¿Cuál es el 40% de S/. 100? S/. _____.

2. 2. Si existe el 25% de posibilidad que llueva, ¿cuál es el porcentaje de posibilidad que no llueva? _____.

2. 3. Imagina sortear una pelota en una bolsa que contiene 3 pelotas azules y 7 pelotas rojas. ¿Cuál es la probabilidad de que puedas escoger una pelota de color azul? _____.

<u>Instrucciones</u>: Lees el texto siguiente.

"Este cuestionario presenta unas pocas preguntas sobre usted y les pedirá jugar en dos juegos económicos con dinero real con el objetivo de testear teoría económica. No hay respuestas correctas o incorrectas. Porque su desempeño en los dos juegos dictara cuánto dinero podrá ganar, tú tienes que hacer su mejor en ambos juegos."

Preguntas de información demográfica:

3.1 ¿Cuál es su edad (en años)? ______

3.2 ¿Es hombre o mujer? Por favor seleccione una opción M F

3.3 ¿Cuál es el nivel educativo más alto alcanzado?

3.3.1. Educación inicial
3.3.2. Educación primaria
3.3.3. Educación secundaría
3.3.4. Universidad

3.3.5. Instituto técnico

3.3.6. Otro

3.4. ¿Usted cultiva papas? _____ (1= Sí; 2= No.)

Instrucciones: Por favor avise al encuestado que, en virtud de haber contestado las preguntas de arriba, ha ganado un pago por su participación de S/. 45, pero que está por jugar dos sets de juegos donde podrá ganar dinero adicional entre los rangos de S/. 1.51 to S/. 52.86 dependiendo en su desempeño y en su suerte.

Instrucciones: Tira un dado de 6 lados (D6)

4.1 Registra el número aquí: _____

Instrucciones: Para 1-2-3, juega el juego de producción primero, después el juego de la lotería; para 4-5-6 juega el juego de la lotería primero, después finaliza con el juego de producción.

Si juega el juego de producción primero, ve a la siguiente página 4.

Si tú juegas el juego de la lotería primero, ve a la página 8.

5. Juego de producción

Instrucciones: lees el texto siguiente:

“Este es un estudio de economía de toma de decisiones individuales. Nosotros tratamos de entender como las personas toman decisiones de producción cuando no tienen conocimiento del precio que recibirán por su producto. También, hemos diseñado simples juegos de decisión donde le preguntaremos que tome decisiones en una serie de situaciones diferentes.

Para este juego, usted comienza con un capital de S/. 25 Soles, donde puede perder casi todo y terminar con S/. 1.21 soles o ganar más dinero y terminar con S/. 41.31. Ambas son la ganancia mínima o máxima, sin embargo en la mayoría de los casos, usted podrá ganar un valor entre este rango por ser parte del juego.

Usted necesita tener una buena comprensión en como su decisión puede afectar su paga. Por favor avísame en cualquier momento durante la sesión si tiene alguna pregunta.

Imagine que usted es un agricultor que produce y vende únicamente un bien/producto, papas.

El precio de venta de un saco de 10 kg de papa en soles (S/.) será uno de 5 valores posibles: 5, 6, 7, 8, o 9, y este será dado después que usted tome su decisión de producción para reflejar la incertidumbre del precio de venta del mundo real.

Recibirá unas tablas/imágenes del 1 hasta el 5 donde se documenta la cantidad de costo que se debe incurrir acorde al nivel de producción que va del 0 al 20 (en 10 kilos), y la correspondiente ganancia (en S/.) que ocurriría bajo las 5 diferentes posibilidades de precios. Estas tablas contienen toda la información acerca de cómo tu decisión de producción, costos de producción, y la ganancia se relacionan entre ellos. La tabla 6 es un resumen de las tablas del 1 al 5 y muestra únicamente la relación entre el nivel de producción y la ganancia.

Instrucciones: Oriente al participante en como leer las tablas. Dígales que ellos son libres de inspeccionar los sacos al finalizar del juego si quieren estar seguros que efectivamente representan a los números presentes en las tablas.

Instrucciones: Ahora, es necesario que el participante tenga conocimiento de cómo el precio será determinado. Lea lo siguiente al encuestado:

"Los precios se determinaran de la siguiente manera: en cada ronda, se te presentará una imagen de un saco con 20 bolas. Cada una de las 20 bolas tienen distintos precios (5, 6, 7, 8, y 9) asignados. Hay 5 sacos con distintas composiciones de 20 bolas. En cada ronda, una bolsa será seleccionada aleatoriamente. El promedio de precios asignado en las 20 bolas será siempre S/. 7, pero la composición de bolas asignadas por diferentes precios cambiara en cada ronda."

Dada una imagen de un saco, tú decides cuantos sacos de papas producir, conociendo solo la composición de precios asignadas en el saco, no el precio actual que será sorteado.

Este es un ejemplo (muestra la imagen del escenario 0). En el saco mostrado aquí, en todas las bolas se les asignó el precio de S/.7. Por lo tanto, tú estás 100% seguro que el precio de la papa será 7 Soles por saco de papas.

Aquí hay otro ejemplo (muestra la imagen del escenario 2). En el saco mostrado aquí, entre las 20 bolas hay dos bolas cada una con S/. 5 y S/. 9 asignados, 5 bolas con 6 S/. y 8 s/. , y 6 bolas con S/.7 marcados. Hay un 10 % de probabilidad de que haciendo un sorteo aleatorio de este saco el precio será S/. 5, un 25% de probabilidad que el precio sea S/. 6, etc.

Aquí hay otro ejemplo (muestra la imagen del escenario 3). En esta bolsa, podemos ver que todos los posibles precios de la papa puedan darse por igual. En comparación con las últimas situaciones mostradas, es probable de tener más precios extremos que los casos anteriores.

Dada esta información, se te preguntara que escojas un nivel de producción entre 0 a 20. Puedes referirte a las tablas 1-6 para facilitar tu decisión.

Nota que no hay una restricción de subsistencia, lo que significa que no hay un nivel mínimo requerido de producción para tu supervivencia. Tampoco hay un requerimiento para obtener una ganancia positiva para que sobrevivas. Ganancias negativas significa que pierdes algo del capital (S/.25) que se te ha entregado.

Después de que hayas escogido cuanto producir, una bola será sorteada aleatoriamente del saco la cual determinará el precio de venta. Tú podrás vender tus papas a este precio, y con esto se determinará tu ganancia.

Usted primero jugara 10 rondas de práctica. Después de los juegos de práctica, jugarás 20 rondas reales de juego. En los juegos verdaderos, tus ganancias van a afectar tus actuales pagos en los juegos.

En este set de juegos, tú comienzas con un capital de S/.25. En cada ronda, tus ganancias estarán entre "- 47.58 y 32.61". Después de 20 actuales rondas, nosotros al azar seleccionaremos una ronda. Tu paga de este juego se determinara de la siguiente forma: S/. 25 de capital base + la mitad de la ganancia en la ronda seleccionada al azar. Por ejemplo, si tú has tenido una pérdida de 30 Soles en la ronda seleccionada, tu pago final será S/. 25 + (S/. -30 X 0.5) = S/. 10. Si, en cambio, has tenido una ganancia positiva de 28, tu pago final será S/. 25 + (S/. 28 X 0.5) = S/. 39.

Tu pago final en este set de juegos será entre el rango de S/. 1.21 y S/. 41.31."

Instrucciones:

Muestre las imágenes en el dado para ayudar a los encuestados a entender el proceso de aleatorización. Recuerda usar un dado de 6 lados (D6) y un dado de cuatro lados (D4) para este juego. El tiro del D6 determinará a qué precio se enfrentará el encuestado (escenario 0) de S/. 7 o un precio incierto, como sigue:

1-2 = Precio certero (escenario 0, o precio de S/. 7);

3-4-5-6 = Precio incierto. Para estos precios inciertos tire el D4.

El tiro del D4 determinará en cuál escenario el participante se encuentra:

1 = escenario 1,

2 = escenario 2,

3 = escenario 3,

4 = escenario 4.

Cada escenario corresponde al número en su bolsa de bolas de ping pong.

Muestre al sujeto la tabla/imagen para el escenario relevante. Anote el escenario en la parte de abajo de la hoja de respuestas. Dígale que usted al azar extraerá el precio de la bolsa por ese escenario, y que el realice lo que cree sea su mejor decisión de producción. Una vez que haya decido cuanto producir, anote su decisión de producción para esta ronda en la hoja de respuesta. Sucesivamente, el encuestado puede escoger su un precio de la bolsa. Registra el precio y deja que el encuestado mire cuanto es lo que ha ganado o ha perdido en esta ronda, de acuerdo a su decisión de producción y bola extraída.

5.1. Rondas de Práctica

Instrucciones: Dígale al encuestado que el ahora estará jugando 10 ronda de práctica que lo ayudaran a entender mejor el juego. Avísele que las ganancias que tenga en estas rondas no afectaran su pago actual.

5.1.1. Ronda	**5.1.2.Escenario (0 a 4)**	**5.1.3. Producción de papas (0 a 20)**	**5.1.4. Precio (5 a 9)**	**5.1.5. Ganancias (-47.58 a 32.61)**
1				
2				
3				

4				
5				
6				
7				
8				
9				
10				

<u>Instrucciones:</u> Después de terminar las rondas de práctica, pregunta al encuestado si tiene alguna pregunta. Contesta su pregunta lo mejor que puedas. Una vez que su pregunta haya sido contestada, muévete a las rondas reales.

5.2. Rondas Reales

<u>Instrucciones</u>: Ahora, explica al encuestado que a pesar que hayan 20 rondas solo una se pagará, y se determinará al final al azar, así que tendrá todo el incentivo de hacer lo que cree sea lo mejor en cada ronda. Registre la información de la misma manera que en la 10 rondas de práctica.

5.2.1 Ronda	**5.2.2. Escenario (0 a 4)**	**5.2.3. Producción de papas (0 a 20)**	**5.2.4. Precio (5 a 9)**	**5.2.5. Ganancias (-47.58 a 32.61)**
1				
2				
3				
4				
5				
6				
7				
8				
9				

10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Instrucciones: Realiza la siguiente pregunta al encuestado:

“Fue el juego fácil de entender?”

Registra la respuesta aquí:____(1=Sí; 2 = No.)

Instrucciones: Si tú has jugado el juego de producción primero, ve a la siguiente página del juego de lotería. Si tú has jugado primero el juego de lotería, ve a la página 9, la sesión de pago.

6. Juego de Lotería

Instrucciones: Muestre la hoja con las bolsas de colores correspondientes. Lea lo siguiente al encuestado.

En este set de juego, se le presentara una tabla de 10 pares de loterías, opción A y opción B, donde se le preguntara que escoja la que prefiere.

Aquí hay un ejemplo de las opciones que se te dará (muestra la primera fila al encuestado). Si escoges la opción A, hay un 10% de probabilidad que tu recibirás S/. 6, y un 90% de probabilidad que tu recibas S/.4.8. Si escoges la opción B, hay un 10 % de probabilidad que tu recibirás S/. 11.55 lo cual es mucho más grande que S/.6 en la opción A. Sin embargo, también hay un 90% de probabilidad que tú puedas recibir solo S/. 0.3.

Si escoges la opción A, muévete a la siguiente fila. Para una vez que escojas la opción B.

Tu paga por este juego de lotería se determinara de la siguiente forma: un número al azar entre 1 a 10 se realizara para determinar el número de fila de una de tus elecciones. Después, de acuerdo a la elección que tú realices, una de la lotería A o B será extraída, y esto determinará tu pago.

El pago de esta ronda será entre el rango de S/. 0.3 y S/. 11.55.”

<u>Instrucciones:</u> Ahora, ve línea por línea. Por cada línea, pregunta al sujeto si prefiere la lotería A o la lotería B. Recuerda: ana vez que el sujeto escoja B, el juego para - nosotros asumimos que escogen B por el resto de líneas. Tú simplemente necesitas registrar la línea en la que se dé el cambio de A a B.

	Opción A	**Opción B**	**Su elección** **(Marque una)**
1	1/10 de S/. 6.00, 9/10 de S/. 4.80	1/10 de S/. 11.55, 9/10 de S/. 0.30	A B
2	2/10 de S/. 6.00, 8/10 de S/. 4.80	2/10 de S/. 11.55, 8/10 de S/. 0.30	A B

3	3/10 de S/. 6.00, 7/10 de S/. 4.80	3/10 de S/. 11.55, 7/10 de S/. 0.30	A B
4	4/10 de S/. 6.00, 6/10 de S/. 4.80	4/10 de S/. 11.55, 6/10 de S/. 0.30	A B
5	5/10 de S/. 6.00, 5/10 de S/. 4.80	5/10 de S/. 11.55, 5/10 de S/. 0.30	A B
6	6/10 de S/. 6.00, 4/10 de S/. 4.80	6/10 de S/. 11.55, 4/10 de S/. 0.30	A B
7	7/10 de S/. 6.00, 3/10 de S/. 4.80	7/10 de S/. 11.55, 3/10 de S/. 0.30	A B
8	8/10 de S/. 6.00, 2/10 de S/. 4.80	8/10 de S/. 11.55, 2/10 de S/. 0.30	A B
9	9/10 de S/. 6.00, 1/10 de S/. 4.80	9/10 de S/. 11.55, 1/10 de S/. 0.30	A B
10	10/10 de S/. 6.00, 0/10 de S/. 4.80	10/10 de S/. 11.55, 0/10 de S/. 0.30	A B

6.1 En que línea el concursante empieza a escoger B en vez de A?

Instrucciones: Realiza la siguiente pregunta al encuestado:

“El juego fue fácil de entender?”

Registra la respuesta aquí:____(1=Sí; 2 = No.)

Instrucciones: Instrucciones: si has jugado el juego de producción primero, ve a la siguiente página e inicia la sesión de pago. Si has jugado primero el juego de lotería, ve a la página 4 donde encuentras el juego de producción.

Pago

Instrucciones: lea lo siguiente al encuestado: "Por participar en estos juego y contestar unas breves preguntas demográficas, usted ha ganado S/. 45 como cuota de participación. Ahora nosotros determinaremos su pago por el juego de producción y el juego de la Lotería."

Instrucciones: Haga que el participante tire el dado de 20 lados para determinar en cuál ronda del juego de producción será la ronda de pago.

7.1 Registre el tiro de dado del encuestado aquí: _____

Instrucciones: Mirando la cantidad producida por el encuestado y el precio generado en la ronda seleccionada aleatoriamente arriba, y del precio en las tablas, asegúrese de registrar correctamente la ganancia.

Después de haber confirmado la ganancia, lea al encuestado lo siguiente: "Por el juego de producción, su pago será de S/. 25 más la mitad de (indicar la pérdidas o ganancias en la ronda de paga)."

7.2 Registra el pago del juego de producción del encuestado aquí: ______

Instrucciones: Haga que el encuestado tire un dado de 10 lados para determinar en cuál de las 10 rondas de juego de lotería estará la ronda de pago.

7.3 Registra el tiro del dado del encuestado aquí: ____

Instrucciones: Mira la línea del juego de la lotería que corresponde al número que salió en el tirar el dado. Si el encuestado escogió A para esa línea, hágale jugar en la lotería A; si el encuestado escogió B para esa línea, hágale jugar en la lotería B. Recuerde al participante que el cero en el dado de 10 lados significa "10". Mira la tabla de producción por visualizar la ganancia por cada cantidad.

Después de determinar cuánto el encuestado ha ganado, léale lo siguiente: "Por el juego de la lotería, su pago será (indicar la ganancia o pérdida en el juego de la lotería)."

7.4 Registre el pago por el juego de la lotería del encuestado aquí: ____.

Instrucciones: Dígale al encuestado: "Sus ganancias de hoy día son S/. 45 por su participación más S/. X por su desempeño en el juego de producción más S/. Y por su desempeño en el juego de la lotería. Todo esto por un monto total de S/. ¡Felicitaciones, y gracias por su ayuda!"

7.5 Registre el pago final por todo el experimento del encuestado aquí: ______

Instrucciones: Haga que el encuestado firme el recibo.

FIN

Exhibit C4. Visual Aid for the Holt and Laury (2002) List Experiment

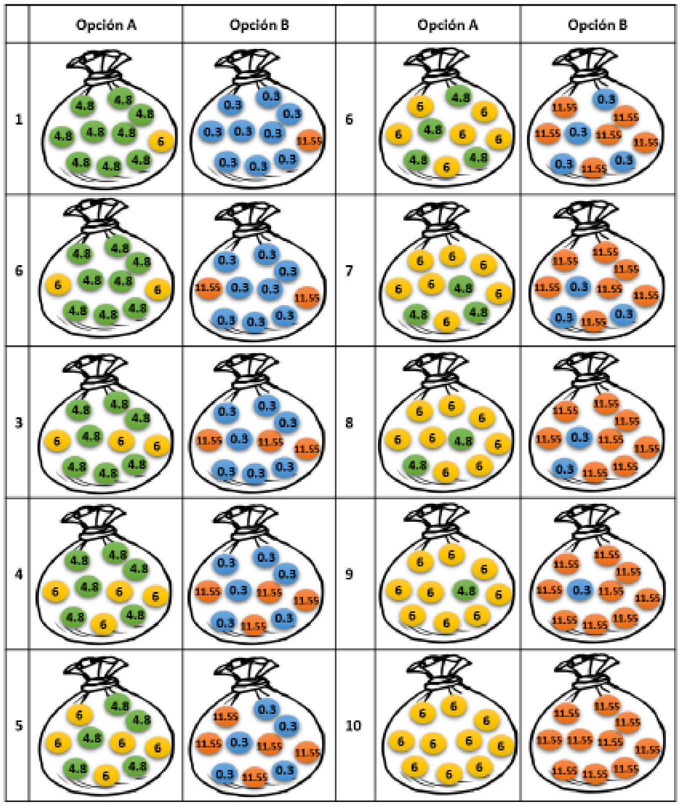


Exhibit C5. Visual Aid for the Price Risk Game I

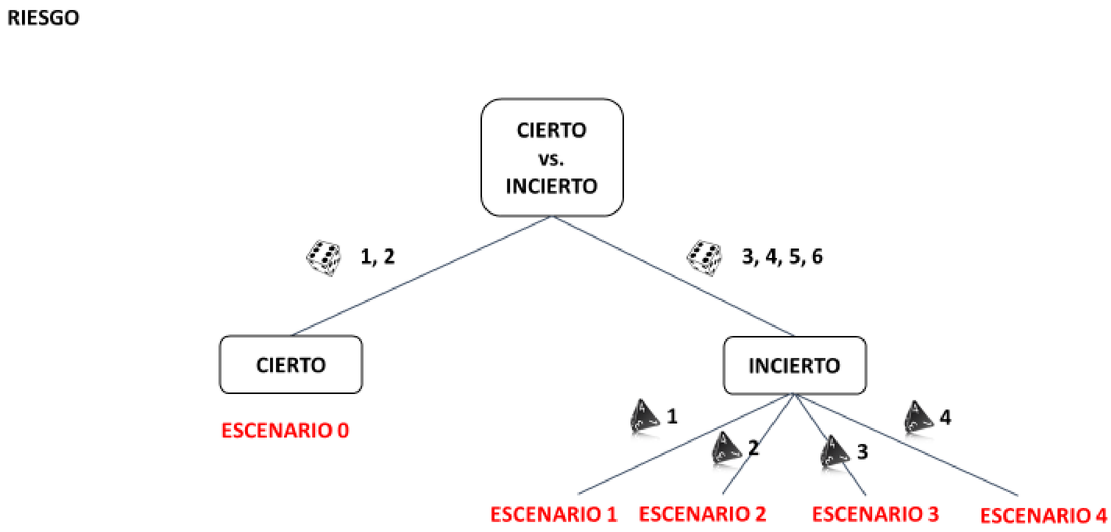
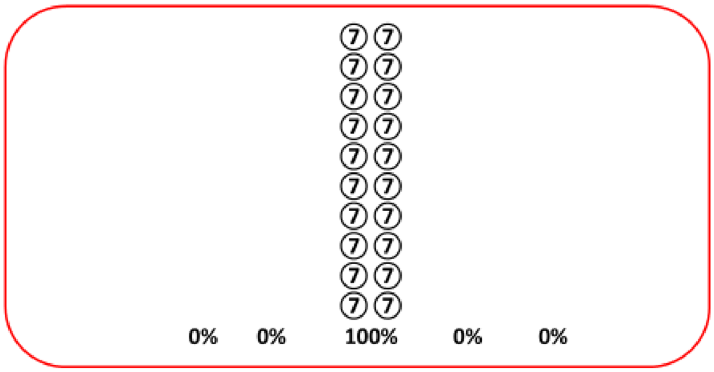


Exhibit C6. Visual Aids for the Price Risk Game II

Escenario 0

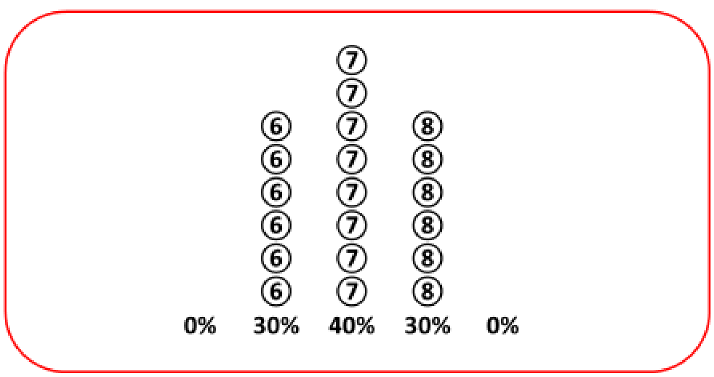
- Hay 20 bolas en la bolsa marcados con precios de S/. 5, S/. 6, S/. 7, S/. 8 y S/. 9. El número de bolas marcadas con cada precio se muestra en la siguiente imagen.



- Escriba su opción de entrada (0-20) en la hoja de respuestas .

Escenario 1

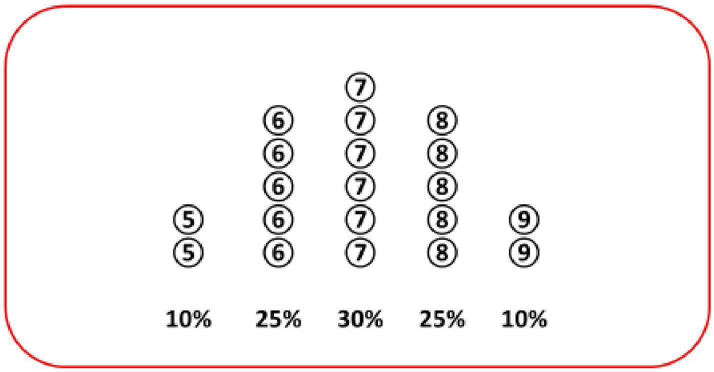
- Hay 20 bolas en la bolsa marcados con precios de S/. 5, S/. 6, S/. 7, S/. 8 y S/. 9. El número de bolas marcadas con cada precio se muestra en la siguiente imagen.



- Escriba su opción de entrada (0-20) en la hoja de respuestas .

Escenario 2

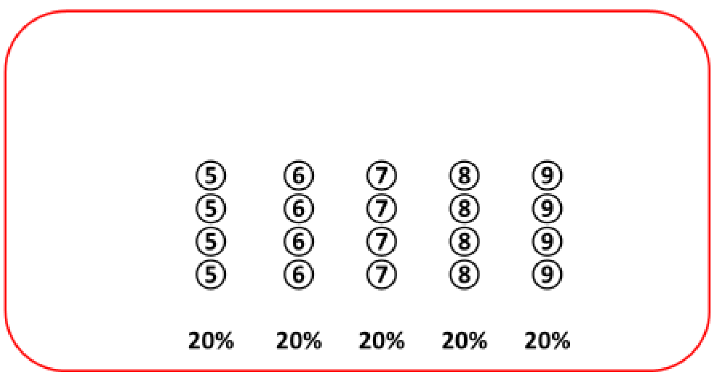
- Hay 20 bolas en la bolsa marcados con precios de S/. 5, S/. 6, S/. 7, S/. 8 y S/. 9. El número de bolas marcadas con cada precio se muestra en la siguiente imagen.



- Escriba su opción de entrada (0-20) en la hoja de respuestas .

Escenario 3

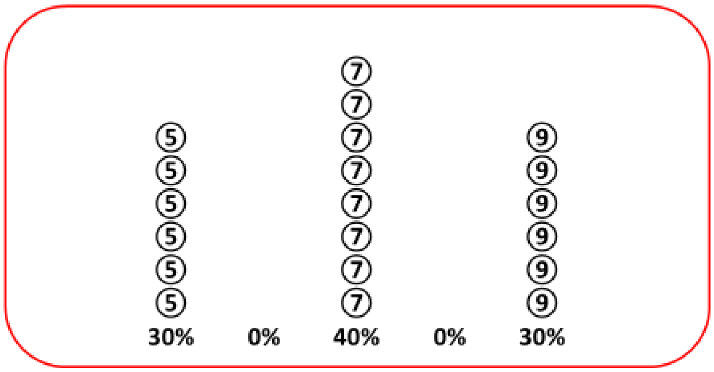
- Hay 20 bolas en la bolsa marcados con precios de S/. 5, S/. 6, S/. 7, S/. 8 y S/. 9. El número de bolas marcadas con cada precio se muestra en la siguiente imagen.



- Escriba su opción de entrada (0-20) en la hoja de respuestas .

Escenario 4

- Hay 20 bolas en la bolsa marcados con precios de S/. 5, S/. 6, S/. 7, S/. 8 y S/. 9. El número de bolas marcadas con cada precio se muestra en la siguiente imagen.



- Escriba su opción de entrada (0-20) en la hoja de respuestas .