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Essays on Behavioral Economics in Climate Change Adaptation

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ABSTRACT

ESSAYS ON BEHAVIORAL ECONOMICS IN CLIMATE CHANGE ADAPTATION

BY

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Climate scientists have predicted an increase in weather variability in the last decades that will continue in the future. My dissertation focuses on understanding the behavioral factors that encourage household adaptation to climate change and testing the effectiveness of one popular policy recommendation taking into account behavioral factors.

Since climate change is fundamentally an intertemporal decision under risk, time and risk preferences will shape how individuals and groups adapt on their own and in response to public policies and programs. Applying recent developments in experimental designs and estimators, in my first chapter I conduct field experiments to characterize time and risk preferences in a rural population in the western, arid region of Costa Rica, targeted by policymakers for climate change adaptation investments. Decisions about these investments are often made at the household-level, rather than at the individual-level. Thus, I expand on previous experimental studies by characterizing time and risk preferences at both the levels of individuals and married couples. My results show that

people are impatient and optimistic, that couples are more impatient than individuals and that the preferences of married couples are the ones that best described the household adaptation decision.

Being optimistic and impatient requires adaptation technologies that offer immediate benefits even when no drastic weather changes occur, like resource-conserving technologies. In my second chapter, I report the results from a randomized controlled trial to test the impact of water-efficient technology adoption on water use in the same area in Costa Rica. The adoption of such technologies has been highlighted in numerous government and multilateral plans as a key component of climate change adaptation strategies even though no rigorous studies have been implemented. My experimental estimate is 11%, which is economically and statistically lower than what engineers estimate (up to 35%). I explore the reasons why the experimental estimator differs from the predicted impacts using an engineering estimation approach. Finally, I perform a cost-benefit analysis, and compare the discounted expected utility of purchasing and not purchasing the technology.

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ACCEPTANCE

This dissertation was prepared under the direction of María Nilda Bernedo Del Carpio's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctoral of Philosophy in Economics in the Andrew Young School of Policy Studies of Georgia State University.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Climate scientists are predicting that weather variability and the probability of extreme weather events will continue to increase. Societies will need to adapt to the consequences of these changes, which include droughts, floods, and heat waves. Even though governments may invest in major infrastructure projects, climate change adaptation will also lead to investments at the private level. My dissertation compiles two essays that analyze household preferences and behavior to help understand private adaptation decisions and outcomes. It highlights important challenges for policymakers that want to encourage private adaptation investments, and explores the use of resource-conserving technologies as a potential solution.

Since climate change adaptation requires a certain investment today in exchange for uncertain benefits in the future, adaptation investments are strongly influenced by people's preferences over risk and time. To better understand these preferences and their influence on climate change adaptation decisions and policy design, I conduct an artefactual field experiment with a rural population in the western, arid part of Costa Rica. This study, which applies recent developments in experimental designs and econometric estimation, is my first dissertation essay, entitled "*Household Time and Risk Preferences and Adaptation to Climate Change*". I find that people are predominantly optimistic, in the sense that they tend to overweigh the likelihood of positive outcomes. And even though people do not exhibit a present-bias, they exhibit high subjective discount rates (around 30% per annum). Furthermore, I connect households' levels of impatience and optimism to their private adaptation decisions in home water tanks, which some of them purchased to protect themselves against water variability over the year, and find a negative correlation in both cases. This points to significant challenges for policymakers looking to encourage private adaptation decisions.

One potential solution is to pursue policies that offer households short-term benefits, even in the absence of weather variability. A prime example for such a measure could be resource-conserving technologies, which I explore in my second essay.

To address water scarcity now and in the future, governments and multilateral agencies have encouraged people to adopt technologies that increase the efficiency of water use. However, the popularity of this technological solution is based on engineering estimates of demand reduction that rely on many unverified assumptions about field conditions and household behavioral responses to technology adoption. The actual effect of the adopted technologies could differ substantially from these engineering estimates. For example, adoption can lead to an increase in water-using activities, which blunts the impact of the technologies.

To generate more credible empirical evidence about the effectiveness of water-efficient technologies in reducing water demand among rural households, I design and implement a randomized controlled trial in a drought-prone area in Costa Rica, whereby technologies are offered for free to the population. To my knowledge, this is the first randomized controlled trial to test the impact of water-efficient technologies under naturally occurring conditions. The results of this experiment are analyzed in my second dissertation essay, entitled "*Climate Change Adaptation through Resource-Conserving Technologies*". I find that the technologies are significantly more effective in reducing water consumption than other programs (10.8% compared to 3.5%-6.8% for social norm message programs, for example). On the other hand, the actual reduction is only around half of the comparable engineering estimate. This highlights the need for considering the households' behavioral responses to the technologies. Moreover, I find that disadoption rates a constant concern in the related literature are reduced with a monetary bonus payment that (random) households receive for keeping the technologies for at least four months.

Another advantage of water-conserving technologies is that due to the water savings these technologies are self-financing for households over two to three years, even when applying the large subjective discount rates elicited for the local population. This suggests that people might be willing to purchase the technologies if they were available in the local markets, and if policymakers succeed in communicating the estimated water savings to the target population.

The dissertation enhances our understanding of decision-making for married couples: by and large, adaptation investment decisions appear to be made jointly by the couple rather than the head of household. Differences in preferences between couples and individuals therefore suggest that policymakers should target their messages and other interventions to both spouses instead of just the head of household, where applicable. This also highlights the need for additional research on the decision-making process within the household.

Chapter 1

Household Time and Risk Preferences and Adaptation to Climate Change

1.1 Introduction

Earth's climate is expected to change considerably in the future. Although scientists do not yet know with great certainty the full effects of climate change on human populations, most agree that weather variability and the probability of extreme climate events will increase (Fischer & Knutti, 2015). These changes increase the risk of water scarcity and damage to infrastructure and crops, among other stresses. The costs of adapting to changes in risks will vary across regions and populations, but every society will have to adapt to climate change in some way.

According to the Intergovernmental Panel on Climate Change (Field, 2012), "adaptation is the process of adjustment to actual or expected climate and its effects, in order to either lessen or avoid harm or exploit beneficial opportunities." These adjustments can take many forms. For example, individuals or households can acquire insurance, they can save money for the future, or they can invest in technologies (water storage, floating houses, water-conserving technologies, efficient irrigations systems, change in crops, etc.). Moreover, communities and governments can invest in collective infrastructure (e.g., sea walls) that also help people adapt to climate change.

Citizens in poor countries that depend heavily on natural resources are particularly vulnerable to climate change. Their income, food, and water security are already precarious and they have limited adaptive capacity. To help them adapt, policymakers need to not only develop large-scale interventions, but also develop programs that encourage the citizens in poor nations to make private adaptation investments. To develop policies and programs that encourage such investments, we must understand the factors that shape household adaptation decisions.

Two factors that may play important roles in shaping adaptation decisions are time and risk preferences. An investment in climate change adaptation requires a fixed payment today in exchange for uncertain payoffs at a later time. Adaptation is therefore fundamentally an intertemporal decision under risk. As a result, the parameters and forms of risk and time preferences are likely to shape adaptation decisions. Drawing on recent advances in behavioral economics, I clarify how adaptation decisions are shaped by time and risk preferences.

To empirically assess the role of these preferences in an adaptation context, I apply recent developments in experimental designs and estimators in an artefactual field experiment with a rural population in the western, arid part of Costa Rica that has been targeted by policymakers for climate change adaptation investments. Because most adaptation decisions are intra-household decisions, I elicit risk and time preferences for both individuals and married couples. I then connect the variation in individual and couples' preferences to the variation in an adaptation measure: investment in private water-storage tanks that reduce intra-annual variability in water supply.

My study makes three contributions. First, it assesses the relationship between preferences and investment in climate change adaptation. The way in which adaptation decisions are affected by risk aversion is ambiguous: more risk aversion can increase or decrease investment in adaptation depending on the level of uncertainty surrounding the benefits of the investment (Koundouri, Nauges, & Tzouvelekas, 2006). Although risk aversion is high in the study population, I find no significant correlation between individual or couples' degrees of risk aversion and my measure of adaptation investment. However, probability weighting is common in this population: people tend to overweigh the likelihood of the most favorable outcomes. Consistent with theory, more "optimistic" households are significantly less likely to invest in adaptation.

The way in which adaptation decisions are theoretically affected by time preferences is unambiguous: higher discount rates and greater time inconsistency (hyperbolic discounting) lead to lower levels of investment. In the study population, I detect no evidence of time inconsistency. Yet, even after adjusting for the curvature of the utility function, individual and couple discount rates are high ($> 30\%$). Consistent with theory, higher discount rates are associated with lower adaptation investment.

The second contribution of my study is an examination of whose preferences – individuals' or married couples' – best explain household adaptation decisions. My measure of adaptation investment is better described by the joint preferences of the couple than by the individual preferences of the head of household. This result is consistent with household survey response about decision-making. Couples have similar risk aversion and probability weighting to individuals, but they are substantially less patient than individuals: their discount rates are an estimated 14 percentage points higher than the rates of individuals. Were these findings to generalize to poor populations in other areas targeted for climate change adaptation programs, they strongly imply a need for policies that focus on incentivizing couple decision-making for climate change adaptation. We discuss the full implications for policy design in the conclusions.

The third contribution of my study is to replicate, improve and extend prior empirical research on risk and time preferences and on the difference in preferences between individuals and couples. Some studies have estimated time preferences in developing nations (Duflo, Kremer, & Robinson, 2008; Pender, 1996; Tanaka, Camerer, & Nguyen, 2010). However, their elicitation designs assume that subjects make decisions over nominal payouts rather than utilities, which implies subjects are risk neutral. If subjects are risk averse, the estimator is biased. To eliminate this bias, I elicit and estimate subjects' risk and time preferences jointly (Andersen, Harrison, Lau, & Rutström, 2008, 2014). Accounting for risk aversion reduces the annualized discount rate substantially: from 500%, under a risk neutral specification, to 45%.

This joint estimator will be biased, however, if risk preferences are not well approximated by Expected Utility Theory (EUT), introduced by Neumann and Morgenstern (1947), but rather by Rank-Dependent Utility (RDU) framework, introduced by Quiggin (1982). Under RDU, risk preferences are shaped not only by a coefficient of risk aversion but also by a (non-linear) transformation of objective probabilities. For my study population, I strongly reject the EUT framework in favor of an RDU model with a Prelec probability weighting function (pwf) that reflects optimistic probability weighting: subjects, on average, overweigh the probability of the best outcome. Adjusting for this weighting reduces estimate annualized discount rates by ten percentage points to 35%.

I also seek to detect another important feature of time preferences: "present-bias" or "hyperbolic discounting", which implies a discounting function where discount rates "decline as the discounted event is moved further away in time" (Laibson, 1997). Such discounting leads an individual to overweigh present consumption so that investments, like adaptation investments, are postponed or never occur. Were present-bias to be widespread in vulnerable populations, adaptation policy design may require certain "commitment device" to effectively encourage private adaptation investments. In contrast to previous studies in developing countries (Bauer, Chytilová, & Morduch, 2012; Duflo, Kremer, & Robinson, 2011; Tanaka et al., 2010), I cannot detect evidence of present bias.

Finally, I add to the inchoate literature that contrasts individual preferences to the preferences of couples (mates). My study includes two innovations: (a) to differentiate a married effect from a group effect (two people, rather than one person, making decision), the design uses both real and "fake" couples (non-mates); and (b) to better characterize the couples' decisions in a structural model, I apply a household bargaining model under uncertainty, which estimates the spouses' respective weights in the household decision process. For the risk preference tasks, a bargaining process appears to take place, with the wife leading the decision. For the time preference tasks, couples express significantly less patience than both husband and wife show individually, in line with predictions that a preference shift occurs when decisions are made as a group (Eliaz, Ray, & Razin, 2006). The results imply that one should not assume that the risk and time preferences of the head of household is representative of the preferences of the married couple or reflect household decision-making.

The remainder of the paper is structured in the following way. I commence with a review of the literature on risk and time preferences and climate change adaptation decision in Section 2.

Sections 3 to 6 describe the methodology, experimental design, econometric model, and experimental procedure, respectively. Section 7 provides a descriptive analysis of the experimental data. In Section 8, I present the results for individuals' and couples' time and risk preferences. In Section 9, I assess the relationship between the estimated preferences and the households' investments in water tanks. Section 10 relates the findings to the existing literature, and Section 11 discusses policy implications. Finally, Section 12 concludes.

1.2 Literature Review

There is an extensive literature that discusses the appropriate framework to model decisions under risk. The main contestants are EUT, which is the most commonly known framework, and RDU when no losses are considered. Under EUT, the expected utility of any risky choice is the sum of the utility of the possible outcomes, weighted by the known probabilities of each outcome. In this framework, risk attitudes are formally characterized as individuals' aversion to variability of final outcomes and are characterized by the concavity of the utility function. Nevertheless, Quiggin (1982) argues that subjects' risk attitudes do not only come from the variability of payoffs. Under RDU, risk aversion is formally characterized as aversion to variability of final outcomes, as well as "pessimism" or "optimism" over probabilities, which is captured by the pwf. The pwf transforms the cumulative distribution of the objective probabilities so that outcomes are weighted differently than they are under EUT. RDU assumes that peoples' decisions are affected not simply by the objective probabilities of an event, but rather by peoples' attitudes towards those probabilities. Thus under RDU, risk aversion is explained by the properties of both the utility function and the pwf (Harrison & Rutstrom, 2008).

The empirical relevance of RDU has been shown in several papers for developed and developing countries (Harrison, Humphrey, & Verschoor, 2010; Tanaka et al., 2010; Wu & Gonzalez, 1996). A priori, I do not know which framework applies to my data. Thus I consider both and test which one is more appropriate for the data.

Regarding time preferences, the discounting utility (DU) model of Samuelson is the traditional framework applied by economists to explain intertemporal decisions and is represented by the exponential discounting function. One of the key features of the DU model is a constant discount rate for different time horizons. Nevertheless, there is some empirical evidence that shows that discount rates are not constant and that they in fact decline over time. A declining discount rate implies that intertemporal preferences are time-inconsistent and people exhibit preference reversals. People who discount hyperbolically do not fulfill the plans they make today because when the time to commit arrives present consumption seems more valuable than the future profits of the new endeavor. This form of discounting is known as hyperbolic discounting and has been modeled in different ways: quasi-hyperbolic model (Phelps & Pollak, 1968), fixed cost model (Benhabib, Bisin, & Schotter, 2010), the Mazur discounting function (Mazur, 1984), the Weibull discounting function (Read, 2001), etc.

The evidence of hyperbolic behavior in rigorous studies that elicit discounting functions is scarce. Moreover, one of the main criticisms to the current studie s that test for the presence of hyperbolic discounting is that they do not consider discounted utilities. In an intertemporal decision, individuals compare a utility level today versus a utility level in the future. Thus, a key feature of any good experimental design that seeks to elucidate discounting behavior is to consider the curvature of the utility function. Many experimental studies that test for the presence of hyperbolic discounting, particularly earlier studies, fail to consider this curvature, which could bias their results. Andersen et al. (2008, 2014); Andreoni and Sprenger (2012); Coller, Harrison, and Rutström (2012) introduce the shape of the utility function in their estimation. In Coller et al. (2012), the authors estimate exponential and quasi-hyperbolic models as well as a mixture model of both discounting functions[1]. They find that the sample follows both discounting functions in similar proportions. In contrast, neither Andersen et al. (2014) nor Andreoni and Sprenger (2012) find hyperbolic discounting in their samples. Andersen et al. (2014) posit that one explanation for the difference between their results and Coller et al.'s results is that they use a sample of Danish individuals, whereas Coller et al. (2012) use students in the U.S. The authors suggest that more studies should be done with a variety of populations. In my analysis, I include risk choices to model the curvature of the utility function as in Andersen et al. (2014) and both exponential and hyperbolic discounting functions are tested to see if people have constant or declining discount rates.

Adaptation decisions are taken by individuals but also by collective entities, such as communities or households. Since adaptation decisions at the household level are sometimes taken by the married couple and I do not know if couple decisions are similar to the spouses' decisions, I elicit couples' preferences. Elicitation of risk preferences at the couple level has been done by Abdellaoui, L'Haridon, and Paraschiv (2013); Bateman and Munro (2005); Carlsson, Martinsson, Qin, and Sutter (2013); De Palma, Picard, and Ziegelmeyer (2011). These studies use subjects from developed countries, except for Carlsson et al. (2013) which elicits risk preferences for households

[1]Two well-cited studies that do not consider the shape of the utility function in their analysis find evidence of hyperbolic discounting (Benhabib et al., 2010; Tanaka et al., 2010)

in rural China. Bateman and Munro (2005) find that couples show more risk aversion when making choices jointly rather than individually. Abdellaoui, L'Haridon, and Paraschiv (2013) find that women show more risk aversion than couples and men. They also find that spouses have equal weight in the household decision. The authors also test for joint and individual differences using the RDU framework and find little differences: both individuals and couples overweight small probabilities and underweight high probabilities but men seem to overweight small probabilities more and underweight high probabilities less than women and couples. Carlsson et al. (2013) conclude that the individual and joint decisions are not statistically different from each other, but that the joint decisions are typically closer to the husbands' decisions. So, the evidence regarding differences between individuals' and couples' decision making under risk is inconclusive.

Regarding time preferences, there are two studies that elicit time preferences at the couple level: Abdellaoui, L'Haridon, Paraschiv, et al. (2013); Carlsson, He, Martinsson, Qin, and Sutter (2012). Carlsson et al. (2012) elicit time preferences using a sample of married couples in rural China, while Abdellaoui, L'Haridon, Paraschiv, et al. (2013) use French couples. Carlsson et al. (2012) find that none of the individual or joint decisions exhibit quasi-hyperbolic discounting, joint decisions are in between the individual choices, and husbands have a stronger influence on joint decisions than wives. Using longer time horizons than Carlsson et al. (2012) (1 month up to 2 years, rather than 4 up to 8 days), Abdellaoui, L'Haridon, Paraschiv, et al. (2013) find that couples are more patient than individuals and that couples discount rates cannot be expressed as a convex combination of spouses' rates. The authors also find increasing and then decreasing annual discount rates over time for individual and joint decisions, contrary to hyperbolic behavior (and thus contrary to time inconsistency). Only Abdellaoui, L'Haridon, Paraschiv, et al. (2013) takes into account the curvature of the utility function. In my study, I take into account the shape of the utility function, use a structural model to estimate the spouses' weight in the household decision, control for the order in which individuals' and couples' decisions are taken, and differentiate a married couple effect from a group effect using random pairs of individuals.

Few studies have analyzed the relationship between risk and time preferences and adaptation to climate change. According to Mendelsohn (2012), adaptation to climate change is any change in behavior that an agent does to reduce the costs or increase the gains from climate change. Adaptation can take many forms: people can buy insurance, keep savings or invest in a new technology. In my study I focus on the last form of adaptation: technology adoption.

Although studies that seek to clarify the factors that determine technology adoption have a long history, few empirical studies assess the role of risk aversion. Some studies elicit risk aversion from survey data and correlate these measures with technology adoptions (Bozzola et al., 2014; Koundouri et al., 2006), but experimental measures of risk aversion using salient incentives are scarce. Moreover, not much attention has been put on the relationship between attitudes towards probabilities captured by the pwf of RDU and adaptation decisions. The only study that we know is Liu (2013). The author studies the case of Chinese cotton farmers who were offered the option to adopt genetically modified cotton to deal with bollworms, the primary cotton pest. The author uses survey questions and experiments to elicit risk preferences, and the econometric methodology of Tanaka et al. (2010) to estimate aversion to variability in gains and losses and probability attitudes. Liu finds that more risk-averse farmers and more loss-averse farmers adopt the new cotton variety later, and that farmers with an inverted S shape pwf adopt the new cotton variety earlier. Liu argues that farmers with an inverted S shape pwf overweight the small probability of severe bollworm infestation and thus adopt the technology earlier than other farmers.

We know of only one study that examines the relationship between time preferences and the adoption of technologies relevant for climate change adaptation. Duflo et al. (2011) develop a theoretical model that includes present-bias to predict fertilizer take-up by farmers in West Kenya. In the model, naïve hyperbolic farmers who plan to buy fertilizer in the future may procrastinate and end up not buying it. The model predicts that a small, time-limited discount on the cost of acquiring fertilizer increases the quantity of fertilizer that farmers buy, which increases crop yields. In a randomized field experiment, this prediction is verified. Thus, the paper suggests that present-biased behavior reduces fertilizer take-up.

1.3 Study Site and Sampling

The study takes place in the driest area of Costa Rica that covers the provinces of Guanacaste and part of Puntarenas, close to the border with Nicaragua. The experiment is part of a larger Canadian government-funded research project on climate change adaptation and water scarcity in Central America. Climate modelers in the project have predicted that this area (like most of Central America) will see more frequent and more extreme droughts in the next fifty years. Moreover, since 2014 the area has been experiencing higher temperatures and drought associated with a very strong El Niño-Southern Oscillation.

Around 85% of the communities in these provinces use underground water, which is pumped to homes by a community system of pipes. In about half of the communities, water is managed by the Costa Rican Water Agency "Instituto Costarricense de Acueductos y Alcantarillados" (AyA).

The other communities manage their own water systems through community associations called ASADAS. As part of the larger climate adaptation project, surveys were conducted in 2013 in 82 randomly chosen communities that met three conditions: 1) belong to the first decile of driest communities in Costa Rica, 2) their water supply comes from one or more community wells and 3) water supply is managed by the ASADA. The survey teams interviewed a random sample of households and the ASADA management committees. During the households' survey, heads of household were informed that as part of the water project my team would conduct workshops – the experimental sessions – the following year. The survey team explained them that for their participation people would obtain 5 000 Colones (around US$ 10) and have the opportunity to win more. The team asked them if they were interested in participating in the workshops, and to provide their contact numbers if that was the case.

Out of the 82 communities, I chose 30 that satisfy the following criteria: 1) had the lowest number of hours per day with water availability; 2) community leaders were willing to provide a place for the experimental session; 3) community had at least 25 individuals that showed interest in participating in the experimental sessions in the 2013 household survey.

The communities are very small: on average they have 183 habitants. Most of the sessions took place after 4 pm in the local school which is located in a very centric area and walking distance from any house. This implies an advantage over having the session at home where the participants are commonly distracted without the disadvantage of costly access to the session. The schedule of the session was suggested by the community leaders to guarantee that most of the people interested in participating were available. Sessions took place from Sunday to Thursday because banks do not open during the weekend and my design established payments one and four days after the session.

A month before the experimental sessions, the team invited the heads of household by phone. Since I want to distinguish between the married effect and group effect, my original objective was to take half of the married couples and pair them up randomly with other married or single individuals, and be able to compare married couples with other different types of couples. Nevertheless, in the pilots I realized that many couples would not be able to come together to the experimental session because of work or children. In order to have enough married couples working as a couple, I decided to form the "fake" couples only with married individuals that came alone to the session and with singles, and acknowledge that this could bias the difference between real and fake couples.

1.4 Experimental Design

I conduct a risk aversion experiment and a discounting experiment. At the beginning of the session, each person in the sample is assigned a partner and a group that indicates the order in which decisions are taken. Real couples, who are composed by married couples or couples that cohabit, are partnered with their spouses. Fake couples are composed by married people that came alone to the session or singles that were paired up at random. All individuals have to solve discounting tasks and risk aversion tasks individually and in pairs. So, in total each person participates in four events: individual discounting (Di), individual risk aversion (Ri), couple discounting (Dc), couple risk aversion (Rc). To control for order effects regarding the choices made individually and in pairs, I introduce a within session treatment where half of the sample first make the choices in pairs and then individually, while the other half start with the individual tasks.

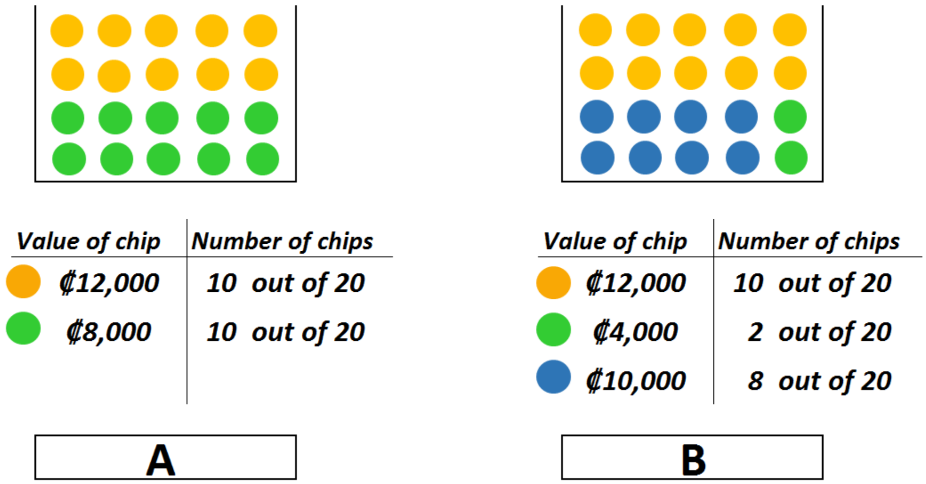


Figure 1.1: Example of Risk Aversion Decision (in Colones)

In the risk aversion experiment, I use a design with 30 binary lottery choices in the gain frame with three prizes from Wakker, Erev, and Weber (1994). I choose to use these lotteries because they are designed to distinguish between EUT and RDU. For each choice, individuals have to decide between two lotteries A and B. Figure 1.1 shows the display for one of the decisions.

Each lottery is represented as a bag with twenty colored balls. We use three colors that represent the three different prizes and the number of balls per color reflects the probability of that prize being selected. For example, the lottery A in Figure 1.1 has two different balls: orange and green. The orange ball stands for 12 000 Colones and has a probability of 50%. I use the exchange rate of 500 Colones per dollar.

In the discounting experiment, individuals are asked to choose between a sooner payment A and a larger, later payment B in a Multiple Price List design (MPL). Payment A is the principal and it is 8 000 Colones (US$16) which is approximately the official daily minimum wage of a worker out of high school in 2013 in Costa Rica[2]. Payment B changes depending on the annual interest rate and the time horizon. There are 6 tasks that correspond to different time horizons. The time horizons used are: 3 days, 1 week, 2 weeks, 1 month, 3 months and 6 months. Each task contains 8 choices between a sooner and a later payment. The annual interest rates of each choice is 50%, 75%, 100%, 150%, 200%, 300%, 450% and 800%. In total, every subject has to solve 48 choices. I use different periods because I want to be able to specify the discount rate function. Four out of six horizons are in the very short run because I want to test for the presence of quasi-hyperbolic behavior.

I introduce a between session treatment in which I display the horizons in an ascending order in half of the community sessions while horizons are presented in a descending order in the other half of the sessions.

One concern when estimating discount rates are the transaction costs associated with the future payment. The literature has tried to deal with this problem by introducing front end delays and/or by using the same payment procedure for both payments. The front end delay (FED) refers to the fact that the sooner payment is not paid now but with a delay of some days, weeks or months. The idea behind this procedure is to make the individual equally confident about the realization of both payments by pushing the sooner payment into the future. The problem with the FED is that the delay can also cover up quasi-hyperbolic behavior.

The transaction costs associated with the later payment are also reduced by using the same payment procedure for sooner and later payments. The idea behind this is that the transaction costs of a payment in cash at the end of the session are smaller than the transaction costs of a bank

[2] In Costa Rica, the government establishes minimum wages for many occupations. Daily wages go from 7 500 to 16 500 Colones for a computer analyst or an audio technician (de Trabajo y Seguridad Social de Costa Rica, n.d.)

deposit where the individual requires going to the bank. Having both payments done in the same way eliminates the effect of the payment procedure.

The experimental design deals with this problem by using the same method of payment for all sooner and later payments, and introducing a FED for the earliest payment as a between community treatment. The method of payment is a personal bank transfer where the individual withdraws the money by presenting their Costa Rican id. Half of the communities faced a FED of one month while the other half did not. Since all sessions took place in the afternoon or during the weekends when banks were closed, No FED people were able to withdraw the money the next business day in the morning.

Considering the order of horizons and the FED treatments, there are 4 types of community sessions: 1A, 1D, 2A and 2D where the sessions 1A and 1D are NO FED sessions and horizons are presented in an ascending and a descending order, respectively. In sessions 2A and 2D, I use the 30 day FED and horizons are displayed in an ascending and descending order, respectively.

The choices are presented to the individuals in a table like the one in Figure 1.2, where only the time period in days, weeks or months and the payoffs in options A and B are shown.

All the participants receive a participation fee of 5 000 Colones (US$ 10) and the additional money they earn in the experiments. The participation fee is paid in cash after completion of the survey and the money from the experiments is paid using a personal bank transfer. Besides an individual survey, married couples also have to answer a brief couple survey.

To determine the amount of payment from the experiments for each individual, I use a "pay one randomly" or POR payment design (Cox et al. 2015). One choice is selected randomly to be played out for each of the experiments in which the subjects participated (Di, Ri, Dc, Rc). I divide the group randomly into four subgroups and each individual in each subgroup receives payment for one of the selected choices. If the individual receives her payment for a decision made in a couple, only she receives the money. For instance, if the husband is selected to get paid for a Dc choice, only he gets paid for the couple's decision in the selected question.

Under the independence axiom of EUT, the method of payment POR is suggested in the literature to avoid inconsistencies in the choices produced by the portfolio effect and the wealth effect. Nevertheless, Cox, Sadiraj, and Schmidt (2015) argues that POR is not incentive compatible to test other theories that do not assume the independence axiom, like RDU or CPT. In these cases, the authors suggest other payment methods that are incentive compatible, like "pay all correlated", "pay all sequentially" or "one task". I acknowledge that this implies a problem in my design since the answers obtained with the POR method of payment are used to test both EUT and RDU. The alternative would be to use the "one task" method that is always incentive compatible. This means that I obtain only one decision from each subject. But this is a very costly procedure and only allows between subjects-data. Since I need to use a within subject design for the main part of the study (time preference elicitation, individual vs. couple decision), I decided to use POR and accept that the RDU estimations may be biased.

1.5 Econometric Model

I apply maximum likelihood estimation to the structural model of the latent choice to characterize risk and time preferences parameters, as in Andersen et al. (2008, 2014).

I estimate the risk preferences using only the answers of the risk tasks, and through the joint

	A You get the money TOMORROW	B You get the money in 15 DAYS
Decision 1	₡8,000	₡8,154
Decision 2	₡8,000	₡8,230
Decision 3	₡8,000	₡8,304
Decision 4	₡8,000	₡8,452
Decision 5	₡8,000	₡8,597
Decision 6	₡8,000	₡8,878
Decision 7	₡8,000	₡9,282
Decision 8	₡8,000	₡10,154

Figure 1.2: Example of Discounting Choices for 2 Weeks Horizon and No FED (in Colones)

estimation of time and risk preferences. Both procedures should provide similar results.

Using only the risk tasks, I pool all the individuals' and couples' answers and compare different RDU models to determine the model that best fit the data. I focus on the RDU framework because EUT model is embedded in it. The properties of the RDU framework are determined by the utility function and the pwf. If the data fits best an EUT model, then the parameter estimates of the pwf make it the identity function. I apply the CRRA and the Expo-power utility functions and three different types of pwfs: the power pwf $\omega(p) = p^{\gamma}$, the Tversky - Kahneman or inverse-S shaped pwf $\omega(p) = \frac{p^{\gamma}}{(p^{\gamma}+(1-p)^{\gamma})^{\frac{1}{\gamma}}}$ (Tversky & Kahneman, 1992), and the Prelec pwf $\omega(p) = \exp(-\delta[-\ln(p)]^{\phi})$ by Prelec (1998) where $\delta > 0$, $\phi > 0$. In order to compare among the different RDU models, I use the Vuong and Clarke statistics (Clarke, 2003; Vuong, 1989).

In the risk tasks, the individual chooses between lottery A and lottery B. Under RDU, the decision weights replace the probabilities provided by the experimenter. In the model, the decision weights are represented in the following way. For each lottery, the outcomes are ranked and the cumulative probability for each outcome is calculated starting with the highest outcome. The pwf is applied to the cumulative probabilities, so that the decision weight for the best outcome is the value of the pwf, and the decision weights for the rest of the outcomes are calculated by subtracting the decision weights of the higher outcomes.

Under RDU, the expected utility of lottery i is the sum of the utilities for each outcome weighted by the decision weights, as in equation (1.1).

$$RDU_i = \omega_{i1} \cdot U(M_{i1}) + \omega_{i2} \cdot U(M_{i2}) + \omega_{i3} \cdot U(M_{i3}) \tag{1.1}$$

M_1, M_2 and M_3 are the outcomes; $U(M_1)$, $U(M_2)$ and $U(M_3)$ are the utilities of the outcomes; and ω_1, ω_2 and ω_3 are the decision weights.

As in Andersen et al. (2014), in order to calculate the log likelihood I use the logistic distribution g(.) of the difference of the expected utility of both lotteries divided by the contextual error and the behavioral error μ. The contextual error is the difference of the highest and lowest utility in the choice and normalizes the difference of the expected utility of both lotteries to lie between 0 and 1 for every choice. The behavioral error μ is the Fechner type error which assumes that individuals might make mistakes when comparing the expected utilities of the lotteries. The log likelihood per choice is:

$$\begin{aligned} \ln g(\Delta RDU) &= \ln \frac{\exp(\Delta RDU)}{1+\exp(\Delta RDU)} \\ \Delta RDU &= \frac{RDU_B - RDU_A}{(High-Low)\cdot\mu} \end{aligned} \tag{1.2}$$

The final log-likelihood is formed linking all observed risk choices and their likelihood.

$$\ln L(r|x,w)^{RA} = \sum \ln g(\Delta RDU_i)\cdot I(x_i=1) + \ln g(-\Delta RDU_i)\cdot I(x_i=-1) \tag{1.3}$$

where I is an indicator function for choices $B(x_i=1)$ and $A(x_i=-1)$ in the risk aversion tasks.

Once I determine the model that best fits the data, I estimate the individuals' risk preferences, the couples' risk preferences and the differences between both, for all the couples and for real and fake couples. In the individual estimation, decisions are clustered at the individual level. In the couples' estimation, decisions are clustered at the couple level. The methodology allows me to explain all the individuals' parameter estimates as a function of demographic variables like age, gender, income, education and marital status.

In the case of the time preferences, I pool individuals' and couples' answer to determine the best model that fits the data. I compare different discounting functions and also consider the RDU models from the previous analysis. I assume exponential discounting and different forms of hyperbolic discounting: the Mazur discounting function, the Weibull discounting function and the quasi-hyperbolic discounting function presented in equations (1.4), (1.5) and (1.6), respectively.

$$D_M(t) = \frac{1}{(1 + r \cdot t)} \tag{1.4}$$

$$D_W(t) = \exp(-r \cdot t^{(1/s)}) \tag{1.5}$$

$$\begin{aligned} D_{QH}(t) &= 1 \quad \text{if} \quad t = 0 \\ D_{QH}(t) &= \tfrac{\beta}{(1+\delta)^t} \quad \text{if} \quad t > 0 \end{aligned} \tag{1.6}$$

The data shows quasi-hyperbolic behavior when $\beta < 1$ so that the discount rate is very high in the first periods and then declines drastically and converges to δ. The quasi-hyperbolic discounting function reduces to the exponential discounting when $\beta = 1$. The Weibull discounting function shows decreasing discount rates over time for estimates of $s > 1$ and becomes the exponential discounting when $s = 1$. The Mazur discount rate decreases over time for $r > 0$.

In the discounting decisions, individuals have to choose between receiving money in two different periods. In the model, the present value of the utility of money in the earliest period t is PVA in equation (1.7), while the present value of the utility of money in the later period $t + \tau$ is PVB in equation (1.8). D_t is the discount factor in period t. If we assume an exponential discounting function, then $D_t = 1/(1 + \delta)^t$ and δ is the constant discount rate.

$$PV_A(t) = D_t \cdot U(M_t) \tag{1.7}$$

$$PV_B(t) = D_{t+\tau} \cdot U(M_{t+\tau}) \tag{1.8}$$

The final log likelihood per choice is built using the logistic distribution of the difference PV_B-PV_A divided by the behavioral error of the discounting choices μ_d, as in equation (1.9).

$$\begin{aligned} \ln g(\Delta PV) &= \ln \tfrac{\exp(\Delta PV)}{1+\exp(\Delta PV)} \\ \Delta PV &= \tfrac{PV_B - PV_A}{\mu_d} \end{aligned} \tag{1.9}$$

The log likelihood is formed linking all observed discounting choices and their likelihood.

$$\ln L(\delta|x,w)^D = \sum \ln g(\Delta PV_i) \cdot I(x_i = 1) + \ln g(-\Delta PV_i) \cdot I(x_i = -1) \tag{1.10}$$

Finally, I create a vector that stacks both $\ln L(r|x,w)^{RA}$ and $\ln L(\delta|x,w)^D$ and then I find the risk and time preferences parameters that maximize the joint log-likelihood.

Once I determine the best model, I estimate the individuals' and couples' preferences. To measure the difference between individuals and couples, I pool all their choices and add a dummy variable couple that explain the difference in each parameter.

To estimate the spouses' weight in the household risky decision, I extend on Andersen et al. (2008) joint estimation. In a risky decision under EUT, the households expected utility of lottery x=A, B is:

$$
\begin{aligned}
EU^{H,x} &= \textstyle\sum_i^2 \rho_i \cdot EU_i^x \\
EU^{H,x} &= \textstyle\sum_i^2 \rho_i \cdot \left[p(M_1^x) \cdot U_i(M_1^x) + p(M_2^x) \cdot U_i(M_2^x)\right] \\
EU^{H,x} &= p(M_1^x) \cdot U^{H,M_1^x} + p(M_2^x) \cdot U^{H,M_2^x}
\end{aligned}
\tag{1.11}
$$

where ρ_i is the weight that each spouse i has in the decision and $U_i()$ is the utility of each spouse determined by the individual parameters. I measure the ratio ΔEU^H that represents the couple's latent choice for outcome B.

The conditional log likelihood is built as before, where I is an indicator function for the couples' choices $A(x_j = -1)$ and $B(x_j = 1)$ in the risk aversion tasks and J is the number of choices that couples make.

$$
\ln L(r|x,w)^{RA,H} = \sum \ln g(\Delta EU_j^H) \cdot I(x_j = 1) + \ln g(-\Delta EU_j^H) \cdot I(x_j = -1) \tag{1.12}
$$

I build a vector that stacks $\ln L(r|x,w)^{RA,women}$, $\ln L(r|x,w)^{RA,men}$ and $\ln L(r|x,w)^{RA,H}$ and find the utility parameter estimates for men and women, and the weights that maximize the joint log-likelihood.

In order to estimate the relationship between the behavioral estimates and the adaptation measure, I only keep the observations of the married couples and add the variable water tank to look at the correlation of this variable with each of the parameter estimates of the risk and time preferences. Since I do not know who takes the decision to buy a water tank, in the survey I ask married couples whether the decision was taken by one of the spouses or together. If the decision is taken as a couple, I would expect to see the theoretical relationships when I correlate the variable *water tank* with the couples' preferences.

1.6 Experimental Procedures

The day of the experiments, the team of assistants and I welcomed participants and verified that they had been invited. First, we identified the group of real couples and the group of fake couples. During registration, I paired up the fake couples based on similarity of age and gender so that couples were formed by a man and a woman if possible. Every individual received an id and every couple received an id-couple. I divided the real and fake couples in two groups (A, B) that made the individual and pair decisions in different order. In one side of the room, side A, I placed the real couples and fake couples that make the couple decisions first. In the other side of the room, side B, I placed the subjects that start with the individual decisions. Couples in side B were not seated next to each other: a person from a different couple was seated in between them. Once all individuals were seated, I read the informed consent. After the first round of risk and time preferences games, participants took a short recess where we provided cookies and beverages.

In the second round, individuals in side A completed the tasks individually and couples were seated apart from each other; individuals in side B completed the tasks with their respective couples. Once the experimental session was over, individuals completed a short survey. Real couples completed a couple survey and an individual survey. Both spouses of the real couples fill out the individual survey individually and separated from each other, and the couple survey together. Fake couples just completed an individual survey. In the couple survey, real couples were asked, for instance, how long they have been together, the number of members in the home, whether they have a water tank and who took the decision to buy the water tank. The surveys are presented in Appendix B.

1.7 Descriptive Analysis

1.7.1 Data

The final sample is comprised of 482 individuals. 24 individuals participated only in the individual tasks mainly because we had sessions with an odd number of participants. There are 229 couples:124 are real couples and 105 are fake couples. Among the fake couples, 40 couples have different gender, 64 couples are woman-woman couples and 1 couple is a man-man couple.

1.7.2 Risk Task Choices

In this section, I will describe the choices in the risk task of individuals and couples. Then, I follow Wakker et al. (1994) to do a first analysis of the type of model that fits best the data, EUT or RDU.

The 30 choices used in the experiment are composed of 6 sets of 4 choices (the RDU choices) and 6 additional choices or "fillers". The RDU choices were designed by Wakker et al. (1994) to distinguish between EUT and RDU choices. The fillers have lotteries with clearly different expected values and thus, their goal is to motivate subjects to analyze the choices carefully. In all the choices, lottery B is the risky one.

The individuals choose the risky lottery on average 16.62 times out of 30. The average does not vary much by gender, age and marital status but varies by education level and income (rows 7 and 10 in column A of Table 1.1). "$Age > p50$" corresponds to individuals older than 44 years old, which is the percentile 50 in the sample. "$Income > p75$" represents individuals with income greater than the income range $150,000-250,000$ colones, which is the percentile 75 in the sample.

Individuals that have at least completed primary school choose less frequently the risky choices than individuals that have not. Similarly, high income individuals select the risky choices less often than individuals with lower income. Looking at the couples' choices (row 2 in column A of Table 1.1), the difference between individuals' and couples' choices is not statistically significant. The same occurs with the difference between real and fake couples (row 3). When I analyze separately the sample with only the RDU choices and the sample with only the fillers, I find very similar results between the complete sample and the RDU choices. In the case of the fillers, the sign of the difference between the subsamples is the same in most of the variables, as shown in Table 1.1, columns B and C.

Following the analysis of Wakker et al. (1994), I focus on the RDU choices arranged in 6 sets of 4 choices and analyze the independence condition and the comonotonic independence condition for a first examination of the EUT and RDU framework. In each set, there are four choices and in each choice the probabilities of both lotteries are the same and do not change within a set. Each lottery has two different prizes and one common prize. Within a set, this common prize is the only one that changes. Take, for instance, the choices in the set in Table 1.2. In the first choice the common prize is 1000 colones, then it becomes 7000, 13000 and 19000 colones. The independence condition of EUT implies that the preference should not change if a common prize changes. Thus, within a set a violation of EUT occurs when the individual changes her preference. In each set, there are two mutually comonotonic choices. Here, two choices are called mutually comonotonic if the change in the common prize does not alter the ranking of the prizes within a lottery. Comonotonic independence holds when preferences are the same in the mutually comonotonic choices. A violation of RDU occurs when there is a violation of comonotonic independence.

Table 1.1: Average Number of Risky Choices by Subsample.

Group	A. All choices				B. RDU choices				C. Fillers			
	Obs.	Mean	S.E.	p-val.	Obs.	Mean	S.E.	p-val.	Obs.	Mean	S.E.	p-val.
Individuals vs. Couples												
Total individuals	482	16.62			482	13.39			482	3.22		
individuals in couples†	458	16.73	0.29	0.86	458	13.49	0.25	0.96	458	3.24	0.07	0.56
couples	229	16.65	0.37		229	13.47	0.33		229	3.18	0.07	
fake couples	105	16.49	0.5	0.69	105	13.35	0.45	0.75	105	3.13	0.11	0.57
real couples	124	16.78	0.54		124	13.56	0.49		124	3.22	0.1	
Individuals by treatment and demographic variables												
individual decisions first	253	16.5	0.42	0.66	253	13.17	0.36	0.35	253	3.32	0.09	0.09
couples' decisions first	229	16.75	0.39		229	13.64	0.34		229	3.11	0.09	
men	175	16.67	0.48	0.88	175	13.32	0.42	0.82	175	3.35	0.1	0.12
women	307	16.58	0.36		307	13.44	0.31		307	3.15	0.08	
age <p50	242	16.33	0.38	0.31	242	13.16	0.34	0.35	242	3.17	0.08	0.37
age >p50	240	16.91	0.43		240	13.63	0.36		240	3.28	0.1	
no primary school	120	18.23	0.67	0	120	14.83	0.55	0	120	3.4	0.15	0.11
at least primary school	361	16.09	0.31		361	12.92	0.27		361	3.17	0.07	
no high school	399	16.79	0.33	0.21	399	13.54	0.28	0.22	399	3.25	0.07	0.37
at least high school	82	15.83	0.56		82	12.73	0.53		82	3.1	0.11	
not married	241	16.58	0.4	0.9	241	13.31	0.35	0.73	241	3.27	0.09	0.42
married	241	16.65	0.41		241	13.48	0.36		241	3.17	0.09	
income <p75	334	16.84	0.35	0.09	334	13.57	0.3	0.11	334	3.27	0.08	0.17
income >p75	137	15.76	0.5		137	12.68	0.44		137	3.08	0.11	

† Individuals that also participated in couples' tasks.

Table 1.2: One set of lotteries.

Choice	Safe choice			Risky choice		
	L1	L2	L3	R1	R2	R3
1	0.55 1,000	0.25 12,000	0.2 14,000	0.55 1,000	0.25 9,000	0.2 18,000
2	0.55 7,000	0.25 12,000	0.2 14,000	0.55 7,000	0.25 9,000	0.2 18,000
3	0.25 12,000	0.55 13,000	0.2 14,000	0.25 9,000	0.55 13,000	0.2 18,000
4	0.25 12,000	0.2 14,000	0.55 19,000	0.25 9,000	0.2 18,000	0.55 19,000

Violations to independence or comonotonic independence signal individuals' behavior but people can also make "errors". Moreover, the lotteries in the RDU choices have similar expected values and in some cases, individuals might be indifferent about the lotteries. The analysis acknowledges the presence of these behavioral errors and assumes that they occur randomly across the decisions.

First, I study whether there is evidence in favor of EUT or RDU. The null hypothesis is that the data follows EUT. In each set like the one in Table 1.2, there is one test of comonotonic independence and two tests of non-comonotonic independence. If we do not consider the possibility of errors, under the null hypothesis there should be no violations of any type of independence. However, if we do, the proportion of violations of comonotonic independence should the same as the proportion of violations of non-comonotonic independence. Under the alternative hypothesis that the data follows the RDU model, however, the latter is higher.

In my sample, there are 482 individuals that generate 8666 tests of independence: 2888 comonotonic tests and 5778 non-comonotonic tests[3]. There were 2905 violations of independence[4]. Under the null hypothesis, one third of the violations (969.3) should be violations of comonotonic tests and two thirds (1936.7), of non-comonotonic tests. I find that 894 (30.8%) were violations of comonotonic tests and 2011 (69.2%) were violations of non-comonotonic tests. These results seem to favor RDU over EUT.

Using a similar analysis, I study the special cases of RDU: RDU with pessimism, RDU with optimism, RDU with inverse-S shaped pwf and S shaped pwf. These cases prohibit violations of comonotonic independence but also impose additional restrictions on the non-comonotonic tests depending on the type of RDU. For instance, pessimistic individuals put more weight on the probability of the lowest prize. When the common prize changes from the lowest to the middle rank, pessimistic individuals are more inclined to prefer the lottery whose lowest prize is now higher. A change like that happens in the second and third choices of the set shown in Table 1.2. In the second choice the common prize is the lowest prize in both lotteries and increases from 7000 to 13000 colones in the third choice. With such an increase, the common prize becomes the new middle prize in both lotteries. In the third choice, the new lowest prize of the safe lottery is 12000

[3]With 482 individuals, there should be $482 \cdot 3 \cdot 6 = 8676$ tests but I had 5 missing answers resulting in 10 fewer tests.

[4]In Wakker et al. (1994), the authors ask the same 24 choices twice to test for consistency of answers. This generates two types of violations of independence: weak and strong violations. A weak violation in an independence test occurs when in a certain choice the individual selects a lottery consistently (selects the same lottery the two times she is asked the same question) but in the adjacent question within a set changes her preference in one of the opportunities. If 1 is a risky choice, 0 is a safe choice, 2 stands for consistently choosing the risky choice and 0, for consistently choosing the safe choice, examples of weak violations are the pairs (0,1), (1,0), (1,2), (2,1). A strong violation in an independence test occurs when the individual chooses consistently in two contiguous questions but changes her preference. Examples of strong violations are the pairs (0,2) and (2,0). The authors find 6% of strong violations and 41% of weak violations. In my study, I find 34% (2905/8666) of violations. Because there are two types of violations and none of them correspond to the type of violation in my analysis, it is not possible to directly compare the number of violations of Wakker et al. (1994) and the number of violations in my study. However, I can compare the types that have a similar probability of violation if it were at random. When considering two choices, the chance of weak violation in Wakker et al. (1994) is 44% (4 out of 9 possibilities) and the chance of violation in my study (2 out of 4) is 50%. Thus, it seems that the 34% of violations in my study is lower than the 41% of weak violations of in the Wakker et al. (1994)'s sample.

colones which is higher than the new lowest prize (9000 colones) of the risky lottery. Because the new lowest prize is higher in the safe lottery, a change of preference from the safe to the risky lottery is not expected in the case of a pessimistic individual. The converse applies for the optimistic RDU individuals.

When the common prize changes from the middle to the highest rank, pessimistic individuals prefer the lottery with the highest new middle prize. Such a change occurs in decisions three and four in Table 1.2. In decision three the common prize is the middle prize 13000 colones and it increases to 19000 colones. The new middle prize in the safe lottery is 14000 colones and in the risky lottery is 18000 colones. Because the new middle prize is higher in the risky lottery, pessimistic individuals are not expected to change their preference from the risky to the safe lottery. The converse is true for the optimistic RDU individuals.

In the case of the inverse-S shaped probability weighters, they overweight the probability of the extreme lottery outcomes. Thus, the restrictions for an inverse-S shaped pwf match those of an RDU-pessimist when the common prize changes from the lowest to the middle rank, and match those of an RDU-optimist when the common prize changes from the middle to the highest rank. The opposite holds true for an S-shaped pwf.

Within each set of four lotteries like the one in Table 1.2, there are six types of possible violations of independence: from the safe to the risky lottery and from the risky to the safe one in each of the three independence tests. From these six violations of independence, four correspond to violations of RDU with pessimism (RDU with optimism, RDU with inverse-S shaped pwf or RDU with S shaped pwf). Under the null hypothesis, two thirds of the violations are expected to be violations of RDU with pessimism. The same logic applies to the other types of RDU.

I find 1939 violations of RDU with pessimism, which correspond to two thirds of the violations. There are 1860 violations of RDU with optimism that correspond to 64% of the total violations. Regarding RDU with inverse S shape pwf, while I find 1750 (60%) violations, there are 2049 (71%) violations of RDU with S shaped pwf. So, the data seem to fit RDU with optimism and inverse-S pwf rather than EUT. As expected, results are very similar when I only consider the individuals that participated in the couples' experiments.

I do the same type of analysis using the data of couples. There are 229 couples that generate 4120 tests[5]. I find 1405 violations of independence[6]. Under the null hypothesis, one third should be violations of comonotonic tests and two thirds of non-comonotonic tests. There were 400 violations of comonotonic tests which represent 28.5% of the total violations, a lower proportion than the case of the individuals. So, the data seems to fit the RDU model. For the special cases of RDU, there are less than two thirds of the violations for RDU with optimism (64%) and I find similar results for RDU with pessimism (65%) and RDU with inverse-S shaped pwf (57%). The only special case that exceeds the two thirds condition is the RDU with S shaped pwf (72%). So, all the RDU types except RDU with S shaped seem to be preferable than the EUT model.

The data allows another type of analysis where I compare the proportion of risky choices in each decision across individuals. If the difference in the proportion of risky choices is statistical significant, it provides evidence against independence. In the six sets of four choices, the common prize increases eighteen times $(6*3)$. In the sample of individuals, I find eight statistically significant differences. Of these, two (25%) correspond to comonotonic tests and this proportion is less

[5] I should have 4122 tests $(229 \cdot 6 \cdot 3)$ but I ended up with less tests due to missing values.

[6] This is almost the same percentage as in the individuals. Thus, the sample of couples violates the independence axiom even less frequently than the Wakker et al. (1994) sample.

Table 1.3: Number of Observed Violations and Number of Violations Predicted by the H_0.

	RDU		RDU pessimism		RDU optimism		RDU inverse S-shaped		RDU S-shaped		EUT
Individuals†											
Observed	894	31%	1,939	67%	1,860	64%	1,750	60%	2,049	71%	2,905
Predicted by H_0	968	33%	1,937	67%	1,937	67%	1,937	67%	1,937	67%	
Couples											
Observed	400	28%	909	65%	896	64%	795	57%	1,010	72%	1,405
Predicted by H_0	468	33%	937	67%	937	67%	937	67%	937	67%	

† Individuals that also participated in couples' tasks show the same percentages.

Table 1.4: Number of Statistically Significant Differences in the Proportion of Risky Choices.

Number of Differences	Individuals	Indiv. in couples†	Couples
Total	8	7	5
In mutually comonotonic choices	2	1	1
Against RDU with optimism	2	2	2
Against RDU with pessimism	4	4	2
Against RDU with S shaped pwf	6	6	4
Against RDU with inverse-S shaped pwf	0	0	0

† Individuals that also participated in couples' tasks.

than the one third dictated by the null hypothesis which indicates RDU behavior. Of the other six statistically significant changes, four were evidence against RDU with pessimism (in favor of RDU with optimism) and the other two show evidence against RDU with optimism (in favor of RDU with pessimism). All the six significant changes were in line with RDU with inverse S shaped pwf (against S-shaped pwf). So, the results of this analysis support once again RDU with inverse S shaped pwf and RDU with optimism to a small degree. I find very similar results when I consider only the choices of individuals that take decisions in pairs.

In the case of the couples' answers, I find five statistically significant differences and one of them is a comonotonic test. Under the null hypothesis of EUT, this proportion (20%) provides some evidence for the RDU model. Two of the differences are against RDU with optimism and the other two are against RDU with pessimism. All the changes are in line of RDU with inverse-S shaped pwf and against the S shaped pwf. RDU with inverse-S shaped pwf seems to be the model supported by the data.

In summary, in the descriptive analysis I do not find statistically significant differences between the number of risky choices selected by individuals and couples and between the real and fake couples' choices. More educated and higher income people choose less often the risky choices. The analysis of the RDU choices shows that individuals are better described by the RDU model rather than by EUT model, specifically the RDU model with inverse-S shaped pwf and RDU with optimism to a small degree. Couples' choices show similar results.

1.7.3 Discounting Task Choices

I use local polynomial regressions (LPR) and probit estimations for a descriptive exploration of the discounting behavior and the effect of the treatments: the FED, the order in which horizons are displayed and the order in which couples and individual decisions are presented to the participants.

The LPR estimates the conditional distribution of the later payment choices given the implied annual interest rate (AIR). The relationship of both variables is expected to be positive. Figure 1.3 shows the LPR with the individual choices. The interception between the curve and the dashed line at 50% of the later payment choices gives the median discount rate 163% for the individual sample, as shown in Table 1.5. This is the level at which subjects jump to the choice B on average and it does not take into account any correction for the curvature of the utility function.

Looking at the effect of the demographic variables, I do not find any difference in the fitted lines by gender, income, age or marital status. However, education seems to be an important source of heterogeneity in the sample. Individuals that have not completed primary school show lower discount rates (99%) than the ones that did (168%). Looking at the different horizons, I find that the discount rate seem to decrease the longer the horizon, as shown in Figure 1.4 and Table 1.5.

Figure 1.5 shows the graphs for the FED and no FED groups. Individuals that face no FED

Table 1.5: Median Discount Rate for Different Subsamples.

Results are stated in percentages.

Variables	Median	95% Conf. Interval	
All individuals	163	134	166
Individual characteristics			
women	160	138	165
men	144	134	164
married	158	143	167
not married	139	131	163
age >p50	150	136	161
age <p50	162	136	167
at least primary school	168	165	171
no primary school	99	68	112
at least high school	157	147	171
no high school	139	134	165
income >p75	158	145	169
income <p75	161	137	166
Time horizon			
3,4,5 day horizon	185	168	196
7 day horizon	156	145	177
14 day horizon	159	152	171
30 day horizon	141	124	163
90 day horizon	139	128	151
180 day horizon	123	115	138
Treatment variables			
couples' decisions first	164	139	169
individual decisions first	143	130	156
30 day FED	175	171	179
no FED	122	116	132
ascendant order	129	121	140
descendant order	172	168	176
ascendant order if no FED	111	103	121
descendant order if no FED	147	128	153
ascendant order if 30 day FED	151	142	165
descendant order if 30 day FED	181	177	184

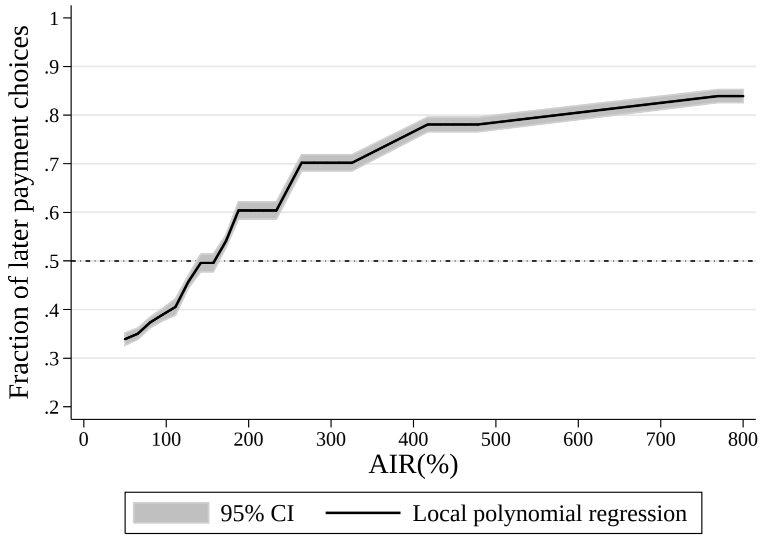


Figure 1.3: Local Polynomial Regression with Individuals' Decisions

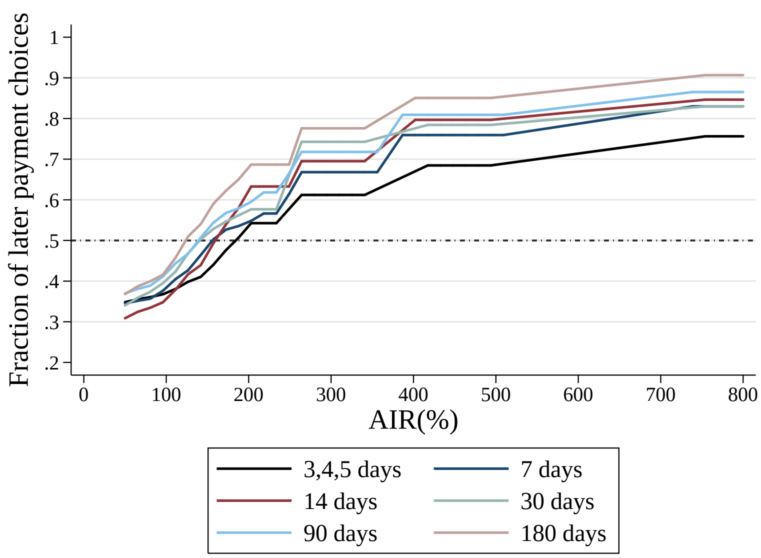


Figure 1.4: LPR by Horizon using Individuals' Decisions

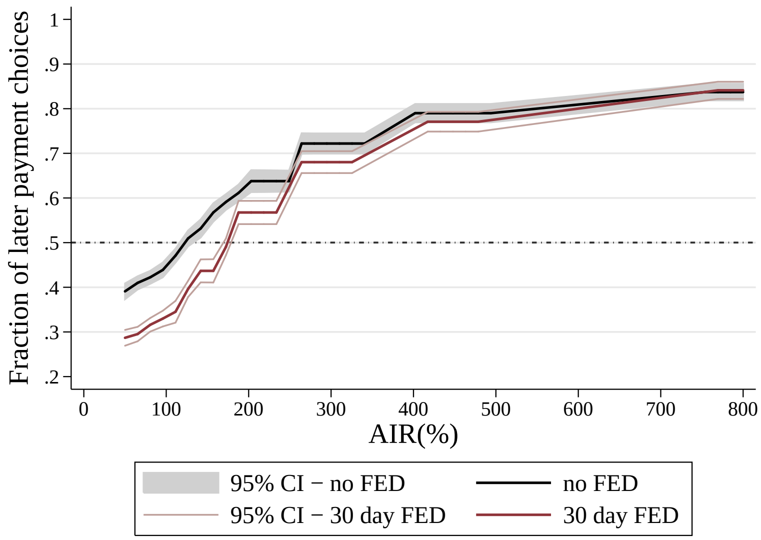


Figure 1.5: LPR by FED using Individuals' Decisions

are more willing to choose later payments than the individuals with a 30 day FED, which indicates lower discount rate levels for the no FED group.

Regarding the order in which horizons are presented, Figure 1.6 shows that the fraction of later payment choices is higher when horizons are presented in an ascending order. This result holds when I analyze the data by FED, as shown in Figure 1.7. With respect to the order in which couple and individual decisions are taken, the order does not seem to affect the willingness to wait for a later payment.

Next, I use probit estimations to explore the discounting behavior in the individual decisions (Table 1.6). The dependent variable is the variable choice and the independent variables are sociodemographic and treatment variables. Results are in line with the previous graphical analysis. Calculating the marginal effects at the means, I find that a 30 day FED decreases the probability of choosing a later payment by 7 percentage points. Having the horizons displayed in an ascend-

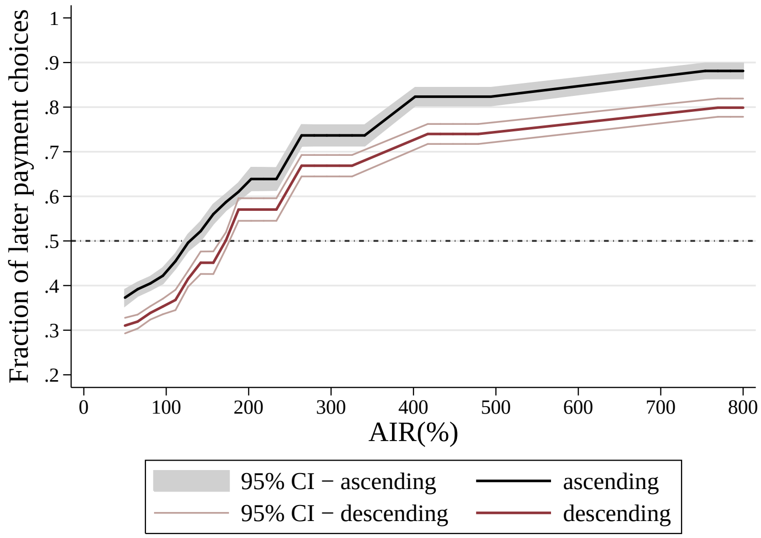


Figure 1.6: LPR by Order of Horizons using Individuals' Decisions

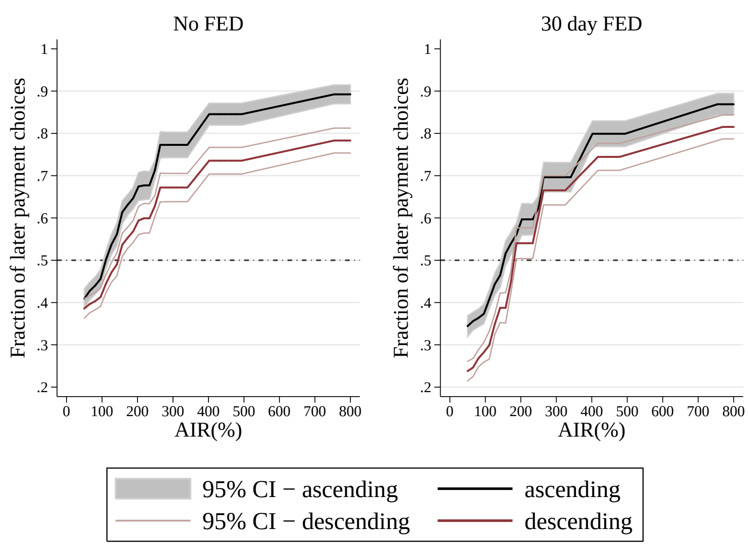


Figure 1.7: LPR by Order of Horizons and FED using Individuals' Decisions

Table 1.6: Marginal Effects at Means Using Individual Decisions.

Variables	dy/dx	Std.Err.	P>z	95% Conf. Interval	
30 day FED	-0.07	0.01	0.00	-0.08	-0.06
couples' decisions first	-0.01	0.01	0.08	-0.02	0.00
ascendant order	0.08	0.01	0.00	0.06	0.09
gender	0.01	0.01	0.31	-0.01	0.02
age >p50	0.00	0.01	0.74	-0.02	0.01
married	-0.03	0.01	0.00	-0.05	-0.02
primary school	-0.06	0.01	0.00	-0.07	-0.04
income >p75	0.00	0.01	0.51	-0.02	0.01

ing order increases the odds of choosing the later payment by 8 percentage points. Presenting the couples' decisions first decreases the probability of choosing a later payment by 1 percentage point. The effect of gender, age and income are not statistically significant but the effects of being married and primary school are. Both, being married and having at least finished primary school decrease the percentage of later payments by 3 and 6 percentage points, respectively.

The LPR with couples' decisions shows no clear difference between real and fake couples' decisions. The same happens when I compare individuals' and couples' decisions, as shown in Figure 1.8. However, the median discount rate for couples is slightly higher than the one for individuals. As in the case of the individual decisions, the average discount rate seems to be lower the longer the horizon. The difference between no FED and 30 day FED almost disappear in the couples' decisions, as shown in Figure 1.9.

As in the case of individuals, the order in which the horizons are presented to the couples does affect couples' willingness to wait for a later payment. When horizons are presented in an ascending order, couples show a higher fraction of later payment choices, which implies lower discount rates. This difference persists for each type of FED.

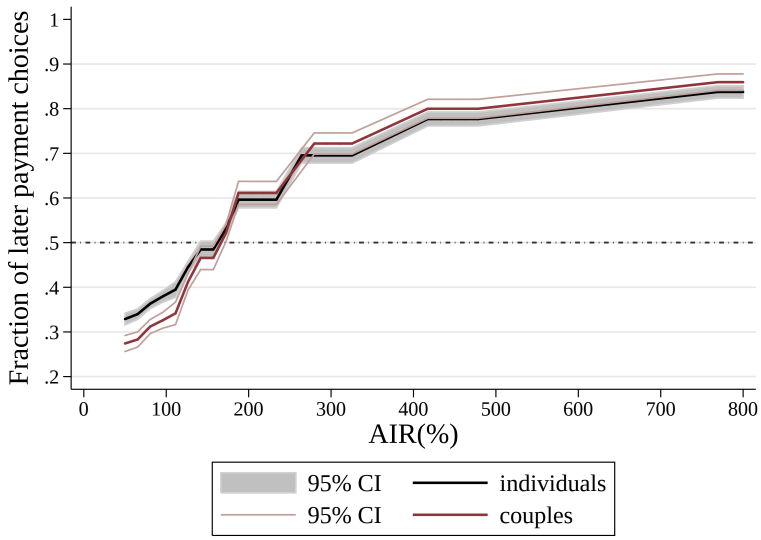


Figure 1.8: LPR using Individuals' and Couples' Decisions

Looking at the probit estimation, I find a statistically significant difference between individuals' and couples' choices. Couples seem to be less patient than individuals. There is no statistically significant difference between real and fake couples' choices. Facing a 30 day FED reduces the probability of choosing a later payment by 2 percentage points, a smaller effect than in the case of the individuals. Presenting the couples' decisions first increases the probability of later payments by 5 percentage points. Finally, displaying the horizons in an ascending order increases the chances of choosing a later payment by 8 percentage points, a similar result than the one of individuals.

Figure 1.10 shows that couples' decisions show more patience when they are completed before the individual decisions but only for lower levels of the AIR. The difference in the median discount rate in Table 1.7 supports this finding.

Table 1.7: Couples' Median Discount Rate by Subsamples.

Results are stated in percentages.

Variables	Median	95% Conf. Interval	
Individuals vs. couples			
Individuals in couples	165	137	168
couples	170	168	172
real couple	163	137	169
fake couple	171	166	177
Time horizon			
3,4,5 day horizon	191	159	243
7 day horizon	201	153	247
14 day horizon	157	150	177
30 day horizon	144	133	175
90 day horizon	156	130	171
180 day horizon	161	135	168
Treatment variables			
couples' decisions first	139	130	158
individual decisions first	177	173	181
30 day FED	171	167	176
no FED	161	137	168
ascendant order	142	129	153
descendant order	173	160	187
ascendant order if no FED	146	122	159
descendant order if no FED	181	175	186
ascendant order if 30 day FED	138	128	159
descendant order if 30 day FED	177	173	181

Table 1.8: Marginal Effects at Means using Couples' Decisions.

Variables	dy/dx	Std. Err.	P>z	95% Conf. Interval	
couple	-0.01	0.00	0.07	-0.02	0.00
real	0.01	0.01	0.29	-0.01	0.03
30 day FED	-0.02	0.01	0.01	-0.04	-0.01
couples' decisions first	0.05	0.01	0.00	0.04	0.07
ascendant order	0.08	0.01	0.00	0.06	0.10

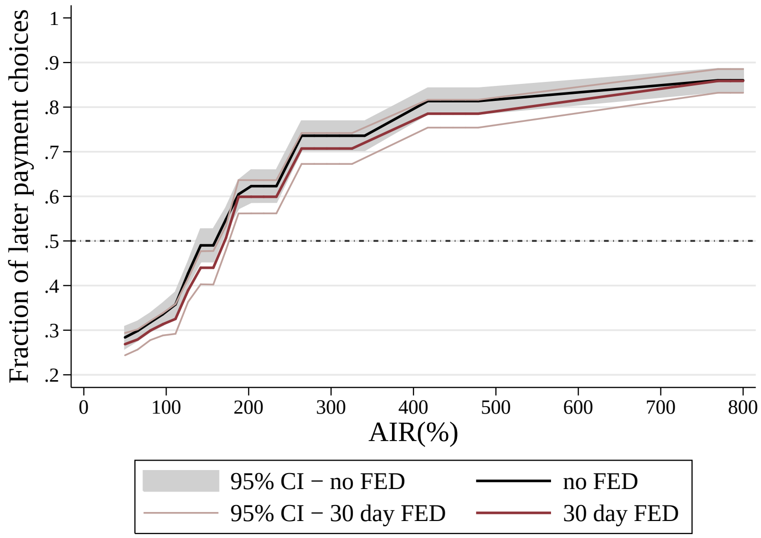


Figure 1.9: LPR by FED using Couples' Decisions

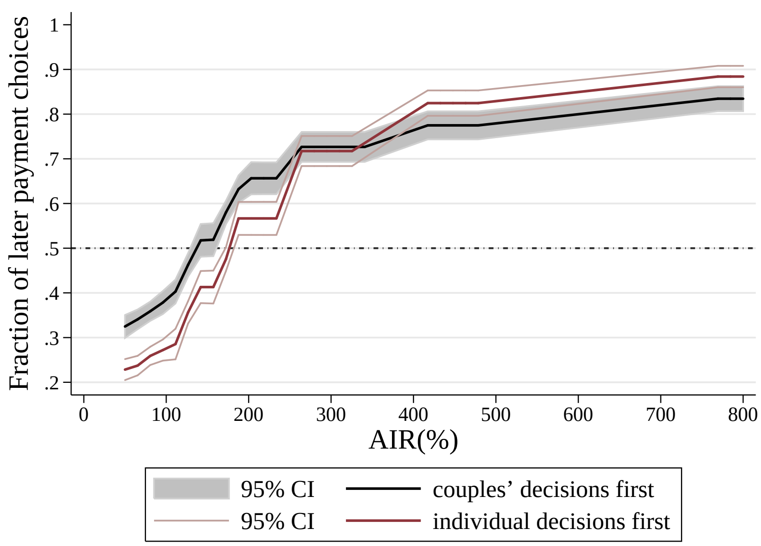


Figure 1.10: LPR by Order of Decisions using Couples' Decisions

1.8 Structural Estimation

1.8.1 Risk Preferences

In this section I analyze the risk preferences of individuals and couples using only the risk tasks. First, I determine the model that fits best the data. Then I analyze the risk preferences of the different subsamples: individuals, couples, real and fake couples.

Selection of the Model

The most common model applied to estimate risk preferences is the EUT framework and the CRRA utility function. I test the appropriateness of different models of EUT and RDU using all observations in the data, the choices from all individuals and couples. I consider two different utility functions, the CRRA and the expo-power utility functions, and three different probability weighting functions: the power pwf, the inverse-S shaped pwf and the Prelec pwf. In all the RDU models, the t-test rejects the null hypothesis that the pwf parameters are equal to one. This means that the hypothesis that individuals behave as in a EUT framework is rejected in all the models. The results are presented in Table A.1.

To compare the different RDU models I use the Vuong and Clarke statistics for non-nested models. The results of the Vuong and Clarke statistics appear in Table 1.9. I compare models by pairs where the number on top is the value of the Vuong (part A) or Clarke statistic (part B) and the number at the bottom is the p-value of the test. For instance, I compare model 1 (the RDU model with CRRA utility and power pwf) with model 2 (RDU model with CRRA utility function and inverse-S pwf). If the value of the Vuong test is positive and statistically significant, model 1 is better than model 2. If the value of the Clarke statistic is greater than a fixed value[7] and statistically significant, model 1 is better than model 2. According to both statistics, the model that best describes the data is the RDU framework with expo-power utility function and Prelec pwf. The parameter estimates of Prelec pwf show that the sample in general overweighs the extreme values but overweighs more the best outcomes, which show optimism behavior.

Individuals' Decisions

First, I analyze the individual decisions. For comparison, I will present the results of the constant relative risk aversion (CRRA) model in the EUT framework which is the model assumed in most studies of individual risk preferences. The CRRA coefficient for the individual decisions is 0.38. In order to study the heterogeneity of the sample, I include one treatment variable and the socioeconomic variables. The treatment variable *order* is 1 when the individual completed the couples' tasks first and 0, otherwise. The socioeconomic variables are: *gender, age, primary school, married*, and *income*. Age is a binary variable that is 1 if individual is older than 44 years old, which is the percentile 50 in the sample. *Primary school* is 1 if the individual has at least completed primary school. *Married* is 1 if the individual is currently married. *Income* takes the value of 1 if the household income is greater than the income range $150,000 - 250,000$ colones (percentile 75). None of the variables are statistically significant. Looking at the total effects of these variables, *order, age, primary school* and *income* are statistically significant. While older individuals show lower relative risk aversion, individuals that have at least finished primary school and high

[7] This value is half the total number of questions in the risk task for all the sample (10 662).

Table 1.9: Clarke and Vuong Statistics for RDU Models.

Values below are p-values.

	CRRA		EP		
	Inverse-S	Prelec2	Power	Inverse-S	Prelec2
A. Vuong Statistic					
CRRA Power	6.378	-6.37	-8.023	-2.617	-8.185
	0.000	*1.000*	*1.000*	*0.996*	*1.000*
CRRA Inverse-S		-11.446	-6.988	-15.274	-14.268
		1.000	*1.000*	*1.000*	*1.000*
CRRA Prelec2			5.258	1.402	-8.326
			0.000	*0.081*	*1.000*
EP Power				-2.099	-7.468
				0.982	*1.000*
EP Inverse-S					-5.415
					1.000
B. Clarke Statistic					
CRRA Power	11,797	9,557	10,222	10,126	10,132
	0.000	*1.000*	*1.000*	*0.996*	*1.000*
CRRA Inverse-S		9,645	9,527	8,572	9,472
		1.000	*1.000*	*1.000*	*1.000*
CRRA Prelec2			11,204	10,523	10,502
			0.000	*0.972*	*0.986*
EP Power				10,126	9,557
				1.000	*1.000*
EP Inverse-S					10,005
					1.000

household income show higher levels of CRRA coefficient. Individuals that completed the couple tasks first show higher levels of CRRA coefficient.

However, the EUT framework with CRRA utility function is not the suitable model for this sample. The best model is the RDU model with expo-power utility function and Prelec pwf (A.2). Because the sign of the parameter is negative, individuals show decreasing relative risk aversion (DRRA). In Figure 1.11, I present the Prelec pwf function for the individual sample, using the coefficients of the homogenous model. The graph on the left shows the pwf. It looks like an inverse-S shaped pwf that is mostly concave. The graph on the right shows with an example the effect of the pwf on the weights. In a lottery of four prizes (red) where each objective probability is 25%, the Prelec pwf transforms the weights so that individuals overweight the extreme outcomes but overweight more the best outcomes. Thus, individuals can be described as optimistic.

I add covariates to analyze the heterogeneity of the sample. I find that the individuals that completed the couple tasks first show more risk aversion. Women show less risk aversion than men and older individuals show less risk aversion than younger individuals. People that have finished primary school are more risk averse than people that have not and married people are more risk averse than singles. Some variables also affect the parameter estimates of the pwf. Individuals that completed the couple tasks first and that have at least finished primary school show more optimism. On the contrary, older individuals show more pessimism than younger individuals. These results are similar to the total effects found in the EUT-CRRA model. Results are shown in Table A.4.

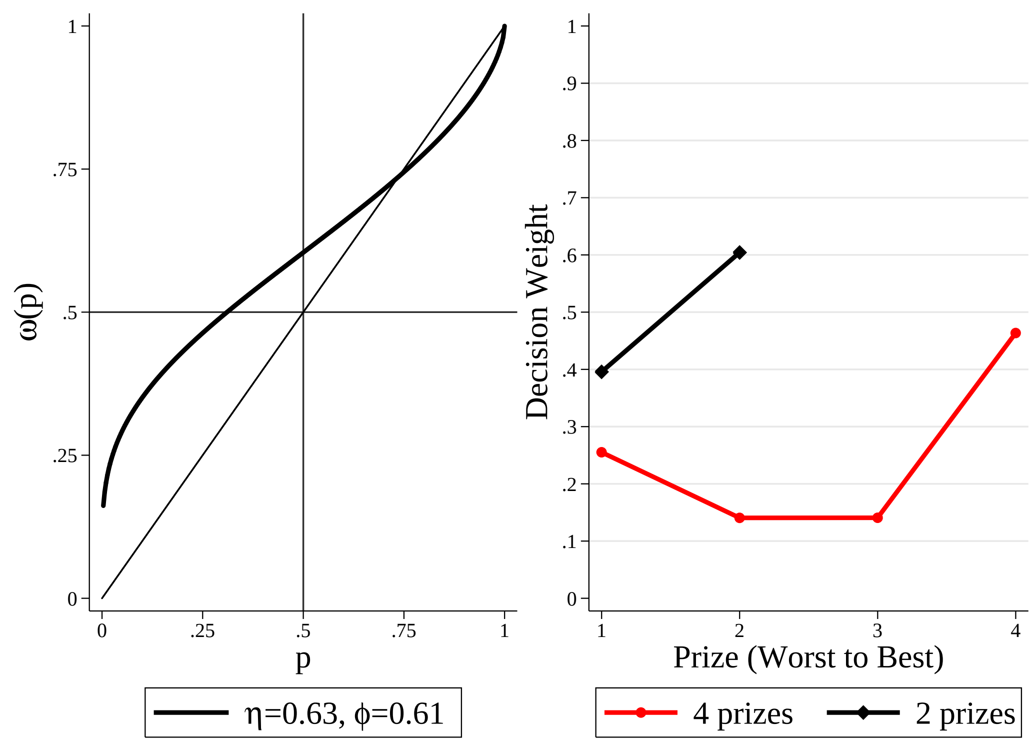


Figure 1.11: Prelec PWF and Decision Weights

Individuals' and Couples' Decisions

Next, I analyze whether individual preferences are similar to couple preferences. To analyze the hypothesis, I pool the decisions of all individuals and all couples and add the variable *couple* as a covariate that takes the value of 1 if the decision was done by a couple. The coefficient represents the effect of being in a couple. I also estimate this effect for real and fake couples, separately.

When comparing all individuals' decisions with the couples' decisions using the EUT model with CRRA utility function, I find that the variable *couple* increases the relative risk aversion by 0.17 (from 0.34 to 0.51). However, in the best model the variable *couple* only has a statistically significant effect in one of the pwf parameters (ϕ) but the effect is very small as shown in Figure 1.12 and Table A.5 in Appendix A.

In order to look for differences between real and fake couples, I analyze the sample of real and fake couples separately. As explained before, a real couple is a married couple or a couple that cohabits. A fake couple is a group of two people paired up at random that take decisions together in the session. The sample of real (fake) couples is composed of individual and couple decisions of real (fake) couples.

In the EUT-CRRA model, real and fake couples show different results. While individuals' and couples' preferences of real couples are similar, they differ substantially in the case of fake couples. However, in the best model the variable couple only affects one of the pwf parameters in the sample of real couples and the effect is very small. The results are shown in Table A.6 in Appendix A.

Then I analyze the sample of individuals and couples separately. For the individual decisions,

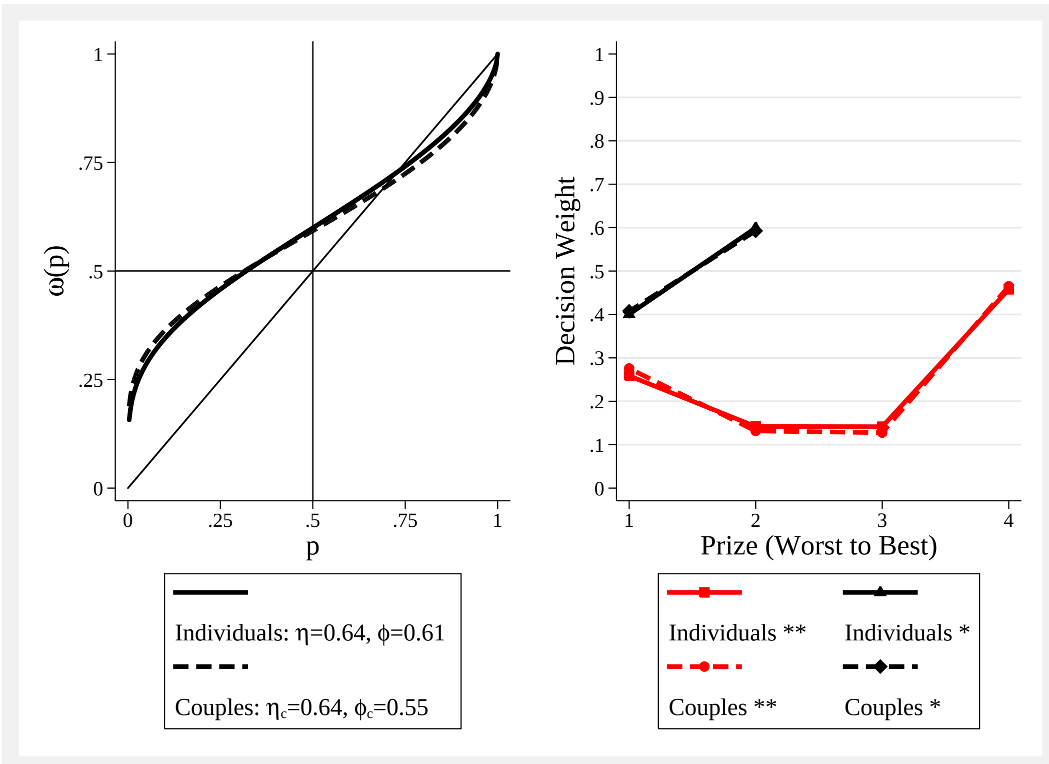


Figure 1.12: Prelec PWF and Decision Weights for Individuals and Couples

Table 1.10: Summary of Estimates by Model and Subsample.

Model	Individuals			Couples		
	All	Real	Fake	All	Real	Fake
EUT						
r	0.35	0.38	0.31	0.49	0.44	0.55
RDU						
r	0.74	0.74	0.73	0.78	0.76	0.80
α	-0.16	-0.16	-0.15	-0.24	-0.20	-0.29
η	0.61	0.64	0.59	0.60	0.61	0.60
ϕ	0.61	0.63	0.57	0.57	0.57	0.57

the CRRA coefficient under the EUT framework is 0.35. In the best model, individuals show DRRA and the Prelec pwf indicates that individuals are optimistic. I analyze the rest of the subsamples in the same manner. The results are shown in Table 1.10.

In summary, I do not find significant differences between individuals and couples in either the fake couples or the real couples.

Bargaining Model

The fact that there is no statistically significant difference between individuals' and real couples' preferences in any of the models suggests that real couples' preferences are a combination of the spouses' preferences. I analyze this possibility by eliciting the decision power within the household under a EUT framework. Interestingly, I find that women are the ones that guide the decision in situations under uncertainty with a decision weight of 0.92 (Table 1.11).

This result is in line with Carlsson et al. (2013) who also find that individuals and married couples' preferences are similar but they find that couples' preferences are more similar to the

Table 1.11: Bargaining Power within the Real Couples.

Parameter	Point Estimate	St. Error	p-value	95% Conf. Interval	
EUT with CRRA utility function					
	Log-Likelihoood: -7,230.41		Observations: 11,158		
r_women	0.50	0.12	0.00	0.26	0.75
r_men	0.24	0.25	0.34	-0.25	0.74
weight_women	0.92	0.13	0.00	0.66	1.19
μ	0.19	0.01	0.00	0.16	0.21

husbands', rather than the wifes' as in my case. This result also explains previous findings in developing countries that show women in charge of the money related decisions (Collins, Morduch, Rutherford, & Ruthven, 2009).

1.8.2 Joint Estimation: Time and Risk Preferences

In this section, I estimate the discount rate for individuals and couples. Risk preferences are also estimated and serve as a robustness check of the previous results. First, I will establish the model that describes best the data. Then I will analyze the parameters of the different subsamples.

Determination of the Model

In order to determine the best model for the data, I consider four different discounting functions: the exponential, the Prelec, the Weibull and the Mazur. As in the previous analysis, I also apply the EUT and the RDU framework. I use the CRRA utility function and two pwfs: the power and the Prelec[8]. In any of the models, neither the quasi-hyperbolic nor the Weibull discounting function

[8] I discarded the inverse-s shaped pwf because in the analysis considering only the risk choices, the inverse-s shaped pwf was always exceeded by the power or the Prelec-2 pwf. I also consider the expo-power utility function but the models did not converge.

show hyperbolic behavior. Moreover, both models show some evidence of the opposite behavior. Since there is no theoretical framework that supports increasing discount rates over time, I discard these models. The Mazur discounting function shows slightly decreasing discount rates. I compare the Mazur discounting function with the exponential discounting function using the statistics for non-nested models. The results are shown in Table 1.12.

In contrast to the analysis of risk preferences, in this case the Vuong and Clarke statistics show slightly different results. Using the Vuong statistic, the best model is the exponential discounting function with a CRRA utility function and the Prelec pwf. With the Clarke statistic, the best model uses the power pwf instead. Both models show very similar results. However, the hit rate for the Prelec model is higher than the one for the power model. I will present the results of both models in Appendix and focus on the results of the Prelec in the explanations. It is important to remark that the best model is under the RDU framework which supports the results of the analysis of risk of the previous section.

Individuals' Decisions

I start with the analysis of the individual decisions. The simplest model is the exponential discounting function. When I assume a linear utility function, the discount rate is 382%. If I consider the curvature of the utility function and assume a EUT- CRRA utility function, the discount rate is 39%, far smaller than the discount rate with a linear utility function. The results of the estimation of the different models with the sample of individuals are presented in Table A.7, Table A.8 and Table A.9 in Appendix A. Looking at the heterogeneity of the sample, only education has an effect on the CRRA coefficient. More educated people are less risk averse. None of the treatment

Table 1.12: Clarke and Vuong Statistics for Discounting Models.

	A	B	C	D	E
	Mazur EUT	Expon. RDU Prelec2	Mazur RDU Prelec2	Expon. RDU Power	Mazur RDU Power
A. Vuong Statistic					
Exp. EUT	7.316	-14.947	-14.351	-14.630	-14.111
	0.000	*1.000*	*1.000*	*1.000*	*1.000*
Mazur EUT		-15.404	-14.892	-15.145	-14.701
		1.000	*1.000*	*1.000*	*1.000*
Exp. RDU Prelec2			10.142	3.715	5.155
			0.000	*0.000*	*0.000*
Mazur RDU Prelec2				1.770	3.422
				0.038	*0.000*
Exp. RDU Power					10.299
					0.000
B. Clarke Statistic					
Exp. EUT	28,828	21,104	24,807	21,455	23,187
	0.000	*1.000*	*1.000*	*1.000*	*1.000*
Mazur EUT		24,641	22,219	23,583	22,551
		1.000	*1.000*	*1.000*	*1.000*
Exp. RDU Prelec2			30,864	22,891	26,120
			0.000	*1.000*	*1.000*
Mazur RDU Prelec2				25,660	24,006
				1.000	*1.000*
Exp. RDU Power					30,033
					0.000

variables have an effect on the CRRA coefficient or the discount rate.

The best model is the exponential discounting function using the RDU framework with CRRA utility function and Prelec pwf. The value of δ is 29%, and the CRRA estimate is 0.8. The parameter estimates of the pwf function are $\eta = 0.42$ and $\phi = 0.73$ so that individuals are optimistic which also confirms the results of the risk analysis. It is interesting to notice that the value of the CRRA coefficient is higher than the value found in the analysis with only risk choices. A possible explanation for this result is that the time preferences choices only contain information on the curvature of the utility function or the aversion to variability. Thus, this characteristic of the intertemporal choices affects the EUT-CRRA estimate in the joint estimation and pushes them upwards. Figure 1.13 shows the pwf for the best model that is very similar in shape to the power pwf.

Looking at the effect of socioeconomic and treatment variables in the best model, people that have finished primary school show lower relative risk aversion and less optimism. Tanaka et al. (2010) also finds that more educated individuals are less risk averse. The authors do not find study the relationship with the pwf parameter estimates. These effects are opposite than the ones found in the analysis with the risk tasks. I prefer the results with the joint estimation because risk preferences have been estimated with more data. Age has a statistically significant effect on one of the pwf parameter estimates: older people overweight extreme values more than younger people. Neither the treatment nor the socioeconomic variables have a statistically significant effect on the discount rate. The results are shown in Table A.10 in Appendix A.

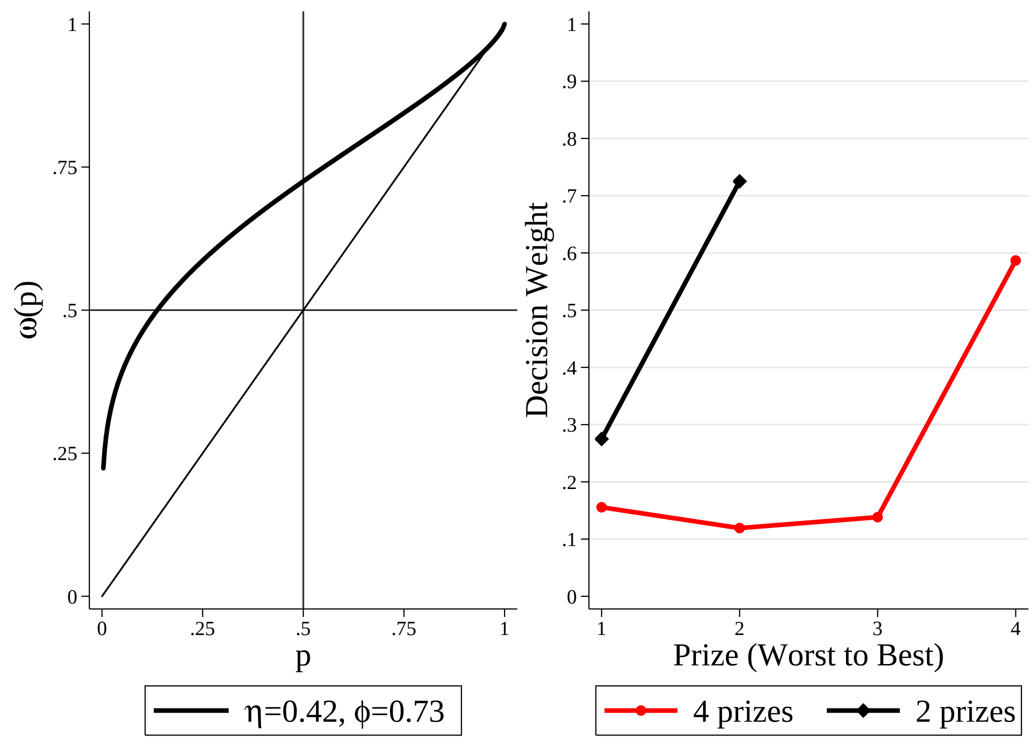


Figure 1.13: Prelec PWF and Decision Weights in the Discounting Model

Individuals' and Couples' Decisions

Following the risk analysis, I estimate the difference between all individuals and all couples using the variable couple. I distinguish between real and fake couples by estimating the difference between individuals and couples in each group. Finally, I estimate the parameters for each subsample.

Considering all individuals and couples choices, the variable couple in the exponential model using the EUT framework and CRRA utility function increases the discount rate by 18% (from 43% to 62%). The variable couple also reduces the CRRA coefficient by 0.04. This effect is statistically significant but small. In the best model, couples have a higher discount rate than individuals by 14% (from 30% to 44%). The variable couple also reduces the CRRA coefficient and reduces one of the pwf coefficients but the effects are very small. Results are shown in Table A.11 in Appendix A.

Results for real and fake couples are presented in Table A.12 and Table A.13 in Appendix A. I will focus only on the results of the best model. Real couples have a discount rate of 46% that is 14% higher than the one of individuals. Real couples have a lower CRRA coefficient than individuals but the effect is small, as is the effect on the pwf. I find similar results in the sample of fake couples but in this case there is a more significant effect on the pwf. Fake couples seem to be less optimistic that their respective individuals. This result is confirmed in the RDU model with power pwf.

In Table 1.13, I present the estimates for every subsample. In general, we can see that there is not much difference between the risk preferences of individuals and couples in the best model.

Table 1.13: Summary of Estimates by Discounting Model and Subsample.

Model	Individuals			Couples		
	All	Real	Fake	All	Real	Fake
Exponential-EUT						
r	0.72	0.68	0.81	0.72	0.68	0.77
δ	0.46	0.53	0.31	0.56	0.66	0.44
Exponential-RDU						
r	0.80	0.78	0.81	0.78	0.77	0.79
η	0.41	0.44	0.37	0.45	0.44	0.46
ϕ	0.73	0.74	0.71	0.64	0.65	0.63
δ	0.32	0.32	0.31	0.41	0.43	0.38

Couples show higher discount rates than individuals both in real and fake couples. These results confirmed the findings in the descriptive analysis.

1.9 Analysis of Correlations

I analyze the correlations between each of the parameter estimates of risk and time preferences and the investment in water tank in the structural model. I measure the correlations using the best model of the joint estimation. As a robustness check, I measure the same correlations with the second best model.

Only 20% of the real couples in the sample have a water tank. In the couple survey, I asked the real couples that that have a water tank whether the decision was taken by the couple or by any of the spouses. In 84% of the cases, the decision was taken by the couple and in 16% the decision was taken by the head of household. Thus, I expect to find a stronger correlation between real couples' preferences and the water tank investment.

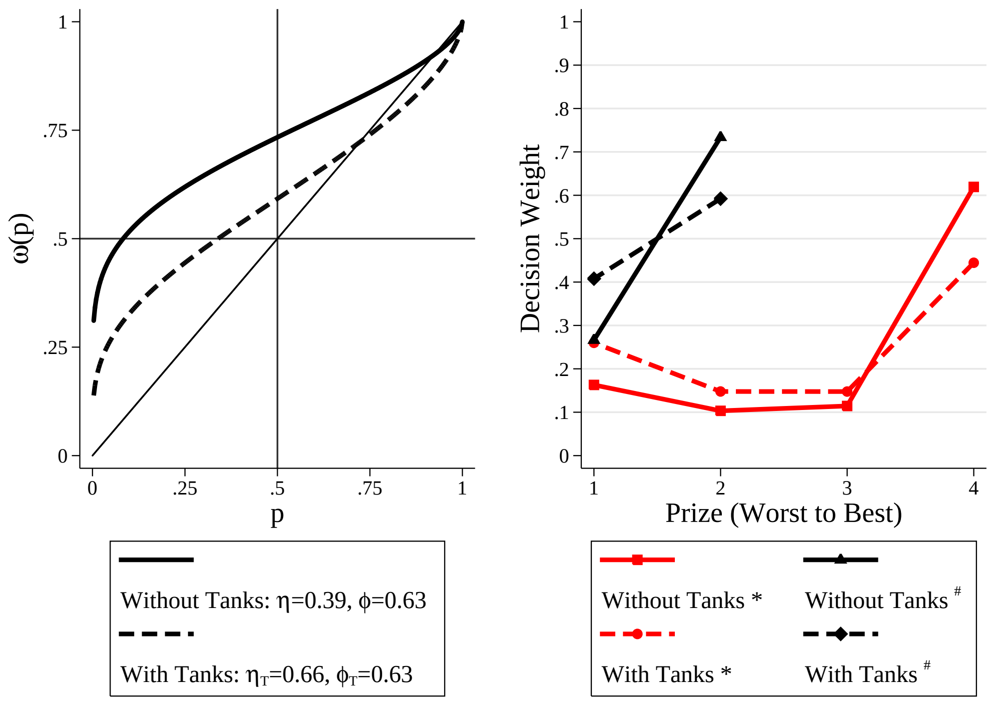


Figure 1.14: Prelec PWF and Decision Weights With and Without Tanks

The results using all the real couples' choices are presented in Table 1.14. Real couples' relative risk aversion is the same for couples that have water tanks and couples that do not have water tanks. However, real couples that have water tanks show less optimism (higher η) than real couples that do not have water tanks as shown in Figure 1.14. Also, I find that real couples that are less patient (higher δ) are less prone to invest in water tanks. However, when I look at the correlation between head of households preferences and water tank, I do not find any statistically significant relationship as shown in Table 1.14. Neither find I a statistically significant correlation with the other spouse's preferences. As a robustness check, I use the exponential model with RDU power pwf. I find the same results as shown in Table A.14 in Appendix A.

Table 1.14: Correlation of Variable *Water Tank* with Parameter Estimates.

Parameter	Variable	Point Est.	Std. Error	p-value	95% Conf. Interval	
A. Couples						
	Log-Likelihoood: -5,996.99			Observations: 9,593		
r	tank	0.013	0.054	0.805	-0.092	0.118
	const	0.778	0.028	0.000	0.723	0.834
η	tank	0.264	0.120	0.027	0.030	0.499
	const	0.392	0.051	0.000	0.292	0.493
ϕ	tank	0.184	0.177	0.297	-0.162	0.531
	const	0.626	0.073	0.000	0.484	0.769
δ	tank	-0.306	0.151	0.043	-0.602	-0.009
	const	0.479	0.106	0.000	0.271	0.687
μ_r	const	0.121	0.008	0.000	0.105	0.138
μ_d	const	2.961	0.886	0.001	1.225	4.697
B. Heads of household						
	Log-Likelihoood: -6117.90			Observations: 9,515		
r	tank	-0.020	0.055	0.715	-0.128	0.087
	const	0.749	0.037	0.000	0.677	0.821
η	tank	0.228	0.156	0.145	-0.079	0.534
	const	0.390	0.060	0.000	0.272	0.508
ϕ	tank	-0.015	0.198	0.939	-0.403	0.373
	const	0.716	0.101	0.000	0.518	0.914
δ	tank	-0.194	0.197	0.325	-0.581	0.192
	const	0.480	0.148	0.001	0.190	0.770
μ_r	const	0.160	0.014	0.000	0.133	0.187
μ_d	const	5.435	1.850	0.003	1.809	9.061

1.10 Discussion of results

In this section, I will compare the results of the structural estimation with the findings of the literature. Regarding the estimation of the risk preferences, the results with just the risk tasks and the joint estimation show very similar results which demonstrate the robustness of the estimation procedure. The best model for individuals and couples in the study site is an RDU model with Prelec pwf. Applying the joint estimation, I find that the sample shows a CRRA coefficient of 0.8 (0.64 in the estimation with the risk tasks only). This means that people not only are averse to the variability of final outcomes but also have an attitude towards probabilities. Specifically, the parameters estimates show that both individuals and couples overweight the objective probability of the best outcome. Using the risk tasks, I find that individuals overweight the extreme values with a clear tendency to overweigh more the best outcome. In the joint estimation, the pwf is more concave and the optimistic behavior is even stronger. This result is confirmed when I applied the RDU model with power pwf. Moreover, more education reduces the risk aversion and the optimism. The results differ from the ones found by Harrison et al. (2010) for Uganda, India and Ethiopia in comparable estimations. The authors find a CRRA coefficient of 0.5 and a convex pwf when assuming the Prelec pwf and a S-shaped pwf when assuming the Tversky-Kahneman pwf. The shape of the Prelec pwf indicates that people underweigh the extreme values with a tendency to overweigh more the worst outcomes. Tanaka et al. (2010) find a CRRA of 0.41 and 0.37 in the north and south of China, respectively. Liu (2013) elicited risk preferences for individuals in Vietnam and finds a CRRA coefficient of 0.52. Both studies use the same elicitation procedure and a one parameter Prelec function. They find individuals overweigh the small probabilities, like an inverse-S shaped pwf, but there is no tendency towards optimism or pessimism. Their pwf does have the flexibility to allow for that.

Using a pool estimation, I do not find a significant difference between individuals and couples risk preferences. When I estimate the balance of power, I find that on average women carry the decision of the household with a weight of 0.92. This result is in line with Carlsson et al. (2013)'s results who finds that couples' decisions are mostly a combination of the spouses decisions. It is also in line with Abdellaoui, L'Haridon, and Paraschiv (2013). They differ from Bateman and Munro (2005) who find that couples are more risk averse than individuals.

I use an exponential discounting model to describe the time preferences of individuals. I have to emphasize the importance of correcting the estimate with the curvature of the utility function. Without it, I find a discount rate of 382%, far higher than the 39% considering a EUT-CRRA framework and the 29% with a RDU-Prelec pwf. I compare my discount rate estimate with the results of studies that also consider the curvature of the utility function and the EUT framework. The discount rate is similar to the 25% – 35% discount rate found by Andreoni and Sprenger (2012) and to the 28% found by Coller et al. (2012) when they assume an exponential discounting function. The subjects in both studies are american students. My discount rate is higher than the 9% estimated by Andersen et al. (2014) for the Danish population. This is the first time this methodology has been applied in a developing country and do not show much difference with other results found in developed countries.

Contrary to much of the literature but consistent with studies (Andersen et al., 2014; Andreoni & Sprenger, 2012; Laury, McInnes, & Swarthout, 2012) with better designs and structural models, I find little evidence of hyperbolic discounting in the individuals and couples' sample. This is in line with results of Carlsson et al. (2012) and contrary to Abdellaoui, L'Haridon, Paraschiv, et al. (2013).

Using a pool estimation, I find significant differences between individuals' and couples' discount rates, in both real and fake couples. Couples show discount rates that are 14% higher than the ones of individuals. This result contradicts the findings of Carlsson et al. (2012) where the joint choices are in between the spouses and the results of Abdellaoui, L'Haridon, Paraschiv, et al. (2013) who find that couples are more patient.

Finally, I estimate the correlation between risk and time preferences and water tanks. Only Liu (2013) analyzes the relationship between investment in adaptation and risk preferences parameters. According to a survey undertaken in the site, the decision to buy a water tank is mostly made jointly by married couples. The correlation between the married couples' parameter estimates and water tanks show the expected relationships. However, when I estimate the correlations with only the heads of household' preferences, I do not find any statistically significant correlation. I find similar results using the next best model with power pwf. These results seem to suggest that adaptation decisions made by married couples are better shaped by the couples' preferences, as suggested by Mazzocco (2004) for the case of savings.

I find a negative correlation between the married couples' discount rates and the adaptation decision, and no correlation between the married couples relative risk aversion coefficient and water tanks. However, less optimistic married couples invest more in adaptation. Theory is ambiguous about the impact of risk aversion on investment in adaptation. More risk averse subjects are expected to invest in adaptation because they want to protect themselves against future climate variability, but more risk averse individuals will invest less in new technologies because they are not certain about their efficacy (Koundouri et al., 2006). Theory does not take into account the attitudes towards probabilities but we could infer that the same forces affect the relationship between pwf parameter estimates and investment in adaptation. My results show that these opposite forces countervail each other in the case of risk aversion but the concerns regarding climate change prevail when considering the attitudes towards probabilities.

1.11 Policy Implications

I have found that individuals in the rural communities in Guanacaste, Costa Rica, are optimistic and impatient. The optimistic behavior affects the investment in adaptation to climate change. For instance, consider the case where there are only two possible future scenarios with the same probability of occurrence, one good where there is no much climate variability and the other where climate shocks increase substantially. Using the parameter estimates, individuals allocate a weight of 73% to the best scenario and a weight of 27% to the worst scenario. Thus, the probability of the best scenario is overweight which dissuades people from investing in adaptation. Moreover, my results reveal annual constant discount rates of individuals and couples that are very high. For instance, a one dollar invested today requires a profit in 10 years of 16 dollars for individuals and 36 dollars for real couples. With such discount rates and optimism, private investment is discouraged as I showed in my results, and policymakers will need to use different strategies to incentivize it. When possible, policymakers could promote the use of technologies that show benefits in the short run, even when no drastic weather changes occur. One example of such technologies are resource-conserving technologies. If other type of products need to be adopted, then policymakers could enhance these products with prizes or raffles, like it has been applied in the case of saving products (Filiz-Ozbay, Guryan, Hyndman, Kearney, & Ozbay, 2015).

Investments in adaptation that involve considerable amounts of money or goods shared by groups are done by collective entities like households. In this study I analyze the case of private water tanks that are mainly a household investment. This type of investment (floating houses, water storages, solar panels) is best explained by the preferences of the married couple, rather the preferences of the head of household. Thus, policies that want to encourage this type of investment in adaptation should consider the characteristics of the couples, and not just the characteristics of the individuals. Moreover, policymakers should target their messages and interventions to the couple and not necessarily assume that the message that one of the spouses receives is shared with the other spouse.

1.12 Conclusions

Private investment in adaptation to climate change constitutes a decision to spend money today in return for uncertain payoffs in the future. Thus, time and risk preferences are important factors that shape adaptation decisions. This study assesses the characteristics of these preferences for populations in rural and drought-prone areas of Costa Rica, and connects them to household investments in water tanks.

My findings paint a gloomy picture: the population tends to be optimistic and exhibits large discount rates, and both factors correlate significantly with a reduced likelihood to invest in adaptation measures. On the other hand, the couples' (high) level of risk aversion does not appear to encourage adaptation investments. As a result, without governmental intervention many households are unlikely to make significant personal investments in climate change adaptation. This further highlights the need for policymakers and researchers to design public policies and programs that encourage private adaptation investments, and it demonstrates that these policies need to overcome substantial hurdles in the form of personal preferences in order to be effective.

The findings in this study give rise to a range of interesting avenues for continued research. For instance, my results call into question the existence of present-bias among populations in developing countries. Prior studies that find evidence for present bias base their conclusion on a set of questions that could suggest the presence of this feature but that do not allow the elicitation of discounting functions. More research (using adequate experimental and econometric designs) is needed to answer this important question conclusively for developing countries.

In addition, the present study focuses on a type of adaptation investment (water tanks) that was not only familiar to the population, but that households had chosen independently. The correlation between preferences and adaptation decisions might differ for technologies that are introduced externally and that have a less foreseeable impact.

Lastly, a common criticism of artefactual field experiments is that, even though they allow us to obtain rich data to estimate parameter estimates, they do not put the subject in the real context for which the preferences are estimated. In spite of that, I find intuitive correlations between (regularly elicited) preferences and household adaptation investments. Nonetheless, in this context a framed field experiment could provide tremendous additional insight into the mindset of individuals and couples in view of climate change adaptation decisions.

Chapter 2

Climate Change Adaptation through Resource-Conserving Technologies

2.1 Introduction

The promotion of resource-conserving technologies to achieve development and environmental objectives is widespread across nations and environmental domains. To mitigate climate change and reduce pollution, environmental scientists and practitioners promote the adoption of energy-efficient technologies (e.g., Field, Barros, Mach, and Mastrandrea (2014)). To mitigate water scarcity and facilitate climate change adaptation, they promote the adoption of water-efficient technologies (e.g., FAO (2014)). To mitigate agriculture's effects on habitat loss, they promote the adoption of land-efficient ("land sparing") technologies (e.g., Balmford, Green, Scharlemann, et al. (2005)). These technologies are also postulated to improve human welfare by reducing input costs, particularly in low-income rural areas of developing countries.

Yet the arguments in favor of public programs to encourage the adoption of these resource-conserving technologies are based on incomplete models of human behavior. Proponents seem unaware that the impacts of adopting these technologies are theoretically ambiguous and empirically unsupported. Performance, market and behavioral factors can increase or reduce the effect of the resource conserving technologies on the resource consumption. For instance, the performance of the technology may differ depending on the characteristics of the resource and the homes. Besides, the technology reduces the marginal cost of the service which translates into a higher consumption of the service and of other services that use the same resource. It also leads to a higher income which in turn affects consumption of all normal goods; the literature calls the market phenomenon the rebound effect (Chan & Gillingham, 2015). Moreover, individuals may stop using the technology. Or they may have a preference for conservation *per se* and the technology discourages other water conservation efforts.

Impact estimation of adoption is typically done by natural and physical scientists and engineers using one of two approaches: (1) a prospective approach that combines assumptions about the performance of the old technology, the performance of the new technology, and the behavior of the adopters (e.g., EERE (2010)); and (2) a retrospective approach that either uses a non-experimental before-after estimator (e.g., change in water use after adoption) or a with-without estimator (e.g., difference in water use between adopters and non-adopters). In rare cases, they may use a non-experimental difference-in-difference estimator (e.g., Davis, Fuchs, and Gertler (2014)). Experimental estimators are rare (e.g., Fowlie, Greenstone, and Wolfram (2015)).

A non-experimental before-after approach was applied by the engineers of the Costa Rican Water Agency “Instituto Costarricense de Acueductos y Alcantarillados” (AyA) who tested the effect of some water conserving technologies in the headquarters of the agency. The analysis that disregarded standard rules of experimental design and behavioral factors found reductions in water consumption of around 50%. Based only on these results and because of the drought suffered in several areas of the country, the Costa Rican government presented a bill early in 2016 aimed at reducing taxes for water-conserving technologies (Arias, 2016). This is an example of how engineer estimates currently determine water related public policies.

In this study, I contrast the prospective approach to an analysis based on a randomized controlled trial design (RCT). I also address the "product adoption puzzle," which posits that consumers fail to adopt products with benefits that exceed their costs. This puzzle has been posed in a variety of resource-conserving technology contexts, including energy-efficiency ("the energy efficiency gap") (Allcott & Greenstone, 2012; Gillingham & Palmer, 2014; Kallbekken, Sælen, & Hermansen, 2013), water-efficiency ("the water efficiency gap") (Golin, Cox, Brown, & Thomas, 2015), and improved cook stoves. Whether the lack of widespread adoption is really a puzzle is the subject of much debate, often because of arguments over the technologies' impacts, their costs, and the preferences of consumers (including time and risk preferences and subjective beliefs).

I aim to accomplish two objectives: (1) to assess whether common engineering approaches to estimating the effect of water-efficient technology adoption are accurate; and (2) to assess whether there is a "water efficiency gap or paradox," whereby the subjective marginal benefits from adoption exceed the subjective marginal costs by a large margin, but consumers nevertheless fail to adopt the technologies. In a drought-prone area of Central America where residents have not adopted water-efficient technologies, I ran an RCT to test the impact of water-efficient technology adoption on household water use. I also explore the mechanisms through which observed impacts differ from engineering predictions and conduct cost-benefit analyses using the experimental estimator of impact, experimentally elicited measures of time and risk preferences, and detailed field and survey data.

I find an intent-to-treat effect of 2.69 m^3 (10.76%), much higher than a similar RCT done in the country. Even though a bonus payment discourages dis-adoption, I still find a small percentage of people that uninstall the technology. Measuring the technology impact for the households that kept the technology does not have a statistically significant effect in the experimental estimate. There is an important difference between my experimental estimate and the engineering estimate, calculated using the realized installation rates and the actual water flows with the old and new technologies on the field. The fact that some people reported to take more time for showering, cooking and washing hands and to dislike the flow, leads me to believe that they had a hard time to adjust to the new flow because of habits or because some activities might need a fixed amount of water (cooking, for example). This seems to be the main reason to explain the difference in the estimates, but further research is needed.

The private cost-benefit analysis shows that the technology recovers its costs three years after installation, even considering the individuals subjective discount rates. The comparison between the disutility of buying or not buying the technology indicates the preference for the technology, even considering beliefs about prices and the effectiveness of the technology.

This chapter is organized as followed. In the next section, I explain the theoretical reasons behind the differences between the standard engineering estimate of water conserving technologies and the experimental estimate. In the third section, I describe the design of the study. In the fourth section, I present the results and in the fifth section, I conclude.

2.2 Reasons for Divergence between Engineering and Experimental Estimates

For resource-conserving technologies, there are a variety of reasons why engineering impact estimates may differ from experimental estimates. I group these reasons into: (1) behavioral reasons, which emphasize deviations from the behavioral assumptions implicitly made by engineers; and (2) design reasons, which emphasize deviations from the assumptions made by experimentalists.

2.2.1 Behavioral Reasons

Engineering estimates typically assume that humans do not change their behaviors post-adoption (e.g., while washing dishes, adopters continue to run the water for the same amount of time as before adoption) and that they use new technologies under similar conditions to those observed in the laboratory settings used to rate the technologies' performance. These assumptions may be violated in practice.

1. Performance ratings: The performance ratings of resource-conserving technologies are often generated under carefully controlled laboratory conditions, for appropriate reasons. For example, in the United States and Canada, the performance standards of plumbing supply fittings are tested in accordance with procedures set out by the American Society of Mechanical Engineers (ASME A112.18.1/CSA B125.1). The maximum flow rate is the highest value obtained through testing at three water pressures (20, 45 and 80 PSI). Engineers typically assume that the maximum flow rate measured under laboratory conditions is a good

approximation for the performance standards observed in the field under both the status quo and new technologies. But under naturally-occurring circumstances, three variables can affect field performance: (1) water pressure in the home; (2) how far the residents open the spigots (i.e., do they turn the faucet all the way open or only a fraction?); and (3) the degree to which mineral and other deposits attach to the technologies. Variations in these field conditions can lead the engineering estimate to be greater than or less than the experimental estimate. To assess this explanation for a divergence between engineering and experimental estimates, I calculate an engineering estimate based on the actual change in flow between old and new technologies in a sample of households from the communities with the spigots open all the way and with the spigots opened "the way [the residents] normally open it."

2. Installation success: Engineers typically assume 100% success in swapping old technology for new technology. If, for example, the average home in the target population has one shower, one toilet, three sinks, and one outdoor spigot, the engineering approach typically assumes that one can replace the old technology with a new technology on each water source. But it often turns out, particularly in older homes, that the newer technologies cannot be installed without extensive changes to the home. In these homes, full adoption of the technologies is not feasible. Thus the engineering estimate can overestimate the post-adoption reduction in water use. To assess this explanation for a divergence between engineering and experimental estimates, I calculate engineering estimates that are based on a 100% installation success rate and the realized one.

3. Dis-adoption: There is a growing recognition in the technology adoption literature that dis-

adoption is a problem (Hanna, Duflo, & Greenstone, 2016). For example, studies have found that one in four or five adopters of efficient cook stoves dis-adopt the technology within one year. Engineers, however, typically assume that 100% of adopters continue to use the technology well after adoption. Thus the engineering approach can overestimate the post-adoption reduction in resource use. To assess this explanation for a divergence between engineering and experimental estimates, I conduct an audit of dis-adoption in all treated households about four months after treatment assignment. Should dis-adoption be an important issue phenomenon, I will estimate a local average treatment effect for the complier population. Moreover, to reduce the likelihood of dis-adoption, I randomized a performance bonus that was conditional on maintaining the technology until a random audit was performed four to six months after installation. If the bonus is effective at eliminating most dis-adoption, I can re-analyze the data using only the bonus treatment group (acknowledging that the statistical power will be lower).

4. Conventional rebound (take-back) effect: Resource-conserving technologies lower the effective price of consuming the services that the resources provide, thus inducing a greater quantity demanded of the services, and thus the resource (Chan & Gillingham, 2015). Engineering estimates typically ignore this effect, and thus can overestimate the post-adoption reduction in resource use. Measuring rebound effects is difficult without detailed behavioral data within the household and without an ability to control for changes in other attributes of the resource-using experience that the new more efficient technology may have changed.

5. Changes in attributes unrelated to efficiency: It is typically difficult to create technology

that only improves resource use efficiency without changing any other attributes of the use experience (Gillingham & Palmer, 2014). Changes in water flow, for example, may change the "feel" of the water and thus the use experience. Engineering estimates typically ignore these changes, and thus can overestimate or underestimate the post-adoption reduction in resource use. As an indirect means of assessing this explanation for a divergence between engineering and experimental estimates, I use survey questions that ask treated households what they like and dislike about the new technologies and how, if at all, they changed their behaviors post-treatment assignment.

6. Unconventional rebound (resource-dampening) effect: If pro-social preferences induce resource conservation (e.g., via altruism, conformity to social norms, or conditional cooperation), then resource-conserving technologies lower the effective price of expressing pro-social preferences, thus inducing a greater quantity of conservation "consumed" which translates into lower resource consumption. This effect is the opposite of the conventional rebound effect. In other words, once I allow utility to be gained from conservation activities, then a countervailing effect to the rebound effect exists. Measuring this effect is difficult. Instead I use survey data collected in 2013 in the same communities (two years before the experiment) to ascertain whether households were taking conservation actions prior to treatment assignment. If conservation actions were rare, the unconventional rebound effect is unlikely to be an important explanation for a divergence between engineering and experimental impact estimates.

7. Moral licensing effect: If household members' identities are linked to resource conservation

actions (e.g., "I am a good person who contributes to conserving collective resources"), the adoption of resource-conserving technologies may create licensing effects, whereby adopters feel they can increase their resource use because they have confirmed their sense of identity through adoption of the more efficient technology (Miller & Effron, 2010; Tiefenbeck, Staake, Roth, & Sachs, 2013). Although the mechanism for moral licensing differs from the mechanism of the rebound effect, the direction of its effect on resource use is similar: it makes the engineering approach overestimate the technologies' effect on resource use. Like with the attempt to measure the unconventional rebound effect, I use survey data collected in 2013 to ascertain whether households were taking conservation actions prior to treatment assignment. If such conservation were rare, the moral licensing effect is unlikely to be an important explanation for a divergence between engineering and experimental impact estimates.

8. Priming (salience) effect: Most resource-conserving technologies are visible whenever the resource is being used. If the efficiency attribute of the technology is a salient attribute to the consumers (e.g., the technology was adopted because it uses resources more efficiently), a visible technology will serve as a reminder to the user about the importance of resource conservation (for both private and social reasons). This form of priming may lead to other behavioral conservation actions unrelated to the technology (an alternative causal path from technology adoption to water use). Engineering approaches do not include such actions, and thus can underestimate the post-adoption reduction in resource use.

2.2.2 Design Reasons

1. Engineers estimate a different estimand: Engineering calculations implicitly assume they are measuring the expected effect of technology adoption for a randomly selected household from the entire population of targeted water users, also known as the average treatment effect (ATE). In other words, engineers implicitly assume a regulation or standard that requires everyone to adopt the technology. But RCTs cannot typically force households to adopt a technology. They can thus only measure treatment effects on voluntary adopters (compliers), and the composition of this subgroup may vary depending on the form of the treatment. I take several actions to ensure compatibility between the engineering estimator and the experimental estimator: (a) I offer the technology for free to ensure a large complier group; (b) I only randomize treatment among the group of compliers (i.e., I exclude Never Takers from the treatment assignment process; no Always Takers exist because the experimenters control access to the technology); and (c) I calculate the engineering estimate using data from a sample of households that are willing to adopt the technology when offered for free.

2. Violations of excludability in the experiment: All RCTs impose an excludability assumption (exclusion restriction): the only relevant causal agent is the receipt of treatment. One potential violation of excludability comes from the packaging of water-efficient technology with conservation messages: the technologies are specifically marketed as ways to reduce water use, which has private and social benefits. Thus in many studies of resource-conserving technologies, it is difficult to disentangle the effect of technology adoption from the effect of the resource conservation marketing. I eliminate this exclusion violation by ensuring that all

households receive the same marketing information about the technology and the benefits of reducing water use, prior to randomization of the technology. Note, however, that the priming effect of the technology described above may be strengthened in an experimental design because the way in which households obtained the technology was unusual (randomization of free technology by a research group collaborating with your community water association). This violation implies that the experimental estimator is biased toward finding a larger reduction in water use than would be found in a naturally-occurring, non-experimental technology adoption program.

3. Interference among units in the experiment (Stable Unit Treatment Value violations): If treated households discuss or show the technology to their untreated neighbors, the control group may try to acquire the technology on their own and thus may no longer represent the counterfactual water use of the treated group. Because the technologies are only available through the experimenters (they are not sold in regional stores), interference of this form is very unlikely. However, people could get a more efficient technology than their current appliances (for example, people that shower without a shower head could get one). To address these concerns, I sampled four untreated households at random five months after treatment assignment in each of the nine communities to inquire whether they had changed their water delivery technology since treatment assignment and, if so, how. A few homes replaced a broken faucet or pipe, but none of them adopted water efficient technologies.

4. Sampling variability: The engineering and experimental estimates may differ or may be similar simply by chance. To guard against Type 1 and Type 2 errors, I conduct a power

analysis with the Type 1 error rate set at 5% and the Type 2 error rate set at 20% (see Section 2.3) to determine the experimental sample size. When I report the results, I also report confidence intervals to better characterize the degree of uncertainty about the difference between the engineering and experimental estimates.

2.3 Design

2.3.1 Study Site

The study takes place in the western provinces of Guanacaste and Puntarenas, Costa Rica. The experiment is part of a large Canadian government-funded research project on climate change adaptation and water scarcity in Central America.

Most communities (85%) in the provinces obtain water from underground sources, which is pumped to homes by a community system of pipes. In around 50% of the communities, water is managed by the AyA, while the rest of communities manage their own water systems through community associations called ASADAS. As part of the climate adaptation project, 82 communities of this area were randomly chosen, using the criteria explained in Section 1.3. From this set of 82 communities, I selected communities who met the following conditions: (1) ASADAs use water meters, (2) ASADAs apply variable rate pricing (so households save money if they reduce water use), (3) ASADAs have monthly water records of households dating back to 2012, and (4) ASADAs were interested in collaborating with the team to install water-efficient technology in a randomly chosen subset of their customers. Ten communities were the first ones to answer to my request and agree to share their data after several attempts. I chose randomly nine of them to meet the sample size requirements (see Section 2.3.3).

2.3.2 Treatments

Based on conversations with water engineers in Costa Rica, I offer two water efficient technologies: (1) 1.5 gpm (gallon per minute) shower heads; and (2) 1 gpm faucet aerators. Dishwashers are absent in the study region. Almost all homes have toilets and manual washing machines, but I excluded these technologies from the study because no engineer believed that they were cost-effective ways to reducing water use in the region (for either private or social benefits). None of the selected water conserving technologies is available in hardware stores in rural Central America. They are not even common in urban areas of Costa Rica, including Guanacaste's regional capital of Liberia. I found two retail stores (no wholesale) selling limited amounts of shower heads in San Jose, the capital of Costa Rica, which is at least five hours away from the study communities. No home surveyed in the communities had such technologies prior to the experiment.

The experiment has three treatment arms:

1. Control Group: A control group of residents who expressed interest in installing the technologies when the technology and installation was free to the resident, but who did not receive the technology.

2. No Bonus Group: A treatment group of residents who expressed interest in installing the technologies when the technology and installation was free to the resident, and who received the technology.

3. Bonus Group: A treatment group of residents who expressed interest in installing the tech-

nologies when the technology and installation was free to the resident, who received the technology, and who were also offered (after they agreed to install the technology) a performance bonus of USD 20 if, when the team returned unannounced between four and six months later, they still had all of the technologies installed. A proportional bonus was paid if some but not all of technologies were still installed.

The main unit of analysis is the household. I cannot use the home as the unit of analysis because only five out of the nine communities keep home IDs in their water consumption records. However, results between both estimation strategies should only differ if I have several movers in the sample. I calculate the number of movers and compare the estimate using the home and the household as the treated unit in the five communities. I expect results with both strategies to be similar since people are mostly owners and do not move frequently.

2.3.3 Power Analysis

Engineers in the focus groups estimated that water would decrease by somewhere between 20% and 35%. Because of the strong beliefs among engineers that the treatment should reduce average water consumption, I developed a power analysis that could detect a policy-relevant treatment effect of a 6% reduction (i.e., test of the null of zero average effect). Before the field work started, I collected consumption data from January 2013 to March 2014, two months prior to treatment assignment. The objective was to take advantage of the intertemporal correlation in water consumption to calculate the required sample size, and to explain part of the post-treatment water use variance which will allow us to reduce the sample size. The inter-year correlation between 2013 and 2014 average water use was well over 0.70. I set the Type 1 error rate at 5% and the power at

80%. The sample size of the treatment group was designed to be twice as large as the control group because I would split the treatment group into Bonus and No Bonus groups. Based on the mean (22.5) and standard deviation (13.9) from May through October 2014 and the inter-year correlation between 2013 and 2014 use during the same months (I use 0.70 to be conservative), I estimated a sample size of 752 households in the treatment group and 376 households in the control group.

For the test of whether the bonus payment affected dis-adoption rates, I had no guidance from previous studies. Expert opinion from engineers in the capital and the ASADA committees suggested fewer than 15% of the sample would dis-adopt in the first six months. I undertook a power calculation with a moderate 25% dis-adoption rate and a difference in proportions of 5% between the Bonus and No Bonus groups. With these parameters and Type 1 error rate set at 5% and Type 2 error rate set at 20%, I obtained a sample size of around 362 households in each treatment arm, which is smaller than the 376 estimated group size derived in previous paragraph. Thus I use the larger sample sizes as my guide.

2.3.4 Experimental Design

In my nine communities, there were 2,246 billed customers in March 2015. Using pre-treatment billing data, I eliminated any households that had zero consumption for the period December 2014 through March 2015. In April 2015, part of the field team went to each community to confirm plans for treatment assignment in the subsequent months. In this visit, they created community maps with the location of each home. They also went to each household with the ASADA plumber to confirm that the final sample did not include commercial establishments or households that shared a meter. As a way to ensure measurement fidelity, the team placed identification number labels on every water meter in the community that matched my database. Based on billing data and the field visit, I eliminated 345 customers.

The survey team comprised four Costa Rican interviewers with bachelors' degrees and survey experience who were trained to implement the randomization protocol. Interviews were conducted using a tablet. Each interviewer was accompanied by a plumber to form four installation teams. Using the community maps, I divided the community into four equally populated sectors and assigned each team to one of them. If a household did not answer the first time, the team visited it a second time the next day.

Of the 1901 households on the target list, the team interviewed 1346 heads of households. Each team interviewer used a standard ethical protocol. They read a short script containing 1) information about recent and future weather changes in the region, 2) advocating the need to save water, 3) a description and presentation of the technology with a video, and 4) the offer to install the water-efficient technologies for free in some of the homes. The script is presented in Appendix B. Of these 1346 households, 1310 agreed to have the technologies installed should they be selected to receive the technologies. The interviewers randomized the treatment arms across these 1310 households. Note two key features of the design: (1) I only randomized households into one of the three treatment arms if a head of household indicates he or she is interested in accepting the installed technology for free; and (2) all households received the same marketing script, thereby ensuring any treatment effect I detect is from the technology rather than from the information on water conservation.

Randomization was done by the resident putting her hand inside an opaque bag with three colored chips inside (blue, red and white). Each chip assigned the resident to one of the three treatment groups. Since I did not know the number of people willing to accept installation of the technology, in each community every team received a bag of chips in the amount of 50% of the number of homes per sector. Once teams were done with the initial bag of chips, I gave them chips in the amount of 50% of the available households. When there were fewer than 9 available households in the sector, the team receives only 3 chips per load. Thus, randomization was done within community and team.

This design helps to increase power and ensure roughly equal numbers of households assigned to each treatment arm: 440 households assigned to the control condition, 432 households assigned to the technology treatment with no performance bonus, and 438 assigned to the technology treatment with a performance bonus. After the installation, old technologies were taken away in order to avoid dis-adoption and re-installation of the old technology. In the 870 households selected for technology installation, the plumber was able to install at least one technology fixture in all but six households (99+% success). I retain these six households in the analysis. The number of each type of technology installed appears in Table A.15. Of the 1310 households randomized to treatment, 395 were assigned to treatment in May 2015 and 915 were assigned to treatment in June 2015. The post-treatment period of analysis is June-September 2015 for the first group and July-September 2015 for the second group.

To provide indirect evidence that the randomization protocol was followed by the field team, I examine whether treatment assignment predicts water use in the same period in 2014 (see Table 2.3). It does not. The average pre-treatment monthly water use in both treated and untreated groups was about 23.65 m^3.

2.3.5 Engineering Estimate

Conversations with engineers in the capital city, who based their estimates on rated technology performance and their experience studying urban and semi-urban residential water use, lead to a range of estimates of the water use reduction from technology adoption of between 20% and 35%, with an informal consensus around 25%. However, I calculate my own engineering estimates and compare it to the experimental estimate. I mainly consider two engineering estimates. To construct both estimates I include the proportion of water use that came from different exit points in rural homes of the study area. The first engineering estimate (first column in Table 2.1) is calculated using the assumptions that I believe are usually considered by engineers, the ones under ideal conditions. That is I assume the water flow of the new technologies that is described in the package (1.5 gpm for shower head and 1gpm for faucet aerator); the water flow of the old technologies when faucet is opened all the way as in laboratory studies; and that the team installs all the technologies in each house. The second engineering estimate (6th column in Table 2.1) is closely adjusted to the study area. It is calculated using the actual flow of the old and new technologies on the field measured by letting individuals open the faucet as for the typical daily use, and the realized installation rate of shower heads and aerators during the experiment. With respect to the installation rate, note that the team could not install all the technology fixtures in all the houses, either because there was no faucet, the plumbing could not be adapted to fit the technology or the head of household did not allow us to replace it. The first engineering estimate is 24.1%. The second estimate is 20.3%. In Table 2.1 I also include the standard errors and estimates constructed using different combinations of the assumptions for completeness.

Table 2.1: Engineering Estimates under Different Flow and Installation Rate Assumptions.

Engineering estimates of water reduction between old and new technology usage, depending on assumed water flows and installation rates (that is, what share of new technologies could be installed in each household).

	100% installation rate			Realized installation rate		
	Label flow⋆	Maximum†	Usual‡	Label flow⋆	Maximum†	Usual‡
Mean	24.09%	33.43%	26.69%	18.23%	25.57%	20.34%
Standard Error	0.04	0.03	0.02	0.03	0.03	0.02

⋆ Old technology flow: faucet is opened all the way; new technology flow: based on product label.

† Old and new technology flow: faucet is opened all the way.

‡ Old and new technology flow: faucet is opened as for typical daily use.

2.4 Results

2.4.1 Dis-adoption

All the results are calculated using the statistical software package Stata. Of the 870 treated homes, I audited 748 four months after the installation: 82% of the No Bonus group and 89% of the Bonus group. The attrition group is mainly composed of empty homes (67.2%), absent heads of household (11.5%) and rejections (5.7%).

Households can uninstall all the technologies or some of them. If I consider complete dis-adoption, I found that 6.5% of the households without bonus and 3.1% of the households with bonus uninstalled all the technologies. These percentages differ when I extend the definition of dis-adoption and include partial dis-adoption: 16.9% for households without bonus and 8.2% for households with bonus. Under both definitions, the bonus seems to reduce the willingness to dis-adopt. To further analyze the decision to dis-adopt, I apply a probit estimation to explain complete-partial and complete dis-adoption in Table 2.2. The explanatory variables are: pre-treatment water consumption; technology flow that indicates whether the head of household likes the flow of the technologies installed in the home; technology appearance that stands for whether the head of household prefers how the new technologies look like; secondary school equals one if the head of household has at least finished secondary education; home owner equals one if the head of the household owns the house; participant in ASADA meetings is equal to one if any member of the family participated in any of the last two ASADA sessions, and bonus that is equal to one if the household received a bonus. The results show that people that like the flow of the new technologies are less likely to dis-adopt them. Having received a bonus and being a home owner also reduce the likelihood of partial-complete and complete dis-adoption. Other variables that show statistically significant effect for either of the definitions of dis-adoption are pre-treatment water consumption and secondary school.

2.4.2 Water Use Impacts: Intent-To-Treat Estimate (ITT)

Table 2.3 presents the engineering and experimental estimates of the effect of the technology adoption on the average monthly water consumption of households interested in the technology. I ignore for now dis-adoption and calculate the intent-to-treat effect (ITT). The post-treatment period runs from June through September 2015. I have complete post-treatment data for 1294 households (98.8% of the sample). The control group consumed on average 25.03 m^3 of water per month (standard deviation= 14.80). The engineering estimates are 6.03 m^3 (24.09%) and 5.09 m^3 (20.34%).

I estimate the treatment effect on average monthly water consumption using an OLS regression estimator with robust standard errors since the Breusch-Pagan-Cook-Weisberg test implies

Table 2.2: Average Marginal Effects of Impact on Partial-Complete and Complete Dis-adoption of Technologies.

	Partial-Complete	Complete
Technology flow	-0.191 (0.023)***	-0.083 (0.017)***
Technology appearance	-0.038 (0.029)	0.009 (-0.018)
Pre-treatment water consumption (March 2015)	0.001 (0.001)***	0.000 (0.00)
Secondary school	-0.019 (0.026)	-0.052 (0.024)**
Home owner	-0.076 (0.032)**	-0.038 (0.022)*
Participate in ASADA meetings	0.002 (0.023)	0.009 (-0.015)
Bonus	-0.054 (0.022)**	-0.027 (0.015)*
Community Dummy Variables	Yes	Yes
Interviewer Dummy Variables	Yes	Yes
Robust Standard Errors	Yes	Yes
Observations	742	742

***p<0.001, **p<0.01, *p<0.05.

Table 2.3: Engineering and Experimental Estimates of Impact on Water Consumption from Adoption of Water-Efficient Technology.

	Engineering Estimate		Experimental Estimate		
Flow	label	usual			
Installation rate	100%	realized			
Pre-/Post-Treatment			Pre	Post	Post
Year (June-Sept.)			2014	2015	2015
Treatment Effect†	-6.03	-5.09	-0.03	-2.66	-2.69
Standard Error			(0.95)	(0.85)**	(0.44)***
Confidence Interval (95%)			{-1.04, -0.98}	{-4.32, -1.00}	{-3.55, -1.84}
Percent Reduction‡	24.09%	20.34%	0.12%	10.64%	10.76%
Effect Size⋆	0.47	0.34	0.00	0.18	0.18
Community Dummy Variables			Yes	No	Yes
Interviewer Dummy Variables			Yes	No	Yes
Pre-treatment Water Use Variables			Yes	No	Yes
Robust Standard Errors			Yes	Yes	Yes
Observations			1259	1294	1294

***$p<0.001$, **$p<0.01$, *$p<0.05$.

† Technology Adoption Treatment Effect (in m^3 water/month).

‡ Percent Reduction (in experiment, compared to controls).

⋆ Effect Size=(treatment effect)/(standard deviation of control group); i.e. mean reduction in use divided by SD of the counterfactual water use.

evidence of heteroskedasticity (chi-square statistic = 5.06). The covariate-adjusted estimator uses dummy variables for the nine communities and for the interviewers, and monthly pre-treatment water consumption from February to April 2015 (column 5) to explain the outcome variable and thus to reduce the variance of the estimator. I lose 16 observations from the experimental sample because of attrition (1.2%) but the probability of missing is not related to the treatment or other pre-treatment explanatory variables so that I consider the missing observations random. The ITT estimation yields a point estimate of -2.69 m^3, with a 95% confidence interval of -3.55 m^3, -1.84 m^3; in percentage terms, a point estimate of 10.8% and a 95% confidence interval of -14.18%, -7.35%. Technologies reduce monthly water consumption of people that were interested in the technologies by 10.8%. For comparison with impacts of resource-conserving technologies in other study sites or domains (e.g., energy), the estimated effect size is 0.18. There is no detectable difference between the treatment effects of the Bonus and the No Bonus groups. The No Bonus group experienced an estimated reduction of 2.79 m^3 and the Bonus group experienced an estimated reduction of 2.60 m^3.

As mentioned before, the unit of the analysis is the household. I compare the results using the household as the unit of analysis with the ones using the home as the unit of analysis focusing on the data of the five communities that keep a home ID (Table A.16 in Appendix A). I obtain similar results in both analyses mainly because there is not that much rotation: less than 2% of households share the same home over time. Point estimates are higher than the main estimation but within the 95% confidence interval, so not statistically different.

2.4.3 Water Use Impacts: Local Average Treatment Effect (LATE)

I can reject the null hypothesis that the ITT is statistically different from zero and different from the lowest engineering estimate. Hence, the difference between the lowest engineering estimate and the ITT might come from any of the sources listed in the theoretical section. Consider dis-adoption. I can approximate the effect of dis-adoption by using the decision to keep the technologies instead of the assignment to treatment as the treatment variable. As in Section 2.4.1, I consider two definitions of keeping the technologies: (i) keeping all of them or (ii) keeping at least one. However, the randomization no longer assures that the new treatment variable is exogenous. Even though treatment and control groups are similar in terms of the observable variables, there could be some differences in unobservable variables. Moreover, I only have information about dis-adoption for 86% of the treated group. Thus, I need to instrument the new treatment variable and estimate a local average treatment effect (LATE) for the set of the complier population. I use two instruments: the treatment assignment variable and the bonus variable. To deal with the missing observations, I follow two procedures: (i) I reweight the data using the predicted probability of missing (I apply the command *pweight* in Stata), and (ii) I impute the missing observations using the predicted probability of keeping the technologies (regression imputation). Results with the variable keeping all technologies appeared in Table 2.4. I present the results with the variable keeping at least one technology in the Appendix A (Table A.17). The LATE of keeping all the technologies (-3.09, -3.04) is not statistically different than the ITT effect and it is closer to the lowest engineering estimate but still lower. This seems to suggest that the difference between the engineering estimate and the experimental estimate is to a small degree explained by the dis-adoption rate but that there

Table 2.4: Local Average Treatment Effect of Keeping all the Technologies.

All estimations include community and interviewer dummies and pre-treatment water use variables.

OLS Regression	OLS	OLS-Reweight	OLS-Imputation†
LATE	-3.18	-3.03	-3.02
Standard Error	(0.41)***	(0.40)***	(0.42)***
Confidence Interval (95%)	{-3.98, -2.38}	{-3.83, -2.24}	{-3.84, -2.19}
Percent Reduction	12.70%	12.11%	12.07%
Observations	1,176	1,175	1,294
R-squared	0.75	0.75	0.72

IV Regression	IV	IV-Reweight	IV-Imputation&
1st Stage			
Instrument: Treatment	0.83	0.83	0.83
	(0.02)***	(0.02)***	(0.02)***
Instrument: Bonus	0.09	0.09	0.09
	(0.02)***	(0.02)***	(0.02)***
2nd Stage			
LATE	-3.23	-3.09	-3.04
Standard Error	(0.47)***	(0.47)***	(0.50)***
Confidence Interval (95%)	{-4.15, -2.31}	{-4.01, -2.17}	{-4.01, -2.07}
Percent Reduction	12.90%	12.35%	12.15%
Observations	1,176	1,175	1,294
R-squared	0.75	0.75	0.72

***p<0.001, **p<0.01, *p<0.05.

† I apply Regression Imputation.

are other factors that explain the difference.

2.4.4 Assessing Alternative Explanations for the Difference Between Engineering and Experimental Estimates

According to Section 2.2, other reasons that could explain the positive difference between the engineering and the experimental estimate are the moral licensing effect, the rebound effect and the change in attributes. In order for the moral licensing effect to serve as an explanation for the divergence between the engineering and the experimental outcomes, people in the study should have undertaken conservation measures in the past. I look for evidence of conservation behavior in the 2013 survey that included the nine communities of the study. To the question whether people had done something to deal with warmer and longer summers in the previous five years, 14% responded affirmatively and 33% of this subgroup had reduced water consumption. When asked about the future summers, 60% of the sample believed that summers will be longer and warmer than in the past and 56% of them planned to reduce water consumption. That is, less than 5% of the sample in 2013 had undertaken some efforts to reduce their water consumption and 34% planned to conserve water in the coming years but I do not have evidence whether they have put this plan in action. Therefore, the percentage of households who had been actively conserving water already is probably quite small and as a result it seems unlikely that moral licensing can explain the gap in water consumption; however this warrants further studying.

Another potential source of deviation between the engineering and experimental estimates is the change in the attributes of the use experience. That is, by changing the efficiency of water use, it changes the water flow rate which people might like or not. Among the people that the team audited in November 2015, approximately 85% reported that they liked the water flow with the new technologies in place. Initially, I expected that people who like the flow with the new shower head will also take longer showers. However, the correlation coefficient between whether people take longer showers and whether they like the flow of the shower is negative (-0.30). The same is true for the kitchen faucet (-0.17) and bathroom faucet (-0.20). While those that reportedly like the new flow of water largely report that they have not changed the duration of their showers, people who dislike the flow might do so because they need to take longer showers than they used to. Consistent with this hypothesis, I find a small negative correlation (-0.08) between people liking the flow of water and their post-treatment water consumption. More broadly, these findings suggest that a key assumption underlying my engineering estimate namely that people will take the same amount of time to perform the tasks, but with less water may be incorrect. Instead, the new technology may affect only part of people's daily water usage, either due to their habits or because they need a fixed amount of water for certain tasks (e.g., cooking). Understanding what part of water usage is affected by water-conserving technologies is important to look at in further exploration.

The last potential explanation is the rebound effect. Due to the reduction in the relative cost of taking a shower, washing hands and cooking, it is conceivable that people might increase the duration and frequency of these activities (or of other activities that use water as a resource). In my survey, less than 1% of the people reported an increase in the frequency of using water-related services. As discussed above, a fair number of people reported that the activities affected by the technology now take longer; however, the fact that this is positively correlated with their dislike of the flow leads me to believe that it is the technology itself that causes the extended usage rather than a voluntarily response of the individuals to the reduction of the cost of water services. I cannot rule out the presence of rebound effect but it seems likely that the effect of habits and fixed-amount-of-water activities have a more important role.

2.4.5 Heterogeneity

Until now I have focused on the average treatment effect but it is important to determine if the technology might be more or less effective for certain groups. First, I analyze if the treatment

Table 2.5: Quantile Treatment Effect of the ITT.

	Quantile				
	5%	25%	50%	75%	95%
Treatment Effect	-1.14	-1.97	-2.21	-2.46	-4.03
Standard Error	0.71	(0.31)***	(0.35)***	(0.48)***	(-1.62)*
Percent Reduction†	-21%	-13%	-10%	-8%	-8%
Observations	1,294	1,294	1,294	1,294	1,294

† In experiment: compared to controls in the quantile.
***p<0.001, **p<0.01, *p<0.05.

effect differs by the level of water consumption. To calculate the quantile treatment effect, the rank preservation assumption must hold: the individual's potential rank must be the same whether the individual is treated or not (Bitler, Gelbach, & Hoynes, 2008; Djebbari & Smith, 2008). To test the assumption, I compare the values of pre-treatment variables that explain consumption for treated and control households in different quantiles of the outcome variable. In only 3 out of 32 comparisons (8 variables times 4 quantiles), I reject the null hypothesis of equal means between treated and control households at the 5% level, which is evidence in favor of the rank preservation assumption[1]. The covariate balance per quantile is presented in Table A.18 in Appendix A.

Assuming rank preservation, I calculate the quantile treatment effect for the 5%, 25%, 50%, 75% and 95% quantiles. As shown in Table 2.5, the size of treatment effect increases as the quantile goes up. However, the differences are not statistically significant. So, I do not find evidence for different treatment effects by consumption level.

I also investigate whether the treatment effect differs by other variables that might affect the effectiveness of the technologies like education, water scarcity in the community, whether the

[1] This is 9.4% of the cases. Using the same test, Ferraro and Miranda (2013) reject 25% of the cases and Djebbari and Smith (2008) reject 30% of the cases. In both studies, the rank preservation assumption is assumed to hold.

house has the three appliances where technologies were installed, and attendance to the ASADA meetings. Treatment effect did not vary by any of these factors at a 5% level of significance.

2.4.6 Cost-Benefit Analysis and Cost-Effectiveness

In order to investigate if the technology is a valuable investment for households in rural Costa Rica, I undertake a private cost-benefit analysis. I also examine whether the technology program is cost effective for the government.

For the private benefits, I calculate the average household monthly monetary savings generated by the technology. I use the ITT effect (2.69 m^3) and apply the tariffs charged in each community during 2015. Since most of the communities apply variable pricing, the marginal cost of water depends on the level of consumption. I approximate the future water consumption using an annual growth rate of 3.88% based on the water consumption levels since 2013.

To calculate private costs, I assume that people pay for the technology and the installation. I cannot use the price of the technologies in Costa Rica because they are not sold there. Nor can I use the price at which I bought the technologies for the experiment because I imported the technologies from the US at the wholesale price. Instead, I use the Amazon and Home Depot price of the technologies in the US[2]. The market price of the technology package that includes a shower head and two aerators is \$8.40. I also take into account the cost of installation. For the cost of installation I consider the cost of a local plumber and the cost of additional fixtures (new faucets or adapters, for example) needed to install the resource conserving technologies. The cost per home

[2] I look for the price of a basic faucet in these online stores and they were similar to the corresponding prices in Costa Rica so I believe the assumption that the technologies in Costa Rica would cost the same as the products in the US is feasible. These prices do not take into account transportation costs.

of a plumber is \$2.30 and the cost of the additional fixtures is \$10.80 so that the cost of installation is \$13.10. Adding the cost of installation and the price of the technology, I obtain a total cost per home of \$21.50.

In order to compare the private benefits and costs, I need to define a lifespan of the technologies. According to Costa Rican engineers, the lifespan is highly determined by the effect of the minerals in the water. Since I do not have this information, I will assume different lifespans, from two years until five years. This is a conservative assumption since the technology warranty is ten years.

I use two market interest rates to discount the monthly savings: 5% and 10%. The present value of the cost and benefits are presented in Table 2.6. At these rates, the average household recovers the investment in the technology in less than two years: in twenty months when the interest rate is 5% and in twenty one months when the rate is 10%.

I also include the individuals' and married couples' annual discount rate elicited in Chapter 1 for a sample of 485 individuals from thirty communities of the area of Guanacaste, nine of which are in this study. The individual discount rate is $\delta = 0.29$ which is similar to the one elicited in other studies with American students (Andreoni & Sprenger, 2012; Attema, Bleichrodt, Gao, Huang, & Wakker, 2016; Coller et al., 2012) and higher than the 0.09 elicited by Andersen et al. (2014) for a representative sample in Denmark. Since the decision to buy the technologies could be taken by the couple, I also consider couples' discount rate and compare the results. The present values calculated with these rates are included in Table 2.6. At these rates, the technology pays its full cost in three years. At the annual discount rate $\delta = 0.29$, the average household recovers the cost of the technology in twenty five months, while at $\delta = 0.43$ the cost is recovered in thirty months.

Table 2.6: Private Cost-Benefit (in US-$).

Present Value of Costs and Benefits					
Annual Interest/		Lifespan of Technology			
Discount Rate		2 years	3 years	4 years	5 years
0.05	Benefit	25.7	37.7	49.5	61.2
	Cost	(21.5)	(21.5)	(21.5)	(21.5)
	Net	4.3	16.3	28.0	39.7
0.10	Benefit	24.5	35.2	45.2	54.6
	Cost	(21.5)	(21.5)	(21.5)	(21.5)
	Net	3.0	13.7	23.7	33.1
0.29	Benefit	20.9	28.0	33.7	38.3
	Cost	(21.5)	(21.5)	(21.5)	(21.5)
	Net	(0.6)	6.5	12.2	16.8
0.43	Benefit	18.9	24.4	28.4	31.3
	Cost	(21.5)	(21.5)	(21.5)	(21.5)
	Net	(2.6)	2.9	6.9	9.8

Based on the results of Chapter 1 and using the monthly water payments, I compare the discounted disutility of purchasing the technology versus the discounted disutility of not purchasing the technology using the individuals' and couples' annual discount rates and the corresponding relative risk aversion coefficients (r). The discounted disutility of purchasing the technology is expressed as: $U^0_{Tech} = u(P_0 + Cost) + \sum_{t=1}^{T} d_t * u(P_t)$, where P are the monthly water payments, Cost is the cost of the technology and d is the discount factor. The discounted disutility of not purchasing the technology is expressed as: $U^0_{NoTech} = \sum_{t=0}^{T} d_t * u(P_t)$. The results are presented in Table 2.7. Purchasing the technology provides the average household with more utility than not purchasing it even if I only consider a lifespan of two years.

Until now I have assumed that people believe that prices will not increase in the future and that the technology will perform as expected. Nevertheless, people might expect that prices will go up in the future or/and that the water savings due to the technology will be lower than what we advertised. I do not know their beliefs about these potential scenarios so I assume that they believe they might occur with a 50% probability. Based on the results of Chapter 1, I assume that people in my sample are optimistic and that they transform the 50% probabilities to 73% for the good outcome and 27% for the bad outcome. Using this result, I compare the discounted expected utility with technology and without technology assuming the good scenario where prices stay the same and technology performs as advertised, and two bad scenarios: (i) prices increase by 10% (20%,50%) in 2016 and 2018 and (ii) technology reduces water consumption by less than the ITT result: by 1.345 m^3 (0.67m^3). In all the cases, the disutility without the technology is higher than the disutility with technology after two years. This difference (disutility without technology minus disutility with technology) increases slightly assuming the first bad scenario but reduces to almost half in the second one. Thus, the belief about higher prices makes the technology more attractive but the belief about the effectiveness of the technology could discourage take-up, but since people are optimistic the best outcome results overpower the bad scenario.

In summary, both analyses show that the cost of the technology is recovered three years after the treatment and that the utility of purchasing the technology is higher than not buying it even considering only a two year technology lifespan. Moreover, even if I consider expectations about price increments and lower effectiveness of the technology, buying the technology still provides more utility than not buying it.

Next, I analyze the program from the government point of view. I will not undertake a public cost-benefit analysis because I do not know how the government or the communities value water. Instead, I estimate the cost-effectiveness of a governmental program that provides the technology

Table 2.7: Discounted Disutility of Payments With and Without the Technology.

Discounted Disutility of Payment					
Household		Lifespan of Technology			
Preferences†		2 years	3 years	4 years	5 years
0.29/0.80	Without Technology	169.1	223.9	266.7	300.1
	With Technology	168.3	222.3	264.5	297.4
	Difference‡	0.8	1.6	2.2	2.7
0.43/0.77	Without Technology	145.5	185.5	213.6	233.5
	With Technology	144.9	184.2	211.9	231.4
	Difference‡	0.6	1.3	1.7	2.1

† Annual subjective discount rate (δ) / Coefficient of relative risk aversion (r).

‡ Denotes the difference between the discounted disutility of payment without and with the technology. A positive value indicates purchasing the technology increases the utility of the average household.

for free, such as the one in my study. I assume the costs of the program are similar to the costs in my study and leave aside the costs of interviewers because they are part of the evaluation, not of the program itself. I include the cost of the technologies and the salaries of the plumber team and a field work coordinator. Using the water savings from the ITT estimation, I calculate the cost-effectiveness for four months (post-treatment period) and one year after the installation. Four months after the installation, every dollar spent saves 0.49 m^3. After one year, every dollar spent saves 1.48 m^3. If I assume that people pay for the technologies, the values are 0.83 m^3 and 2.49 m^3 four months and one year after the program, respectively.

It is difficult to find an appropriate comparison for this result, because there are only a few studies about programs aimed at reducing water consumption. The most similar is the social norm message study of Datta et al. (2015) that takes place in urban Costa Rica. Due to their low costs – Datta et al. (2015) reported that the cost of the program was US$400 –, I calculate a cost-effectiveness between 6.6 m^3 and 10.6 m^3 one month after the treatment. This program is more cost-effective in the very short term, and the authors do not present estimates for longer periods. However, both studies should also be compared in terms of their medium and long term effects and it is expected that the impact of the technologies will last for a few years.

2.5 Conclusion

Resource conserving technologies have been promoted as a measure to conserve and adapt to climate change. These recommendations are mainly based on engineering estimates that either under- or overestimate the effect of the technologies because of deficiencies in the study design or because of ignoring the behavioral factors.

Even though there is a need for experimental studies, these are scarce and there is no experimental study that measures the impact of water conserving technologies. I undertake an RCT to measure the impact of water conserving technologies and find that the technology program reduces monthly water consumption for people interested in the technologies by 2.69 m^3, which represents a percent reduction of 10.76%. This result is much higher than the results of two "nudge" type interventions, Datta et al. (2015) and Jaime and Carlsson (2014), where water consumption was reduced through social norm messages in urban Costa Rica (between 3.5% and 5.6%) and urban Colombia (6.8%). This suggest that the adoption of water conserving technologies could be a better policy in terms of reducing water consumption but the long term effects of both measures should be compared.

The ITT is much lower than the engineer estimate of AyA (50%). Even though the study by AyA also included efficient toilets, the engineer estimate seems highly overestimated. This not only harms the public planning to face water scarcity in the country, but it also inflates the benefits of the proposed tax cuts. Engineer estimates can misguide policy makers by not considering experimental design and behavioral factors as in this case. In other cases proponents of a policy could be guided by other particular reasons. To mitigate this channel, policy evaluations should be undertaken by external parties with no conflict of interest.

The ITT is also lower than our lowest engineering estimate (20.3%). If I take into account dis-adoption and measure the impact in the group of households that kept the technology, the estimated water reduction (12.15%) is higher but not statistically different than the ITT and still lower than the engineering estimate.

According to some hypotheses, there are other reasons that could explain the difference between the engineering and the experimental effect. It is unlikely that moral licensing plays a role in this context because the 2013 survey suggests that most of the population in these communities was not accustomed to save water. Nevertheless, the population could have updated their habits in recent years. I will look further into this channel in future research. My survey suggests that after installation of the technology people take more time to shower, cook and wash their hands, and this is correlated with them disliking the new flow. This suggests that the assumption that people will take the same time but less water to perform their usual activities does not completely hold. Instead, the new technology may affect only part of people's daily water usage because of their habits or the water needs of certain activities. This could explain the difference between the engineering and the experimental estimate but more research is needed.

The technology recovers its cost three years after the program, even considering very high discount rates and assuming beliefs about the effectiveness of the technology and changes in prices.

This evidence suggests that the technology is valuable and households might buy it when offered at a market price; however, further analysis should offer the technology at different prices and elicit people's beliefs. From the government point of view, the program seems expensive in the very short run if I compare it with the Datta et al. (2015)'s program; but I believe that medium and long term effects will show the lasting impact of the technology.

In a future study I plan to replicate and extend the experiment. This will allow me to dig further into the behavioral explanations that affect the impact of the technologies. Moreover, I plan to offer the technology at the market price to measure adoption and whether the change in water consumption is affected by having to pay for the technology.

Appendices

Appendix A

Tables

Table A.1: Best Model Analysis: Parameter Estimates using all the Choices.

Parameter	Point Est.	Std. Error	p-value	95% Conf. Interval	
A. EUT with CRRA utility function					
	Log-Likelihoood: -13,937.67		Observations: 21,324		
r	0.42	0.08	0.00	0.26	0.57
μ	0.21	0.01	0.00	0.19	0.23
B. EUT with Expo-Power utility function					
	Log-Likelihoood: -13,840.94		Observations: 21,324		
r	0.59	0.05	0.00	0.49	0.69
α	-0.04	0.02	0.03	-0.08	0.00
μ	0.19	0.01	0.00	0.17	0.20
C. RDU with CRRA utility function and Power pwf					
	Log-Likelihoood: -13,669.61		Observations: 21,324		
r	0.78	0.02	0.00	0.73	0.82
γ	0.43	0.03	0.00	0.37	0.50
μ	0.18	0.01	0.00	0.16	0.19
D. RDU with CRRA utility function and Inverse-S pwf					
	Log-Likelihoood: -13,826.26		Observations: 21,324		
r	0.18	0.08	0.02	0.03	0.34
γ	0.74	0.02	0.00	0.71	0.77
μ	0.17	0.01	0.00	0.16	0.18

E. RDU with CRRA utility function and Prelec pwf

	Log-Likelihoood: -13,586.62		Observations: 21,324		
r	0.65	0.02	0.00	0.61	0.70
η	0.51	0.03	0.00	0.45	0.57
ϕ	0.61	0.03	0.00	0.55	0.68
μ	0.16	0.01	0.00	0.15	0.17

F. RDU with Expo-Power utility function and Power pwf

	Log-Likelihoood: -13,656.25		Observations: 21,324		
r	0.87	0.02	0.00	0.84	0.90
α	-0.51	0.08	0.00	-0.66	-0.36
γ	0.46	0.03	0.00	0.39	0.53
μ	0.18	0.01	0.00	0.16	0.19

G. RDU with Expo-Power utility function and Inverse-S pwf

	Log-Likelihoood: -13,609.72		Observations: 21,324		
r	0.51	0.03	0.00	0.45	0.57
α	-0.02	0.01	0.00	-0.04	-0.01
γ	0.68	0.02	0.00	0.65	0.71
μ	0.15	0.01	0.00	0.14	0.16

H. RDU with Expo-Power utility function and Prelec pwf

	Log-Likelihoood: -13,541.45		Observations: 21,324		
r	0.75	0.02	0.00	0.71	0.79
α	-0.18	0.03	0.00	-0.25	-0.12
η	0.62	0.04	0.00	0.54	0.69
ϕ	0.59	0.03	0.00	0.53	0.65
μ	0.16	0.01	0.00	0.15	0.17

Table A.2: Parameter Estimates using Individuals' Choices.

Parameter	Point Est.	Std. Error	p-value	95% Conf. Interval	
A. EUT with CRRA utility function					
	Log-Likelihoood: -9,517.27		Observations: 14,455		
r	0.38	0.08	0.00	0.23	0.53
μ	0.23	0.01	0.00	0.21	0.25
B. EUT with Expo-Power utility function					
	Log-Likelihoood: -9,454.79		Observations: 14,455		
r	0.57	0.05	0.00	0.47	0.66
α	-0.04	0.01	0.01	-0.07	-0.01
μ	0.20	0.01	0.00	0.18	0.22
C. RDU with CRRA utility function and Power pwf					
	Log-Likelihoood: -9,361.66		Observations: 14,455		
r	0.76	0.02	0.00	0.71	0.81
γ	0.43	0.03	0.00	0.37	0.50
μ	0.20	0.01	0.00	0.18	0.21
D. RDU with CRRA utility function and Inverse-S pwf					
	Log-Likelihoood: -9,457.39		Observations: 14,455		
r	0.17	0.08	0.03	0.01	0.32
γ	0.75	0.02	0.00	0.72	0.78
μ	0.19	0.01	0.00	0.17	0.20
E. RDU with CRRA utility function and Prelec pwf					
	Log-Likelihoood: -9,321.10		Observations: 14,455		
r	0.64	0.03	0.00	0.59	0.70
η	0.51	0.03	0.00	0.44	0.58
ϕ	0.63	0.03	0.00	0.57	0.70
μ	0.18	0.01	0.00	0.16	0.19
F. RDU with Expo-Power utility function and Power pwf					
	Log-Likelihoood: -9,352.12		Observations: 14,455		
r	0.85	0.02	0.00	0.82	0.89
α	-0.45	0.08	0.00	-0.60	-0.30
γ	0.46	0.03	0.00	0.40	0.53
μ	0.20	0.01	0.00	0.18	0.22
G. RDU with Expo-Power utility function and Inverse-S pwf					
	Log-Likelihoood: -9,329.05		Observations: 14,455		
r	0.50	0.03	0.00	0.45	0.56
α	-0.02	0.01	0.00	-0.03	-0.01
γ	0.69	0.02	0.00	0.66	0.72

μ	0.16	0.01	0.00	0.15	0.17

H. RDU with Expo-Power utility function and Prelec pwf

Log-Likelihoood: -9,291.87 Observations: 14,455

r	0.74	0.03	0.00	0.69	0.79
α	-0.16	0.04	0.00	-0.23	-0.09
η	0.63	0.04	0.00	0.55	0.71
ϕ	0.61	0.03	0.00	0.55	0.66
μ	0.18	0.01	0.00	0.16	0.19

Table A.3: Marginal and Total Effects Using Individuals' Choices and EUT

All estimations are calculated using CRRA utility function.

Parameter		Point Est.	Std. Error	p-value	95% C.I.	
A. Marginal effects						
	Log-Likelihoood: -9,235.60			Observations: 14,096		
r	order	0.10	0.13	0.46	-0.16	0.36
	gender	0.08	0.13	0.54	-0.18	0.34
	age	-0.17	0.16	0.28	-0.47	0.14
	primary school	0.55	0.37	0.14	-0.18	1.28
	married	0.10	0.14	0.50	-0.18	0.37
	income	0.19	0.13	0.14	-0.06	0.44
	const	-0.22	0.36	0.55	-0.93	0.49
μ	const	0.21	0.01	0.00	0.19	0.24
B. Total effects						
r	order	0.26	0.15	0.08	-0.03	0.56
	gender	0.12	0.16	0.45	-0.19	0.44
	age	-0.30	0.17	0.08	-0.64	0.04
	primary school	0.87	0.38	0.02	0.12	1.62
	married	0.09	0.16	0.54	-0.21	0.40
	income	0.30	0.14	0.03	0.03	0.57

Table A.4: Marginal Effects using Individuals' Choices and RDU Prelec pwf

All estimations are calculated using Expo-Power utility function.

Parameter		Point Est.	Std. Error	p-value	95% C.I.	
		Log-Likelihoood: -9,230.30		Observations: 14,425		
r	order	0.10	0.05	0.06	0.00	0.20
	gender	-0.11	0.05	0.02	-0.20	-0.02
	age	-0.28	0.06	0.00	-0.39	-0.17
	primary school	0.13	0.05	0.01	0.04	0.22
	married	0.12	0.05	0.02	0.02	0.21
	income	0.01	0.04	0.73	-0.06	0.09
	const	0.55	0.08	0.00	0.40	0.71
α	order	0.00	0.00	0.30	-0.01	0.00
	gender	0.01	0.01	0.25	-0.01	0.02
	age	0.02	0.02	0.23	-0.01	0.05
	primary school	0.00	0.00	0.93	0.00	0.00
	married	-0.01	0.01	0.26	-0.02	0.01
	income	0.00	0.00	0.27	0.00	0.01
	const	-0.03	0.02	0.19	-0.07	0.01
η	order	-0.17	0.10	0.08	-0.36	0.02
	gender	0.15	0.11	0.18	-0.07	0.37
	age	0.39	0.12	0.00	0.14	0.63
	primary school	-0.21	0.11	0.07	-0.43	0.02
	married	-0.13	0.10	0.18	-0.32	0.06
	income	0.01	0.11	0.90	-0.20	0.22
	const	0.86	0.14	0.00	0.59	1.14
ϕ	order	-0.02	0.07	0.75	-0.16	0.11
	gender	-0.06	0.07	0.40	-0.20	0.08
	age	-0.21	0.06	0.00	-0.33	-0.09
	primary school	0.08	0.08	0.36	-0.09	0.24
	married	-0.06	0.07	0.41	-0.19	0.08
	income	0.07	0.08	0.37	-0.08	0.23
	const	0.74	0.10	0.00	0.54	0.94
μ	const	0.16	0.01	0.00	0.14	0.17

Table A.5: Individuals' vs. Couples' Choices.

Parameter		Point Est.	Std. Error	p-value	95% C.I.	
A. EUT with CRRA utility function						
	Log-Likelihoood: -13,457.36			Observations: 20,605		
r	couple	0.17	0.07	0.01	0.04	0.30
	const	0.34	0.10	0.00	0.15	0.53
μ	const	0.21	0.01	0.00	0.19	0.22
B. RDU with Expo-Power utility function and Prelec pwf						
	Log-Likelihoood: -13,059.60			Observations: 20,605		
r	couple	0.03	0.03	0.30	-0.03	0.10
	const	0.74	0.03	0.00	0.67	0.80
α	couple	-0.04	0.05	0.46	-0.14	0.06
	const	-0.17	0.05	0.00	-0.26	-0.08
η	couple	-0.06	0.06	0.31	-0.17	0.05
	const	0.64	0.06	0.00	0.53	0.75
ϕ	couple	-0.05	0.03	0.09	-0.12	0.01
	const	0.61	0.03	0.00	0.55	0.66
μ	const	0.16	0.01	0.00	0.15	0.17

Table A.6: Individuals' vs. Couples' Decisions of Real and Fake Couples.

Parameter		Point Est.	Std. Error	p-value	95% C.I.	
1. Real Couples						
A. EUT with CRRA utility function						
	Log-Likelihoood: -7,232.38			Observations: 11,158		
r	couple	0.07	0.08	0.34	-0.08	0.22
	const	0.37	0.11	0.00	0.15	0.59
μ	const	0.19	0.01	0.00	0.17	0.21
B. RDU with Expo-Power utility function and Prelec pwf						
	Log-Likelihoood: -7,014.35			Observations: 11,158		
r	couple	0.01	0.04	0.79	-0.07	0.10
	const	0.74	0.04	0.00	0.66	0.82
α	couple	0.00	0.07	0.99	-0.13	0.13
	const	-0.17	0.06	0.00	-0.28	-0.06
η	couple	-0.07	0.08	0.36	-0.23	0.08
	const	0.66	0.07	0.00	0.52	0.81
ϕ	couple	-0.08	0.04	0.04	-0.15	0.00
	const	0.63	0.04	0.00	0.55	0.71
μ	const	0.15	0.01	0.00	0.13	0.16
2. Fake Couples						
A. EUT with CRRA utility function						
	Log-Likelihoood: -6,218.42			Observations: 9,447		
r	couple	0.29	0.13	0.02	0.04	0.54
	const	0.29	0.17	0.09	-0.04	0.62
μ	const	0.23	0.01	0.00	0.20	0.26
B. RDU with Expo-Power utility function and Prelec pwf						
	Log-Likelihoood: -6,038.50			Observations: 9,447		
r	couple	0.06	0.06	0.29	-0.05	0.17
	const	0.73	0.06	0.00	0.62	0.84
α	couple	-0.09	0.09	0.31	-0.25	0.08
	const	-0.16	0.08	0.03	-0.31	-0.01
η	couple	-0.04	0.09	0.69	-0.21	0.13
	const	0.61	0.09	0.00	0.44	0.78
ϕ	couple	-0.03	0.05	0.61	-0.13	0.08
	const	0.58	0.04	0.00	0.49	0.66
μ	const	0.17	0.01	0.00	0.15	0.19

Table A.7: Joint Estimation using Individuals' Choices and EUT

All estimations are calculated using CRRA utility function.

Parameter	Point Est.	Std. Error	p-value	95% C.I.	
A. Exponential discounting function					
	Log-Likelihoood: -24,640.65		Observations: 37,587		
r	0.75	0.05	0.00	0.65	0.85
δ	0.39	0.11	0.00	0.17	0.60
μ_r	0.28	0.02	0.00	0.24	0.33
μ_d	5.75	2.86	0.05	0.14	11.37
B. Quasi-hyperbolic discounting function					
	Log-Likelihoood: -24,546.42		Observations: 37,587		
r	0.70	0.05	0.00	0.61	0.80
δ	0.60	0.15	0.00	0.30	0.90
β	1.06	0.02	0.00	1.01	1.11
μ_r	0.27	0.02	0.00	0.23	0.31
μ_d	9.40	4.60	0.04	0.39	18.41
C. Mazur discounting function					
	Log-Likelihoood: -24,652.85		Observations: 37,587		
r	0.79	0.06	0.00	0.68	0.90
K	0.28	0.09	0.00	0.11	0.46
μ_r	0.79	0.06	0.00	0.68	0.90
μ_d	0.28	0.09	0.00	0.11	0.46
D. Weibull discounting function					
	Log-Likelihoood: -24,580.84		Observations: 37,587		
r	0.71	0.05	0.00	0.61	0.81
r_{wei}	0.67	0.15	0.00	0.37	0.96
s_{wei}	0.55	0.06	0.00	0.45	0.66
μ_r	0.27	0.02	0.00	0.23	0.31
μ_d	8.51	4.10	0.04	0.47	16.54

Table A.8: Joint Estimation using Individuals' Choices and RDU with Prelec Pwf

All estimations are calculated using CRRA utility function.

Parameter	Point Est.	Std. Error	p-value	95% C.I.	
A. Exponential discounting function					
	Log-Likelihoood: -24,387.51		Observations: 37,587		
r	0.80	0.02	0.00	0.77	0.84
η	0.42	0.03	0.00	0.36	0.48
ϕ	0.73	0.05	0.00	0.63	0.83
δ	0.29	0.05	0.00	0.20	0.38
μ_r	0.18	0.01	0.00	0.17	0.20
μ_d	3.43	0.68	0.00	2.11	4.75
B. Quasi-hyperbolic discounting function					
	Log-Likelihoood: -24,296.52		Observations: 37,587		
r	0.79	0.02	0.00	0.75	0.82
η	0.43	0.03	0.00	0.37	0.48
ϕ	0.71	0.05	0.00	0.62	0.81
δ	0.39	0.06	0.00	0.28	0.51
β	1.04	0.01	0.00	1.01	1.06
μ_r	0.18	0.01	0.00	0.17	0.20
μ_d	4.17	0.84	0.00	2.51	5.82
C. Mazur discounting function					
	Log-Likelihoood: -24,398.21		Observations: 37,587		
r	0.82	0.02	0.00	0.78	0.85
η	0.41	0.03	0.00	0.35	0.47
ϕ	0.74	0.06	0.00	0.63	0.85
K	0.25	0.04	0.00	0.17	0.32
μ_r	0.18	0.01	0.00	0.17	0.20
μ_d	3.08	0.61	0.00	1.88	4.29
D. Weibull discounting function					
	Log-Likelihoood: -24,330.45		Observations: 37,587		
r	0.79	0.02	0.00	0.75	0.83
η	0.43	0.03	0.00	0.37	0.48
ϕ	0.72	0.05	0.00	0.62	0.81
r_{wei}	0.46	0.06	0.00	0.34	0.58
s_{wei}	0.57	0.06	0.00	0.46	0.68
μ_r	0.18	0.01	0.00	0.17	0.20
μ_d	3.94	0.79	0.00	2.40	5.48

Table A.9: Joint Estimation using Individuals' Choices and RDU with Power Pwf.

All estimations are calculated using CRRA utility function.

Parameter	Point Est.	Std. Error	p-value	95% C.I.	
A. Exponential discounting function					
	Log-Likelihoood: -24,400.11		Observations: 37,587		
r	0.86	0.02	0.00	0.83	0.89
γ	0.38	0.03	0.00	0.33	0.44
δ	0.20	0.03	0.00	0.13	0.26
μ_r	0.20	0.01	0.00	0.18	0.21
μ_d	1.98	0.35	0.00	1.29	2.68
B. Quasi-hyperbolic discounting function					
	Log-Likelihoood: -24,311.79		Observations: 37,587		
r	0.85	0.02	0.00	0.82	0.88
γ	0.39	0.03	0.00	0.33	0.44
δ	0.26	0.04	0.00	0.18	0.34
β	1.03	0.01	0.00	1.01	1.04
μ_r	0.20	0.01	0.00	0.18	0.21
μ_d	2.27	0.42	0.00	1.45	3.09
C. Mazur discounting function					
	Log-Likelihoood: -24,408.81		Observations: 37,587		
r	0.87	0.02	0.00	0.84	0.90
γ	0.38	0.03	0.00	0.32	0.43
K	0.17	0.03	0.00	0.12	0.23
μ_r	0.20	0.01	0.00	0.18	0.21
μ_d	1.86	0.33	0.00	1.21	2.50
D. Weibull discounting function					
	Log-Likelihoood: -24,345.36		Observations: 37,587		
r	0.85	0.02	0.00	0.82	0.89
γ	0.39	0.03	0.00	0.33	0.44
r_{wei}	0.31	0.05	0.00	0.22	0.41
s_{wei}	0.58	0.06	0.00	0.47	0.70
μ_r	0.20	0.01	0.00	0.18	0.21
μ_d	2.17	0.39	0.00	1.40	2.95

Table A.10: Marginal Effects of Treatment and Socioeconomic Variables in the Joint Estimation.

All estimations are calculated using exponential discounting function and RDU with CRRA utility function and Prelec pwf.

Parameter		Point Est.	Std. Error	p-value	95% C.I.	
	Log-Likelihoood: -23,547.06			Observations: 36,652		
r	order	-0.01	0.02	0.49	-0.05	0.02
	gender	0.00	0.02	0.95	-0.03	0.04
	age	0.02	0.02	0.18	-0.01	0.05
	primary school	-0.06	0.03	0.04	-0.12	0.00
	married	0.01	0.02	0.44	-0.02	0.04
	income	-0.03	0.02	0.23	-0.07	0.02
	const	0.85	0.04	0.00	0.78	0.92
η	order	0.00	0.04	0.98	-0.08	0.08
	gender	0.00	0.04	0.95	-0.09	0.08
	age	-0.06	0.04	0.12	-0.15	0.02
	primary school	0.21	0.09	0.02	0.03	0.39
	married	-0.02	0.04	0.62	-0.10	0.06
	income	0.10	0.06	0.11	-0.02	0.21
	const	0.30	0.07	0.00	0.16	0.44
ϕ	order	-0.10	0.15	0.50	-0.40	0.19
	gender	-0.11	0.16	0.51	-0.43	0.21
	age	-0.34	0.17	0.04	-0.66	-0.01
	primary school	-0.07	0.21	0.74	-0.48	0.34
	married	-0.17	0.15	0.25	-0.47	0.12
	income	0.07	0.17	0.67	-0.27	0.42
	const	1.10	0.25	0.00	0.60	1.59
δ	order	0.01	0.04	0.90	-0.07	0.08
	FED	0.15	0.10	0.13	-0.05	0.35
	ascendant	-0.07	0.05	0.16	-0.18	0.03
	gender	-0.03	0.04	0.35	-0.11	0.04
	age	0.00	0.04	0.91	-0.09	0.08
	primary school	0.18	0.16	0.26	-0.13	0.49
	married	0.00	0.04	0.91	-0.08	0.07
	income	0.05	0.09	0.60	-0.13	0.23
	const	0.17	0.08	0.04	0.01	0.33
μ_r	const	0.18	0.01	20.43	0.00	0.16
μ_d	const	3.07	0.71	4.31	0.00	1.67

Table A.11: Joint Estimation using Couples' Choices.

Parameter		Point Est.	Std. Error	p-value	95% C.I.	
A. Exponential discounting function and EUT with CRRA utility function						
	Log-Likelihoood: -34,829.60			Observations: 53,575		
r	couple	-0.04	0.01	0.00	-0.06	-0.02
	const	0.74	0.05	0.00	0.65	0.83
δ	couple	0.18	0.06	0.00	0.07	0.30
	const	0.43	0.12	0.00	0.20	0.66
μ_r	const	0.25	0.02	0.00	0.21	0.29
μ_d	const	6.21	2.86	0.03	0.60	11.82
B. Exponential discounting function and RDU with CRRA utility function and Prelec pwf						
	Log-Likelihoood: -34,829.60			Observations: 53,575		
r	couple	-0.04	0.01	0.00	-0.06	-0.02
	const	0.81	0.02	0.00	0.77	0.84
η	couple	0.04	0.03	0.14	-0.01	0.10
	const	0.41	0.03	0.00	0.35	0.47
ϕ	couple	-0.10	0.05	0.03	-0.19	-0.01
	const	0.72	0.05	0.00	0.62	0.82
δ	couple	0.14	0.03	0.00	0.08	0.21
	const	0.30	0.05	0.00	0.20	0.40
μ_r	const	0.16	0.01	0.00	0.15	0.17
μ_d	const	3.30	0.60	0.00	2.12	4.47
C. Exponential discounting function and RDU with CRRA utility function and Power pwf						
	Log-Likelihoood: -34,422.22			Observations: 53,575		
r	couple	-0.04	0.01	0.00	-0.05	-0.02
	const	0.87	0.02	0.00	0.84	0.90
γ	couple	0.05	0.03	0.15	-0.02	0.11
	const	0.36	0.03	0.00	0.31	0.42
δ	couple	0.11	0.02	0.00	0.06	0.15
	const	0.19	0.03	0.00	0.12	0.26
μ_r	const	0.17	0.01	0.00	0.16	0.19
μ_d	const	1.73	0.30	0.00	1.14	2.32

Table A.12: Joint Estimation using Real Couples' Choices.

Parameter		Point Est.	Std. Error	p-value	95% C.I.	
A. Exponential discounting function and EUT with CRRA utility function						
	Log-Likelihoood: -18,791.04			Observations: 29,013		
r	couple	-0.03	0.01	0.01	-0.05	-0.01
	const	0.69	0.06	0.00	0.58	0.80
δ	couple	0.22	0.09	0.02	0.04	0.40
	const	0.50	0.15	0.00	0.21	0.79
μ_r	const	0.22	0.02	0.00	0.18	0.26
μ_d	const	9.39	4.74	0.05	0.10	18.69
B. Exponential discounting function and RDU with CRRA utility function and Prelec pwf						
	Log-Likelihoood: -18,545.94			Observations: 29,013		
r	couple	-0.03	0.01	0.01	-0.05	-0.01
	const	0.79	0.02	0.00	0.74	0.83
η	couple	-0.01	0.04	0.86	-0.08	0.07
	const	0.44	0.05	0.00	0.35	0.53
ϕ	couple	-0.10	0.06	0.07	-0.22	0.01
	const	0.74	0.07	0.00	0.60	0.87
δ	couple	0.14	0.05	0.00	0.05	0.24
	const	0.31	0.07	0.00	0.17	0.46
μ_r	const	0.15	0.01	0.00	0.13	0.17
μ_d	const	3.68	0.88	0.00	1.95	5.41
C. Exponential discounting function and RDU with CRRA utility function and Power pwf						
	Log-Likelihoood: -18,565.51			Observations: 29,013		
r	couple	-0.03	0.01	0.01	-0.05	-0.01
	const	0.85	0.02	0.00	0.81	0.89
γ	couple	-0.01	0.04	0.88	-0.09	0.08
	const	0.40	0.05	0.00	0.31	0.49
δ	couple	0.10	0.03	0.00	0.04	0.16
	const	0.20	0.05	0.00	0.11	0.29
μ_r	const	0.16	0.01	0.00	0.14	0.18
μ_d	const	1.93	0.38	0.00	1.20	2.67

Table A.13: Joint Estimation using Fake Couples' Choices.

Parameter		Point Est.	Std. Error	p-value	95% C.I.	
A. Exponential discounting function and EUT with CRRA utility function						
	Log-Likelihoood: -16,024.59			Observations: 24,562		
r	couple	-0.053	0.014	0.000	-0.080	-0.025
	const	0.815	0.093	0.000	0.633	0.997
δ	couple	0.149	0.062	0.017	0.027	0.272
	const	0.307	0.197	0.119	-0.079	0.692
μ_r	const	0.301	0.042	0.000	0.219	0.383
μ_d	const	3.180	2.910	0.274	-2.523	8.884
B. Exponential discounting function and RDU with CRRA utility function and Prelec pwf						
	Log-Likelihoood: -15,826.45			Observations: 24,562		
r	couple	-0.054	0.014	0.000	-0.081	-0.027
	const	0.825	0.023	0.000	0.779	0.871
η	couple	0.099	0.042	0.020	0.016	0.182
	const	0.368	0.041	0.000	0.288	0.449
ϕ	couple	-0.097	0.075	0.196	-0.245	0.050
	const	0.703	0.080	0.000	0.546	0.859
δ	couple	0.148	0.041	0.000	0.068	0.228
	const	0.286	0.074	0.000	0.140	0.432
μ_r	const	0.173	0.011	0.000	0.151	0.195
μ_d	const	2.898	0.808	0.000	1.315	4.481
C. Exponential discounting function and RDU with CRRA utility function and Power pwf						
	Log-Likelihoood: -15,843.17			Observations: 24,562		
r	couple	-0.051	0.013	0.000	-0.077	-0.025
	const	0.891	0.027	0.000	0.837	0.945
γ	couple	0.112	0.050	0.026	0.013	0.210
	const	0.325	0.039	0.000	0.248	0.402
δ	couple	0.115	0.030	0.000	0.056	0.175
	const	0.167	0.056	0.003	0.058	0.276
μ_r	const	0.189	0.013	0.000	0.163	0.215
μ_d	const	1.530	0.466	0.001	0.617	2.444

Table A.14: Correlation of Variable Tank using RDU with Power pwf

All estimations are calculated using CRRA utility function.

Parameter		Point Est.	Std. Error	p-value	95% C.I.	
A. Couples						
	Log-Likelihoood: -6,008.77			Observations: 9,593		
r	tank	0.008	0.051	0.873	-0.091	0.108
	const	0.855	0.025	0.000	0.806	0.904
γ	tank	0.297	0.133	0.025	0.037	0.557
	const	0.340	0.051	0.000	0.240	0.439
δ	tank	-0.173	0.097	0.073	-0.363	0.016
	const	0.287	0.065	0.000	0.159	0.414
μ_r	const	0.133	0.010	0.000	0.113	0.152
μ_d	const	1.451	0.354	0.000	0.757	2.145
A. Heads of Household						
	Log-Likelihoood: -6,123.22			Observations: 9,515		
r	tank	-0.021	0.054	0.701	-0.127	0.085
	const	0.813	0.031	0.000	0.751	0.874
γ	tank	0.267	0.192	0.165	-0.110	0.644
	const	0.342	0.056	0.000	0.232	0.452
δ	tank	-0.123	0.139	0.376	-0.396	0.150
	const	0.334	0.094	0.000	0.150	0.519
μ_r	const	0.173	0.016	0.000	0.141	0.204
μ_d	const	2.974	0.820	0.000	1.368	4.581

Table A.15: Installation of Technologies.

		Shower head	Kitchen aerator	Bathroom aerator
Units available	0	27	215	403
	1	791	639	426
	2	52	16	41
Units installed	0	72	284	467
	1	760	575	383
	2	38	11	20
Installation success rate		93%	89%	83%
At least one in each home		92%	67%	46%

Table A.16: Experimental Estimates using Household and Home ID for Five Communities.

	Experimental Estimates Post-Treatment 2015 (June-Sept)	
	Household ID	Home ID
Treatment Effect†	-3.30	-3.27
Standard Error	(0.59)***	(0.59)***
Confidence Interval (95%)	{-4.47, -2.14}	{-4.44, -2.11}
Percent Reduction‡	12.37%	12.62%
Effect Size⋆	0.21	0.22
Community Dummy Variables	Yes	Yes
Interviewer Dummy Variables	Yes	Yes
Pre-treatment Water Use Variables	Yes	Yes
Robust Standard Errors	Yes	Yes
Observations	836	843

***p<0.001, **p<0.01, *p<0.05.

† Technology Adoption Treatment Effect (in m^3 water/month).

‡ Percent Reduction (in experiment, compared to controls).

⋆ Effect Size=(treatment effect)/(standard deviation of control group); i.e. mean reduction in use divided by SD of the counterfactual water use.

Table A.17: Local Average Treatment Effect of Keeping At Least One Technology.

All estimations include community and interviewer dummies and pre-treatment water use variables.

OLS Regression	OLS	OLS-Reweight	OLS-Imputation
LATE	-3.07	-2.91	-2.92
Standard Error	(0.41)***	(0.41)***	(0.43)***
Confidence Interval (95%)	{-3.88, -2.26}	{-3.71, -2.11}	{-3.76, -2.08}
Percent Reduction	12.27%	11.63%	11.67%
Observations	1,176	1,175	1,294
R-squared	0.75	0.75	0.72

IV Regression	IV	IV-Reweight	IV-Imputation
1st Stage			
Instrument: Treatment	0.93	0.93	0.93
	(0.01)***	(0.01)***	(0.01)***
Instrument: Bonus	0.04	0.04	0.04
	(0.01)***	(0.02)***	(0.01)***
2nd Stage			
LATE	-2.98	-2.85	-2.82
Standard Error	(0.43)***	(0.43)***	(0.46)***
Confidence Interval (95%)	{-3.83, -2.13}	{-3.70, -2.00}	{-3.71, -1.92}
Percent Reduction	11.91%	11.39%	11.27%
Observations	1,176	1,175	1,294
R-squared	0.75	0.75	0.72

***p<0.001, **p<0.01, *p<0.05.

Table A.18: Experimental Estimates of Impact on Water Consumption using Household and Home ID for Five Communities.

Variable	Quantile	Control	Treated	P-value
Pre-Treatment Water Consumption				
June-Sept 2014	0% – 25%	10.46	11.69	0.10
	25% – 50%	17.85	18.59	0.37
	50% – 75%	25.83	26.08	0.83
	75% – 100%	38.43	39.40	0.57
Feb 2015	0% – 25%	13.94	13.02	0.53
	25% – 50%	20.32	20.26	0.95
	50% – 75%	28.55	28.57	0.98
	75% – 100%	43.80	43.95	0.94
March 2015	0% – 25%	12.97	12.91	0.95
	25% – 50%	20.67	21.36	0.43
	50% – 75%	29.58	29.27	0.78
	75% – 100%	48.20	45.91	0.36
April 2015	0% – 25%	12.38	13.80	0.09
	25% – 50%	21.24	23.61	0.01
	50% – 75%	31.66	31.69	0.97
	75% – 100%	48.38	47.93	0.84
Secondary school	0% – 25%	0.29	0.29	1.00
	25% – 50%	0.24	0.24	0.91
	50% – 75%	0.28	0.27	0.86
	75% – 100%	0.28	0.28	0.99
Participate in ASADA meetings	0% – 25%	0.38	0.37	0.86
	25% – 50%	0.39	0.33	0.26
	50% – 75%	0.45	0.43	0.74
	75% – 100%	0.39	0.42	0.71
Years living in home	0% – 25%	19.01	16.09	0.16
	25% – 50%	16.99	16.14	0.64
	50% – 75%	18.03	19.15	0.52
	75% – 100%	20.71	22.37	0.36
Household members	0% – 25%	2.34	2.63	0.05
	25% – 50%	3.12	3.48	0.01
	50% – 75%	4.16	3.97	0.34
	75% – 100%	4.70	4.63	0.75

Appendix B

Supplementary Documents to Chapter 1

B.1 Script of Time and Risk Experiment

[Se dice el script mientras se muestra una presentacin de power point.]

- Bienvenidos! Muchas gracias por venir y participar en este taller.
- Mi nombre es ________ y yo voy a estar a cargo de este taller organizado por CATIE, la universidad de Turrialba. Me acompañan mis compañeros Melissa, Luis Fernando, Rodrigo, Eugenia y Germán.
- El taller de hoy es parte del proyecto de agua de CATIE para el que ustedes fueron encuestados el año pasado. Cuando el proyecto termine, las conclusiones del mismo serán presentadas en algunas comunidades de la zona.
- El día de hoy, ustedes van a tomar decisiones muy simples, que se parecen a las decisiones que ustedes toman día a día.
- Usted ha recibido una tarjeta con su código de individuo y su código de pareja. La tarjeta es muy importante para realizar los pagos. Entonces, no pierda el papel, manténgalo siempre con usted.

- Antes de empezar, quisiera pedirle su permiso para participar en este taller.
- Usted también ha recibido una carta de consentimiento y una copia. La carta de consentimiento es un permiso que ustedes firman si quieren y pueden participar del taller.
- Yo voy a leer la carta.
- [Luego de leer la carta.] En resumen, la carta dice que el taller dura 3 horas y van a tomar decisiones. No hay ningún riesgo en el taller. Sus nombres no aparecerán cuando se presenten los datos del estudio. Si tiene alguna queja (que no la van a tener), los datos de contacto aparecen en la carta. Firme, por favor, con lapicero si puede y quiere participar en el taller.

Inicio

- En el taller vamos a tener parejas reales y parejas formadas en el taller. Es decir, todos tienen una pareja.
- Las parejas reales y las formadas en el taller tienen el mismo código de pareja.
- Algunas parejas van a empezar tomando las decisiones individualmente. El resto empieza tomando las decisiones en parejas.
- La sesión está dividida en 4 Dinámicas y una encuesta corta al final. [Mostrar dinámicas]
- En cada Dinámica, ustedes van a tomar varias decisiones donde elige entre 2 alternativas: A y B.
- Al final voy a elegir a la suerte 4 decisiones, una de cada dinámica.
- Usted va a recibir su pago por su respuesta en sólo una de esas decisiones. Usted podrá retirar este dinero del Banco Nacional con la presentación de su cédula. Las ganancias pueden ser entre 0 y 50 000 colones, y en algunos casos más.

- Ahorita usted no sabe qué decisión le va a tocar para su pago. Por eso, usted debe pensar bien cada decisión que tome porque le puede tocar cualquiera.
- Además, usted recibirá al final 5000 colones en efectivo s'olo por quedarse durante todo el taller.
- Para que este taller salga bien y podamos hacer un buen estudio, es muy importante que nos demos a entender y que ustedes piensen bien cada decisión. Por eso, les pedimos que por favor sigan las instrucciones y hagan preguntas si algo no está claro.
- ¿Tiene alguna pregunta? ¿Seguros?
- Si alguien necesita usar el baño ahorita, puede ir y los esperamos antes de empezar.
- Ahora les pedimos que guarden sus celulares y lo pongan en modo vibrador. No pueden usar sus celulares durante el taller para evitar distracciones. Gracias.

Dinámica 1

- Empecemos con la Dinámica 1.
- En esta dinámica usted debe tomar decisiones en las que tiene que elegir entre dos opciones: A y B. En la opción A usted recibe la plata mañana y en la opción B usted recibe más plata pero en el futuro. Yo quiero saber qué opción prefiere en cada decisión: A o B.
- Ahora vamos a hacer ejemplos para entender mejor la Dinámica 1.

Dinámica 1 - Ejemplos

- El primer y segundo ejemplo los hacemos juntos. El tercer ejemplo lo van a hacer ustedes solos y los asistentes van a pasar por sus asientos para contestar preguntas y ver si todos hemos entendido, ok?
- Empecemos con el primer ejemplo. Mire la pantalla.

- Vamos a tomar 8 decisiones independientes. Cada fila es una decisión: decisión 1, decisión 2, decisión 3, etc.

- Cada decisión tiene dos opciones: A y B. En la opción A usted recibe 2000 colones mañana y en la opción B usted recibe más plata en 15 días.

- En la primera decisión, en la opción A usted recibe 2 000 colones mañana y en la opción B usted recibe 2 038 colones en 15 días. ¿Qué opción prefiere? Si prefiere recibir 2000 colones mañana, marca la opción A. Pero si usted prefiere recibir 2 038 colones en 15 días, marca la opción B. Supongamos que usted prefiere recibir 2 000 colones mañana. En ese caso, usted marca la opción A. Haga la marca bien clarita para que se pueda leer.

- En la segunda decisión, también hay 2 opciones: A y B. En la opción A usted recibe 2000 colones mañana y en la opción B usted recibe 2057 colones en 15 días. ¿Qué opción prefiere? Supongamos que usted prefiere recibir 2000 colones mañana. Entonces, usted marca la opción A.

- En la tercera decisión, en la opción A usted recibe 2000 colones mañana y en la opción B usted recibe 2076 colones en 15 días. ¿Qué opción prefiere? Supongamos que usted también prefiere recibir 2000 colones mañana. Entonces, marca la opción A.

- En la cuarta decisión, en la opción A usted recibe 2000 colones mañana y en la opción B usted recibe 2 113 colones en 15 días. Supongamos que usted también prefiere recibir 2000 colones mañana. Entonces, marca la opción A.

- Fíjese que la plata en A siempre es la misma, 2000 colones, pero la plata de B va aumentando en cada decisión.

- En la quinta decisión, en la opción A usted recibe 2000 colones mañana y en la opción B usted recibe 2 219 colones en 15 días. ¿Qué opción prefiere? Supongamos que ahora sí usted prefiere la opción B. Es decir, por 2219 colones usted sí puede esperar 15 días. Entonces, marca la opción B.

- Fíjese que en el resto de decisiones, la plata de la opción B sigue aumentando, 2320 colones, 2417 colones, 2538 colones. Entonces, una vez que usted elija la opción B por primera vez, tiene sentido que usted elija B en el resto de decisiones de la tabla, porque si usted prefiere esperar 15 días por 2219 colones, con mayor razón prefiere esperar 15 días si el monto es mayor.

- Así analiza usted todas las decisiones.

- Al final de la tabla usted debe tener 8 marcas, una en cada fila.

- ¿Tiene alguna pregunta? ¿Seguro?

- Veamos el ejemplo 2 en la pantalla. Es una tabla con 8 decisiones independientes. Cada decisión tiene 2 opciones: A y B.

- En la opción A, usted recibe el dinero mañana pero en la opción B usted recibe el dinero en 2 meses.

- En la primera decisión, en la opción A usted recibe 2000 colones y en la opción B usted recibe 2170 colones pero en 2 meses. ¿Qué opción prefiere? Supongamos que usted prefiere recibir 2000 colones mañana. Entonces, usted marca la opción A y pasa a la siguiente decisión.

- En la segunda decisión, en la opción A usted recibe 2000 colones y en la opción B usted recibe 2347 colones en 2 meses. ¿Qué opción prefiere? Supongamos que ahora sí usted prefiere la opción B. Es decir, por 2347 colones usted sí puede esperar 2 meses. Entonces, marca la opción B.

- Fíjese que en el resto de decisiones el monto en B sigue aumentando (2531, 2722, 2920, 3125, etc). Entonces, una vez que usted marque la opción B por primera vez, tiene sentido que usted elija la opción B en el resto de decisiones de la tabla porque si prefirió esperar 2 meses por 2258 colones, con mayor razón prefiere esperar 2 meses si el monto es mayor.
- Entonces, al final de la tabla usted debe tener 8 marcas, una en cada fila.
- Recuerde que sólo una decisión de todas las que tome se considera para su pago. Si la decisión elegida es la decisión 3, vemos su respuesta en la decisión 3. La decisión fue la opción B. Entonces, usted gana 2531 colones que puede retirar en 2 meses en cualquier ventanilla del Banco Nacional.
- ¿Tiene alguna pregunta? ¿Seguro?
- Ahora es el turno de ustedes de hacer el ejemplo 3.
- Mis compañeros le están repartiendo el ejemplo. [Esperar].
- En cada decisión usted elige entre 2 opciones A o B. En la opción A usted recibe 3000 colones mañana y en la opción B usted recibe más plata en 1 mes.
- Por favor, complete todas las 8 decisiones.
- Piense bien cada decisión, como si ésa fuese la única de su pago.
- [Luego de unos minutos] Supongamos que la única decisión elegida para el pago del sr. _________ es la decisión _________ [saco de bolsa]. En la decisión _________ el señor marcó _________ . Entonces, él podría retirar _________ colones del Banco Nacional mañana (en 1 mes). Pero este sólo es un ejemplo.

Inicio Dinámica 1

- En un momento usted empezará la Dinámica 1.

- [Al lado A]: Este lado va a tomar las decisiones en parejas. Ustedes van a recibir el folleto Dinámica 1 por pareja. Escriban el código de pareja en cada hoja. Piensen primero y luego escuchen la opinión de su pareja. Ambos deben estar de acuerdo con las elecciones que hacen. No hablen muy alto por favor.

- [Al lado B]: Este lado va a tomar las decisiones individualmente. Cada uno de ustedes va a recibir el folleto Dinámica 1. Escriba su código de individuo en cada hoja.

- En cada hoja del folleto hay 8 decisiones como las del ejemplo pero con pagos reales en colones que usted podrá retirar del Banco Nacional.

- Lo único que cambia en cada tabla es la fecha en la que se realizan los pagos y los montos de los pagos.

- En todas las hojas, en la opción A usted recibe la plata mañana. En la primera hoja, en la opción B usted recibe el dinero en 4 días. En la segunda hoja, en la opción B usted recibe el dinero en 8 días. En la tercera hoja, en la opción B usted recibe el dinero en 15 días. En la cuarta hoja, en la opción B usted recibe el dinero en 1 mes. En la quinta hoja, en la opción B usted recibe el dinero en 3 meses. En la sexta hoja, en la opción B usted recibe el dinero en 6 meses.

- Por favor, empiece con la primera tabla y luego continúe con el resto en orden. No se saltee hojas.

- Analice cada decisión como si esa fuese la única decisión que vale para su pago.

- En cada hoja debe escribir 8 marcas, una marca por fila.

- Por favor, empiece. Cuando acabe cada hoja, pasa a la siguiente. Cuando acabe, por favor voltee el folleto. Gracias!

- [Luego de que todas han terminado, se recogen los folletos.]

Dinámica 2

- Ahora veamos la Dinámica 2.
- Esta Dinámica es totalmente diferente a la anterior. En cada decisión, hay 2 opciones: A y B. Los pagos de cada opción se hacen en el mismo momento, mañana.
- Cada opción tiene 20 fichas con 3 colores diferentes y 3 valores diferentes en una bolsa. Saco una ficha de cada opción y el valor de la ficha es el premio de esa opción.

Dinámica 2 - Ejemplos

- Vamos a hacer 3 ejemplos. El primero lo hago yo y los otros dos los hacen ustedes solos.
- En el ejemplo uno, en la opción A, cada ficha amarilla vale 1 000 colones y hay 3 fichas amarillas. Cada ficha azul vale 6 000 colones y hay 17 fichas azules.
- En la opción B cada ficha verde vale 2 000 colones y hay 5 fichas verdes, y cada ficha azul vale 6 000 colones y hay 15 fichas de color azul.
- Usted debe elegir si prefiere la opción A o la opción B.
- Note que es más probable que la ficha de un color salga cuando hay más fichas de ese color.
- Supongamos que usted prefiere la opción A. Entonces, marca A bien clarito.
- Luego se saca las fichas ganadoras de cada opción. Saco una ficha sin ver de la opción A. La ficha es de color _________ que vale _________. Luego, saco una ficha sin ver de la opción B. La ficha es de color _________ que vale _________. Como usted eligió A, usted gana _________.
- Ahora le toca a ustedes.
- Mis compañeros le están entregando el folleto con 2 ejemplos.

- En cada decisión usted elige entre 2 opciones: A o B. En el primer ejemplo, en la opción A la ficha amarilla vale 1000 colones y hay 6 fichas amarillas. La ficha azul vale 6 000 colones y hay 14 fichas azules. En la opción B, la ficha amarilla vale 1000 colones y hay 3 fichas amarillas, la ficha verde vale 2000 colones y hay 5 fichas verdes, y la ficha azul vale 6000 colones y hay 12 fichas azules. ¿Cuál prefiere A o B?
- Hace el mismo análisis en el ejemplo 2.
- ¿Tiene alguna pregunta? ¿Seguro?
- Por favor, hago los 2 ejemplos.
- Los asistentes pasaran por sus asientos para responder preguntas y revisar que todos hayamos entendido.
- [Luego de unos minutos] Supongamos que la decisión elegida para su pago es la decisión 2. [Juego ambas opciones]. La opción A es ________que vale ________. La opción B es ________ y paga ________. Entonces, si el señor ________ recibe pago por esta Dinámica, se le pregunta su respuesta en la decisión 2. Su respuesta es ________. Y se le entrega ________ colones.

Inicio Dinámica 2

- En un momento usted empezará la Dinámica 2.
- [Al lado A]: Este lado va a tomar las decisiones en parejas. Se juntan las parejas. Ustedes van a recibir el folleto Dinámica 2 por pareja. Escriban el código de pareja en cada hoja. Piensen primero y luego escuchen la opinión de su pareja. Ambos deben estar de acuerdo con las elecciones que hacen. No hablen muy alto por favor.
- [Al lado B]: Este lado va a tomar las decisiones individualmente. Cada uno de ustedes va a recibir un folleto Dinámica 2. Escriba su código de individuo en cada hoja.

- En esta Dinámica, usted debe realizar 30 decisiones similares a las que realizó en los ejemplos anteriores. En cada decisión, los valores de las fichas pueden variar.
- Recuerde que usted recibe pago sólo por una decisión. Por eso, analice cada decisión como si esa fuese la de su pago.
- Tome el tiempo que necesite.
- Si tienen alguna duda, levanten la mano y nos acercamos a su silla.
- Cuando acabe, por favor voltee el folleto. Por favor, empiece.
- BREAK: Pasamos ahora a una pausa de unos minutos para comer y tomar algo. Luego regresan por favor a sus sitios. (Acomodar sillas).
- Ok, regresemos por favor a nuestros sitios.

Segunda parte

- Todos han terminado la primera parte de la sesión. ¡Muy bien! Vamos a empezar la segunda parte del taller.
- Ustedes ya saben de qué se tratan las Dinámicas 1 y 2, verdad? Ahora vamos a tomar las mismas decisiones pero la gente que tomó las decisiones en parejas va a tomar las decisiones individualmente. Las personas que tomaron las decisiones individualmente van a tomar las decisiones en parejas.
- Empecemos con la Dinámica 3.
- [Al lado A]: Este lado va a tomar las decisiones individualmente. Cada uno de ustedes va a recibir el folleto Dinámica 3. Escriba su código de individuo.
- [Al lado B]: Este lado va a tomar las decisiones en parejas, es decir con sus vecinos. Verifique que ambos tienen el mismo código de pareja. Ustedes van a recibir el folleto Dinámica 3

por pareja. Escriban el código de pareja. Piensen primero y luego escuchen la opinión de su pareja. Ambos deben estar de acuerdo con las elecciones que hacen. No hablen muy alto por favor.

- La Dinámica 3 tiene las mismas decisiones que la Dinámica 1.
- Recuerde que usted recibe pago sólo por una decisión. Por eso, analice cada decisión como si esa fuese la de su pago.
- Una vez que acabe, por favor voltee el folleto. Empiece.
- Ok, todos hemos terminado la Dinámica 3. Continuemos con la Dinámica 4.
- [Al lado A]: Este lado va a tomar las decisiones en parejas. Ustedes van a recibir el folleto Dinámica 4 por pareja.
- [Al lado B]: Este lado va a tomar las decisiones individualmente. Cada uno de ustedes va a recibir el folleto Dinámica 4. Escriba su código de individuo en cada hoja.
- La Dinámica 4 tiene las mismas decisiones que la Dinámica 2.
- Cuando termine, voltee el folleto. Empiece.

Encuesta y Pago

- Antes de pasar al pago, les pido que por favor contesten esta breve encuesta. Les ruego que sean lo más exactos posibles en sus respuestas para tener la mejor información. Si alguno necesita ayuda para llenar el cuestionario levanta la mano y vamos a su sitio.
- Las parejas casadas deben responder algunas preguntas adicionales como pareja. Cuando terminen, por favor levanten la mano para recibir las encuestas individuales.
- [Los asistentes caminan entre los participantes y verificar que todos estén completando la encuesta sin problemas.]

- [Cuando terminan] Ahora voy a seleccionar las decisiones que serán pagadas.
- Necesito un notario por favor.
- Primero empiezo con las Dinámicas 1 y 3.
- Para la Dinámica 1, la decisión es ________ : [saco ficha de bolsa con 48 decisiones]
- Para la Dinámica 3, la decisión es ________ : [saco ficha de bolsa con 48 decisiones]
- Para la Dinámica 2, la decisión es ________ : [saco ficha de bolsa con 30 decisiones]. El premio de la opción A es ________ y el premio de la opción B es ________ .
- Para la Dinámica 4, la decisión es ________ [saco ficha de bolsa con 30 decisiones]. El premio de la opción A es ________ y el premio de la opción B es ________ .
- Hay N personas en el taller. $N/4$ reciben pago por la Dinámica 1. Los códigos de individuo son: [listar IDs]. $N/4$ reciben pago por la Dinámica 2. Los códigos de individuo son: [listar IDs]. $N/4$ reciben pago por la Dinámica 3. Los códigos de individuo son: [listar IDs]. $N/4$ reciben pago por la Dinámica 4. Los códigos de individuo son: [listar IDs].
- Ahora jugamos las loterías. En la Dinamica 2, el premio de la opción A es ________ y el premio de la opción B es ________ . En la Dinámica 4, el premio de la opción A es ________ y el premio de la opción B es ________ .
- Ahora los llamo a cada uno para pagarles por su participación y darles información sobre su pago. Espere por favor a que lo llame. Muchas gracias a todos por su participación.

[Se llama a cada uno en privado para realizar el pago. Se paga el monto por participación. Para el resto del dinero se le dice que cuide la promesa de pago y que la presente al banco con su cédula.]

B.2 Informed Consent Form

Consentimiento Informado

Título del proyecto: Preferencias de riesgo y tiempo
Investigador Principal: Paul Ferraro, Departamento de Economía, Universidad de Georgia State (GSU)
Estudiante Investigador Principal: Maria Bernedo, Departamento de Economía, GSU
Patrocinador: Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)

I. Propósito

Usted ha sido invitado a participar en un estudio. El propósito del estudio es investigar cómo la gente toma decisiones sobre el dinero. Usted es invitado a participar porque usted o su esposa(o) es el (la) jefe de familia y fue entrevistado por CATIE en el 2013. 800 personas van a participar en este estudio. La participación no tomará más de tres horas de su tiempo el día de hoy.

II. Procedimientos

Si usted decide participar, usted va a recibir indicaciones y va a tener muchas oportunidades de hacer preguntas y ser ayudado. Con lápiz y papel, usted va luego a tomar decisiones sobre si prefiere un pago hoy o un pago mayor en el futuro. Usted también va a tomar decisiones en donde la cantidad de dinero que gana es incierta. Usted va a tomar las decisiones individualmente y también en parejas. Al final, usted completará una encuesta.

Por su participación de hoy, nosotros le daremos ₡5 000 en efectivo al final. Además, usted podrá ganar más dinero según sus decisiones. Usted podrá retirar este dinero adicional de cualquier oficina del Banco Nacional, presentando su cédula de identidad o su pasaporte. Las ganancias totales de los participantes son usualmente entre ₡5 000 y ₡50 000, pero algunas veces más. Usted recibirá la información sobre su pago hoy en privado.

III. Riesgos

En este estudio, usted no tendrá ningún riesgo mayor al que tendría en cualquier día normal.

IV. Beneficios

Usted no tendrá ningún beneficio directo por participar en este estudio. Sin embargo, su participación nos ayudará a aprender más sobre cómo la gente toma decisiones sobre el dinero.

V. Participación voluntaria y retiro

La participación es voluntaria. Usted no está obligado a estar en este estudio. Si usted empieza a participar y luego cambia de opinión, tiene el derecho a retirarse en cualquier momento. Usted no tiene que responder las preguntas que no desea responder. Si usted decide dejar el estudio antes del final, a usted no se le podrá pagar por las decisiones que haya tomado en el estudio. Por lo tanto, si usted ya sabe que no puede quedarse por tres horas, le solicitamos no firmar este formato de consentimiento.

VI. Confidencialidad

Sólo María Bernedo tendrá acceso a la información que usted nos dé hoy. La información también puede ser compartida con quienes se aseguran que el estudio se realice correctamente (Junta Revisora Institucional de GSU, la oficina de Protección de Investigación Humana (OHRP), y CATIE). Usaremos un código individual en vez de su nombre en los registros de este estudio. No hay conexión entre su nombre y este código. La información que usted nos dé será guardada en computadores protegidas con contraseña y con controles de acceso y en archivadores con llave. Su nombre y otros datos que puedan identificarlo no aparecerán cuando presentemos los resultados del estudio. Los resultados serán resumidos y reportados como grupo. Usted no será identificado personalmente.

VII. Personas de contacto

Si usted tiene preguntas, inquietudes o quejas sobre este estudio por favor contacte al Dr. Francisco Alpízar en el CATIE (Cartago, Turrialba 30501, 2558-2215; falpizar@catie.ac.cr) o a Paul Ferraro en GSU (Atlanta, GA, EE.UU.; 1-404-413-0201; pferrarogsu@gmail.com). También puede comunicarse por teléfono si piensa que ha sido perjudicado por el estudio. Llame a Susan Vogtner a la Oficina de Integridad de Investigación de GSU al número 1-404-413-3513, o por correo electrónico a svogtner1@gsu.edu, si desea hablar con alguien que no es parte del equipo de este estudio. Usted puede hablar sobre preguntas, inquietudes o sugerencias acerca del estudio. También puede llamar a Susan Vogtner si tiene preguntas o inquietudes acerca de sus derechos en este estudio.

VIII. Copia del consentimiento informado

Le daremos una copia de este consentimiento para que se la quede.

Si usted está dispuesto a ser voluntario en este estudio, por favor firme abajo.

X____ _______________

Participante Fecha

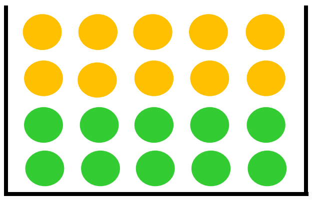
____ _______________

Investigador principal o Investigador quien obtiene el consentimiento Fecha

Versión del Consentimiento Informado: 06/03/2014

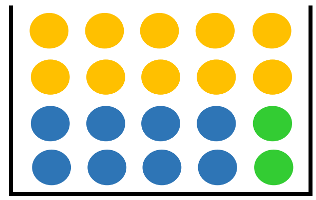
B.3 Lotteries in Risk Aversion Tasks

Código Individuo: __________



Valor de Ficha	*Número de Fichas*
₡12,000	***10 de 20***
₡8,000	***10 de 20***

A



Valor de Ficha	*Número de Fichas*
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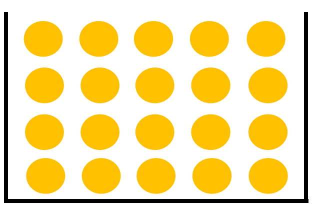
₡4,000	***2 de 20***
₡10,000	***8 de 20***

B

ri_ **1**



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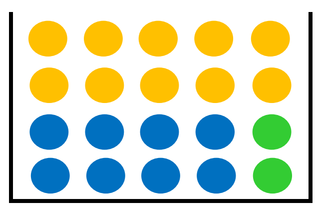
A



Valor de Ficha	*Número de Fichas*
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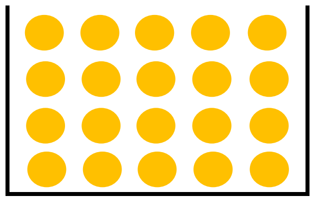
₡0	***2 de 20***
₡6,000	***8 de 20***

B

ri_ **16**



Valor de Ficha	Número de Fichas
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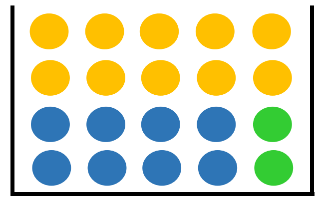
A



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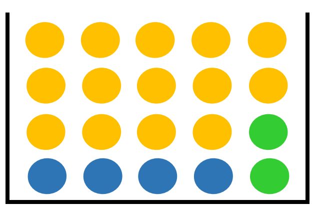
₡0	2 de 20
₡6,000	8 de 20

B

ri_ 2



Valor de Ficha	Número de Fichas
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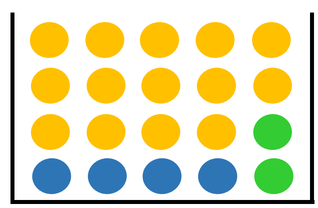
₡11,000	2 de 20
₡21,000	4 de 20

A



Valor de Ficha	Número de Fichas
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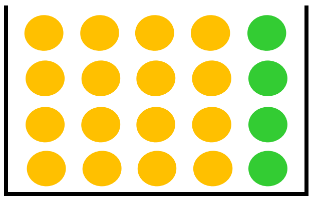
₡7,000	2 de 20
₡25,000	4 de 20

B

ri_ 17



Valor de Ficha	*Número de Fichas*
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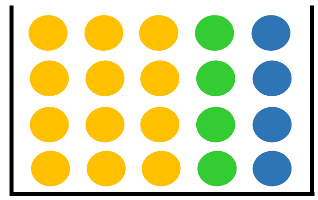
₡70,000	*4 de 20*

A



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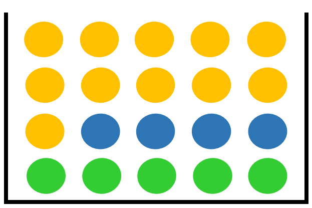
₡35,000	*4 de 20*
₡175,000	*4 de 20*

B

ri_ **3**



Valor de Ficha	*Número de Fichas*
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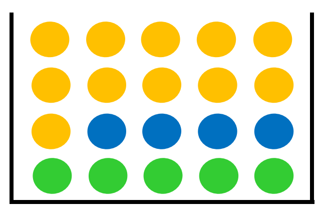
₡12,000	*5 de 20*
₡14,000	*4 de 20*

A



Valor de Ficha	*Número de Fichas*
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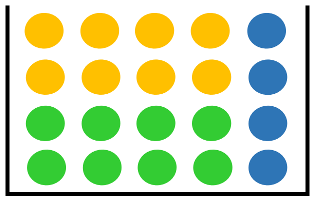
₡9,000	*5 de 20*
₡18,000	*4 de 20*

B

ri_ **18**



Valor de Ficha	Número de Fichas
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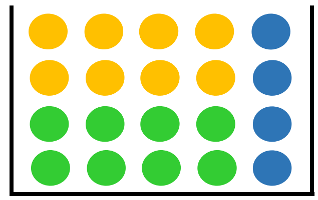
₡5,000	8 de 20
₡12,000	4 de 20

A



Valor de Ficha	Número de Fichas
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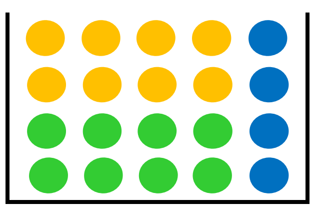
₡3,000	8 de 20
₡15,000	4 de 20

B

ri_ 4



Valor de Ficha	Número de Fichas
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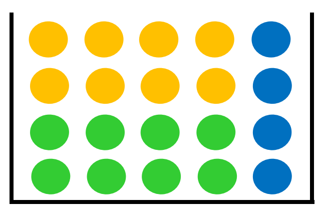
₡5,000	8 de 20
₡12,000	4 de 20

A



Valor de Ficha	Número de Fichas
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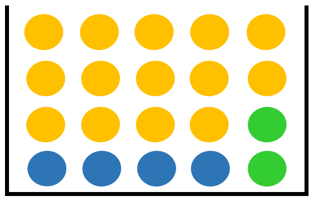
₡3,000	8 de 20
₡15,000	4 de 20

B

ri_ 19



Valor de Ficha	Número de Fichas
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₡11,000	2 de 20
₡21,000	4 de 20

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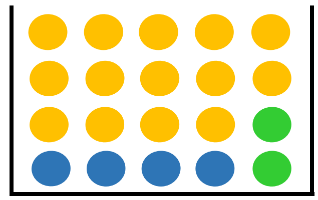

Valor de Ficha	Número de Fichas
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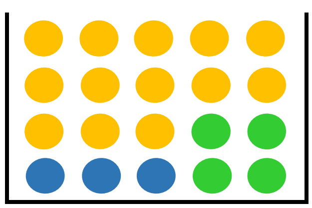
₡7,000	2 de 20
₡25,000	4 de 20

B

ri_ 5



Valor de Ficha	Número de Fichas
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₡7,000	4 de 20
₡11,000	3 de 20

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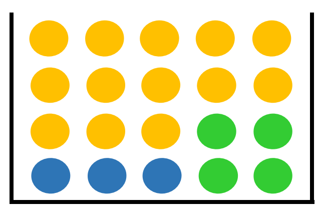

Valor de Ficha	Número de Fichas
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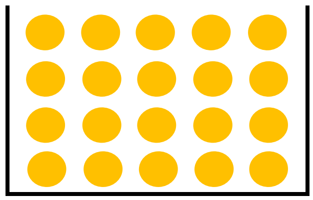
₡6,000	4 de 20
₡12,000	3 de 20

B

ri_ 20



Valor de Ficha	Número de Fichas
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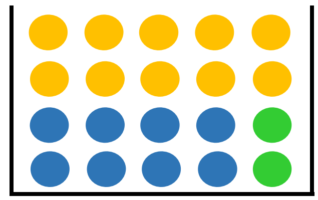
A



Valor de Ficha	Número de Fichas
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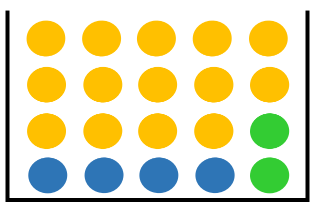
₡4,000	2 de 20
₡10,000	8 de 20

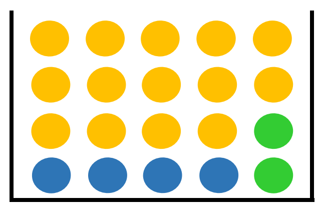
B

ri_ 6



Valor de Ficha	Número de Fichas
₡12,000	14 de 20
₡11,000	2 de 20
₡21,000	4 de 20

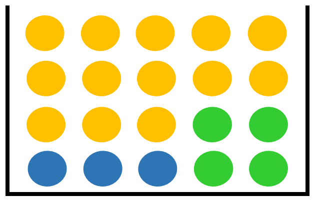
A



Valor de Ficha	Número de Fichas
₡12,000	14 de 20
₡7,000	2 de 20
₡25,000	4 de 20

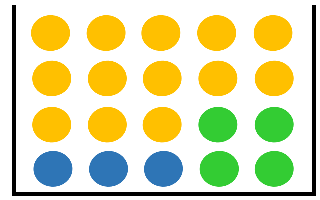
B

ri_ 21



Valor de Ficha	Número de Fichas
₡9,000	13 de 20
₡7,000	4 de 20
₡11,000	3 de 20

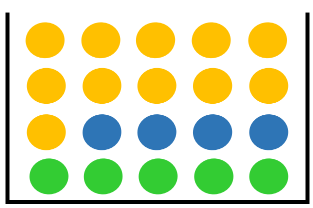
A



Valor de Ficha	Número de Fichas
₡9,000	13 de 20
₡6,000	4 de 20
₡12,000	3 de 20

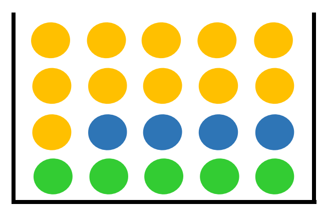
B

ri_ 7



Valor de Ficha	Número de Fichas
₡7,000	11 de 20
₡12,000	5 de 20
₡14,000	4 de 20

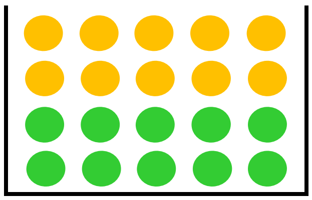
A



Valor de Ficha	Número de Fichas
₡7,000	11 de 20
₡9,000	5 de 20
₡18,000	4 de 20

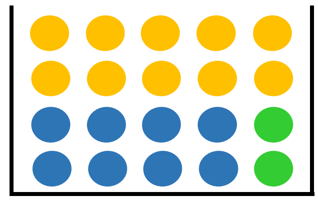
B

ri_ 22



Valor de Ficha	Número de Fichas
₡12,000	10 de 20
₡4,000	10 de 20

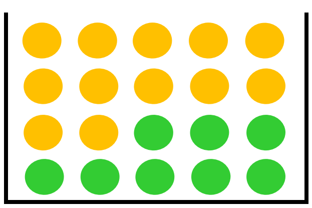
A



Valor de Ficha	Número de Fichas
₡12,000	10 de 20
₡0	2 de 20
₡6,000	8 de 20

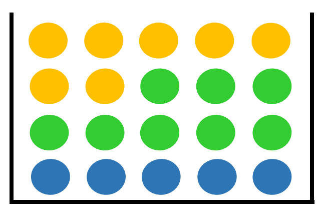
B

ri_ 8



Valor de Ficha	Número de Fichas
₡1,000	12 de 20
₡2,000	8 de 20

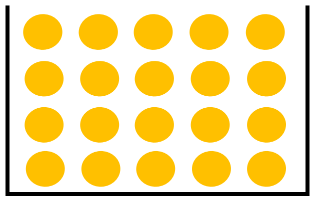
A



Valor de Ficha	Número de Fichas
₡1,000	7 de 20
₡3,000	8 de 20
₡6,000	5 de 20

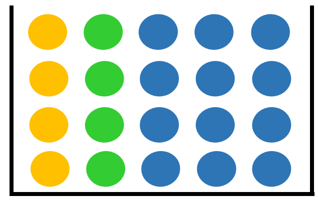
B

ri_ 23



Valor de Ficha	Número de Fichas
₡1,000	20 de 20

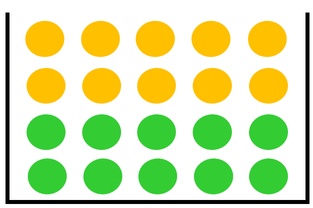
A



Valor de Ficha	Número de Fichas
₡1,000	4 de 20
₡0	4 de 20
₡4,000	12 de 20

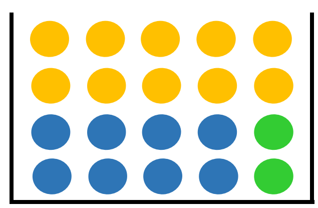
B

ri_ 9



Valor de Ficha	Número de Fichas
₡16,000	10 de 20
₡8,000	10 de 20

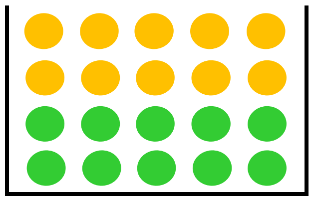
A



Valor de Ficha	Número de Fichas
₡16,000	10 de 20
₡4,000	2 de 20
₡10,000	8 de 20

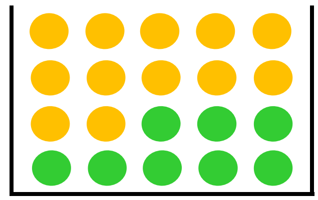
B

ri_ 24



Valor de Ficha	Número de Fichas
₡3,000	10 de 20
₡5,000	10 de 20

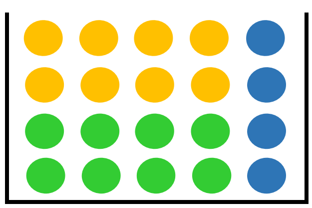
A



Valor de Ficha	Número de Fichas
₡0	12 de 20
₡6,000	8 de 20

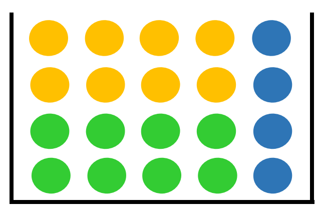
B

ri_ 10



Valor de Ficha	Número de Fichas
₡11,000	8 de 20
₡5,000	8 de 20
₡12,000	4 de 20

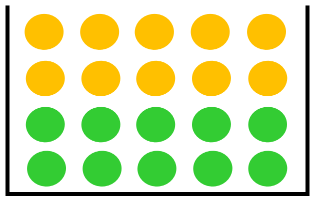
A



Valor de Ficha	Número de Fichas
₡11,000	8 de 20
₡3,000	8 de 20
₡15,000	4 de 20

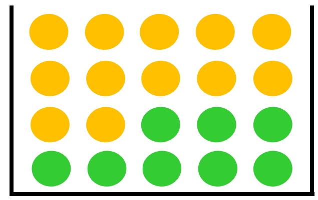
B

ri_ 25



Valor de Ficha	Número de Fichas
₡0	10 de 20
₡4,000	10 de 20

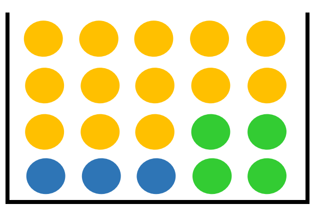
A



Valor de Ficha	Número de Fichas
₡0	12 de 20
₡6,000	8 de 20

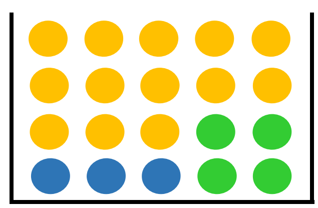
B

ri_ 11



Valor de Ficha	Número de Fichas
₡5,000	13 de 20
₡7,000	4 de 20
₡11,000	3 de 20

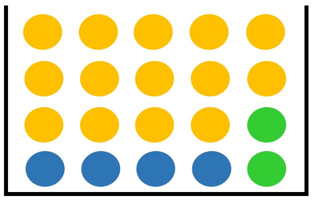
A



Valor de Ficha	Número de Fichas
₡5,000	13 de 20
₡6,000	4 de 20
₡12,000	3 de 20

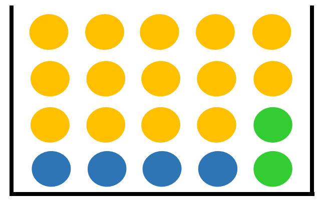
B

ri_ 26



Valor de Ficha	Número de Fichas
₡5,000	14 de 20
₡11,000	2 de 20
₡21,000	4 de 20

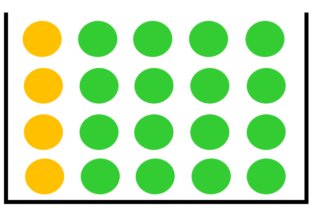
A



Valor de Ficha	Número de Fichas
₡5,000	14 de 20
₡7,000	2 de 20
₡25,000	4 de 20

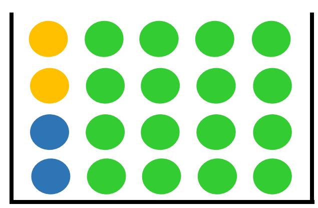
B

ri_ 12



Valor de Ficha	Número de Fichas
₡2,000	4 de 20
₡4,000	16 de 20

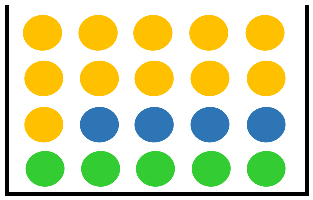
A



Valor de Ficha	Número de Fichas
₡2,000	2 de 20
₡0	16 de 20
₡8,000	2 de 20

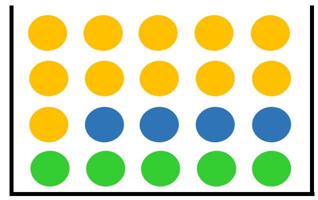
B

ri_ 27



Valor de Ficha	Número de Fichas
₡1,000	11 de 20
₡12,000	5 de 20
₡14,000	4 de 20

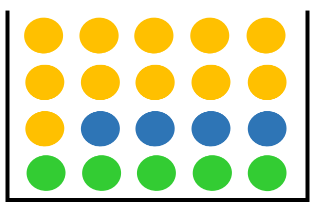
A



Valor de Ficha	Número de Fichas
₡1,000	11 de 20
₡9,000	5 de 20
₡18,000	4 de 20

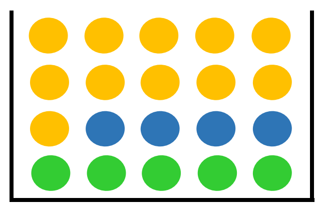
B

ri_ 13



Valor de Ficha	Número de Fichas
₡19,000	11 de 20
₡12,000	5 de 20
₡14,000	4 de 20

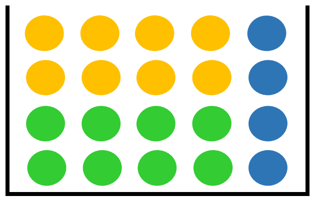
A



Valor de Ficha	Número de Fichas
₡19,000	11 de 20
₡9,000	5 de 20
₡18,000	4 de 20

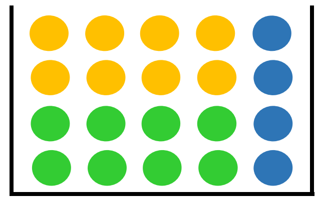
B

ri_ 28



Valor de Ficha	Número de Fichas
₡1,000	8 de 20
₡5,000	8 de 20
₡12,000	4 de 20

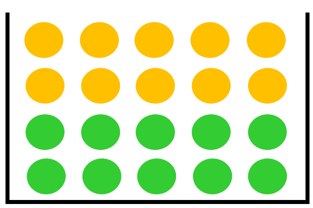
A



Valor de Ficha	Número de Fichas
₡1,000	8 de 20
₡3,000	8 de 20
₡15,000	4 de 20

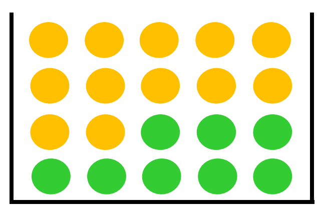
B

ri_ **14**



Valor de Ficha	Número de Fichas
₡4,000	10 de 20
₡8,000	10 de 20

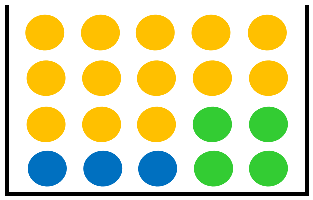
A



Valor de Ficha	Número de Fichas
₡4,000	12 de 20
₡10,000	8 de 20

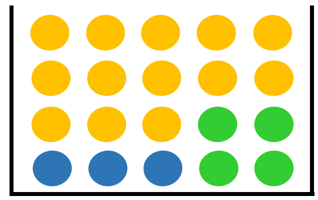
B

ri_ **29**



Valor de Ficha	Número de Fichas
₡1,000	13 de 20
₡7,000	4 de 20
₡11,000	3 de 20

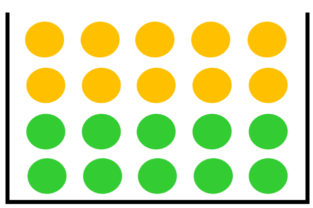
A



Valor de Ficha	Número de Fichas
₡1,000	13 de 20
₡6,000	4 de 20
₡12,000	3 de 20

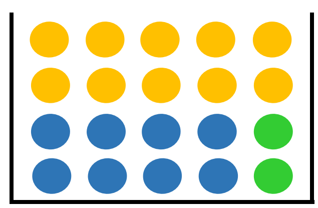
B

ri_ **15**



Valor de Ficha	Número de Fichas
₡8,000	10 de 20
₡4,000	10 de 20

A



Valor de Ficha	Número de Fichas
₡8,000	10 de 20
₡0	2 de 20
₡6,000	8 de 20

B

ri_ **30**

B.4 Multiple Price Lists in Discounting Tasks

Código Individuo:__________

	A Usted recibe la plata MAÑANA	B Usted recibe la plata en 4 DÍAS
Decisión 1	₡8,000	₡8,033
Decisión 2	₡8,000	₡8,049
Decisión 3	₡8,000	₡8,064
Decisión 4	₡8,000	₡8,095
Decisión 5	₡8,000	₡8,124
Decisión 6	₡8,000	₡8,181
Decisión 7	₡8,000	₡8,259
Decisión 8	₡8,000	₡8,419

diF1_1

	A Usted recibe la plata MAÑANA	B Usted recibe la plata en 8 DÍAS
Decisión 1	₡8,000	₡8,077
Decisión 2	₡8,000	₡8,114
Decisión 3	₡8,000	₡8,151
Decisión 4	₡8,000	₡8,223
Decisión 5	₡8,000	₡8,293
Decisión 6	₡8,000	₡8,428
Decisión 7	₡8,000	₡8,617
Decisión 8	₡8,000	₡9,013

diF1_2

	A Usted recibe la plata MAÑANA	B Usted recibe la plata en 15 DÍAS
Decisión 1	₡8,000	₡8,154
Decisión 2	₡8,000	₡8,230
Decisión 3	₡8,000	₡8,304
Decisión 4	₡8,000	₡8,452
Decisión 5	₡8,000	₡8,597
Decisión 6	₡8,000	₡8,878
Decisión 7	₡8,000	₡9,282
Decisión 8	₡8,000	₡10,154

diF1_3

	A Usted recibe la plata MAÑANA	B Usted recibe la plata en 1 MES
Decisión 1	₡8,000	₡8,333
Decisión 2	₡8,000	₡8,500
Decisión 3	₡8,000	₡8,667
Decisión 4	₡8,000	₡9,000
Decisión 5	₡8,000	₡9,333
Decisión 6	₡8,000	₡10,000
Decisión 7	₡8,000	₡11,000
Decisión 8	₡8,000	₡13,333

diF1_4

	A Usted recibe la plata MAÑANA	B Usted recibe la plata en 3 MESES
Decisión 1	₡8,000	₡9,042
Decisión 2	₡8,000	₡9,596
Decisión 3	₡8,000	₡10,171
Decisión 4	₡8,000	₡11,391
Decisión 5	₡8,000	₡12,704
Decisión 6	₡8,000	₡15,625
Decisión 7	₡8,000	₡20,797
Decisión 8	₡8,000	₡37,037

diF1_5

	A Usted recibe la plata MAÑANA	B Usted recibe la plata en 6 MESES
Decisión 1	₡8,000	₡10,220
Decisión 2	₡8,000	₡11,510
Decisión 3	₡8,000	₡12,932
Decisión 4	₡8,000	₡16,218
Decisión 5	₡8,000	₡20,173
Decisión 6	₡8,000	₡30,518
Decisión 7	₡8,000	₡54,064
Decisión 8	₡8,000	₡171,468

diF1_6

B.5 Survey for Time and Risk Experiment

B.5.1 Survey for Individuals in Fake Couples

Código Individuo: ____________ **Encuesta Individuo** 1

1 . ¿Hasta qué nivel de estudios cursó usted?

1	Ninguno	☐
2	Primaria Incompleta	☐
3	Primaria Completa	☐
4	Secundaria Incompleta	☐
5	Secundaria Completa	☐
6	Universitaria Incompleta	☐
7	Universidad Completa	☐
8	Técnico	☐
9	No sabe	☐

2 . ¿Usted visitó al médico en el último año para hacerse una revisión o chequeo médico general de prevención, no por sentir alguna molestia?

☐ Sí ☐ No

3 . ¿Hasta qué edad cree usted que va a vivir? ☐ años

4 . ¿Cuántos hijos tiene? ☐ hijos

5 . ¿A qué edad tuvo su primer hijo? ☐ años

6 . **SOLO MUJERES**: En los últimos 12 meses, ¿se hizo usted alguno de los siguientes exámenes?

Mamografía	☐ Sí	☐ No
Examen de Pap (Papanicolaou)	☐ Sí	☐ No

7 . En los últimos 12 meses, ¿ha tomado usted algún préstamo del banco, cooperativa, grupo local, prestamista,de un amigo u otra fuente?

☐ Sí ☐ No

8 . **SOLO CASADOS O EN UNION LIBRE**: ¿Usted y su pareja deciden juntos cómo y dónde ahorrar dinero?

☐ Sí ☐ No *(Si su respuesta es "No", pase a pregunta 12)*

9 . **SOLO CASADOS O EN UNIÓN LIBRE**: ¿Usted y su pareja tienen ahorros de dinero juntos?

☐ Sí ☐ No *(Si su respuesta es "No", pase a pregunta 12)*

10 . **SOLO CASADOS O EN UNION LIBRE**: ¿Cómo y dónde guardan usted y su pareja los ahorros que tienen juntos? Marque una o más opciones.

1	Banco o Cooperativa	☐
2	Empresa de crédito comunal/ bancomunal	☐
3	En casa	☐
4	Otros	☐
5	No tienen ahorros	☐

11 . **SOLO CASADOS O EN UNION LIBRE:** ¿Cuánto dinero tienen usted y su pareja ahorrado juntos?

1	Más de 0 y menos de 10 000 colones	☐
2	De 10 000 a menos de 50 000 colones	☐
3	De 50 000 a menos de 100 000 colones	☐
4	De 100 000 a menos de 200 000 colones	☐
5	De 200 000 a menos de 500 000 colones	☐
6	Más de 500 000 colones	☐
7	No saben	☐
8	No tienen ahorros	☐

12 . Aparte de los ahorros con su pareja, ¿tiene usted sus propios ahorros de dinero?

☐ Sí ☐ No *(Si su respuesta es "No", pase a pregunta 15)*

13 . ¿Cómo y dónde guarda usted sus propios ahorros ? Marque una o más opciones.

1	Banco o Cooperativa	☐
2	Empresa de crédito comunal/ bancomunal	☐
3	En casa	☐
4	Otros	☐
5	No tiene ahorros propios	☐

14 . ¿Cuánto dinero tiene en sus ahorros propios?

1 Más de 0 y menos de 10 000 colones ☐
2 De 10 000 a menos de 50 000 colones ☐
3 De 50 000 a menos de 100 000 colones ☐
4 De 100 000 a menos de 200 000 colones ☐
5 De 200 000 a menos de 500 000 colones ☐
6 Más de 500 000 colones ☐
7 No sabe ☐
8 No tiene ahorros propios ☐

15 . ¿Esta semana tienen usted y su familia mayores o menores gastos que lo acostumbrado?

☐ Menores ☐ Iguales ☐ Mayores ☐ No sabe

16 . **SOLO SI USTED TRABAJA:** ¿Hasta qué edad piensa usted trabajar? ☐ años

17 . ¿Cómo cubrirá sus gastos después que usted y su pareja dejen de trabajar? Marque una o más opciones.

1. Ahorros propios ☐
2. Pensión de vejez de la CCSS (usted cotiza) ☐
3. Dinero de hijos/familiares/pareja ☐
4. Planeo trabajar hasta que muera ☐
5. Ayuda del gobierno ☐
6. Otros ☐
7. No sabe ☐

18 . ¿Qué tan probable es que los próximos 5 veranos sean más fuertes que el verano 2014?

☐ Nada probable ☐ Poco probable ☐ Muy probable ☐ Va a ocurrir

19 . ¿Almacenan ustedes agua en su casa? ☐ Sí ☐ No

20 . ¿Cuidan ustedes la cantidad de agua que se usa en casa? ☐ Sí ☐ No

21 . ¿Tiene usted un tanque de agua en su casa?

- ☐ Sí
- ☐ No

22 . Suponga que usted toma un préstamo de 100 colones con una tasa de interés mensual de 3%. Si usted no hace ningún pago de la deuda, después de tres meses usted debe:

- ☐ más de 103 colones
- ☐ menos de 103 colones
- ☐ exactamente 103 colones
- ☐ No sabe

23 . Suponga que usted pone hoy 1000 colones en una cuenta de ahorro por un año. El banco le paga una tasa de interés anual de 1%. Además, los precios de las cosas que usted compra crecen un 2% en un año. Después de 1 año, ¿el dinero en su cuenta de ahorro le permite comprar ...

- ☐ ... MÁS cosas que las que puede comprar hoy?
- ☐ ... MENOS cosas que las que puede comprar hoy?
- ☐ ... LA MISMA CANTIDAD DE COSAS que las que puede comprar hoy?
- ☐ No sabe

24 . ¿Me podría indicar su ingreso mensual aproximado? (Considere todo tipo de ingreso: sueldo, pensión, transferencias de familiares/amigos, transferencias del gobierno, becas y otros.)

1	Más de 0 y menos de 75 000 colones	☐
2	De 75 000 a menos de 150 000 colones	☐
3	De 150 000 a menos de 250 000 colones	☐
4	De 250 000 a menos de 450 000 colones	☐
5	De 450 000 a menos de 650 000 colones	☐
6	De 650 000 a menos de 850 000 colones	☐
7	Más de 850 000 colones	☐
8	No tiene ingresos	☐

25 . ¿Cuántas personas hay en su hogar? ☐ personas

26 . ¿Me podría indicar aproximadamente el ingreso mensual total de todos los miembros de su hogar? (Considere todo tipo de ingreso: sueldo, pensión, transferencias de familiares/amigos, transferencias del gobierno, becas y otros.)

1	Más de 0 y menos de 75 000 colones	☐
2	De 75 000 a menos de 150 000 colones	☐
3	De 150 000 a menos de 250 000 colones	☐
4	De 250 000 a menos de 450 000 colones	☐
5	De 450 000 a menos de 650 000 colones	☐
6	De 650 000 a menos de 850 000 colones	☐
7	Más de 850 000 colones	☐

Muchas gracias!

B.5.2 Survey for Individuals in Real Couples

Código Individuo: _____________ **Encuesta Individuo** 1

1 . ¿Hasta qué nivel de estudios cursó usted?

- 1 Ninguno ☐
- 2 Primaria Incompleta ☐
- 3 Primaria Completa ☐
- 4 Secundaria Incompleta ☐
- 5 Secundaria Completa ☐
- 6 Universitaria Incompleta ☐
- 7 Universidad Completa ☐
- 8 Técnico ☐
- 9 No sabe ☐

2 . ¿Usted visitó al médico en el último año para hacerse una revisión o chequeo médico general de prevención, no por sentir alguna molestia?

☐ Sí ☐ No

3 . ¿Hasta qué edad cree usted que va a vivir? ☐ años

4 . ¿Cuántos hijos tiene? ☐ hijos

5 . ¿A qué edad tuvo su primer hijo? ☐ años

6 . **SOLO MUJERES**: En los últimos 12 meses, ¿se hizo usted alguno de los siguientes exámenes?

Mamografía	☐ Sí	☐ No
Examen de Pap (Papanicolaou)	☐ Sí	☐ No

7 . ¿Qué tan probable es que los próximos 5 veranos sean más fuertes que el verano 2014?

☐ Nada probable ☐ Poco probable ☐ Muy probable ☐ Va a ocurrir

8 . En los últimos 12 meses, ¿ha tomado usted algún préstamo del banco, cooperativa, grupo local, prestamista,de un amigo u otra fuente?

☐ Sí ☐ No

9 . Aparte de los ahorros con su pareja, ¿tiene usted sus propios ahorros de dinero?

☐ Sí ☐ No *(Si su respuesta es "No", pase a pregunta 12)*

10 . ¿Cómo y dónde guarda usted sus propios ahorros? Marque una o más opciones.

1 Banco o Cooperativa ☐
2 Empresa de crédito comunal/ bancomunal ☐
3 En casa ☐
4 Otros ☐
5 No tiene ahorros propios ☐

11 . ¿Cuánto dinero tiene usted en sus ahorros propios?

1 Más de 0 y menos de 10 000 colones ☐
2 De 10 000 a menos de 50 000 colones ☐
3 De 50 000 a menos de 100 000 colones ☐
4 De 100 000 a menos de 200 000 colones ☐
5 De 200 000 a menos de 500 000 colones ☐
6 Más de 500 000 colones ☐
7 No sabe ☐
8 No tiene ahorros propios ☐

12 . **SOLO SI USTED TRABAJA**: ¿Hasta qué edad piensa usted trabajar? ☐ años

13 . ¿Cómo cubrirá sus gastos después de que usted y su pareja dejen de trabajar? Marque una o más opciones.

1. Ahorros propios ☐
2. Pensión de vejez de la CCSS (usted cotiza) ☐
3. Dinero de hijos/familiares/pareja ☐
4. Planeo trabajar hasta que muera ☐
5. Ayuda del gobierno ☐
6. Otros ☐
7. No sabe ☐

14 . Suponga que usted toma un préstamo de 100 colones con una tasa de interés mensual de 3%. Si usted no hace ningún pago de la deuda, después de tres meses usted debe:

- ☐ más de 103 colones
- ☐ menos de 103 colones
- ☐ exactamente 103 colones
- ☐ No sabe

15 . Suponga que usted pone hoy 1000 colones en una cuenta de ahorro por un año. El banco le paga una tasa de interés anual de 1%. Además, los precios de las cosas que usted compra crecen un 2% en un año. Después de 1 año, ¿el dinero en su cuenta de ahorro le permite comprar ...

- ☐ … MÁS cosas que las que puede comprar hoy?
- ☐ … MENOS cosas que las que puede comprar hoy?
- ☐ … LA MISMA CANTIDAD DE COSAS que las que puede comprar hoy?
- ☐ No sabe

16 . ¿Me podría indicar su ingreso mensual aproximado? (Considere todo tipo de ingreso: sueldo, pensión, transferencias de familiares/amigos, transferencias del gobierno, becas y otros.)

1	Más de 0 y menos de 75 000 colones	☐
2	De 75 000 a menos de 150 000 colones	☐
3	De 150 000 a menos de 250 000 colones	☐
4	De 250 000 a menos de 450 000 colones	☐
5	De 450 000 a menos de 650 000 colones	☐
6	De 650 000 a menos de 850 000 colones	☐
7	Más de 850 000 colones	☐
8	No tiene ingresos	☐

Muchas gracias!

B.5.3 Survey for Real Couples

Código Pareja:__________ **Encuesta Pareja** 1

1 . ¿Desde hace cuánto tiempo viven ustedes juntos? ☐

2 . ¿Usted y su esposa deciden juntos cómo y dónde ahorrar dinero?

☐ Sí ☐ No *(Si su respuesta es "No", pase a pregunta 6)*

3 . ¿Usted y su esposa tienen ahorros de dinero juntos?

☐ Sí ☐ No *(Si su respuesta es "No", pase a pregunta 6)*

4 . ¿Cómo y dónde guardan ustedes los ahorros que tienen juntos? Marque una o más opciones.

1	Banco o Cooperativa	☐
2	Empresa de crédito comunal/ bancomunal	☐
3	En casa	☐
4	Otros	☐
5	No tienen ahorros	☐

5 . ¿Cuánto dinero tienen ustedes ahorrado juntos?

1	Más de 0 y menos de 10 000 colones	☐
2	De 10 000 a menos de 50 000 colones	☐
3	De 50 000 a menos de 100 000 colones	☐
4	De 100 000 a menos de 200 000 colones	☐
5	De 200 000 a menos de 500 000 colones	☐
6	Más de 500 000 colones	☐
7	No saben	☐
8	No tienen ahorros	☐

6 . ¿Esta semana tiene su familia mayores o menores gastos que lo acostumbrado?

☐ Menores ☐ Iguales ☐ Mayores ☐ No sabe

7 .	¿Almacenan ustedes agua en su casa?	☐ Sí ☐ No
8 .	¿Cuidan ustedes la cantidad de agua que se usa en casa?	☐ Sí ☐ No
9 .	¿Tienen ustedes un tanque de agua en su casa?	☐ Sí ☐ No
10 .	Si tiene tanque, ¿quién tomó la decisión de comprar el tanque? ☐ Ambos decidieron ☐ La señora decidió ☐ El señor decidió ☐ Ninguno de los dos decidió ☐ No tengo tanque	
11 .	¿Cuántas personas hay en su hogar? ☐ personas	
12 .	¿Me podría indicar aproximadamente <u>el ingreso mensual total de todos los miembros de su hogar</u>? (Considere todo tipo de ingreso: sueldo, pensión, transferencias de familiares/amigos, transferencias del gobierno, becas y otros.)	

1	Más de 0 y menos de 75 000 colones	☐
2	De 75 000 a menos de 150 000 colones	☐
3	De 150 000 a menos de 250 000 colones	☐
4	De 250 000 a menos de 450 000 colones	☐
5	De 450 000 a menos de 650 000 colones	☐
6	De 650 000 a menos de 850 000 colones	☐
7	Más de 850 000 colones	☐

Muchas gracias!

Appendix C

Supplementary Documents to Chapter 2

C.1 Script of Installation of Water-Conserving Technologies

[Toda la información se completa usando la tablet. Las preguntas están enumeradas y en negrita, y esa información se registra. El script del entrevistador está en viñetas y las notas para el entrevistador están en corchetes.]

1. Entrevistador : ___________________

2. Comunidad: ___________________

3. ID Medidor: ___________________

   - Buenos días/tardes, mi nombre es ___________________ y soy representante de la universidad CATIE en Turrialba. [Mostrar cédula y membrete]

   - El CATIE les había informado mediante un boletín que iba a visitar sus hogares.

4. ¿Les llegó esta información? Sí _________ No _________

5. ¿Podemos conversar con alguno de los jefes de hogar? Sí _________ No _________ Regresar _________

- [Si Regresar] Ok, ¿cuándo podemos encontrar a alguno de los jefes de hogar? Regresaremos a esa hora. Buenas tardes.
- [Si No] Ok, no hay problema. Gracias por recibirnos. Buenas tardes. [Fin de la encuesta]
- [Una vez que los jefes de hogar acepten participar, empieza la entrevista.]
- La visita de hoy no tomará mucho tiempo. Es para conversar sobre la importancia de ahorrar agua. Le haremos una pequeña encuesta y vamos a regalar tecnologías a algunos hogares seleccionados.
- Para nosotros es importante asegurarles que todas sus respuestas serán totalmente confidenciales y serán utilizadas únicamente para este proyecto. Por ejemplo, necesitamos preguntarle su nombre completo pero este dato será manejado únicamente por el jefe del estudio.

6. ¿Podemos continuar? Sí ________ No ________

- [Si Sí, continuar]
- [Si No, fin de la encuesta]
- Empecemos, si le parece, con algunas preguntas sobre su hogar y su consumo de agua.
- ¿Me podría dar su nombre completo, por favor?

7. Nombre del jefe de hogar: ________________________

8. Apellidos del jefe de hogar: ________________________

- ¿A nombre de quién salen los recibos de la ASADA?

9. Nombre del abonado: ________________________

10. Apellidos del abonado: ________________________

11. ¿Vivía esta familia en esta casa en mayo del 2014? Sí ________ No ________

a. [Si Sí] ¿Cuántos años ha vivido la familia en esta casa? _________ años

b. [Si No] ¿Cuándo se mudó la familia a esta casa? Mes _________ Año _________

12. ¿Hasta qué nivel de estudios cursó usted? [No leer opciones]

a. Ninguna

b. Primaria incompleta

c. Primaria completa

d. Secundaria incompleta

e. Universidad incompleta

f. Universidad completa

g. Técnica

h. No sabe

13. ¿Cuántas personas viven en esta casa al menos 7 meses del año? _________ personas

14. ¿Esta vivienda es __________________ ? [Leer opciones]

a. Propia totalmente pagada

b. Propia pagando a plazos

c. Alquilada

d. Prestada

15. El servicio de agua en el hogar es _________ :

a. Sólo para esta vivienda

b. Para ésta y otras viviendas

16. ¿Me podría decir cuántas unidades de estas tecnologías tiene en casa? [Leer opciones]

	Número
a. Ducha con sólo tubo	
b. Ducha simple	
c. Termoducha	
d. Inodoro o servicio sanitario	
e. Lavamanos de baño	
f. Llave de cocina	
g. Llave de cuarto de pila	
h. Lavadora automática	
i. Lavadora semiautomática	

17. Además del agua, ¿qué otros de los siguientes aparatos tiene en su hogar? [Leer opciones]

a. Radio o equipo de sonido

b. Línea telefónica fija

c. Pantalla de tv (plasma, LCD o LED)

d. Televisor convencional

e. Televisión por cable o por satelite

f. Sistema de agua caliente para toda la casa

g. Tanque de almacenamiento de agua

h. Computadora de escritorio

i. Internet

j. Moto propia

k. Carro propio

18. ¿Usted u otro miembro de su familia ha participado en alguna de las últimas dos Asambleas Generales que convocó la ASADA? Sí _________ No _________

19. ¿Es usted o alguna persona de su familia miembro de alguna organización comunal? Sí _________ No _________

- Gracias por sus respuestas. Continuemos.
- Como usted habrá notado, en los últimos dos años la cantidad de lluvia se ha reducido con respecto a años anteriores en toda Costa Rica, y Guanacaste y Puntarenas no son la excepción. El año 2013 fue un año difícil y el año 2014 fue un año aún más seco. Estudios muestran que en promedio la temperatura va a aumentar y la lluvia se va a reducir en esta zona. Debido a esto, la universidad CATIE aconseja que los hogares deben empezar a reducir el consumo de agua. Actualmente muchos hogares utilizan muchísima agua al ducharse, al lavarse las manos, al lavar los platos.
- La tecnología puede ayudarnos a reducir este consumo de agua.
- Hoy hemos venido a ofrecerle la instalación sin costo alguno para usted, de estos dispositivos para la ducha y llaves de su casa [Mostrar dispositivos]. En el caso de la ducha, se trata de una cabeza de ducha. Estos aparatos reducen la cantidad de agua que sale de la ducha y de la llave pero el chorro de agua es mucho más agradable, según la opinión de muchas personas. Además, al gastar menos agua, con esta tecnología usted ahorra plata. Aproximadamente usted puede ahorrar 17 000 colones al año.
- Tomamos estos videos de los grifos y ducha con los nuevos dispositivos en una casa en Guanacaste. Así se ve el chorro de agua. [Mostrar videos de cada dispositivo.]
- La tecnología y la instalación es gratuita y nos llevaríamos la pieza vieja que sacamos y que ya no va a utilizar.
- Desafortunadamente, no podemos instalar esta tecnología en todos los hogares porque no nos alcanza la plata. Si su hogar fuera seleccionado por sorteo para recibir esta tecnología, ¿estaría usted de acuerdo en que instalemos estos aparatos en su hogar el día de hoy? Como le dije, todo es gratis. Además, la instalación es muy sencilla y no causará ningún

problema. Si usted acepta que realicemos la instalación, lo visitaríamos dentro de los próximos 6 meses para revisar las instalaciones y saber su opinión sobre los productos.

20. Entonces, ¿le gustaría que instalemos estos aparatos en su hogar el día de hoy? Sí ________
No ________

   - [Si Sí] Ok, vamos a ver cómo está su suerte el día de hoy.
   - [If No] Ok, no hay problema. Antes de terminar con la entrevista, quisiera hacerle una última pregunta sobre su hogar. [Pase a la pregunta 22].
   - Vamos a hacer el sorteo usando fichas de 3 colores que se encuentran en esta bolsa: rojas, azules y blancas. Si sale una ficha roja o azul, usted recibe la tecnología. Si sale la ficha blanca, lamentablemente no podríamos instalarle la tecnología. Elija por favor una ficha de la bolsa.

21. El color de la ficha que salió en el sorteo es ________

   a. Rojo

   b. Azul

   c. Blanca

   - [Si ROJA] Usted ha salido beneficiado para la instalación. Felicitaciones. La instalación tomará 30 minutos como máximo. Además, nosotros LE DAREMOS 20 000 COLONES en nuestra próxima visita si usted no quita las tecnologías que le instalaremos hoy. Esta visita se realizaría dentro de los siguientes seis meses. Si no encontramos a nadie en casa en la primera visita, usted tiene una segunda oportunidad. Antes de pasar a la instalación, quisiera hacerle una última pregunta sobre su hogar.
   - [Si AZUL] Usted ha salido beneficiado para la instalación. Felicitaciones. La instalación tomará 30 minutos como máximo. Dentro de los siguientes seis meses, nosotros estare-

mos pasando por su casa para ver cómo le ha ido con la tecnología. Antes de pasar a la instalación, quisiera hacerle una última pregunta sobre su hogar.

- [Si Blanca] Lamentablemente usted no salió favorecido para la instalación. Por razones presupuestarias no podemos instalar la tecnología a todas las casas que visitamos. Sin embargo, para nosotros es muy importante completar esta encuesta. Antes de terminar con la entrevista, quisiera hacerle una última pregunta sobre su hogar.

22. Quisiera pedirle que por favor escoja en la siguiente tabla el rango de ingreso mensual de todos los miembros de su hogar. Recuerde que toda la información que nos dé es confidencial. Considere todo tipo de ingreso: sueldo, pensión, transferencias de familiares/amigos, transferencias del gobierno, becas y otros.

    a. Más de 0 y menos de 75 000 colones
    b. De 75 000 a menos de 125 000 colones
    c. De 125 000 a menos de 250 000 colones
    d. De 250 000 a menos de 450 000 colones
    e. Más de 450 000 colones
    f. No sabe/no responde

23. ¿Está conforme con la medición de consumo de agua en su casa? Sí _________ No _________

- [Si ROJO o AZUL] Ok, muchas gracias por la información. Ahora podemos pasar a la instalación. El sr. __________________ es uno de los plomeros contratados por CATIE para ayudarnos a hacer las instalaciones.
- [Si no quiso la tecnología o ficha BLANCA] Ok, muchas gracias por la información. Eso sería todo por ahora. Muchas gracias por su tiempo y toda su atención. Buenas tardes. [Fin de la encuesta]

- [[Entrevistador permanece en la casa durante la instalación de las tecnologías para anotar qué instalaciones se realizarán.]

24. Resumen Instalación de Aireadores de Cocina

- [Recordatorio: El número de aireadores de cocina instalados es:________]

24.1 ¿Cuántas unidades de aireadores de cocina se instalaron?

24.2 ¿Algún problema en la instalación del aireador de la cocina?

a. Ninguno

b. Nueva Llave

c. Adaptador

d. Otro:________________

24.3 ¿Qué tecnología se retiró?

a. Nada

b. Aireador viejo

c. Llave vieja

- [Recordatorio: La cantidad de aireadores no instalados en la cocina es:________]

24.4 El número de unidades no instaladas es:________

24.5 ¿Por qué no se instaló el aireador de cocina?

a. No se pudo

b. No quiso

25. Resumen Instalación de Aireadores de Lavamanos

- [Recordatorio: El número de aireadores de lavamanos instalados es:________]

25.1 ¿Cuántas unidades de aireadores de lavamanos se instalaron?

25.2 ¿Algún problema en la instalación del aireador de lavamanos?

a. Ninguno

b. Nueva Llave

c. Adaptador

d. Otro:_________

25.3 ¿Qué tecnología se retiró?

a. Nada

b. Aireador viejo

c. Llave vieja

- [Recordatorio: La cantidad de aireadores de lavamanos no instalados es:_________]

25.4 El número de unidades no instaladas es:_________

25.5 ¿Por qué no se instaló el aireador de lavamanos?

a. No se pudo

b. No quiso

26. Resumen Instalación de Duchas Eficientes

- [Recordatorio: El número de duchas instaladas es:_________]

26.1 ¿Cuántas unidades de duchas eficientes se instalaron?

26.2 ¿Algún problema en la instalación de duchas eficientes?

a. Ninguno

b. Otro:_________

26.3 ¿Qué tecnología se retiró?

a. Nada

b. Ducha simple vieja

c. Termoducha vieja

- [Recordatorio: La cantidad de duchas no instalados es:________]

26.4 El número de unidades no instaladas es:________

26.5 ¿Por qué no se instaló la ducha?

a. No se pudo

b. No quiso

- [Si ROJA] Dentro de 6 meses lo visitaremos para saber su opinión sobre las tecnologías. Recuerde que USTED RECIBIRÁ 20 000 COLONES si en nuestra próxima visita nosotros encontramos las tecnologías instaladas. Sin embargo, si usted tiene un problema con LOS NUEVOS DISPOSITIVOS Y NECESITA DESINSTALAR ALGUNO, por favor llámenos a este número: 8922-8839. [Entregar nota ROJA].
- [Si AZUL] Dentro de 6 meses lo visitaremos para saber su opinión de las tecnologías. Si usted tiene un problema con LOS NUEVOS DISPOSITIVOS Y NECESITA DESINSTALAR ALGUNO, por favor llámenos a este número:8922-8839. [Entregar nota AZUL].

27. Material predominante en las paredes exteriores

a. Block o ladrillo

b. Zócalo (con madera, zinc o fibrocemento)

c. Madera

d. Prefabricado

e. Zinc

f. Fibrocemento (Fibrolit,Ricalit)

g. Fibras naturales (bambú, caña, chonta)

h. Otro

28. Material predominante en el techo

a. Lámina de metal o zinc

b. Fibrocemento

c. Entrepiso

d. Fibras naturales (bambú,caña, chonta)

e. Otro

29. Material predominante en el piso

a. Mosaico, cerámica, terrazo

b. Cemento (lujado o no)

c. Madera

d. Material natural (bambú, caña, chonta)

e. Otro

C.2 Script of Technology Audit

[Se entrevista a todos los hogares que recibieron tecnología y se revisan las instalaciones. Al grupo B se le hace además aforo. El grupo B está conformado por 4 hogares en cada comunidad elegidos al azar.]

1. Entrevistador: ________________
2. Comunidad: ________________
3. ID Medidor: ________________
4. Tipo de tratamiento: (tecnología o tecnología+bono)

   Preguntas para todos:

   - Buenos días/ tardes. Mi nombre es ________________y vengo en representación de CATIE, la universidad de Turrialba. [Mostrar cédula y membrete de CATIE].
   - Nosotros estuvimos por aquí el ________ para hablar sobre la importancia de ahorrar agua e hicimos unas instalaciones en las llaves de agua. Ese día fuimos atendidos por el (la) Sr(a):________________.

5. ¿Podemos conversar con él(ella) u otro jefe de hogar?

   - [Si Sí] Gracias
   - [Si NO] Ok, no hay problema. Gracias por recibirnos.
   - [Si jefe no está]: ¿A qué hora podemos regresar? ________
   - En esta oportunidad quisiéramos pedirle su permiso para hacerle una entrevista muy breve y revisar las instalaciones de agua.

6. ¿Podría usted participar?

- [Si Sí]: Gracias.
- [Si No]: No hay problema. Gracias. Buenas tardes. [Fin de la encuesta]
- [Sólo Grupo B]: Además algunas casas en su comunidad han sido seleccionadas a la suerte para realizar aforos, es decir, mediciones del flujo de agua en algunos puntos de su casa: ducha, cocina, llave de bao. Queremos saber si la tecnología funciona como se espera. Esta medición no tomará más de 10 minutos de su tiempo.

7. [Sólo Grupo B]: ¿Podemos realizar la medición?
   - [Si Sí]: Ok, empecemos.
   - [Si No]: No hay problema. Entonces, haremos sólo la entrevista.
8. ¿Nos podría dar por favor su nombre completo?: __________________
9. ¿Desde cuándo vive esta familia en esta casa? Mes _________ Año _________
   - ¿Cuál es el nombre que aparece en los recibos de agua?
10. [Pregunta para el Entrevistador]: ¿Es el mismo abonado? Sí _________ No _________

    10.1 [Si No]: Nombre abonado: __________________

    10.2 [Si No]: ¿Por qué cambió el nombre? __________________

   - En nuestra visita anterior nosotros instalamos algunas tecnologías.
   - [Recordatorio:
     - Número de duchas eficientes: X
     - Número de aireadores de llaves de lavamanos: X
     - Número de aireadores de llaves de cocina: X]
   - ¿Podemos pasar a revisar las instalaciones? [Hacer *check* si tecnología está instalada y sale agua de la llave.]

11. Instalaciones de duchas eficientes

    11.1 Ducha 1: _________

    11.2 Ducha 2: _________

    11.3 Ducha 3: _________

12. Instalaciones de aireadores de cocina

    12.1 Aireador de cocina 1: _________

    12.2 Aireador de cocina 2: _________

    12.3 Aireador de cocina 3: _________

13. Instalaciones de aireadores de lavamanos

    13.1 Aireador de lavamanos 1: _________

    13.2 Aireador de lavamanos 2: _________

    13.3 Aireador de lavamanos 3: _________

14. Sobre las duchas eficientes que no están en uso

    14.1 ¿Cuántas llaves con el dispositivo se dejaron de usar totalmente?

    14.2 ¿En qué mes se dejó de usar? [Recordatorio: Mes de instalación es: _________]

    14.3 ¿En cuántas se desinstaló el dispositivo?

    14.4 ¿En qué mes desinstaló el dispositivo? [Recordatorio: Mes de instalación es: _________]

    14.5 ¿Por qué lo desinstaló? [No leer opciones]

        (a) El aireador se tapó.

        (b) Poca agua. No me agrada el chorro de agua.

        (c) Otro:_________

14.6 ¿Cómo quedó la salida de agua después de que desinstaló? [No leer opciones]

(a) Compraron otra cachera.

(b) Dejaron el tubo sin cachera.

15. Sobre los aireadores de cocina que no están en uso

15.1 ¿Cuántas llaves con el dispositivo se dejaron de usar totalmente?

15.2 ¿En qué mes se dejó de usar? [Recordatorio: Mes de instalación es: _________]

15.3 ¿En cuántas se desinstaló el dispositivo?

15.4 ¿En qué mes desinstaló el dispositivo? [Recordatorio: Mes de instalación es: _________]

15.5 ¿Por qué lo desinstaló? [No leer opciones]

(a) El aireador se tapó.

(b) Poca agua. No me agrada el chorro de agua.

(c) La llave se dañó.

(d) Otro:_________

16. Sobre los aireadores de lavamanos que no están en uso

16.1 ¿Cuántas llaves con el dispositivo se dejaron de usar totalmente?

16.2 ¿En qué mes se dejó de usar? [Recordatorio: Mes de instalación es: _________]

16.3 ¿En cuántas se desinstaló el dispositivo?

16.4 ¿En qué mes desinstaló el dispositivo? [Recordatorio: Mes de instalación es: _________]

16.5 ¿Por qué lo desinstaló? [No leer opciones]

(a) El aireador se tapó.

(b) Poca agua. No me agrada el chorro de agua.

(c) La llave se dañó.

(d) Otro:_________

17. ¿ Desconectó usted o alguien de la familia las tecnologías por algún periodo de tiempo? Sí _________ No _________

    17.1 ¿Desconectó usted o alguien de la familia la ducha eficiente? Sí _________ No _________

    17.2 ¿Cuál fue la razón? [No leer opciones]

    (a) Para limpiar filtro.

    (b) A una persona de la casa no le gusta usar la tecnología y la retira.

    (c) Otro: _________

    17.3 ¿Desconectó usted o alguien de la familia el filtro de la llave de cocina? Sí _________ No _________

    17.4 ¿Cuál fue la razón? [No leer opciones]

    (a) Para limpiar filtro.

    (b) A una persona de la casa no le gusta usar la tecnología y la retira.

    (c) Otro: _________

    17.5 ¿Desconectó usted o alguien de la familia el filtro de la llave de cocina? Sí _________ No _________

    17.6 ¿Cuál fue la razón? [No leer opciones]

    (a) Para limpiar filtro.

    (b) A una persona de la casa no le gusta usar la tecnología y la retira.

    (c) Otro: _________

18. ¿Cree usted que ahora que tiene las tecnologías ... [Leer opciones]

    18.1 demora _________ en ducharse?

    (a) más tiempo

(b) menos tiempo

(c) igual

18.2 el número de veces que se ducha _________ ?

(a) ha aumentado

(b) ha disminuido

(c) no ha cambiado

18.3 mantiene la llave abierta _________ para lavarse las manos, la cara o los dientes?

(a) más tiempo

(b) menos tiempo

(c) igual

18.4 el número de veces que se lava las manos, la cara o los dientes _________?

(a) ha aumentado

(b) ha disminuido

(c) no ha cambiado

18.5 mantiene la llave abierta _________ para lavar los platos y para cocinar?

(a) más tiempo

(b) menos tiempo

(c) igual

18.6 el número de veces que jala la cadena del servicio _________ ?

(a) ha aumentado

(b) ha disminuido

(c) no ha cambiado

18.7 el número de veces que riega las plantas _________ ?

(a) ha aumentado

(b) ha disminuido

(c) no ha cambiado

18.8 el número de veces que lava la ropa _________ ?

(a) ha aumentado

(b) ha disminuido

(c) no ha cambiado

18.9 el número de veces que limpia la casa _________ ?

(a) ha aumentado

(b) ha disminuido

(c) no ha cambiado

19. Sobre el chorro de agua

19.1 ¿Prefiere usted el actual chorro de la ducha que el chorro anterior? Sí _________ No _________

19.2 ¿Prefiere usted el actual chorro de la llave de la cocina que el chorro anterior? Sí _________ No _________

19.3 ¿Prefiere usted el actual chorro de la llave de lavamanos que el chorro anterior? Sí _________ No _________

20. Sobre la apariencia

19.1 La apariencia de la nueva ducha es:

(a) mejor que lo que tenía antes

(b) peor que lo que tenía antes

(c) igual que lo que tenía antes

19.2 La apariencia de la llave de cocina es:

(a) mejor que lo que tenía antes

(b) peor que lo que tenía antes

(c) igual que lo que tenía antes

19.3 La apariencia de la llave de lavamanos es:

(a) mejor que lo que tenía antes

(b) peor que lo que tenía antes

(c) igual que lo que tenía antes

21. ¿Piensa usted mantener instaladas las tecnologías en el futuro?

21.1 ¿Por qué? Digame por favor todas las razones.

(a) Ahorro plata.

(b) Ahorro agua.

(c) Me gusta el chorro de agua.

(d) Otro: _________

21.2 ¿Desea retirar la ducha? Sí _________ No _________

21.3 ¿Por qué? Digame por favor todas las razones.

(a) No me gusta el chorro de agua.

(b) El filtro se obstruye con frecuencia.

(c) Otro: _________

21.4 ¿Desea retirar el filtro de la llave de lavamanos? Sí _________ No _________

21.5 ¿Por qué? Digame por favor todas las razones.

(a) No me gusta el chorro de agua.

(b) El filtro se obstruye con frecuencia.

(c) Otro: _________

21.6 ¿Desea retirar el filtro de la llave de cocina? Sí _________ No _________

21.7 ¿Por qué? Digame por favor todas las razones.

(a) No me gusta el chorro de agua.

(b) El filtro se obstruye con frecuencia.

(c) Otro: _________

- Como usted habrá notado, en los últimos dos aos la cantidad de lluvia se ha reducido con respecto a aos anteriores en toda Costa Rica. Estudios muestran que en promedio la temperatura va a aumentar y la lluvia se va a reducir en la zona de Guanacaste y Puntarenas. Debido a esto, los hogares deben empezar a reducir el consumo de agua. Actualmente muchos hogares utilizan muchísima agua al ducharse, al lavarse las manos, al lavar los platos.La tecnología puede ayudarnos a reducir el consumo de agua.
- Desde hace algunos meses usted tiene instalada en su casa una ducha eficiente.Esta ducha reduce el consumo de agua para baarse pero el chorro de agua es mucho más agradable, según la opinión de muchas personas. Además, al gastar menos agua, usted puede ahorrar plata cada mes. Supongamos que usted no tiene la ducha eficiente y hoy vengo a ofrecérsela. Tomando en cuenta su experiencia con la tecnología en estos meses,

22. ¿Estaría usted dispuesto a pagar por una ducha eficiente? Sí _________ No _________

- Yo le voy a sugerir un monto y le voy a preguntar si usted está dispuesto a pagar ese monto por la ducha.
- Pero antes de responder le pido pensar cuidadosamente su respuesta. Muchas veces la gente responde esta pregunta sin prestarle mucha atención, pero para las ASADAS en Guanacaste es muy importante tener una respuesta real, que tome en cuenta su experiencia con la tecnología y el impacto del pago sobre las cuentas de la casa.

23. ¿Entonces, pagaría usted *price* colones por la ducha? Sí ________ No ________

24. [Encuestador: Es posible que algunas personas le pidan retirar las technologías. Si ese es el caso, preguntar por qué. No retirar y decir que no tienen el equipo para retirarlas.]

    24.1 ¿El jefe de hogar solicitó retirar la ducha? Sí ________ No ________

    24.2 ¿Cuál fue la razón?

    (a) Problema técnico

    (b) Gusto

    24.3 ¿El jefe de hogar solicitó retirar el aireador de cocina? Sí ________ No ________

    24.4 ¿Cuál fue la razón?

    (a) Problema técnico

    (b) Gusto

    24.5 ¿El jefe de hogar solicitó retirar el aireador de lavamanos? Sí ________ No ________

    24.6 ¿Cuál fue la razón?

    (a) Problema técnico

    (b) Gusto

- Ahora le pido que por favor me acompañe a realizar el aforo. Si es tan amable, abra la llave de la cocina (lavamanos, ducha) como normalmente lo hace. Yo voy a apuntar el tiempo que toma llenar el recipiente. [Aforar sólo las llaves y duchas con tecnología.]

References

Abdellaoui, M., L'Haridon, O., & Paraschiv, C. (2013). Individual vs. couple behavior: an experimental investigation of risk preferences. *Theory and decision*, *75*(2), 175–191.

Abdellaoui, M., L'Haridon, O., Paraschiv, C., et al. (2013). Do couples discount future consequences less than individuals. *Université De Rennes*, *1*, 2013–20.

Allcott, H., & Greenstone, M. (2012). Is there an energy efficiency gap? *The Journal of Economic Perspectives*, *26*(1), 3.

Andersen, S., Harrison, G. W., Lau, M. I., & Rutström, E. E. (2008). Eliciting risk and time preferences. *Econometrica*, *76*(3), 583–618.

Andersen, S., Harrison, G. W., Lau, M. I., & Rutström, E. E. (2014). Discounting behavior: A reconsideration. *European Economic Review*, *71*, 15–33.

Andreoni, J., & Sprenger, C. (2012). Estimating time preferences from convex budgets. *American Economic Review*, *102*(7), 3333–56.

Arias, L. (2016). *Water and sewer institute seeks tax cuts for water-efficient appliances, fixtures* (Tech. Rep.). The Tico Times News.

Attema, A. E., Bleichrodt, H., Gao, Y., Huang, Z., & Wakker, P. P. (2016). Measuring discounting without measuring utility. *American Economic Review*, *106*(6), 1476–1494.

Balmford, A., Green, R., Scharlemann, J. P., et al. (2005). Sparing land for nature: exploring the potential impact of changes in agricultural yield on the area needed for crop production. *Global Change Biology*, *11*(10), 1594–1605.

Bateman, I., & Munro, A. (2005). An experiment on risky choice amongst households*. *The Economic Journal*, *115*(502), C176–C189.

Bauer, M., Chytilová, J., & Morduch, J. (2012). Behavioral foundations of microcredit: Experimental and survey evidence from rural india. *The American Economic Review*, *102*(2), 1118–1139.

Benhabib, J., Bisin, A., & Schotter, A. (2010). Present-bias, quasi-hyperbolic discounting, and fixed costs. *Games and Economic Behavior*, *69*(2), 205–223.

Bitler, M. P., Gelbach, J. B., & Hoynes, H. W. (2008). Distributional impacts of the self-sufficiency project. *Journal of Public Economics*, *92*(3), 748–765.

Bozzola, M., et al. (2014). Adaptation to climate change: Farmers' risk preferences and the role of irrigation. In *European association of agricultural economists conference on'agri-food and rural innovations for healthier societies.*

Carlsson, F., He, H., Martinsson, P., Qin, P., & Sutter, M. (2012). Household decision making in rural china: Using experiments to estimate the influences of spouses. *Journal of Economic Behavior & Organization*, *84*(2), 525–536.

Carlsson, F., Martinsson, P., Qin, P., & Sutter, M. (2013). The influence of spouses on household decision making under risk: an experiment in rural china. *Experimental Economics*, *16*(3), 383–401.

Chan, N. W., & Gillingham, K. (2015). The microeconomic theory of the rebound effect and its welfare implications. *Journal of the Association of Environmental and Resource Economists*, *2*(1), 133–159.

Clarke, K. A. (2003). Nonparametric model discrimination in international relations. *Journal of Conflict Resolution*, *47*(1), 72–93.

Coller, M., Harrison, G. W., & Rutström, E. E. (2012). Latent process heterogeneity in discounting behavior. *Oxford economic papers*, *64*(2), 375–391.

Collins, D., Morduch, J., Rutherford, S., & Ruthven, O. (2009). *Portfolios of the poor: how the world's poor live on $2 a day*. Princeton University Press.

Cox, J. C., Sadiraj, V., & Schmidt, U. (2015). Paradoxes and mechanisms for choice under risk. *Experimental Economics*, *18*(2), 215–250.

Datta, S., Miranda, J. J., Zoratto, L. D. C., Calvo-González, O., Darlingm, M., & Lorenzana, K. (2015). A behavioral approach to water conservation: evidence from costa rica. *World Bank Policy Research Working Paper*(7283).

Davis, L. W., Fuchs, A., & Gertler, P. (2014). Cash for coolers: evaluating a large-scale appliance replacement program in mexico. *American Economic Journal: Economic Policy*, *6*(4), 207–238.

De Palma, A., Picard, N., & Ziegelmeyer, A. (2011). Individual and couple decision behavior under risk: evidence on the dynamics of power balance. *Theory and decision*, *70*(1), 45–64.

de Trabajo y Seguridad Social de Costa Rica, M. (n.d.). *Decreto nÂ 37784-mtss.* `http://rerumnovarum.or.cr/documentos/SalariosSectorPrivado/`

2013/DecretodesalariossectorprivadoIIsemestre2013.pdf. (Online, 2013)

Djebbari, H., & Smith, J. (2008). Heterogeneous impacts in progresa. *Journal of Econometrics*, *145*(1), 64–80.

Duflo, E., Kremer, M., & Robinson, J. (2008). How high are rates of return to fertilizer? evidence from field experiments in kenya. *The American economic review*, *98*(2), 482–488.

Duflo, E., Kremer, M., & Robinson, J. (2011). Nudging farmers to use fertilizer: Theory and experimental evidence from kenya. *The American Economic Review*, *101*(6), 2350–2390.

EERE. (2010). *Review of selected home energy auditing tools: in support of the development of a national building performance assessment and rating program* (Tech. Rep.). U.S. Department of Energy, Energy Efficiency and Renewable Energy.

Eliaz, K., Ray, D., & Razin, R. (2006). Choice shifts in groups: A decision-theoretic basis. *The American economic review*, *96*(4), 1321–1332.

FAO. (2014). *Adapting to climate change through land and water management in eastern africa* (Tech. Rep.). United Nations.

Ferraro, P. J., & Miranda, J. J. (2013). Heterogeneous treatment effects and mechanisms in information-based environmental policies: Evidence from a large-scale field experiment. *Resource and Energy Economics*, *35*(3), 356–379.

Field, C. B. (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation: special report of the intergovernmental panel on climate change*. Cambridge University Press.

Field, C. B., Barros, V. R., Mach, K., & Mastrandrea, M. (2014). *Climate change 2014: impacts, adaptation, and vulnerability* (Vol. 1). Cambridge University Press Cambridge, New York, NY.

Filiz-Ozbay, E., Guryan, J., Hyndman, K., Kearney, M., & Ozbay, E. Y. (2015). Do lottery payments induce savings behavior? evidence from the lab. *Journal of Public Economics*, *126*, 1–24.

Fischer, E. M., & Knutti, R. (2015). Anthropogenic contribution to global occurrence of heavy-precipitation and high-temperature extremes. *Nature Climate Change*, *5*(6), 560–564.

Fowlie, M., Greenstone, M., & Wolfram, C. (2015). *Do energy efficiency investments deliver? evidence from the weatherization assistance program* (Tech. Rep.). National Bureau of Economic Research.

Gillingham, K., & Palmer, K. (2014). Bridging the energy efficiency gap: policy insights from economic theory and empirical evidence. *Review of Environmental Economics and Policy*, ret021.

Golin, C., Cox, M., Brown, M., & Thomas, V. (2015). The water efficiency gap. *Sustainable Water Resources Management*, *1*(4), 315–324.

Hanna, R., Duflo, E., & Greenstone, M. (2016). Up in smoke: The influence of household behavior on the long-run impact of improved cooking stoves. *American Economic Journal: Economic Policy*, *8*(1), 80–114.

Harrison, G. W., Humphrey, S. J., & Verschoor, A. (2010). Choice under uncertainty: evidence from ethiopia, india and uganda*. *The Economic Journal*, *120*(543), 80–104.

Harrison, G. W., & Rutstrom, E. E. (2008). Risk aversion in the laboratory. *Risk Aversion in Experiments*, *12*, 41.

Jaime, M., & Carlsson, F. (2014). Social norms and information diffusion in water-saving programs: Evidence from a randomized field experiment in colombia. *ECONOMIC STUDIES DEPARTMENT OF ECONOMICS SCHOOL OF BUSINESS, ECONOMICS AND LAW UNIVERSITY OF GOTHENBURG*.

Kallbekken, S., Sælen, H., & Hermansen, E. A. (2013). Bridging the energy efficiency gap: A field experiment on lifetime energy costs and household appliances. *Journal of Consumer Policy*, 1–16.

Koundouri, P., Nauges, C., & Tzouvelekas, V. (2006). Technology adoption under production uncertainty: theory and application to irrigation technology. *American Journal of Agricultural Economics*, *88*(3), 657–670.

Laibson, D. (1997). Golden eggs and hyperbolic discounting. *The Quarterly Journal of Economics*, 443–477.

Laury, S. K., McInnes, M. M., & Swarthout, J. T. (2012). Avoiding the curves: Direct elicitation of time preferences. *Journal of Risk and Uncertainty*, *44*(3), 181–217.

Liu, E. M. (2013). Time to change what to sow: Risk preferences and technology adoption decisions of cotton farmers in china. *Review of Economics and Statistics*, *95*(4), 1386–1403.

Mazur, J. E. (1984). Tests of an equivalence rule for fixed and variable reinforcer delays. *Journal of Experimental Psychology: Animal Behavior Processes*, *10*(4), 426.

Mazzocco, M. (2004). Saving, risk sharing, and preferences for risk. *The American Economic Review*, *94*(4), 1169–1182.

Mendelsohn, R. (2012). The economics of adaptation to climate change in developing countries. *Climate Change Economics*, *3*(02), 1250006.

Miller, D. T., & Effron, D. A. (2010). Chapter three-psychological license: When it is needed and how it functions. *Advances in experimental social psychology*, *43*, 115–155.

Neumann, L. J., & Morgenstern, O. (1947). *Theory of games and economic behavior* (Vol. 60). Princeton university press Princeton.

Pender, J. L. (1996). Discount rates and credit markets: Theory and evidence from rural india. *Journal of development Economics*, *50*(2), 257–296.

Phelps, E. S., & Pollak, R. A. (1968). On second-best national saving and game-equilibrium growth. *The Review of Economic Studies*, *35*(2), 185–199.

Prelec, D. (1998). The probability weighting function. *Econometrica*, 497–527.

Quiggin, J. (1982). A theory of anticipated utility. *Journal of Economic Behavior & Organization*, *3*(4), 323–343.

Read, D. (2001). Is time-discounting hyperbolic or subadditive? *Journal of risk and uncertainty*, *23*(1), 5–32.

Tanaka, T., Camerer, C. F., & Nguyen, Q. (2010). Risk and time preferences: Linking experimental and household survey data from vietnam. *American Economic Review*, *100*(1), 557–571.

Tiefenbeck, V., Staake, T., Roth, K., & Sachs, O. (2013). For better or for worse? empirical evidence of moral licensing in a behavioral energy conservation campaign. *Energy Policy*, *57*, 160–171.

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, *5*(4), 297–323.

Vuong, Q. H. (1989). Likelihood ratio tests for model selection and non-nested hypotheses. *Econometrica: Journal of the Econometric Society*, 307–333.

Wakker, P., Erev, I., & Weber, E. U. (1994). Comonotonic independence: The critical test between classical and rank-dependent utility theories. *Journal of Risk and Uncertainty*, *9*(3), 195–230.

Wu, G., & Gonzalez, R. (1996). Curvature of the probability weighting function. *Management science*, *42*(12), 1676–1690.

VITA

Maria Nilda Bernedo Del Carpio was born in Lima, Peru, the 31st of October 1979. She went to Alexander Von Humboldt Schule in Lima where she completed her studies in 1998.

In 1999, she started her undegraduate studies in Unversidad del Pacifico in Lima, Peru. She obtained the Bachelor in Economics in 2003. After completing her studies she worked as research assistant in the Group for the Analysis of Development (GRADE) and in the Universidad del Pacifico Research Center. In these research centers, she participated in consultancy and research projects in the topics of water, infrastructure, savings, pensions and productivity. She co-authored the book "*Free Trade Agreement with the United States: an Opportunity to Grow*". During this time, she was tutorial instructor for the 2005 Extension Course in Macroeconometrics at the Central Reserve Bank of Peru (a post-graduate course to train and screen potential bank employees) and for the undergraduate courses Principles and Intermediate Macroeconomics. In 2006 she became junior professor in Universidad Del Pacifico, teaching Principles of Microeconomics and Principles of Macroeconomics. In 2008 she completed her Master of Science in Economics in Toulouse School of Economics where she developed the thesis "*The Simplified Tax Regime and the Informal Sector in Latin American Countries*". After obtaining her Master's degree, she went back to Peru where she worked as a senior analyst in the Office of International Economy, Competition and Private Investment Affairs in the Ministry of Economy and Finance in 2009. She evaluated bills from the industrial organization perspective on behalf of the Ministry. She also combined her work at the Ministry with teaching Intermediate Microeconomics in Universidad del Pacfico and as consultant for the World Bank.

In 2010 she started her doctoral studies in the Department of Economics at Georgia State University. In addition to her dissertation work, she has published a co-authored article on the long-term effects of a behavioral "nudge" on water consumption. The article, entitled "The Persistent Impacts of Norm-Based Messaging and Their Implications for Water Conservation," appeared in the Journal of Consumer Policy in 2014. Moreover, she has co-authored a review article about the implications that recent theories and empirical evidence on risk and time preferences have for climate change adaptation behavior and policies. The article, entitled "Behavioral Economics and Climate Change Adaptation: Insights from Experimental Economics on the Role of Risk and Time preferences," will appear as a chapter in a forthcoming reference book on environmental policy in an era of global change.

Maria has been hired as assistant professor in the Department of Economics at the University of Maryland, Baltimore County, starting in the Fall 2016.