Preferences, Uncertainty, and Biases in Land Division: A Bargaining Experiment in the Field

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Abstract

Divisions of rural land in developing countries reduce the possibilities of farmers to profit from agricultural returns to scale. We design and conduct a framed bargaining experiment to study whether land overvaluation (due to affective reasons) and uncertainty in land values are drivers for land division. In our bargaining game, two players with different agricultural productivity jointly inherit a land plot and individually inherit some tokens they can use to agree on a land allocation. The possible set of land allocations and the spread of land returns vary across treatment arms in the game. We conduct this experiment with 256 participants in eight rural municipalities of the Northeast of Colombia. We find that when players are allowed to divide the land plot, 75% of the bargaining interactions yield the most egalitarian, but less efficient, land allocations. Based on the predictions of a Nash bargaining model and the observations from a sample of 120 college students, we rule out land overvaluation as a driver for land divisions in the context of our game. We also find that uncertainty in land yields reduces the efficiency of land allocations when we do not allow land divisions, by increasing the likelihood of the least productive player keeping the entire land plot. Our results are consistent with a bounded rationality rule in which subjects incorporate a behavioral response to uncertainty by first bargaining over land, which is a certain outcome, and then bargaining over a token transfer.

Keywords: land division; Nash bargaining; affective value of land; nonuse value
JEL classification: C78, C90, O13, Q15

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Preferencias, incertidumbre y sesgos en la división de tierras: experimento de negociación en campo

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Resumen

Las divisiones de tierras rurales en los países en desarrollo limitan las posibilidades de los agricultores en estos países de aprovechar economías de escala derivadas de la mecanización. Diseñamos y llevamos a cabo un experimento de negociación para explorar si la sobrevaloración de la tierra (debido a razones afectivas) y la incertidumbre sobre el valor de la tierra explican divisiones ineficientes de tierras en contextos agrícolas. En nuestro juego de negociación, dos jugadores con diferentes niveles de productividad agrícola heredan conjuntamente una parcela de tierra e individualmente heredan algunas fichas que pueden usar para acordar una repartición de la parcela. Variamos aleatoriamente, entre grupos de tratamiento en el juego, el conjunto de posibles reparticiones de la parcela y la dispersión de los retornos de la tierra. Llevamos a cabo este experimento con 256 participantes en ocho municipios rurales del nororiente de Colombia. Encontramos que cuando se permite a los jugadores dividir la parcela, el 75% de las interacciones de negociación generan las asignaciones de tierra más igualitarias, pero menos eficientes. Con base en las predicciones de un modelo de negociación de Nash y las observaciones de una muestra de 120 estudiantes universitarios, descartamos la sobrevaluación de la tierra como motor de divisiones de tierra en el contexto de nuestro juego. Por otro lado, encontramos que una mayor incertidumbre en los rendimientos de la tierra reduce la eficiencia en las asignaciones de tierra cuando eliminamos las divisiones igualitarias del conjunto de posibles reparticiones. Nuestros resultados son consistentes con una regla de racionalidad limitada en la cual los sujetos incorporan una respuesta conductual a la incertidumbre, al negociar primero sobre una asignacin de tierra, que es un resultado fijo y determinado, y luego negociar sobre una transferencia de fichas.

Palabras clave: División de tierras, negociación de Nash, valor afectivo, valor de no uso
Clasificación JEL: C78, C90, O13, Q15

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1 Introduction

Well-functioning land markets may enhance agricultural productivity by allocating land towards its more productive use and creating incentives to invest in better technologies. In developing countries, weak contract enforcement, insecure property rights, and failures in financial markets hinder the development of land sales and rental markets (Besley and Ghatak, 2010; Deininger, 2003; Macours, De Janvry and Sadoulet, 2010). In these contexts, non-market transactions of land, such as inheritances, become an important mechanism of land allocation. Despite its importance, we know little about the extent to which these non-market transactions lead to an efficient allocation of land. Several factors can influence the decisions of individuals when allocating inherited land: land productivity, the functioning of financial and input markets, individual skills and preferences, and uncertainty, among others.

We designed and conducted a framed field experiment to explore the role of preferences towards land ownership and uncertainty about the value of land in the efficiency of the allocations of inherited land. These factors can affect the allocation of inherited land for several reasons. On the one hand, in agrarian societies, land is not only the primary source of income, but it also has political and symbolic importance (Agarwal, 1994). In these contexts, land ownership provides political power and social status (Robinson and Baland, 2008; Bonnemaison, 1984; Edney, 1976; Galor, Moav and Vollrath, 2004; Selvadurai, 1976), and generates a sense of identity and rootedness (Agarwal, 1994; Stavenhagen, 2006). We refer to such attributes of land ownership, that result in land valuation beyond its productive potential, as the affective value of land, and argue these can hamper the efficiency of land allocations.

On the other hand, land valuations can entail significant levels of uncertainty in contexts with incomplete insurance and incomplete and asymmetric information about land markets. In particular, uncertainty in land valuations can result from two alternative sources. First, extreme weather variability, volatile prices, production lags, and perishable outcomes generate significant risks and uncertainty in agricultural profitability. Second, thin, informal, and segmented land markets, along with the lack of information on transactions and prices, hamper the assessment that heirs can make about the value of land. In line with previous experimental research showing that subjects opt for allocation rules that avoid uncertain outcomes (Van Dijk et al., 1999), we argue that uncertainty in land valuation can affect non-market land allocations by shaping the environmental cues employed in a bargaining context. For instance, participants may prefer to avoid uncertainty by applying bargaining rules based on land allocations, that are fixed and observable, rather than the allocation of expected rents. Thus, high uncertainty in land valuations might also favor egalitarian, but not necessarily efficient land divisions.

Testing the effect of preferences and uncertainty on land allocations with experimental data involving real land transactions would require random variations in land inheritance institutions and uncertainty in agricultural activity, which is difficult, if not impossible, to obtain. Instead, we designed a bargaining game with two players and four treatment arms, in which random variations in land division rules and payoffs variability allow us to explore behavioral factors associated with land divisions.

In our game, two players, H and L, individually inherited a token endowment e and jointly inherited a land plot formed of nine triangular tiles. Players have to bargain over a division of the land plot, in which the endowed tokens can be used. Player H is more productive with land than Player L, and therefore she has incentives to accrue a higher proportion of land, giving up some of the endowed tokens in the trade. In case of disagreement, the outside option preserves the original token endowment, gives each player four tiles, and the ninth tile of the original land plot remains unassigned. We execute the game under the conditions that Chertkoff and Esser (1976) would define as *explicit bargaining*: the two parties simultaneously communicate, either side can make provisional offers, but a provisional offer does not fix the outcomes until it is bilaterally accepted.

Given the simultaneous nature in our bargaining game, we adopt the Nash bargaining model (Nash, 1950; Roth and Malouf, 1979) to generate our benchmark predictions.[1] According to the Nash bargaining solution, it is efficient and individually rational that Player H keeps most of the land plot, giving in exchange all of her tokens to Player L. However, a positive affective value per land tile drives the bargaining outcome of the game toward more egalitarian land allocations. Whereas the spread of potential outcomes is the same within groups (i.e., for Players H and L), we introduce an exogenous variation in the uncertainty of land productivity between-treatments by doubling the spread that one half of the groups faces in the experiment. Using this variation we test whether uncertainty in land productivity affects efficiency and inequality of land allocations.

With the purpose of disentangling the effects of preferences from the effects of uncertainty on land allocations, we added a treatment variation in which land divisions are not allowed. Players H and L must bargain on who keeps the land plot in exchange of a transfer. A land division can only be attained with the disagreement outcome, which is identical to the one described above for the original paradigm. This treatment allows us to limit the use of a bargaining norm based on land division, by making egalitarian land splits very costly. The restriction of land allocations also reduces the required computations in the bargaining process. We hypothesize that, when being unable to divide the land, players are more likely to incorporate land productivity into their agreements via an acceptable transfer, and the uncertainty in land productivity reduces the chances to agree on such a transfer.

We thus have a 2×2 between-subjects design with variations in the uncertainty of land productivity in one dimension, and the set of feasible land allocations in the other dimension. We conduct our experiment in eight rural municipalities in the Northeast of Colombia, with a total of 256 participants. We split the set of participants equally into the four treatment cells, yielding four bargaining pairs per treatment per municipality.

Colombia provides an ideal setting to conduct our experiment. About 16 percent of the labor force in the country works in the agricultural sector, and the productivity of this labor force is considerably low. Value added per agricultural worker in Colombia is equivalent to only one-tenth of valued per agricultural worker in the US (Hamann et al., 2019). In addition, Colombia exhibits a combination of land inequality and land informality. The land Gini is 0.87, one of the highest in the world (Maluendas et al., 2015); and estimates of informality in property rights in the country suggest that between 40 and 50 percent of

[1]Alternative bargaining models for sequential games include fairness notions linked to distributional preferences (Bereby-Meyer and Niederle, 2005; Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999) and asymmetric information (Harrison and McCabe, 1996).

rural plots do not have a formal title (Neva, 2014). Land markets present limited dynamism and inheritances are an important mechanism of land allocation. Estimates for a sample of rural households[2] suggest that, between 2010 and 2013, only 9.1 percent of the households acquired land. Among those, 43 percent inherited it and 48 percent purchased it. Moreover, about 95 percent of the land purchases took place between friends or family members (Ibáñez and Montenegro-Helfer, 2014). Small farms prevail in Colombia, with about 64 percent of the farms operating in less than 4 hectares of land, and 40 percent in less than 1 hectare.[3] Moreover, the dynamics of land distribution in the country exhibit a tendency towards land subdivision. Official estimates suggest a yearly fragmentation rate of about 11 percent among rural land. About 71 percent of these divisions take place in plots with less than one hectare (Maluendas et al., 2015). This tendency towards land subdivision is not a special case of Colombia. The average farm size decreased in developing counties in the last century, while it substantially increased in developed nations (Lowder, Skoet and Raney, 2016).[4] To the extent that mechanization can improve agricultural productivity and generate economies of scale (Foster and Rosenzweig, 2017), the evidence of land subdivision suggests that developing countries might be moving away from making profitable use of large mechanized farms.

Our framed lab-in-the-field bargaining game shows the strong persistence of inefficient land divisions. We find that the most egalitarian land divisions account for 75% (48/64) of the observed outcomes in the *Unconstrained* condition. This result goes in contrast with results from recent bargaining experiments conducted in the lab, in which subjects avoid payoff-equalizing outcomes that are Pareto inefficient (Galeotti, Montero and Poulsen, 2018). Among these 48 cases, Player H keeps 5 tiles 65% of the times. Moreover, Player H keeps the entire land plot, the most efficient outcome, only 11% of the cases. These results are consistent with a Nash bargaining model in which players over-value land tiles. Nonetheless, the results from the *Constrained* condition impose an additional challenge for its interpretation in light of this theoretical framework. The model predicts that when players are only allowed to agree on extreme allocations of the land plot, land overvaluation makes them remain in disagreement and receive four tiles, even if the ninth tile is lost. In stark contrast with these predictions, we observe a single disagreement in 64 bargaining pairs. Moreover, among the observed agreements under this *Constrained* condition, in 31% of the cases Player L keeps the land plot. This behavior is particularly pronounced with *High Uncertainty*, where the probability that Player L keeps the land plot increases in 22 percentage points. We find that higher uncertainty in land productivity reduces efficiency of land allocations, but only when land divisions are not allowed. When divisions are allowed, egalitarian allocations dominate even in the *High uncertainty* condition.

Land overvaluation and uncertainty alone are insufficient to explain our experimental results. Hence, we proposed an alternative mechanism for land division inspired in a bounded rationality rule: players transform the bidimensional bargaining problem, in which they have

[2]The sample corresponds the the households included in the Longitudinal Survey of Universidad de los Andes (ELCA) in four regions of Colombia

[3]Own calculations based on Tercer Censo Nacional Agropecuario, 2014.

[4]This is consistent with the argument that land tenure goes from maintaining a social and political order and guaranteeing survival in agrarian societies, to allowing for productivity increases that release labor in industrialized societies (Kuhnen, 1988).

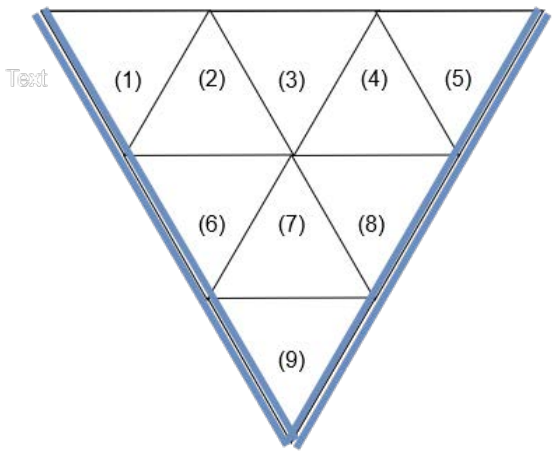
to choose simultaneously the land allocation and the transfer of tokens, into two sequential uni-dimensional bargaining problems. First they solve the land allocation problem. The Nash bargaining solution of this problem predicts that either Player H or L will keep five land tiles, depending on their relative bargaining abilities. Second, players take the land allocation as given to find an acceptable transfer. This mechanism can be consistent with the behavioral response to uncertainty in which players avoid bargaining over unknown outcomes by first allocating land, which is fixed and observable. This mechanism can also be adapted to explain the observed lack of disagreements.

We provide further evidence in favor of the bounded rationality rule, relative to the affective value of land in our experimental context, by replicating the experiment with a sample of college students. If preferences for land were the main driver of land division, students should reach more efficient agreements, as we expect these preferences to be less salient than in the rural sample. By contrast, there are no reasons to think that the bounded rationality rule affects individual choices heterogeneously across populations. Thus, one would expect the distribution of land allocations in the sample of students to be similar to the distribution of land allocations in the rural sample, if bounded rationality is the main mechanism driving land allocation in both populations. We replicate the experiment with students from the main public university of the largest city in the region. Supporting the use of the bounded rationality rule, we find that egalitarian land divisions account for 77.5% (31/40) of the observed outcomes.

Our experimental paradigm dwells in the middle of two types of bargaining experiments outside the laboratory. On the one hand, the controlled and neutrally framed use of the ultimatum game to study cross-cultural differences in fairness norms (Henrich et al., 2001, 2004). On the other hand, field experiments creating a "natural" bargaining situation between the provider of a service and an experimenter in the role of customer (Castillo et al., 2013; Michelitch, 2015). Our bargaining game is highly framed compared to an ultimatum game, with the purpose of inviting participants to bring into the game elements from their experiences and context, which are of particular relevance given our focus in the affective valuation of land (Cárdenas and Ostrom, 2004).

Our paper contributes to the literature exploring efficiency in land allocations and agricultural productivity. This literature has attributed the low levels of agricultural productivity in developing countries to policies and institutions that generate distortions in the allocation of land across heterogeneous agents (Adamopoulos and Restuccia, 2014; Restuccia and Santaeulalia-Llopis, 2017; Macours, De Janvry and Sadoulet, 2010). We explore an alternative source of land misallocation related to preferences, their relationship with environmental uncertainty, and bargaining patterns influenced by bounded rationality. Closely related to our paper, Bryan et al. (2017) implement a lab-in-the-field experiment to test a market mechanism allowing farmers to "defragment" their farms (*i.e.*, reallocate ownership in favor of adjacent land plots), an adaptation to the house reallocation problem in Goeree and Lindsay (2012). Despite the complexity of the mechanism, they show that Kenyan farmers achieved higher efficiency levels in the experiment. This study, and our study, represent complementary efforts to bring lab-in-the-field methods to the domain of land ownership in developing countries. Whereas Bryan et al. (2017) employ mechanism design to improve the efficiency in land markets, we study losses of efficiency related to prevailing non-market mechanisms of land allocation.

Figure 1: Plot configuration in the bargaining game.



Note: Tiles numbered (1), (5), (6), (8) and (9) are irrigated. To understand the additional costs created by *border tiles* suppose an agreement in which H keeps plots (1) to (6), and L keeps plots (7) to (9). In this example, player H will own two border tiles, (4) and (6), and player L will own another two border tiles, (7) and (8).

The remainder of this paper is structured as follows. Section 2 introduces the land division game and the Nash bargaining model with an affective value for land tiles. Section 3 presents the experimental design and the corresponding hypotheses, as well as a description of the field setting and the timing of the land division game. Section 4 reports the results for observed land divisions, efficiency and inequality, and an exploratory analysis using the information from the post-experimental survey. In Section 5, we discuss the experimental results in light of our Nash bargaining model and alternative predictions. Section 6 concludes.

2 The Land Division Bargaining Game

2.1 Game Setting

2.1.1 The plot to be divided and the benefits of accruing land

Two players H and L are jointly endowed with a triangular-shaped plot divided in nine smaller triangular tiles of the same size, as shown in Figure 1. Each player also received an endowment of e tokens. Players can use any amount of tokens as part of a proposal regarding how to allocate the land plot. A proposal $\phi_i([\ell_H : \ell_L], T)$ made by player i, is defined by a land division $[\ell_H : \ell_L]$ (*i.e.*, how many tiles are kept by players H and L, respectively) and a monetary transfer $T \in \{-e, \ldots, e\}$. Positive transfers ($T > 0$) represent a transfer from H to L, whereas negative transfers ($T < 0$) represent a transfer from L to H.

Both players have incentives to accumulate land tiles. At the end of the game, each tile kept by a player will grant her a die roll whose outcome dictates the agricultural production in that tile. Production per tile is uncertain, with three equiprobable outcomes y_i^+, y_i^0 and

y_i^- for player $i \in \{H, L\}$.

We assume that player H is more productive with land than player L. Although both players benefit from accruing tiles, player H has a higher valuation per tile given her productivity. The yield per tile of player H statewise dominates the yield per tile of player L. In particular, we set $y_i = E[y_i] + \kappa$, with $E[y_H] > E[y_L]$ and $\kappa \in \{-k, 0, k\}$. The expected yield of both players, $E[y_H]$ and $E[y_L]$, as well as the spread in their outcomes k are common knowledge: both players know how many dice will roll themselves and their group mate, and they are aware of the dice differences. However, they cannot observe the dice outcome of the other player.[5]

2.1.2 Costs

Players H and L face two costs in this game: border costs and irrigation costs. The border costs arise from any *border tile* resulting from the land division. A border tile marks the boundary between two tiles owned by different players (see an example in the note of Figure 1). Any border tile generates an additional cost c_B to both players. Notice that border tiles affect efficiency in two different ways. The first, and more obvious one, is that if one player keeps the entire land plot there would not be border tiles. Second, players aiming to minimize border costs should avoid land configurations with non-contiguous plots. This allow us to focus on the land division problem, in which inefficiency arises from splitting the plot into smaller parcels; leaving aside the land fragmentation problem, in which inefficiency arises from owning non-contiguous plots.

Irrigation costs emerge from land tiles that do not share a side with any of the two thick double lines in the left and right sides of the plot in Figure 1. These lines represent a water stream flowing through some of the land plot borders. Each non-irrigated tile, numbered (1), (2), (3) and (7) in Figure 1, generates an additional cost c_I to the owner of that particular tile. For the remaining tiles, which are irrigated, this cost is zero. The reason to add the irrigation costs is twofold. First, to reduce the abstractness of the game, providing a more familiar framing for rural participants in the experiment. Second, to blurry the focal points in the allocation of land.

2.1.3 Bargaining process and the disagreement outcome

Players H and L enter into an explicit bargaining situation (Chertkoff and Esser, 1976) for t minutes. When the time is over, or if they reached a verbal agreement before the time limit, player H makes a written proposal $\phi_H([\ell_H : \ell_L], T)$ to player L. Player L can accept the proposal, or make a take-it-or-leave-it counterproposal $\phi_L([\ell_H : \ell_L], T)$. If player H rejects the counterproposal, the following disagreement outcome is implemented: each player keeps her endowment e, player H keeps tiles (1), (2), (3) and (6); player L keeps tiles (4), (5), (7) and (8); and tile (9) is lost (see Figures 1 and A1.5). The disagreement outcome grants an egalitarian allocation of irrigated tiles, non-irrigated tiles and border tiles. Nonetheless, the differences in land productivity grants a higher expected payoff for Player H.

[5] This is equivalent to implement a prospective profit-sharing agreement. For a comparison between prospective and retrospective sharing agreements in a bargaining context see Baranski (2018).

Table 1: Costs from non-irrigated tiles and border tiles for each land division $[\ell_H : \ell_L]$

Land Division	[9:0]	[8:1]	[7:2]	[6:3]*	[5:4]*	[4:5]*	[3:6]*	[2:7]	[1:8]	[0:9]	[4:4]
Player H											
C_I	4	4	3	2(3)	2(3)	2(1)	2(1)	1	0	0	2
C_B	0	1	2	2	2	2	2	2	1	0	2
$\boldsymbol{C}$	4	5	5	4(5)	4(5)	4(3)	4(3)	3	1	0	4
Player L											
C_I	0	0	1	2(1)	2(1)	2(3)	2(3)	3	4	4	2
C_B	0	1	2	2	2	2	2	2	1	0	2
$\boldsymbol{C}$	0	1	3	4(3)	4(3)	4(5)	4(5)	5	5	4	4

Note: The [4:4] allocation corresponds to the disagreement outcome. Land divisions marked with an asterisk (*) have two possible configurations for irrigated and non-irrigated tiles. In these cases, we report outside the parentheses the costs when each player keeps two non-irrigated tiles. We report inside the parentheses the costs for the unique alternative land configuration.

2.1.4 Expected payoffs

We denote by v^H and v^L the expected payoffs for players H and L, respectively, in the case they reach an agreement. These payoffs are shown in Equations 1 and 2. Benefits are given by the endowed tokens and the total expected yield, $\ell_i E[y_i]$. Costs $C_B(\ell_i)$ and $C_I(\ell_i)$, are given by the number of border tiles and non-irrigated tiles. Note that the transfer T differs in the sign for Players H and L because a positive T means that H transfers tokens to L. We write both equations in terms of ℓ_H, the tiles kept by player H in case of agreement.

$$v^H = e - T + \ell_H E[y_H] - C_I(\ell_H) - C_B(\ell_H) \tag{1}$$

$$v^L = e + T + (9 - \ell_H)E[y_L] - C_I(9 - \ell_H) - C_B(9 - \ell_H) \tag{2}$$

Similarly, we denote the disagreement values by d^H and d^L. Under the disagreement outcome each player keeps four tiles and the transfer is null ($T = 0$). The expected payoffs in this case are shown in Equations 3 and 4.

$$d^H = e + 4E[y_H] - C_I(4) - C_B(4) \tag{3}$$

$$d^L = e + 4E[y_L] - C_I(4) - C_B(4) \tag{4}$$

2.1.5 Game Parameterization

Each player receives $e = 10$ tokens at the beginning of the game. We implemented differences in land productivity by setting $E[y_H] = 4$ and $E[y_L] = 3$. The spread of dice outcomes, κ, differs between treatments. Since this spread does not directly affect payoffs, we postpone the details to Section 3. Border costs and irrigation costs were set at 1. Since the total costs generated by borders and non-irrigated tiles depend on the land configuration, we provide this information in Table 1 for every potential land allocation $[\ell_H : \ell_L]$.

2.2 The Nash Bargaining Solution

Given the simultaneous nature of our bargaining problem, our baseline predictions tell us how players H and L share the surplus that they can generate with respect to the disagreement outcome. Hence, they jointly maximize the gains from reaching an agreement superior to the disagreement value, $(v^i - d^i)$; satisfying that $v^H > d^H$ and $v^L > d^L$. Players H and L solve the following problem:

$$\max_{(\ell_H, T)} \left(v^H(\ell_H, T) - d^H(\ell_H, T)\right)^p \times \left(v^L(\ell_H, T) - d^L(\ell_H, T)\right)^{2-p} \tag{5}$$
$$\textit{subject to}$$
$$T \in \{-10, \dots, 10\}$$
$$\ell_H = \{0, \dots, 9\}$$
$$v^i(\ell_H, T) - d^i \geq 0 \;\; \textit{for} \;\; i = \{H, L\}$$

Where the parameter $p \in (0, 2)$ represents the differential bargaining ability of players H and L. A large p implies that the bargaining outcome gives more weight to the surplus obtained by Player H. Conversely, a small p assigns more weight to the surplus obtained by Player L. Replacing the agreement and disagreement values from equations (1) to (4) in (5) we obtain:

$$\max_{(\ell_H, T)} [-T + (\ell_H - 4)(E[y_H]) - (\boldsymbol{C}(\ell_H) - \boldsymbol{C}(4))]^p \times \tag{6}$$
$$[T + (5 - \ell_H)(E[y_L]) - (\boldsymbol{C}(9 - \ell_H) - \boldsymbol{C}(4)))]^{2-p} \tag{7}$$
$$\textit{subject to}$$
$$T \in \{-10, \dots, 10\}$$
$$\ell_H = \{0, \dots, 9\}$$
$$v^i(\ell_H, T) - d^i \geq 0 \;\; \textit{for} \;\; i = \{H, L\},$$

where $\boldsymbol{C}(\ell_i) = C_B(\ell_i) + C_I(\ell_i)$. That is, we add the costs from border tiles and non-irrigated tiles, yielding a single parameter capturing total costs, $\boldsymbol{C}$, that depends on the total number of accrued land tiles.

Finally, after substituting the value of the parameters in our game, the Nash bargaining solution is given by the maximization of

$$\max_{(\ell_H, T)} (-T + 4\ell_H - 12 - \boldsymbol{C}(\ell_H))^p \, (T - 3\ell_H + 19 - \boldsymbol{C}(9 - \ell_H))^{2-p} \tag{8}$$
$$\textit{subject to}$$
$$T \in \{-10, \dots, 10\}$$
$$\ell_H = \{0, \dots, 9\}$$
$$v^i(\ell_H, T) - d^i \geq 0 \;\; \textit{for} \;\; i = \{H, L\}$$

We show in Appendix A.1 that the solutions to this maximization problem, with symmetric bargaining power ($p = 1$), are the land allocations [9:0] and [8:1], with an accompanying transfer $T^* = 10$. Intuitively, the total surplus is maximized when Player H keeps the whole land plot. To transform this efficient outcome into an agreement[6], Player H must make a sufficiently large transfer to Player L. The transfer of the whole endowment is sufficiently attractive for Player L to compensate the 4 foregone tiles obtained under the disagreement outcome.

The multiplicity of equilibria disappears with asymmetric bargaining power. In the appendix we show that when $p > 1$, Player H accrues in equilibrium 9 land tiles with a transfer $T^* = \{9, 10\}$. Whereas when $p < 1$, Player H accrues in equilibrium between 8 and 7 land tiles with an optimal transfer $T^* = 10$. The multiplicity of equilibria depending on the values of p is a minor concern in our analysis. As we will see in the next subsection, our main concern is associated with the emergence of more egalitarian land allocations (i.e., $\ell_H \leq 5$) and the potential mechanisms explaining those allocations.

2.3 Deviations from the efficient allocation of land

In this section we focus on the mechanisms that we highlight in this paper as potential drivers of land division: an overvaluation of land tiles beyond its expected productivity, environmental uncertainty about the monetary value of the land, and the use of a bounded rationality rule in the bargaining process. In the next section, we discuss alternative mechanisms, including concerns about payoffs inequality, the existence of focal points, and credit constraints.

2.3.1 Overvaluation of land tiles

Suppose that Players H and L value each land tile according to its expected productivity $E[y_i]$, plus an additional valuation μ. If land tiles are valued above their productivity potential, then the amount of tokens requested to forego one tile will increase. If both players care about the land for reasons that are not related to its productive potential, they will try to accrue more land tiles. If this is true, Player L would demand more tokens per each foregone tile, limiting the tiles that Player H can afford "buying". The resulting bargaining outcome entails more egalitarian, but less efficient, land divisions.

We show in Appendix A.1 that adding μ to the agreement and disagreement values, v^i and d_i, leads to more egalitarian land allocations. For any $p \geq 1$, as μ increases the solution approaches to [5:4]. If $p < 1$, and μ is sufficiently large, the allocation [4:5] becomes the solution of the Nash bargaining problem.[7] In general, as μ becomes larger, every solution must satisfy that each player keeps at least 4 tiles, which is the amount of tiles received by each player in the disagreement outcome. An important implication is that, regardless of the combination of p and μ, one would never observe a land allocation in which Player H keeps three tiles or less.

[6] Throughout the paper we refer to [9:0] as the efficient outcome, since it minimizes production costs and maximizes the expected total yield of the land plot.

[7] The required parameters are, however, extreme. Some examples are: $p = 0.5$ and $\mu = 13.5$, $p = 0.25$ and $\mu = 10$, $p = 0.05$ and $\mu = 8$.

Now that we have covered the theoretical implications of valuing a land tile by an amount μ above its productivity, we aim to discuss potential reasons for $\mu > 0$. The most evident cause is the affective value that subjects may give to land. As discussed in the introductory section, land tenure is associated with political power, social status, identity and rootedness to the territory. A second cause for $\mu > 0$ could be the endowment effect (Kahneman, Knetsch and Thaler, 1991). The implemented land allocation in the disagreement outcome, [4:4], might create a reference point that increases the value of each foregone land tile by μ units.

An implicit assumption of the model with overvaluation is that μ is symmetric and observable. However, additional simulations reveal that replacing the symmetry assumption by $\mu_1 = \lambda\mu_2$ leads to the same qualitative predictions: as μ_1 increases, the solution approaches to [5:4] or [4:5], depending on whether p is larger or smaller than 1. Regarding public observability of μ, one might plausibly assume that in land division problems derived from inheritances, siblings can infer correctly the affective valuation of land from each other.

2.3.2 Environmental uncertainty and valuation of land tiles

We argue that uncertainty can affect land allocations through a "behavioral" mechanism in which subjects avoid bargaining over unknown outcomes and rely on variables that entail less uncertainty. This potential mechanism is based on the evidence from bargaining games and social dilemmas showing that subjects prefer to use information they are certain about (Van Dijk et al., 1999; Roth and Malouf, 1979). In the context of our game, this behavioral pattern implies that subjects might opt to bargain over land tiles, which are observable and not subject to uncertainty, leaving aside a discussion centered on expected earnings.

Uncertainty in productivity might drive the discussion away from land valuations based on expected outcomes, creating a "shortcut" to focus the bargaining on land division. We discuss below how this mechanism could operate under a bounded rationality rule, in which subjects bargain first over land allocations, possibly in response to uncertainty, and then solve the monetary compensation problem taking land allocations as given. We show that when this is the case, egalitarian land allocations emerge as a Nash bargaining outcome.

Risk aversion is an alternative mechanism through which uncertainty can affect the efficiency of land allocations. In Section 3.2.4, we discuss why in the context of our game the role of risk aversion is likely to be of secondary order of importance.

2.3.3 Bounded rationality: from bidimensional to unidimensional sequential bargaining

Our bargaining game might be cognitively demanding because Players H and L are simultaneously solving a land allocation problem, in which they choose $[\ell_H : \ell_L]$; and a compensation problem, in which they define an acceptable transfer that depends on the land allocation, $T(\ell_H)$. We argue that players may transform this bidimensional bargaining problem into two uni-dimensional bargaining problems. First they focus on the land allocation problem. That is, they agree on how to allocate the extra tile that will be lost in the disagreement outcome. This first problem yields a land allocation $[\ell_H^* : \ell_L^*]$. Second, they take $[\ell_H^* : \ell_L^*]$ as given and focus on the expected productivity of land tiles to find an acceptable transfer T^*, under the threat of the original disagreement outcome ([4:4] and $T = 0$).

To illustrate how the bargaining process described above might alter the predictions with respect to the bidimensional problem, imagine that T is no longer part of the maximization problem described in Equation 5. The agreement values for Players H and L become $v^H = \ell_H$ and $v^L = 9 - \ell_H$, respectively. The disagreement values, on the other hand, are $d^H = d^L = 4$. The Nash bargaining solution of a game giving a weight p to the gains of Player H and a weight $q = 2 - p$ to the gains of Player L corresponds to the maximization of the expression

$$\max_{\ell_H} [\ell_H - 4]^p \left[(9 - \ell_H) - 4\right]^{2-p} \quad \textit{subject to} \quad \ell_H \in \{0, \dots, 9\}$$

The first order condition with respect to ℓ_H yields:

$$\ell_H^* = (p)[\ell_H - 4]^{p-1} \left[5 - \ell_H\right]^{2-p} + [\ell_H - 4]^p \, (2 - p)[5 - \ell_H]^{1-p}$$

The solution of this modified version of the Nash bargaining game yields two predictions[8] with integer values for ℓ_H: [5:4] and [4:5].

We start by finding T when we take the [5:4] allocation as given. We will call this solution $T^*_{5:4}$. Equation 8 becomes:

$$\max_{T} (4 - T)^p \times T^{2-p} \quad \textit{subject to} \quad T \in \{-10, \dots, 10\}$$

Which yields $T^*_{5:4} = 2(2-p)$. Hence, the transfer $T^*_{5:4}$ will lie between 0, when p approaches 2 and Player H has full bargaining power; and 4, when p approaches 0 and Player L has full bargaining power.

Alternatively, if we take the [4:5] allocation as given, Equation 8 becomes:

$$\max_{T} (-T)^p \times (3 + T)^{2-p} \quad \textit{subject to} \quad T \in \{-10, \dots, 10\}$$

When Player L keeps the additional tile the solution is $T^*_{4:5} = -3p/2$. The transfer $T^*_{4:5}$ will lie between 0 (when p approaches 0) and -3 (when p approaches 2). Remember that a negative T means a token transfer from Player L to Player H.[9]

The two-step unidimensional Nash bargaining framework that we presented here predicts egalitarian land allocations. Subjects may follow this pattern of behavior due to bounded rationality: simultaneously choosing a land allocation and a transfer of tokens can be cognitively demanding. Affective values of land and preferences against bargaining over uncertain outcomes can induce subjects to solve the land allocation problem first.

[8]A third prediction, not implementable since tiles are not divisible, is [4+$\frac{p}{2}$: 5-$\frac{p}{2}$]. For extreme values of p, 0 and 2, this outcome coincides with the two solutions described in the main text.

[9]Note that the maximum transfer in $T^*_{5:4}$, 4 tokens, is the expected tile productivity for Player H. Analogously, the maximum transfer in $T^*_{4:5}$, 3 tokens, is the expected tile productivity for Player L. In other words, under the scenario in which land allocation is bargained first, and the transfer T is decided in a second bargaining stage, players will compensate the additional tile they kept with at most the expected benefits of the additional die roll.

3 Experiment

We introduce two variations in our land division game that allow us to exogenously manipulate the set of possible land divisions and the variability in productivity per tile. We describe these variations as follows:

1. **Constrained Land Divisions:** Two treatment arms differ in the set of possible allocations of land. In the *Unconstrained* treatment, we allow players to choose any allocation $[\ell_H : \ell_L]$ with $\ell_H + \ell_L = 9$. In the *Constrained* treatment we restrict possible land allocations to one player keeping the whole land plot, thus only the [9:0] and [0:9] allocations are allowed. The set of possible transfers $T \in \{-10, \ldots, 10\}$ and the disagreement outcome are identical across treatments.

2. **Uncertainty in Land Productivity:** Player i's expected yield is given by $y_i = E[y_i] + \kappa$, with $\kappa \in \{-k, 0, k\}$. We have $k = 2$ in the *High Uncertainty* treatment, and $k = 1$ in the *Low Uncertainty* treatment. Given $E[y_H] = 4$, Player H's equiprobable outcomes are 2, 4 and 6 with *High Uncertainty*; and 3, 4 and 5 with *Low Uncertainty.* Similarly, given $E[y_L] = 3$, we have that Player L's equiprobable outcomes are 1, 3 and 5 with *High Uncertainty*; and 2, 3, and 4 with *Low Uncertainty.*

3.1 Hypotheses

In this section we present our four hypotheses and their connection with the preferences (*i.e.*, affective value of land) and the uncertainty mechanisms of land divisions. As we mentioned earlier, the bounded rationality rule emerged as an ex-post explanation to the observed outcomes.

Our first hypothesis tests whether we observe systematic deviations from the efficient allocation [9:0] when we allow land divisions:

Hypothesis 1 (H1): *In the **Unconstrained** condition, agreements deviate from the efficient land allocation, [9:0].*

Our second hypothesis validates the potential overvaluation of land by comparing land allocations between the *Unconstrained* and *Constrained* conditions. In the Appendix A.1, we show that under the Nash bargaining framework, if tile overvaluation μ is sufficiently large to induce an egalitarian land allocation when land divisions are allowed, then in the *Constrained* condition, Players H and L should prefer to keep four tiles each under the disagreement outcome, rather than any agreement in which the entire land plot is kept by their counterpart. Thus, if the affective value of land explains failures to reject H1, then the following hypothesis most hold,

Hypothesis 2 (H2): *Disagreement outcomes are more frequent in the **Constrained** condition than in the **Unconstrained** condition.*

Our third hypothesis explores the effects of environmental uncertainty on the efficiency of land allocations. As explained above, we argue that *High Uncertainty* decreases the efficiency of the bargaining outcomes, with respect to *Low Uncertainty*, because Players H and L respond to uncertainty by bargaining over land tiles, which are not subject to uncertainty, rather than bargaining over uncertain expected earnings (Roth and Malouf, 1979; Van Dijk et al., 1999).

Hypothesis 3 (H3): *The observed efficiency is higher in the **Low Uncertainty** condition than in the **High Uncertainty** condition.*

Finally, we also hypothesize that there is an interaction effect between our treatment arms. More specifically, the differences between the *High* and *Low Uncertainty* conditions might be more pronounced when land divisions are *Constrained*. This could happen because when the only possible land allocations are [9:0] and [0:9], the difference in total expected payoffs between scenarios becomes more salient, raising efficiency concerns. However, the uncertainty can make this difference less evident, given the difficulties in expected payoffs computations, driving the bargaining problem away from variables related to efficiency.

Hypothesis 4 (H4): *The difference in efficiency between the **High** and **Low Uncertainty** conditions is greater in the **Constrained** condition.*

3.2 Alternative Explanations for Land Division

We discussed so far three mechanisms that might explain egalitarian land divisions: preferences (distorting the tile valuation), uncertainty (in productivity tiles), and bounded rationality rules simplifying the bargaining process. In this section we present potential alternative explanations for land divisions, and discuss the extent and limitations of our experimental design to rule out these additional explanations.

3.2.1 Concerns about payoffs' inequality

The Nash bargaining solution maximizes the surplus to be divided between Players H and L. However, the [9:0] allocation, even if Player H transfers all her tokens to Player L ($T^* = 10$), generates a difference in expected payoffs of 12 tokens,[10] much larger than the expected difference of 4 tokens under the disagreement outcome. An alternative solution concept, the bargaining egalitarian solution (Thomson, 1987), preserves the difference in expected payoffs that would have been obtained under the disagreement outcome. This solution will be given by:

$$v^H(\ell_H, T) - d^H(\ell_H, T) = v^L(\ell_H, T) - d^L(\ell_H, T)$$

Using equations 1 to 4, with our parameterization yields:

$$\hat{T} = \frac{7\ell_H - 31 - (\boldsymbol{C}(\ell_H) - \boldsymbol{C}(9 - \ell_H))}{2},$$

where $\hat{T}$ is the transfer associated to the egalitarian bargaining solution.

[10] The expected payoff for player H is 32 tokens, which corresponds to the expected yield from the nine tiles, $9 \times E[y_H] = 36$, minus the costs from non-irrigated tiles, $\boldsymbol{C}(9) = 4$. Player L receives 20 tokens with certainty, which corresponds to her original endowment plus $T^* = 10$.

Table 2: Expected outcomes under the egalitarian bargaining solution

Land division	[9:0]	[8:1]	**[7:2]**	[6:3]*	[5:4]*	[4:5]*	[3:6]*	[2:7]	[1:8]	[0:9]	[4:4]
$v^H(\hat{T}) - v^L(\hat{T})$	-	-	4	4	4	4	4	4	4	-	
$v^H(\hat{T}) + v^L(\hat{T})$	52	49	46	45	44	43	42	41	42	43	40
$v^H(\hat{T})$	28	26.5	25	24.5	24	23.5	23	22.5	23	23.5	22
$v^L(\hat{T})$	24	22.5	21	20.5	20	19.5	19	18.5	19	19.5	18
$\hat{T}$	14	10.5	**8**	5.5(4.5)	2(1)	-1.5(-0.5)	-5(-4)	-7.5	-10	-13.5	
$(\boldsymbol{C}(\ell_H) + \boldsymbol{C}(9 - \ell_H))$	4	6	8	8	8	8	8	8	6	4	8
$(\boldsymbol{C}(\ell_H) - \boldsymbol{C}(9 - \ell_H))$	4	4	2	0(2)	0(2)	0(-2)	0(-2)	-2	-4	-4	0

Note: The [4:4] allocation corresponds to the disagreement outcome. Land divisions marked with an asterisk (*) have two possible configurations for non-irrigated tiles. In these cases, we report outside the parentheses the costs when each player keeps two non-irrigated tiles. We report inside the parentheses the costs for the unique alternative land configuration.

Multiple combinations of $(\ell_H, \hat{T})$ yield agreements in which the difference in payoffs between H and L is 4 tokens, the same difference that holds in the disagreement outcome. Table 2 shows that $\hat{T}$ exists for every land allocation in which $\ell_H \in \{1, \ldots, 7\}$.[11] If players not only care about minimizing differences in expected payoffs, but also about the expected efficiency $v^H(\hat{T}) + v^L(\hat{T})$, then the solution can be refined to [7:2] and $\hat{T} = 8$. Moreover, Players H and L can set the difference in expected payoffs equal to zero by increasing the transfer to $T = 10$. Therefore, the trade-off between efficiency and expected inequality no longer exists for any agreement in which Player H keeps less than 7 tiles.

We are aware that the computation of the egalitarian bargaining solution that maximizes the surplus is not straightforward. Therefore, one could argue that subjects concerned by payoffs inequality could select [5:4] as their preferred outcome. In particular because the "efficiency penalty" caused by moving from the [7:2] to the [5:4] land allocation is 2 tokens. However, the transfer under the egalitarian bargaining solution that corresponds to the [5:4] allocation is of 2 (rather than 8) tokens. In Section 4 we test if the observed combinations of transfers and land allocations are consistent with an inequality minimizing behavior.

3.2.2 Focal Points

The existence of focal points could also explain egalitarian land divisions (Murnighan, Roth and Schoumaker, 1988). Our experimental design has two features to minimize the role of focal points. First, 50-50 land splits are not possible since the plot has 9 tiles. Even if [5:4] and [4:5] are the closest divisions to a 50-50 split, the decision on whether to keep either 2 or 3 irrigated tiles reduces the salience of a particular land allocation as being focal.

Tables 1 and 2 show that, for allocations in which one player accrues at most six tiles, there are two potential configurations for irrigated and non-irrigated tiles for each land allocation. Costly border tiles create an incentives to accrue contiguous land tiles, making any other land configuration (*i.e.*, with non-contiguous owned tiles) more inefficient. Table 2 also reveals that the unique alternative configuration of irrigated and non-irrigated tiles does

[11]If we also restrict $\hat{T}$ to be an integer, then land allocations guaranteeing $v^H(\hat{T}) - v^L(\hat{T}) = 4$ are limited to $\ell_H \in \{1, 3, 5, 7\}$.

not change the agreement values, v^H and v^L. The explanation is that accruing an additional non-irrigated tile, instead of an irrigated tile, can be compensated with the reduction of the transfer T in 1 token, corresponding to the additional irrigation cost.

Apart from reducing the salience of focal points, the use of this framing invites participants to bring into the bargaining game elements from their experiences and context and ease the understanding of the game rules (Alekseev, Charness and Gneezy, 2017; Cárdenas and Ostrom, 2004). We argue that these benefits exceed the costs of the additional outcomes to be considered in the analysis, which might affect inequality but not efficiency, the main outcome of interest in this study.

3.2.3 Credit constraints

Credit constraints can increase land divisions in developing countries (Mearns, 1999). Even if one of the bargaining parties might accept a monetary transfer in exchange for letting the other party keep the majority of (or all) the plot, credit constraints can make this agreements unattainable. Thus, it would be possible that the constrained player can only "afford" a more egalitarian land allocation than the desired one (see in Table 2 how the transfers become smaller for more egalitarian land divisions).

We acknowledge the importance of credit constraints to explain land divisions. Nonetheless, a caveat from our experiment is that is not appropriate for capturing such effects. In our pilot study we tested a treatment variation in which only half of the endowment (*i.e.*, $e/2 = 5$ tokens) could be part of an agreement. The results from out pilot study, explained in depth in Appendix A.2, reveal a strong tendency to agree on egalitarian land divisions accompanied by small transfers, which made the credit constraint not binding. Bearing the bi-dimensional nature of the bargaining game in mind, this null result motivated us to constrain land allocations instead of transfers, giving origin to the *Constrained* and *Unconstrained* conditions.

3.2.4 Risk aversion

In the Nash bargaining framework the role of risk aversion will depend on which player is the most risk averse, and on whether there is an overlap in the support of the agreement and disagreement payoffs. Roth and Rothblum (1982) show that the most risk averse player is in an advantageous position to bargain if one of the potential outcomes in the agreement payoff yields a worst outcome than the disagreement payoff. For some intuition, think that the most risk averse player's utility will be more affected by the deviations from the expected payoff. Hence, her valuation of the surplus from reaching an agreement is reduced, and her bargaining position improved, when the support of the agreement value includes worse outcomes than a disagreement value subject to less variations. However, Safra, Zhou and Zilcha (1990) argue that this result might be reversed if the disagreement outcome is uncertain and its support contains worse outcomes than the "worst-case scenario" within the agreement.

We argue that, since the theoretical predictions for the role of risk aversion depend on which player is the most risk averse (rather than on the risk aversion of each player), the random assignment to the roles of Players H and L within each bargaining pair partials out any potential role of uncertainty through the curvatures of the subjects' utility function.

3.3 Field Setting

3.3.1 Field Site and Recruitment

We conducted the experiment between September and November 2018 in eight rural municipalities from the *Departamentos* of Santander and Norte de Santander in Colombia. We selected the municipalities in the sample with the purpose of providing variation in market access, the share of rural population, and agroclimatic conditions. Table A.1 presents some characteristics of the municipalities in the sample. Total population varies from almost 100,000 inhabitants in the largest municipality, to 2,000 in the smallest one. The share of rural population in these municipalities varies between 85% and 9%. Average driving time from each municipality to the closest city is about 2.24 ± 1.23 hours, and there is significant variation in the type of city that is closest to each municipality. Four out of the eight municipalities have as nearest city Bucaramanga, where one of the authors of this study is based. With about one million inhabitants in its metropolitan area, Bucaramanga is considered an important outlet for agricultural products. The rest of the municipalities are closer to slightly smaller cities such as Cúcuta and Tunja, with a population of 195,538 and 662,673, respectively. The diverse topology of Colombia provides us with significant variation in the type of agriculture across the municipalities in the sample. The largest shares of planted areas in six out of the eight municipalities correspond to crops usually produced in small farms, such as potato, tomato, coffee, cocoa, and sugar cane for *panela* production. In the remaining two municipalities, African palm, a crop with significant economies of scale in its production process, has the largest shares of planted area.

The experiment was conducted during the weekends, when rural population congregates in local market areas. There was a unique field coordinator in the eight municipalities, but there were six different companion field assistants. One assistant traveled with the field coordinator to each municipality. Either the field coordinator or the assistant were acquainted with the area before the visit. A local person was hired in each municipality to provide aid with the recruitment.

Unlike most lab in the field experiments, selection bias driven by the relatedness or closeness of participants is a minor concern in our study. In general, one would be concerned about post-experimental transfers, which are more likely to occur among relatives or close acquaintances. In our case, the possibility to make post-experimental transfers should make subjects more willing to choose the efficient agreement. Therefore, the observed outcomes represent a lower bound in efficiency compared to a scenario without this selection bias.

3.3.2 Sample

The field coordinator and a field assistant were in charge of conducting eight sessions per municipality. We collected the information from eight subjects per treatment in each municipality, two per treatment cell, yielding a total of 256 participants and 128 independent observations. That is, 32 observations per treatment cell.

Table 3 summarizes the characteristics of the participants in the experiment. We observe variation in the age of participants (40.5 ± 15.0 years old) and their educational attainment

(8.4 ± 4.4 years).[12] More importantly, 53% of all participants were farmers, and 84% declared that their household own a farm. The number of years since farm ownership was on average 19.3 ± 17.5.[13] The most common form of land acquisition was purchase (61%), followed by inheritance (33%).

We asked participants in the post-experimental survey about what they consider as their most important life goal between four options. Fifty eight percent chose "being a landowner," followed by "work his/her own land" with 23%. The other options were earning a college degree (16%) and having a job in the city (4%). We elicit a non-incentivized measure of risk aversion proposed by Dohmen et al. (2011). Previous studies show that this measure is positively correlated with the choice of incentivized lotteries.[14] We opted for a non-incentivized measure of willingness to take risks to simplify the payment procedures in the experimental protocol, and to keep the time per session below 60 minutes.

Tables A.2 to A.4 (see Appendix A.3) show the balance in the observable characteristics from Table 3 across treatment conditions: *Low versus High Uncertainty*, *Unconstrained versus Constrained* agreements, and the assignment of roles as Player H and Player L. Out of sixteen variables, all collected in a post-experimental survey, we find two unbalanced variables in the assignment to the *High* or *Low Uncertainty* condition (education and number of siblings), three unbalanced variables in the assignment to the *Constrained* or *Unconstrained* condition (age, willingness to take risks, and the number of years owning the current farm), and one unbalanced variable in the role assignment (whether the current farm was acquired by purchase, informal inheritance, or possession). Unbalanced variables are included as controls in the regression analysis.

Sessions were conducted with four participants. The field coordinator read aloud the experimental protocol (see Appendix A.4). Subjects were randomly assigned to groups of two participants after receiving the general instructions. The role of Player H and Player L were randomly assigned within each group by a die roll. The field coordinator was in charge of one group and the field assistant of the other. Once instructions were understood, the coordinator and the assistant obtained written consent from all the subjects in the session. During the reading of the informed consent, the participants were informed that the bargaining process will be voice-recorded. We recorded audio from all bargaining processes with two purposes: to make an ex-post analysis of the explicit bargaining and to verify that the coordinator and the assistant followed the instructions from the protocol regarding the bargaining stage (*i.e.*, no intrusion during the bargaining phase, and enforcement of the maximum duration of the bargaining phase).

Each experimental session lasted for at most 60 minutes, including the post-experimental

[12] Throughout the rest of the paper, we will use the notation $X \pm \sigma$ to denote the average plus or minus a standard deviation.

[13] Farm ownership refers to farmers declaring the they have a farm that they consider their own, regardless of the legal conditions of land property.

[14] The original wording of the question is "How do you see yourself: are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please tick a box on the scale, where the value 0 means 'not at all willing to take risks' and the value 10 means 'very willing to take risks'." For understanding purposes, we changed the wording to "In general, are you a person prepared to take risks? Please choose a number in the scale from 1 to 10, where 1 means 'not at all willing to take risks', and 10 means 'very willing to take risks'."

Table 3: Summary Statistics from Participants

Variable	N	Mean	Std. Dev.	Min.	Max.
Gender (=1 if male)	255	0.50	0.50		
Age	244	40.47	15.01	0	84
Education (years)	256	8.42	4.43	0	16
Marital status	256				
Domestic partnership		0.34			
Married		0.35			
Widowed/Divorced		0.08			
Single		0.24			
Farmer	255	0.53	0.50		
Income (1,000 COP/month)	215	578.54	618.59	0	3,800
Adults in Household	253	2.71	1.26	1	8
Children in Household	178	1.84	0.95	0	5
Siblings	256	5.16	2.84	0	12
Risk[a]	251	6.56	2.55	0	10
Has credits with banks?	255	0.68	0.47		
Household owns farm	256	0.84	0.37		
Years with farm	215	19.25	17.50	0.25	80
Land acquisition (owners only)	200				
Purchase		0.61			
Inheritance		0.33			
Possession		0.03			
Other		0.04			
Type of land tenure (not owners)	31				
Possession		0.29			
Unformalized inheritance		0.26			
Rent		0.32			
Other		0.13			
Most important life goal	255				
A job in the city		0.04			
A college degree		0.16			
Work his/her own land		0.23			
Being a landowner		0.58			

[a]Willingness to take risks elicited using the question proposed in Dohmen et al. (2011).

survey. Participants received on average \$23,850 ($\pm$ 8,250) Colombian pesos (COP).[15] This average payment represents between 1.1 and 1.4 times the agricultural daily wage in the areas where the experiment was conducted.

3.3.3 Timing of a session

(i) The field coordinator read the instructions aloud. No written instructions were provided to participants. The field assistant provided a large printed version of Figure 1, which was called the "map" of the inherited land plot. The "map" was marked with a "-1" on each non-irrigated tile, and was delivered to participants in a manner that each subject was next to one of the sides with a water stream. The purpose was to guarantee that both participants had a symmetric view of the "map."

(ii) The field assistant randomly assigned roles H and L. Random assignment of roles was implemented using a different plastic die numbered from 1 to 6. To make clearer that players within a group were asymmetric, Player H received a "big" wooden die (3cm per side), with each one of the three potential outcomes in two sides of the die. Similarly, Player L received a small wooden die (1cm per side) with the corresponding potential outcomes. Both players were reminded that they will roll an identical die to the one they received for each accrued tile.

(iii) When the coordinator explained the rules for border tiles, the assistant delivered to participants a set of wooden red logs to mark the plot boundaries in case it was divided. The coordinator explained that every wooden log needed to trace the boundary between plot divisions would increase the production costs of each participant by 1.

(iv) The coordinator provided a predefined example and announced that participants would have a maximum of five minutes to reach a verbal agreement. Afterwards, player H would make a written proposal to player L, indicating which tiles she intended to keep, and the offered (or requested) transfer, if any. This proposal could deviate from the verbal agreement. In case player L accepted the offer, the game ended with a successful agreement. Otherwise, player L would have a chance to make a take-it-or-leave-it proposal to player H. If player H accepted this offer, the game ended with a successful agreement. Otherwise, one land tile will be eliminated, a loss framed as "lawyers' fees," and each player will receive two irrigated and two non-irrigated neighboring tiles. This division will create two border tiles for each player.

(v) The bargaining phase took place for at most five minutes.

(vi) The coordinator/assistant took each player in private and gave the participant as many dice as tiles she accrued according to the land division. The dice were rolled inside a box to make sure the realized yield, and therefore the final earnings, could not be observed by anyone different to the coordinator/assistant and the player that rolled the dice. The coordinator/assistant completed the post-experimental survey with each participant, and delivered the final earnings to each participant in private.

[15] By the time of the experiment, the exchange rate was \$1 USD = \$3,100 COP. Average payment was \$7.7 USD.

3.3.4 Replication with undergraduate students

The hypotheses introduced in Section 3.1 were not designed to disentangle the role of preferences from the use of the bounded rationality rule previously described. We replicate the lab-in-the-field experiment with a population of undergraduate students with the purpose of disentangling these mechanisms. If students have a lower affective valuation for land (which we validated asking them about their most important life goal, as we did in the field), and affective value drives egalitarian land allocations, one would expect more efficient agreements in the students sample. By contrast, if the distribution of agreements is similar for students and farmers, we can argue that the proposed bounded rationality rule, which represents a more “generalizable” process, is driving egalitarian land divisions.

We replicated the experiment with a sample of undergraduate students in March 2019. One hundred and twenty participants, thirty per treatment cell, were recruited from a public university in Bucaramanga. We chose a university within the same region of study to hold constant factors associated to culture that might affect face-to-face bargaining. The experiment was conducted in six journeys within a time lapse of nine days to minimize gossiping effects. One of the field assistants from the lab-in-the-field experiment acted as field coordinator in the replication experiment. The rest of field assistants from the original experiment were recruited again to help in the execution of the replication experiment. An additional assistant was in charge of the recruitment of participants, following a specific protocol that makes the recruitment process comparable to the one implemented in the rural municipality. The recruiter was instructed to approach students that were alone or in pairs in the different locations of the university and ask them if they were interested in participating in an activity that would take less than an hour, in which they could earn up to \$50,000 COP, with an average earning of \$20,000 COP. Acquaintances from the recruiter were not allowed to participate in the experiment. Students that agree to participate were walked to the open area in which the experiment was conducted.

Table A.5 (see Appendix A.3) summarizes the characteristics of the participants in the replication experiment. Fifty three percent are male. Participants are on average 19.3 ± 2.1 years old. Fifty four percent of them are enrolled in a major related to sciences or engineering, and thirty nine percent are enrolled in a major related to human or social sciences. We also find that 34% reported that their family owns a farm, which is lower than the 84% in the field sample. We ask the students about their parents’ occupation. In seven percent of the cases the occupation of the father is related to agriculture, whereas we did not obtain any report of a mother’s occupation related to agriculture. Non-agricultural unskilled occupations were the most common for the fathers (51%) and mothers (72%), followed by skilled occupations (27% and 25% for the participants’ fathers and mothers, respectively). We gave the participants the same four options regarding their most important goal in life. In stark contrast with the field sample (we report the percentage of choices in the field in squared brackets, next to the students’ percentage), 59% [vs. 16%] chose “a college degree,” 17% [vs. 58%] opted for “being a landowner”, 14% [vs. 4%] chose “having a job in the city,” and 10% [vs. 23%] chose “work his/her own land.”

As in the original experiment, we randomly assigned participants to the treatment cells and to the role of Players H and L (see balance in observable characteristics in Tables A.6 to A.8). Sessions were conducted with four participants. The coordinator read the experimental protocol, as in the field experiment. Sessions lasted between 45 and 50 minutes. The main reason why sessions were shorter is that the post-experimental survey had fewer questions and participants filled it out by themselves. Participants received an average payment of \$23,450 (± 7,233) COP.

4 Results

In this section we report the main results of our experiment. We start by presenting the results with the original field sample. Then we report the results of the replication exercise with the sample of undergraduate students.

4.1 Agreements

Figure 2 displays the observed agreements in the *Unconstrained* (left panel) and *Constrained* (right panel) conditions. An agreement is given by a land division $[\ell_H : \ell_L]$ in the horizontal axis and a transfer T in the vertical axis. An inspection of the left panel shows that the modal land allocation is [5:4], reached in 48.4% (31/64) of the observations. This allocation is followed by [4:5], with 26.6% of the observations. The most efficient agreement, with a [9:0] land allocation, is reached only in 10.9% of the observations; whereas [7:2], the egalitarian bargaining solution maximizing the surplus, is never reached.

In Hypothesis H1 we argue that the egalitarian land divisions, [5:4] and [4:5], are more likely to emerge than the efficient land allocation, [9:0]. We interpret the results reported in the left panel in Figure 2 as evidence in favor of H1. From all outcomes, 75% correspond to a [5:4] or a [4:5] land division; 16% to land divisions in which player H keeps 6 or more tiles, and only 9% to land divisions in which player H keeps 3 or less tiles.

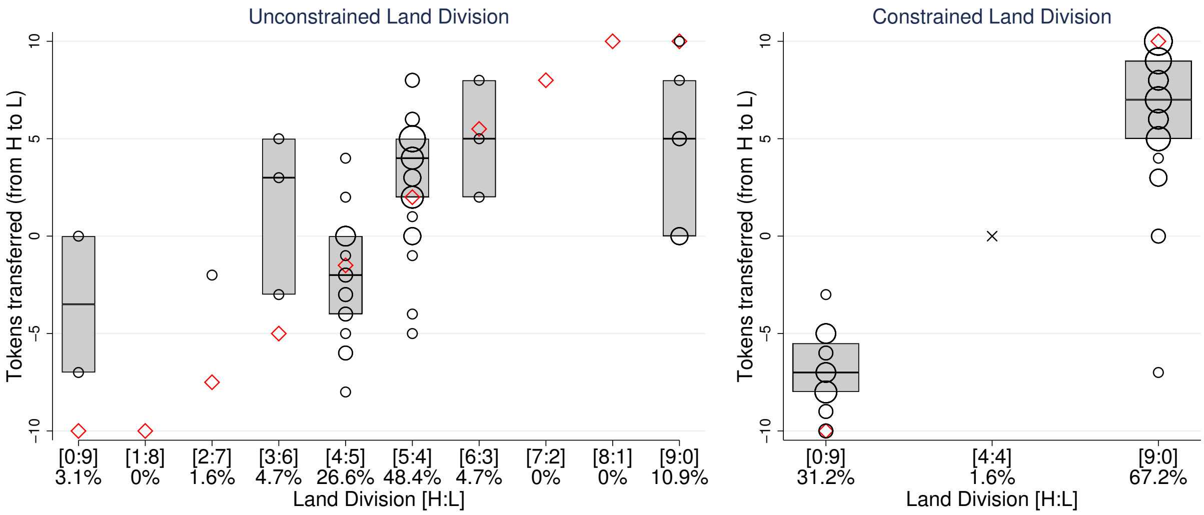
By contrast, the observed outcomes do not support Hypothesis H2. We observe a single disagreement outcome (out of 64) in the *Constrained* condition, marked with an "x" in the right panel in Figure 2; whereas in the *Unconstrained* condition all 64 bargaining pairs reached an agreement. This single disagreement is insufficient to support Hypothesis H2. Note also that 33% of the observed outcomes in the *Constrained* condition deviate from the [9:0] allocation. Land overvaluations in the Nash bargaining framework cannot predict this outcome, since sufficiently large values of μ would drive the predictions of the model to a strict preference of the [4:4] disagreement allocation over any other agreement.

The bounded rationality rule presented in Section 2.3.3 cannot explain the lack of disagreements either. However, it can be more easily adapted to do it. Assume for instance that subjects take the [9:0] or the [0:9] land allocation as given, the differences in bargaining skills might be sufficient to sustain one of these outcomes. We will come back to this argument in Section 5.

4.2 Efficiency and Payoffs Inequality

We define efficiency as the sum of the expected payoffs for Players H and L given the chosen land allocations, and inequality as the absolute difference in these expected payoffs between players H and L. Efficiency goes from 40 tokens, obtained under the disagreement

Figure 2: Observed agreements.



Note: The left panel reports agreements in the *Unconstrained* condition. The right panel reports agreements (and a disagreement) in the *Constrained* condition. Within each panel, a hollow circle represents an agreement, given by a land division and a transfer T. The size of the circle indicates the observed frequency of each agreement. An "x" represents a disagreement. The percentage of agreements for each land division $[\ell_H : \ell_L]$ is reported in the horizontal axis. The size of the transfer T is reported in the vertical axis. The hollow diamonds represent the outcomes from the egalitarian bargaining solution, conditional on each land division. The gray bars display the interquartilic ranges of the observed transfers for each land division.

outcome ([4:4] and $T = 0$); to 52 tokens, obtained with the [9:0] allocation. It means that each additional token increases *relative* efficiency by $(100/12 =)$ 8.3 percentage points.

The average efficiency is 46.7 ± 4.3 tokens. In relative terms, this is equivalent to 55.8% of the attainable efficiency. On the other hand, the average inequality is 11.6 ± 8.7 tokens. This value is not statistically different from 12 tokens (p-value from one-sample t-test is 0.577), which is the minimum inequality level attainable under the efficient land division [9:0]. In other words, inequality is not reduced with respect to the Nash bargaining [9:0] prediction, even though relative efficiency loss is 44% with respect to the same outcome.

The average inequality drops to 6.5 ± 5.0 tokens once we exclude the [9:0] allocations. This value is greater than 4 tokens (p-value from one-sample t-test is <0.001), the expected payoffs inequality under the egalitarian bargaining solution. Our interpretation of this result is that minimizing inequality in land allocation was more salient than minimizing payoffs inequality. In fact, excluding any land allocation for which the bargaining solution was not available (see Table 2), the expected payoffs difference of 4 tokens occurred only 9% of the times (5/55). An alternative is that players set transfers that reduced the expected payoffs difference to zero. However, this occurred only 13% of the time (7/55).

Table 4 reports the differences between treatments in efficiency and inequality. For each comparison we report as well the $p-$value from a Mann-Whitney U test. Panel A displays the comparisons between the *High Uncertainty* and *Low Uncertainty* conditions. Efficiency is

Table 4: Differences between treatment cells in Efficiency and Inequality

Panel A: Effects of Yield Uncertainty

	Low Uncertainty		*High Uncertainty*			
	Mean	(SD)	Mean	(SD)	diff.	$p-$value
Efficiency						
Pooled	47.22	4.28	46.27	4.24	0.95	0.142
Unconstrained	44.41	2.58	44.56	2.95	-0.16	0.873
Constrained	50.03	3.78	47.97	4.67	2.06	0.057
Inequality						
Pooled	12.13	9.28	11.02	8.09	1.11	0.628
Unconstrained	7.22	7.35	8.13	8.64	-0.91	0.726
Constrained	17.03	8.43	13.91	6.41	3.13	0.184

Panel B: Effects of Constraining Land Division

	Unconstrained		*Constrained*			
	Mean	(SD)	Mean	(SD)	diff.	$p-$value
Efficiency						
Pooled	44.48	2.75	49.00	4.34	-4.52	0.000
High Yield Variance	44.56	2.95	47.97	4.67	-3.41	0.092
Low Yield Variance	44.41	2.58	50.03	3.78	-5.63	0.000
Inequality						
Pooled	7.67	7.97	15.47	7.59	-7.80	0.000
High Yield Variance	8.13	8.64	13.91	6.41	-5.78	0.000
Low Yield Variance	7.22	7.35	17.03	8.43	-9.81	0.000

Reported $p-$values correspond to a Mann-Whitney U test.

0.95 tokens larger with *Low Uncertainty*, though not statistically significant ($p-$value 0.142). After splitting the sample into the *Unconstrained* and *Constrained* conditions we observe that the additional efficiency in the *Low Uncertainty* condition is driven by the *Constrained* condition (+2.06 tokens, $p-$value 0.057).

We predict in Hypothesis H3 that a higher spread of tile productivity reduces efficiency because subjects prefer allocation rules based on elements with low uncertainty (Roth and Malouf, 1979; Van Dijk et al., 1999), and in our case, land allocations are more certain than payoffs. The results in Table 4 suggest that when players are allowed to divide the land, increasing uncertainty does not have an effect on efficiency, rejecting Hypothesis H3. However, we do not interpret this result as evidence against the behavioral response to uncertainty that we consider here. Since both the *Low* and the *High Uncertainty* conditions entail some level of uncertainty, players can opt to bargain over land rather than payoffs as a response to uncertainty in both conditions. Moreover, this behavioral response to uncertainty is also consistent with the use of the bounded rationality rule that we propose, since players can solve first the problem that is not subject to uncertainty, land allocation; leaving the computation of the acceptable transfer T, which depends on the uncertain tile productivity, for a second bargaining stage. The results when comparing land allocations across uncertainty conditions might suggests the use of this rule of behavior under both conditions.

In the related Hypothesis H4, we argue that the effect of uncertainty on efficiency is larger in the *Constrained* condition. Our argument is that when we do not allow players to avoid bargaining over uncertain outcomes, payoffs and, therefore efficiency, become more relevant in the bargaining process. However, difficulties to agree on an exchange rate between tokens and tiles when uncertainty is higher can drive again the bargaining problem away from variables related to efficiency. The results in Table 4 validate Hypothesis H4.

Regarding inequality, Panel A in Table 4 shows that there are no statistical differences between the *High* and *Low Uncertainty* conditions. We interpret this null finding as evidence that, even if lower uncertainty increases efficiency, such agreements are not systematically accompanied by transfers that reduce inequality in expected payoffs.

We focus now on Panel B, where we compare the *Constrained* with respect to the *Unconstrained* treatment. The efficiency in the *Constrained* condition is larger by 4.52 tokens ($p-$value < 0.001). This is expected given that we do not observe disagreements, and [9:0] allocations correspond to 67% of the observed outcomes. However, the average inequality of 15.47 exceeds the expected inequality of 12 tokens in the efficient [9:0] allocation (one-side t test, $p-$value < 0.001). In other words, agreements including extreme land allocations were not accompanied by the maximum transfers predicted by the Nash and the egalitarian bargaining solutions. We thus conjecture that innate bargaining abilities played an important role in the observed outcomes in the *Constrained* condition.

4.3 Analysis of the Bargaining Phase

The following results are included with descriptive purposes because we are not aware of other experiments introducing explicit bargaining in the field. We find that the average duration of the bargaining phase was 117.6 ± 82.5 seconds. The 25th, 50th and 75th percentile were 52, 100, and 157 seconds, respectively. The duration of the bargaining phase fell considerably below the time limit of 300 seconds.[16] This result goes against the evidence from laboratory studies, where agreements are often reached in the last seconds of the bargaining phase (Murnighan, Roth and Schoumaker, 1988). However, this is not surprising given the face-to-face bargaining process and the fact that there was a large probability that participants in our sample knew each other.

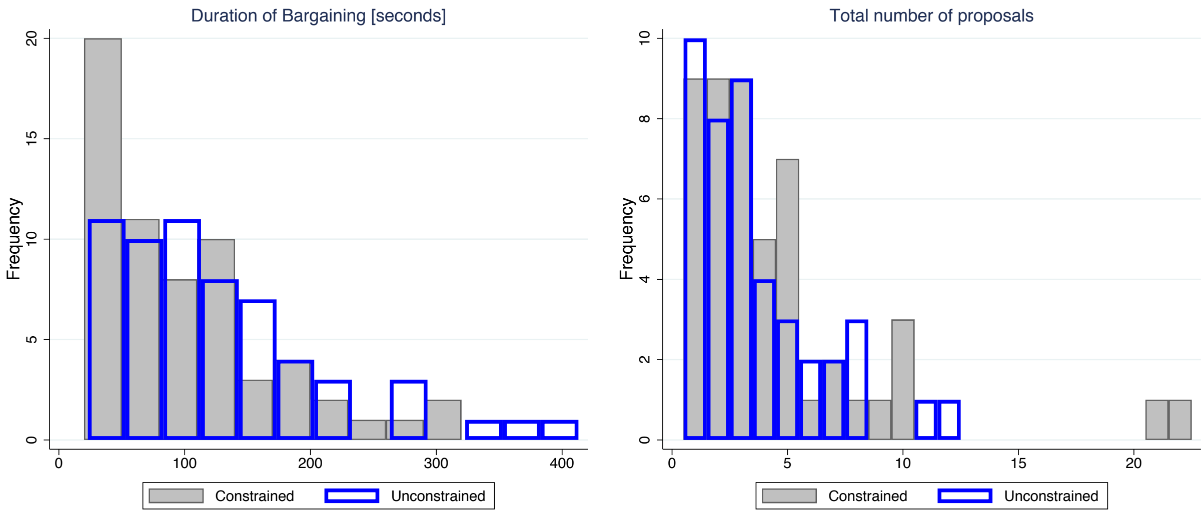
We did not find statistically significant differences in duration between the *High Uncertainty* and *Low Uncertainty* conditions (11.5 seconds, $p-$value 0.435). By contrast, the bargaining phase was 28.9 seconds longer ($p-$value 0.048) in the *Unconstrained* condition with respect to the *Constrained* condition. The left panel in Figure 3 shows the differences in the distributions of duration between the constrained and constrained conditions. Participants reached an agreement in the first 30 seconds twice as often in the *Constrained* than in the *Unconstrained* condition.

We also counted the number of verbal proposals that were exchanged by each bargaining couple in each phase (4.1 ± 3.6 proposals).[17] The right panel in Figure 3 shows that the

[16] The time limit was not enforced for five bargaining groups, whose bargaining time was extended, on average, for 64 seconds.

[17] This procedure was completed for 75.7% of the observations. For the rest of observations, the quality of

Figure 3: Duration and number of proposals in the bargaining phase



difference between treatments in terms of the number of proposals is less noticeable. In the *Low Uncertainty* condition the number of verbal proposals is 3.82, and in the *High Uncertainty* condition this number is 4.37, but the difference is not statistically significant (0.55 proposals, $p-$value 0.462). In the *Constrained* condition the number of verbal proposals is 3.66, and in the *Unconstrained* condition this number is 4.54. This difference is neither statistically significant (0.88 proposals, $p-$value 0.235). Although the bargaining phase took longer in the *Constrained* condition, the number of verbal proposals was the same. Our interpretation is that the elaboration and assessment of proposals was more complex when land could be divided.

4.4 Regression Analysis

We report in Table 5 the comparison between treatments using an OLS regression with standard errors clustered at the municipality level.[18] Our unit of observation is the bargaining couple. We have 127 observations because we exclude the single case of a disagreement outcome. Odd columns replicate the findings discussed before. Constraining land division increases efficiency and inequality because egalitarian land allocations are not feasible. Moreover, the comparison with respect to the baseline probability (9.38%) shows a sevenfold increase in the probability that player H keeps the land plot in the *Constrained* condition. We also confirm that *High Uncertainty* does not decrease efficiency in the *Unconstrained* condition, but it decreases efficiency by roughly two tokens in the *Constrained* condition. This reduction in efficiency is associated to a lower probability that player H keeps the

the audio did not allow us to list the verbal proposals.

[18]Due to the limited number of clusters we estimated clustered standard errors with the Wild bootstrap procedure.

land plot (see columns 5 and 6). However, it does not have a systematic effect on reducing inequality via transfers.

In the even columns we report the regression coefficients for each one of the three outcomes of interest, including as controls the municipality fixed effects and characteristics of participants in the role of players H and L: gender, marital status, number of siblings, educational attainment, and willingness to take risks. The magnitude of the coefficients is robust to the addition of controls.

Two of the individual characteristics included as controls are of special interest since they might capture the affective valuation of land: whether the participant's household owns land[19], and the participant's most important goal in life (among the choices listed in Table 3). With the caveat that these results are of an exploratory nature, we proceed now to interpret their coefficients. When the household of the participant in the role of Player L owns land, inequality is reduced by 3 tokens and efficiency is reduced by 2.3 tokens on average. An inspection of Column (6) suggests that this loss of efficiency is associated to a lower likelihood of accepting a [9:0] allocation. By contrast, land ownership from the participant in the role of Player H increases average inequality in 2 tokens.

The opposite relation between land ownership and payoff inequality across Players in the roles of H and L suggests that bargaining abilities of players can play an important role in determining the magnitude of the transfers, while these abilities appear to be of secondary order of importance in the determination of land allocations, particularly when land divisions are allowed (since in [5:4] and [4:5] allocations prevail in that case regardless of the characteristics of the players). This result is consistent with the predictions of the two-step Nash bargaining model that we presented above.

We find little evidence that participants' reported goals in life are correlated with the outcomes of the bargaining game. The only exception appears for participants in the role of Player H who responded that their main goal in life is to work their own land, in whose case the bargaining outcome was less unequal by 3.5 tokens (with respect to claiming land ownership as their main goal in life). If these variables capture to some extent the affective value of land, the small and statistically insignificant coefficients on efficiency suggest that this mechanism does not seem to play an important role explaining land divisions in the context of our game. In the next subsection we present further evidence of this. Finally, the coefficients on paticipants' educational attainment are small and not statistically significant. We interpret this result as suggestive evidence that the observed land allocations do not respond to a differential understanding of the game between Players H and L.

4.5 Results with the sample of students

We replicated our bargaining experiment with a sample of students with the aim of disentangling the role of preferences (*i.e.*, overvaluation of land tiles) from the use of bounded rationality rules. In Section 3.3.4, we showed that there are important differences between samples in the stated main goals in life (see also Tables 3 and A.5), which could capture differences in their affective value for land. However, in the regression analysis that we presented above, we do not find evidence of these variables having a statistically or economically

[19]Recall that we take into account several forms of land possession regardless its formal status.

Table 5: OLS Regressions

	Efficiency		Inequality		Pr(H keeps plot)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Uncertainty	0.16	-0.16	0.91	-1.87	0.03	-0.02
	(0.25)	(0.59)	(1.83)	(1.87)	(0.03)	(0.06)
	[0.65]	[0.72]	[0.64]	[0.32]	[0.50]	[0.74]
Constrained Division	5.62***	4.49***	9.81***	6.57***	0.69***	0.56***
	(0.86)	(1.08)	(1.23)	(1.63)	(0.09)	(0.12)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
High Uncert. x Const. Division	-1.96***	-1.25	-3.71	-0.47	-0.23***	-0.15
	(0.58)	(0.96)	(3.31)	(3.53)	(0.06)	(0.10)
	[0.00]	[0.19]	[0.30]	[0.92]	[0.00]	[0.13]
H is Owns Land		-0.40		1.91**		-0.01
		(0.56)		(1.12)		(0.06)
		[0.33]		[0.03]		[0.90]
L Owns Land		-2.29***		-3.05***		-0.25***
		(0.76)		(1.51)		(0.07)
		[0.00]		[0.01]		[0.00]
H education (years)		0.44		-0.38		0.03
		(0.35)		(0.94)		(0.04)
		[0.18]		[0.67]		[0.42]
L education (years)		-0.01		-0.31		-0.00
		(0.36)		(0.62)		(0.04)
		[0.98]		[0.58]		[0.97]
Most important goal in life						
baseline: land ownership						
H: college diploma/job in the city		1.05		0.95		0.14
		(1.13)		(3.38)		(0.12)
		[0.30]		[0.93]		[0.22]
H: to work in own farm		-0.33		-3.48***		-0.05
		(0.72)		(0.82)		(0.08)
		[0.61]		[0.00]		[0.55]
L: college diploma/job in the city		-1.22		-2.79		-0.13
		(1.30)		(1.67)		(0.14)
		[0.44]		[0.11]		[0.45]
L: to work in own farm		0.86		-1.07		0.08
		(0.64)		(1.19)		(0.07)
		[0.21]		[0.35]		[0.26]
Observations	127	120	127	120	127	120
R-squared	0.33	0.53	0.23	0.54	0.37	0.57

Clustered standard errors by municipality in parentheses. Wild bootstrap p-values in brackets. *** p<0.01, ** p<0.05, * p<0.1 Controls: gender, farming as main economic activity, whether the person is single or married, number of siblings, willingness to take risks, and enumerator (coordinator/assistant) dummy.

significant effect on the efficiency of land allocations in the rural sample. We interpret this as potential evidence that the affective value land of might not be the relevant mechanism explaining land divisions the context of our game. In this subsection we provide further evidence to support this interpretation.

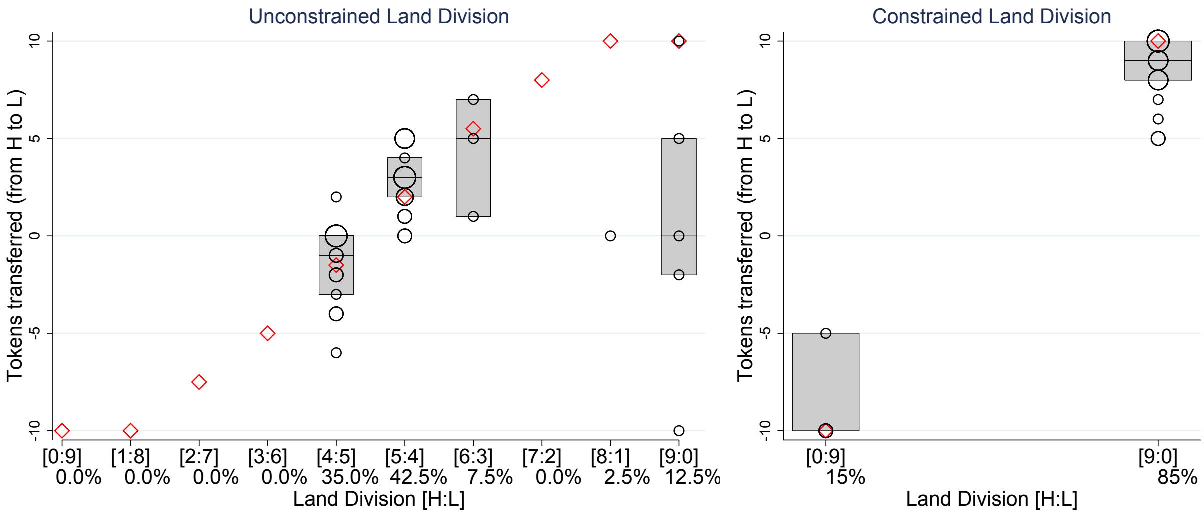
Given the differences in the revealed main goals in life across samples, that we interpret as differences in the affective values of land, observing more efficient agreements in the sample of students could provide evidence in favor of the role of this affective value as a driver of land divisions. However, the left panel in Figure 4 reveals that the distribution of agreements in the students' sample in the *Unconstrained* condition is very similar to the distribution of agreements in the original sample. In the original field sample, 75% of the observed agreements were either [5:4] or [4:5]. This proportion is almost identical in the sample of students, with 77.5% of the agreements. The proportion of [5:4] agreements is slightly lower in the students sample (42.5% vs. 48.4%). The larger proportion of [4:5] agreements is associated with the absence of very inefficient and non-predictable agreements in which Player H keeps less than 4 tiles (which occurred 9.4% of the times in the field sample). The likelihood of [9:0] did not changed drastically, as it increases from 10.9% to 12.5%. The similarities in the distributions of land allocations across samples in favor of a more "universal" behavioral pattern. Thus, this evidence supports the use of our bounded rationality rule that allow players to solve first the land allocation problem, and then solve the accompanying monetary compensation problem.

On the other hand, the right panel in Figure 4 reveals differences between samples in the *Constrained* condition. The likelihood of a [0:9] outcome is reduced by half in the sample of students with respect to the field sample (from 31.2% to 15%). Another difference is that the transfers T accompanying the land allocations are less dispersed in the students sample. The lower dispersion leads to lower levels of inequality in the expected payoffs. Table 6 shows that the average inequality decreased to 9.8 ± 9.8 tokens, whereas in the original sample the average inequality was 11.6 tokens. A detailed comparison of inequality across treatments and across samples reveals that its largest reduction occurs under *Low Uncertainty*. In this treatment arm, inequality falls from 12.1 ± 9.3 tokens in the field sample to 9.3 ± 9.3 tokens in the students sample. Finally, we do not observe any disagreement outcome in the students sample.

We also replicated the regression analysis in the students sample (see Table A.9 in Appendix A.3). In general, similar results hold for the *High Uncertainty* and the *Constrained* coefficients. However, unlike the field sample, the interaction coefficient $High\,Uncertainty \times Constrained$ is not significant. In other words, the variation of uncertainty in tile productivity does not have any effect in the students sample.

Summing up, the distribution of land allocations reflect a similar pattern among farmers and students. This is consistent with our argument that players first bargain over the land allocation, yielding [5:4] or [4:5] in most of the cases, and then players bargain over the transfer T that makes this land allocation acceptable. However, the most noticeable difference is that, holding similar efficiency levels, students tend to reduce inequality to a greater extent. We offer two possible interpretations for this difference. First, participants in the field sample focus on the first bargaining problem in the sequence, land allocation; and once solved they paid less attention to the accompanying transfer. Second, students' ability to compute each players' expected payoffs makes them more likely to reduce payoffs

Figure 4: Observed agreements in the students' sample.



Note: The left panel reports agreements in the *Unconstrained* condition. The right panel reports agreements (and a disagreement) in the *Constrained* condition. Within each panel, a hollow circle represents an agreement, given by a land division and a transfer T. The size of the circle indicates the observed frequency of each agreement. The percentage of agreements for each land division $[\ell_H : \ell_L]$ is reported in the horizontal axis. The size of the transfer T is reported in the vertical axis. The hollow diamonds represent the outcomes from the egalitarian bargaining solution, conditional on each land division. The gray bars display the interquartilic ranges of the observed transfers for each land division.

inequality. Nonetheless, it is interesting that any additional computational abilities were employed to minimize payoffs differences, but not to depart from egalitarian land divisions.

5 Discussion

5.1 The role of environmental uncertainty

Our experimental results are summarized in Figures 2 and 4. They show the high prevalence of egalitarian land divisions: 75% of bargaining outcomes yielded a [5:4] or a [4:5] land allocation. Uncertainty reduces efficiency only in the *Constrained* condition, when it is more costly to solve the land allocation problem in isolation from a token transfer. Under this condition, we observe that higher uncertainty in land productivity increases the chances of a [0:9] agreement.

A higher environmental uncertainty appears to increase the importance of factors such as the innate bargaining ability of players. Even if it does not have anything to do with the randomly assigned land productivity within the game, this factors might influence the likelihood of Player L keeping the land plot in the *Constrained* condition despite the inefficiency of this result. The effect of environmental uncertainty is only observed in the original field sample. We thus argue that students are less prone to use these arguments, either by the

Table 6: Differences between treatment cells in Efficiency and Inequality in the sample of students.

Panel A: Effects of Yield Uncertainty

	Low Uncertainty		*High Uncertainty*			
	Mean	(SD)	Mean	(SD)	diff.	$p-$value
Efficiency						
Pooled	46.33	4.10	47.23	4.10	-0.90	0.232
Unconstrained	44.40	2.66	45.30	3.16	-0.90	0.153
Constrained	50.20	3.79	51.10	2.85	-0.90	0.542
Inequality						
Pooled	9.27	9.28	10.43	10.49	-1.17	0.625
Unconstrained	6.70	9.86	8.80	12.21	-2.10	0.414
Constrained	14.40	5.34	13.70	4.72	0.70	0.701

Panel B: Effects of Constraining Land Division

	Unconstrained		*Constrained*			
	Mean	(SD)	Mean	(SD)	diff.	$p-$value
Efficiency						
Pooled	44.85	2.92	50.65	3.30	-5.80	0.000
High Yield Variance	45.30	3.16	51.10	2.85	-5.80	0.001
Low Yield Variance	44.40	2.66	50.20	3.79	-5.80	0.005
Inequality						
Pooled	7.75	11.01	14.05	4.91	-6.30	0.000
High Yield Variance	8.80	12.21	13.70	4.72	-4.90	0.010
Low Yield Variance	6.70	9.86	14.40	5.34	-7.70	0.002

Reported $p-$values correspond to a Mann-Whitney U test.

lack of contextual arguments (*e.g.*, land ownership) or due to better computational abilities.

When subjects can divide the land, the increasing environmental uncertainty does not have an effect on efficiency because land divisions dominate even in the *Low Uncertainty* condition. This can be consistent with the bounded rationality mechanism that we propose above, and suggests that uncertainty can play a role in determining how this mechanism operates. Subjects simplify the game by transforming it into a two-step unidimensional game. In this game, they first bargain over land (the fixed and observable outcome), and then they bargain over a monetary transfer. In line with previous experimental research showing that subjects opt for allocation rules that avoid uncertain outcomes (Van Dijk et al., 1999), they chose to solve the land allocation problem first, since these allocations are not subject to uncertainty.

5.2 The role of the affective value of land versus bounded rationality

We disentangle the role of the affective value of land from the role of bounded rationality in explaining land divisions by replicating our lab-in-the-field experiment with undergraduate students. The results from this exercise support the proposed bounded rationality rule. In this section we provide additional arguments in favor of bounded rationality. First, we discuss how each mechanism can be adapted (or not) to predict the lack of disagreements in the *Constrained* condition. Second, we reconcile both mechanisms and conjecture how the affective value might be implicitly captured in the use of the bounded rationality rule.

The bargaining model with an affective value predicts disagreements in the *Constrained* condition because the cost of foregoing one tile increases as μ increases. We explored two variations of the model aiming to explain the lack of disagreements. First, we consider a scenario in which disagreements were not observed because a disproportionate bargaining power given to Player L could lead to a [0:9] allocation. However, as we explained in Section 2, even if the parameter $p \rightarrow 0$, Player H would not accept any agreement in which she keeps less than 4 tiles. Second, we added to the Nash bargaining model a cost $-\epsilon$ to the disagreement payoff and check whether this additional loss from not reaching an agreement could explain the absence of disagreements. This ϵ can be interpreted as a disutility from destroying the ninth tile in the land plot, either because there is an "existence value" (Krutilla, 1967); or because there is a normative cost perceived by the participants given the experimental framing of the loss of a tile due to "lawyers' fees" in case of disagreement (*i.e.*, as if it was "incorrect" or "fool" to need the lawyers' intervention). The model predicts that when ϵ increases at a rate p, the optimal transfer T^* decreases. That is, the cost of not reaching an agreement makes cheaper to buy the counterpart's land tiles.[20] However, the surplus remains larger when Player H keeps more tiles, making the cost ϵ an inadequate model variation to explain the [0:9] allocations.

Similarly, the transformation of the bargaining problem into two sequential problems would also predict disagreements in the *Constrained* condition, because none of the players would forgo the entire land plot in exchange for nothing during the bargaining of land allocation. We argue that the bounded rationality scenario can be adapted to the *Constrained* treatment. Consider the following modification. Now that participants can only choose between then [9:0] and [0:9] allocations, they solve the bargaining problem to find an acceptable value of T for *both* scenarios (taking the land allocation as given), and then opt for the scenario that yields the higher utility to both of them. Imagine that they consider the [9:0] and [0:9] allocations as "hypothetical" to be able to proceed to the second bargaining problem. This sequential bargaining problem keeps the essence of the Nash bargaining problem: how to maximize and divide a surplus. The main difference is that the outcome depends on this comparative analysis between the more convenient transfer accompanying the [9:0] and [0:9] land allocation.

Another adaptation of the bounded rationality process is that the player with the highest innate bargaining ability successfully proposes to keep the land plot, under the promise

[20] This is only valid with asymmetric bargaining power. Assuming symmetric bargaining power, the cost $-\epsilon$ does not affect T^*

that she will make an acceptable transfer T in the second stage of the bargaining problem. Since the other player still has the opportunity to refuse the entire agreement, it allows the bargaining couple to move beyond the first stage of the bargaining problem, in which the surplus is created, even if no explicit transfer proposal has been made yet.

Even if the affective valuation of land cannot explain [0:9] allocations and the lack of disagreements, we speculate that some component of this affective valuation of land is embedded in our bounded rationality rule. Remember that the transformed sequential bargaining game consists on solving the land allocation problem first, and then solving a compensation problem by finding an acceptable transfer in exchange for foregoing some of the land tiles. The comparison of agreements between farmers and students revealed that, although the distribution of land allocations is very similar, the accompanying transfer T in the students sample was less dispersed and more effective in reducing expected payoffs inequality. We conjecture that an implicit revelation of the importance of the affective value of land among farmers is that once they solved the land allocation problems, they were more tolerant toward more unequal payoffs differences. Although the transformed bargaining problem is sequential, farmers appear to devote less effort to minimize payoffs inequality. The same pattern could be explained with differences in computational abilities. However, remember that the median duration of the bargaining phase was 100 seconds, one-third of the available time.

6 Concluding Remarks

We have designed and implemented a novel lab-in-the-field experiment to study land division in rural areas. In our game, the two participants are individually endowed with 10 tokens and jointly endowed with a land plot formed by nine tiles. Participants are randomly assigned to asymmetric roles: one of them is more productive with land than the other. The purpose of participants is to find an agreement involving a land allocation and a token transfer. If an agreement is not reached, each player keeps her individual endowment and receives four neighboring tiles. The ninth tile remains unassigned.

Our experimental paradigm included two treatment arms: whether agreements were *Unconstrained* or *Constrained* (*i.e.*, land cannot be divided), and whether tiles' productivity was subject to *High* or *Low Uncertainty*. We find that, if agreements are *Unconstrained*, 75% of the bargaining outcomes corresponded to the most egalitarian land divisions, in which one of the players keeps 5 of the 9 tiles. Although this can be explained by a land overvaluation connected to the affective value of land, then we would also expect a large proportion of disagreements in the *Constrained* condition. However, we observe a single disagreement (out of 64 bargaining pairs). Regarding uncertainty, we find that *High Uncertainty* decreased efficiency, but only in the *Constrained* condition (*i.e.*, a higher likelihood that the least productive player keeps the land plot). Subjects focus on agreements that minimize the role of uncertainty. Land allocations play that role, at the cost of ignoring players' asymmetric and uncertain productivity.

We argue that the affective value of land was insufficient to explain our results. We instead proposed a bounded rationality model that transformed the bidimensional bargaining problem into a sequential bargaining problem. Subjects bargain first over the land allocation. Then, taking the land allocation as given, they solve a monetary compensation problem by setting the transfer level that makes acceptable the land allocation. We replicated the experiment with a sample of undergraduate students in the same region, with the purpose of holding constant local norms that might affect face-to-face bargaining, but testing the bargaining experiment with a population with a lower affective value for land. The distribution of land allocations in this replication was very close to our original findings (77.5% of the bargaining outcomes corresponded to the most egalitarian land divisions), although transfers were less dispersed and created lower differences in expected payoffs. We interpret the similarity of land allocations between samples as evidence that land division is driven by a more "universal" mechanism that fits our proposed bounded rationality rule.

From the methodological perspective, our design contributes to the experimental economics literature by providing an easy-to-grasp bargaining game that can be implemented in less than an hour with rural participants. Alternative parameterizations of the game might be useful to study the use and affective values of water in areas with and without scarcity of this resource, by varying the costs of non-irrigated tiles in the game. This game can also be adapted to study land use decisions in the presence of payments for environmental services that can only be implemented if a minimum protected area is established. For instance, by creating additional rewards for unexploited land tiles that provide neighboring forests.

Our game relies heavily on framing compared to other experimental paradigms, but this could result in an advantage for lab-in-the-field experiments aiming to create a situation in which participants can easily bring elements from their daily context into their game behavior.

Our study contributes to the understanding of land division when non-market allocations are relevant. We find little evidence of the role of affective value in land division. However, the external validity of the consequences of the disagreement outcome in our game might be distant of what happens in reality. Having said this, our game is a good testing ground for bargaining scenarios in which information asymmetries are reduced and the land value in terms of productivity becomes a more objective variable. Our study calls for extending the use of mechanism design from market to non-market contexts in land allocation problems. In particular, we advocate for the design of mechanisms enforcing a truthful revelation of land valuation, including its productive and affective value, that contribute to more satisfactory and less costly agreements.

Finally, our results suggest that once we partial out the effects of preferences and the use of bounded rationality rules, the uncertainty in agricultural returns also has a detrimental effect on the efficiency of land allocations. If industrialization reduces the importance of non-market allocation mechanisms, the development of insurance instruments for agricultural producers should be in the policy agenda of countries seeking to boost agricultural productivity and overcome the potential misallocation that results from uninsured risks.

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A Appendix

A.1 Nash bargaining solution

In this section we derive the solution to the Nash bargaining model that we present in section 2.2. We start with a general version of the model in which we include a parameter μ capturing the over-valuation of each accrued land tile. Then, we derive the solution to the model when $\mu = 0$ and the relative bargaining ability of player H can take any value (*i.e.*, $p \in (0, 2)$). In the last part of the section, we derive the solution to the model when $\mu > 0$.

For simplicity purposes, and to avoid asymmetries of information to drive the predictions of the model, we assume that μ is symmetric between players. We also assume that μ is finite with an upper bound $\overline{\mu} < \infty$. Adding μ modifies the agreement and disagreement values, defined in equations (1) to (4), as follows:

$$\begin{aligned}
\tilde{v}^H(\ell_H, T) =& e - T + \ell_H(E[y_H] + \mu) - C_I(\ell_H) - C_B(\ell_H) \\
\tilde{v}^L(\ell_H, T) =& e + T + (9 - \ell_H)(E[y_L] + \mu) - C_I(9 - \ell_H) - C_B(9 - \ell_H) \\
\tilde{d}^H =& e + 4(E[y_H] + \mu) - C_I(4) - C_B(4) \\
\tilde{d}^L =& e + 4(E[y_L] + \mu) - C_I(4) - C_B(4)
\end{aligned} \tag{9}$$

The Nash bargaining solution of a game giving a weight p to the gains of player H and a weight $q = 2 - p$ to the gains of player L corresponds to the values of (ℓ_H, T) that maximize the following expression:

$$W(\ell_H, T; p, \mu) = \max_{(\ell_H, T)} \left(\tilde{v}^H(\ell_H, T) - \tilde{d}^H(\ell_H, T)\right)^p \left(\tilde{v}^L(\ell_H, T) - \tilde{d}^L(\ell_H, T)\right)^{2-p} \tag{10}$$

$$\begin{gathered}
\textit{subject to} \\
T \in \{-10, \dots, 10\} \\
\ell_H = \{0, \dots, 9\} \\
\tilde{v}^i(\ell_H, T) - \tilde{d}^i \geq 0 \;\; \textit{for} \;\; i = \{H, L\}
\end{gathered}$$

Substituting the agreement and disagreement values from (9) in (10) we obtain:

$$\begin{gathered}
\max_{(\ell_H, T)} (-T + (\ell_H - 4)(E[y_H] + \mu) - (\boldsymbol{C}(\ell_H) - \boldsymbol{C}(4)))^p \times \\
(T + (5 - \ell_H)(E[y_L] + \mu) - (\boldsymbol{C}(9 - \ell_H) - \boldsymbol{C}(4)))^{2-p} \\
\textit{subject to} \\
T \in \{-10, \dots, 10\} \\
\ell_H = \{0, \dots, 9\} \\
\tilde{v}^i(\ell_H, T) - \tilde{d}^i \geq 0 \;\; \textit{for} \;\; i = \{H, L\}
\end{gathered}$$

where $\boldsymbol{C}(.) = C_I(.) - C_B(.)$. That is, we add the costs from non-irrigated tiles and from border tiles into a single cost parameter that depends on the total number of accrued land tiles. We substitute the parameter values employed in our experimental setting to simplify the expression above. Then, the Nash bargaining solution is given by the maximization of

$$\max_{(\ell_H,T)} \left(-T + \ell_H(4+\mu) - 12 - 4\mu - \boldsymbol{C}(\ell_H)\right)^p \left(T + (9-\ell_H)(3+\mu) - 8 - 4\mu - \boldsymbol{C}(9-\ell_H)\right)^{2-p} \tag{11}$$

$$\begin{gathered} \textit{subject to} \\ T \in \{-10, \ldots, 10\} \\ \ell_H = \{0, \ldots, 9\} \\ \tilde{v}^i(\ell_H, T) - \tilde{d}^i \geq 0 \;\; \textit{for} \;\; i = \{H, L\} \end{gathered}$$

The first order condition with respect to T yields:

$$T(\ell_H) = \frac{(8-p)}{2}\ell_H + \frac{(2\ell_H - p - 8)}{2}\mu - \frac{7p}{2} - 12 - \frac{(2-p)\boldsymbol{C}(\ell_H) - p\boldsymbol{C}(9-\ell_H)}{2} \tag{12}$$

Solution with null affective value and unconstrained land allocations

Substituting $\mu = 0$ into (12) we get:

$$T(\ell_H; p, \mu) = \frac{(8-p)}{2}\ell_H - \frac{7p}{2} - 12 - \frac{(2-p)\boldsymbol{C}(\ell_H) - p\boldsymbol{C}(9-\ell_H)}{2} \tag{13}$$

Given the values of $\boldsymbol{C}(.)$ that we present in Table (1), $T(\ell_H) \geq 10$ for $(\ell_H = 9, p < 5/3)$, $(\ell_H = 8, p < 10/9)$, and $(\ell_H = 7, p < 1/3)$. Similarly, $T(\ell_H) \leq -10$ for $(\ell_H = 1, p \geq 1), (\ell_H = 0)$. Thus, in the solution to the maximization problem the optimal transfer must satisfy:

$$T^* = \begin{cases} 10 & \text{if } (\ell_H = 9, p < 5/3), (\ell_H = 8, p < 10/9), (\ell_H = 7, p < 1/3) \\ -10 & \text{if } (\ell_H = 1, p \geq 1), (\ell_H = 0) \\ T(\ell_H) & \text{otherwise} \end{cases} \tag{14}$$

By inspection of the values of $W(\ell_H, T^*; p, \mu)$, for every possible land configuration and every $p \in (0, 2)$, we can verify that the solution to the maximization problem in (10) with $\mu = 0$ is given by

$$(\ell_H^*, T^*) = \begin{cases} (9, 20-6p) & \text{if } \; p > 5/3, \;\; p < 2 \\ (9, 10) & \text{if } \; p \geq 1, \;\; p \leq 5/3 \\ (8, 10) & \text{if } \; p \geq \frac{ln(4/5)}{ln(2/5)}, \;\; p \leq 1 \\ (7, 10) & \text{if } \; p > 0, \;\; p \leq \frac{ln(4/5)}{ln(2/5)} \end{cases}$$

Note that only a subset of interior solutions is attainable since tokens are not divisible. Also, note that when $p = 1$ there are two possible solutions to the bargaining problem with a transfer of 10 tokens from player H to player L and player land allocations [9:0] and [8:1].

Solution with null affective value and constrained land allocations

In the constrained condition, the choice set of players only includes land allocations [9:0] and [0:9]. For $p \in [1, 2)$ the solution to the bargaining problem that we presented before is feasible with this restricted choice set. For $p \in (0, 1)$ the new solution is given by $(\ell_H^*, T^*) = (9, 10)$, which still gives both players a larger payoff than the outside option (i.e., $\tilde{v}^i(9, 10) - \tilde{d}^i \geq 0$ for $i = \{H, L\}$). Thus, the solution to the Nash bargaining problem with the constrained choice set is $(\ell_H^*, T^*) = (9, 10)$ for every $p \in (0, 2)$

Solution with positive affective value and unconstrained land allocations

We first derive the solution to the bargaining problem with $\mu > 0$ and symmetric bargaining ability (i.e., $p = 1$). This allows us to gain some intuition about the implications of including in the model the over-valuation of land tiles. Then, we present some results for alternative values of p.

As before, we substitute in equation (12) the values of $\boldsymbol{C}(.)$ reported in Table 1 for every possible land allocation, and find the values of μ for which the token constraint $T \in [-10, 10]$ is binding. Then, we compute the values of $W(\ell_H, T; p, \mu)$ for every T^* and every land allocation $\ell_H \in \{9, \ldots, 0\}$. The following expression characterizes the solution to the Nash bargaining problem when there is a positive affective value of land and bargaining ability is symmetric across players

$$(\ell_H^*, T^*) = \begin{cases} (8, 10) & \text{if } \; 0 < \mu \leq \tilde{\mu}_1 \\ (7, 10) & \text{if } \; \tilde{\mu}_1 < \mu \leq \tilde{\mu}_2 \\ (6, \frac{9+3\mu}{2}) & \text{if } \; \tilde{\mu}_2 < \mu \leq \tilde{\mu}_3 \\ (6, 10) & \text{if } \; \tilde{\mu}_3 < \mu \leq \tilde{\mu}_4 \\ (5, \frac{2+\mu}{2}) & \text{if } \; \tilde{\mu}_4 < \mu \leq \tilde{\mu}_5 \\ (5, 10) & \text{if } \; \tilde{\mu}_5 < \mu \leq \overline{\mu} \end{cases}$$

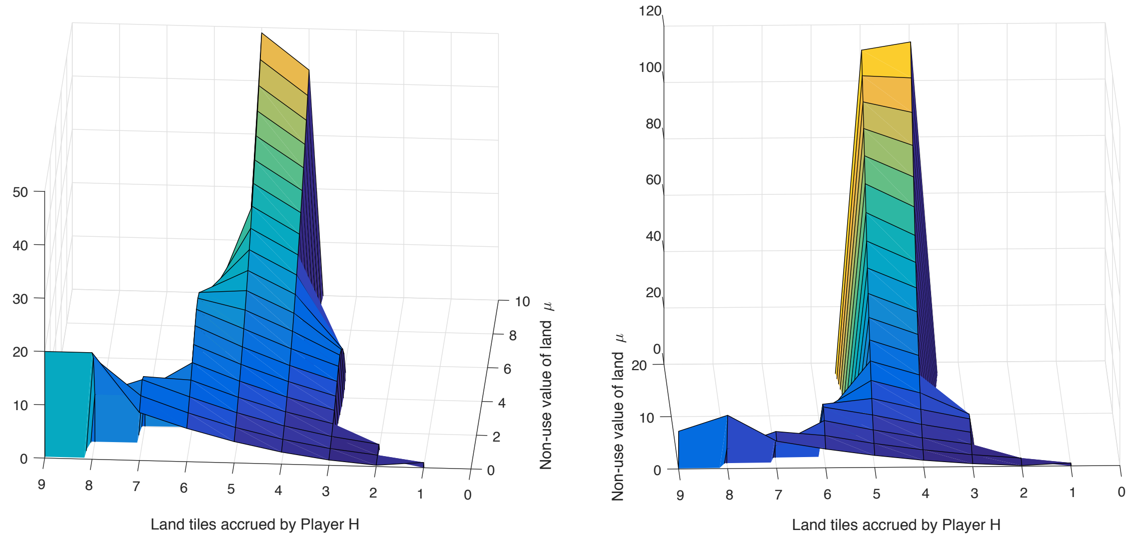
where $\tilde{\mu}_1 = \frac{-2+\sqrt{14}}{2}$, $\tilde{\mu}_2 = \frac{21+2\sqrt{79}}{25}$, $\tilde{\mu}_3 = \frac{11}{3}$, $\tilde{\mu}_4 = \frac{34+2\sqrt{37}}{9}$, and $\mu_5 = 18$.

Note that as μ increases the equilibrium land allocation becomes more egalitarian and less efficient. Also, in contrast to the case when $\mu = 0$, the land allocation [9:0] is no longer a solution to the Nash bargaining problem. This is true because it is no longer possible for player H to compensate, with her token endowment, player L for leaving the game without land tiles.

Figures A1.1 and A1.2 display the three-dimensional and two-dimensional plots summarizing the results of the computation of the value function given by equation (11) for every possible land allocation and $\mu \geq 0$. Both figures contain the simulation outputs of two scenarios. On the left panel, a case in which the players' bargaining abilities are symmetric ($p = 1$) and $\mu \in \{0, 0.5, 1, \ldots, 10\}$. On the right panel, a case in which payoffs from player L have a relatively larger weight than the payoffs from player H ($p = 0.75$, interpreted as asymmetric bargaining abilities) and $\mu \in \{0, 1, 2, \ldots, 18\}$.

Figure A1.1 is useful to describe two features of our model. First, when $\mu = 0$, the land allocations maximizing equation (11) are [9:0] and [8:1] (i.e., player H keeps at least 8 tiles). In other words, if the affective value of land is zero, the bargaining model predicts

Figure A1.1: Value function from Nash bargaining (eq. 10) evaluated in the optimal transfer.



Note: The front axis represents the tiles kept by player H (ℓ_H). The axis running from the front to the bottom represents the effect of an increase of the non-use value of land μ. The vertical axis represents the value attained for each combination of (ℓ_H, μ). Only positive values (i.e., agreements validated by both players) are plotted. **Left panel:** simulation with $p = 1$ (symmetric bargaining ability) and $\mu \in [0, 10]$. **Right panel:** simulation with $p = 0.75$ (asymmetric bargaining ability giving more weight to player L's payoffs) and $\mu \in [0, 18]$.

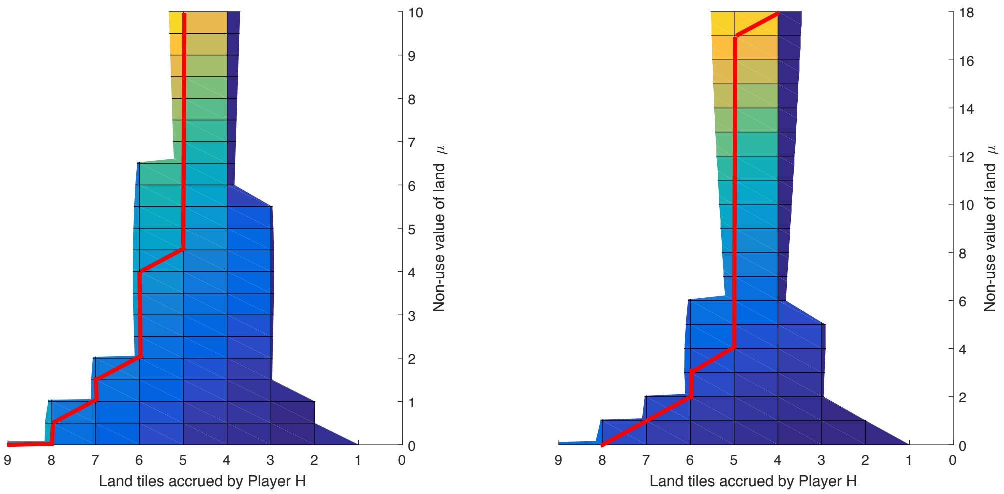
that players H and L would reach the most efficient outcomes. Second, as μ increases, the global maximum in the plotted function moves toward the [5:4] allocation. Moreover, the combinations of (ℓ_H, μ) yielding positive values in equation (11) shrink. These results illustrate the main point from our model: as μ increases, the optimal solution moves toward more egalitarian land divisions.

The comparison of solutions for the maximization problem is more tractable in a two-dimensional space. Figure A1.2 reports the value function in the form of a heatmap, with land allocation (ℓ_H) in the horizontal axis and affective value (μ) in the vertical axis. The red line highlights the optimal land allocation for each value of μ. The right panel, along with some additional simulations not reported in this manuscript, reveal for a sufficiently large μ and a greater bargaining ability of Player L with respect to Player H ($p < 1$), the land allocation that maximizes the function $W()$ is [4:5].

Solution with positive affective value and constrained land allocations

When players are not allowed to divide the land and $\mu > 0$ the maximization problem in (11) turns into:

Figure A1.2: Heatmap of the value function from Nash bargaining (eq. 10).



Note: Bi-dimensional representation of the value function from Figure A1.1. The horizontal axis represents the tiles kept by player H (ℓ_H). The vertical axis represents the effect of an increase of the non-use value of land μ. Warmer color tones represent higher values in eq. (10). The red line represents the optimal land allocation for each value of μ. Only positive values (i.e., agreements validated by both players) are plotted, remaining areas are colored in white. **Left panel:** simulation with $p = 1$ (symmetric bargaining ability) and $\mu \in [0, 10]$. **Right panel:** simulation with $p = 0.75$ (asymmetric bargaining ability giving more weight to player L's payoffs) and $\mu \in [0, 18]$.

$$\max_{(\ell_H,T)} \left(-T + \ell_H(4+\mu) - 12 - 4\mu - \boldsymbol{C}(\ell_H)\right)^p \left(T + (9-\ell_H)(3+\mu) - 8 - 4\mu - \boldsymbol{C}(9-\ell_H)\right)^{2-p} \tag{15}$$

$$\begin{gathered} \textit{subject to} \\ T \in \{-10, \dots, 10\} \\ \ell_H = \{0, 9\} \\ \tilde{v}^i(\ell_H, T) - \tilde{d}^i \geq 0 \;\; \textit{for} \;\; i = \{H, L\} \end{gathered}$$

For symmetric bargaining ability ($i.e.$, $p = 1$), the land allocation [9:0] strictly dominates the allocation [0:9] for any value of μ. Also, player L will only agree on the land allocation [9:0] for values of μ that are sufficiently low. In particular, given the constraint on T

$$\tilde{v}^L(9, T) - \tilde{d}^L \geq 0 \iff \mu \geq 1/2,\, T = 10$$

Thus, the solution to the maximization problem in this case is characterized by

$$(\ell_H^*, T^*) = (9, 10) \quad \text{if} \;\; 0 < \mu \leq 1/2$$

Otherwise, if players cannot divide the land, an affective value of land above $\mu > 1/2$ will result in a disagreement outcome.

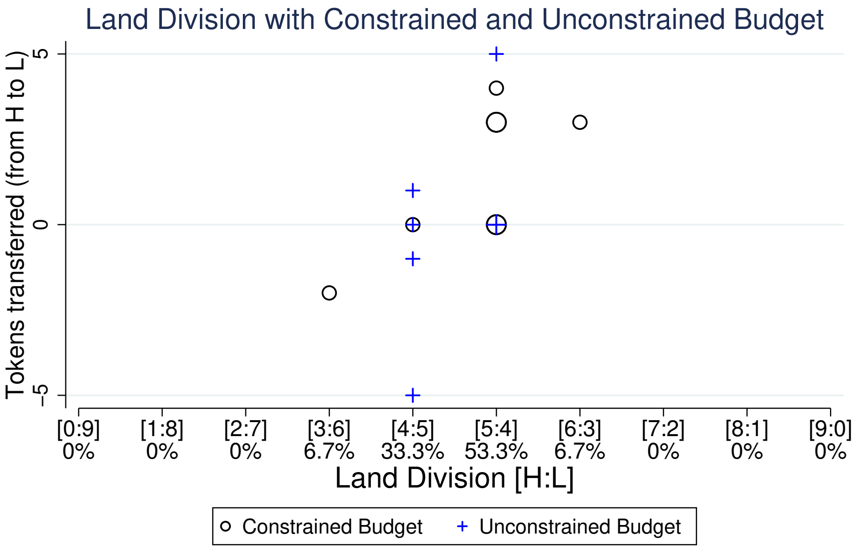


Figure A1.3: Observed agreements in the pilot study.

Note: The hollow circles represent agreements in the *Constrained budget* condition, and the crosses (+) represent agreements in the *Unconstrained budget* condition. The percentage of agreements for each land division $[\ell_H : \ell_L]$ is reported in the horizontal axis. The size of the transfer T is reported in the vertical axis. The size of each market is larger when there are two observations in a given coordinate (i.e., land division and transfer are repeated).

A.2 Results from the Pilot Study with Budget Constraints

We conducted in Lebrija (Santander) a pilot of our experimental design the month before the beginning of the fieldwork. The original pilot included the exogenous variation between *High Uncertainty* and *Low Uncertainty*. However, instead of the variation between *Constrained* and *Unconstrained* land divisions, the initial experimental design included an exogenous variation in the number of endowed tokens that players can use in their transfer T as part of the proposed agreement. We call this exogenous variation the *Constrained budget* and *Unconstrained budget* conditions. This design gave us an originally different 2×2 experimental design.

We conducted eight sessions in the pilot study, two per treatment cell, with four participants per session except in one of the sessions with *High Uncertainty* and *Unconstrained budget*, in which we only had two participants. Figure A1.3 displays the observed agreements across the *Constrained budget* (hollow circles) and *Unconstrained budget* (crosses) conditions. Note that the land division [5:4] accounts for 53.3% of the agreements, and no extreme land allocations are observed in any of the fifteen bargaining pairs. Although the only two agreements outside the [5:4] and [4:5] divisions occurred in the *Constrained budget*, the differences in land allocations between the *Constrained* and *Unconstrained budget* conditions are not statistically significant (Chi-squared test, $p-$value 0.235).

The observed transfers were never constrained by the maximum amount of transferable tokens in each condition. The maximum observed transfer in the *Unconstrained budget* condition is 5 (out of 10) tokens, whereas the maximum observed transfer in the *Constrained* *budget* condition is 4 (out of 5) tokens. Besides, we do not observe differences in the average agreed transfers between treatments. The average transfer in the *Unconstrained budget* condition is 0 ± 1.11 tokens, and in the *Unconstrained budget* condition is 1.38 ± 0.75 tokens (t-test for the difference has a $p-$value of 0.315). We thus concluded that the budget constraint was not binding given the prevalence of egalitarian land divisions, and therefore we replaced the budget constraint for a constraint in allowed allocations.

A.3 Additional Tables

Table A.1 reports agricultural characteristics of the municipalities in the sample. Tables A.2 to A.4 report balance between experimental conditions and within roles in the lab-in-the-field experiment. Tables A.6 to A.8 report balance between experimental conditions and within roles in the replication conducted with students.

Table A.1: General characteristics of municipalities in the sample

Municipality	Total population	Share of rural population (%)	Mean distance to closest city (driving hrs.)	Main crop	Average farm size (ha.)	Farm size 25th percentile (ha.)	Farm size 75th percentile (ha.)
California	2,020	45.6	1.96	Potato	15.55	0.49	10.26
Confines	2,698	85.0	2.86	Coffee	6.64	1.03	7.71
El Playón	11,520	51.2	1.22	Cocoa	24.71	4.59	24.68
Matanza	5,201	79.1	1.33	Coffee	16.99	2.75	11.83
Ocaña	99,741	9.1	4.12	Tomato	24.06	2.29	16.96
Rionegro	26,680	74.4	0.73	African palm oil	29.80	3.28	17.27
Simacota	7,593	67.1	3.77	African palm oil	27.37	0.55	21.30
Vélez	18,932	45.7	1.89	Sugar cane (Panela)	10.16	0.49	6.07

Population are 2017 projections estimated by DANE. Mean distance to closest city is the driving distance calculated on September 28th, 2018, at 4 a.m. according to Google maps. The closest city to California, El Playn, Matanza and Rionegro is Bucaramanga. The closest to Confines, Simacota and Vlez is Tunja, and for Ocaa it is Ccuta. The main crop is defined according to share in the total cultivated area reported by EVA in 2016. Farm size statistics are calculated using CNA, 2014.

Table A.2: Balance between treatments: Low and High Uncertainty conditions

Variable	N (obs.)	Low Uncertainty	High Uncertainty	Diff.	$p-$value
Gender (=1 if male)	255	0.45	0.54	-0.09	0.15
Age	244	39.19	41.78	-2.59	0.18
Education (years)	256	9.36	7.48	1.88	0.00
Marital status	256				0.54
Domestic partnership		0.38	0.30		
Married		0.34	0.35		
Widowed/Divorced		0.07	0.09		
Single		0.21	0.27		
Farmer	255	0.51	0.54	-0.03	0.66
Income (1,000 COP/month)	215	613,01	545,64	67,38	0.43
Adults in Household	253	2.71	2.70	0.01	0.96
Children in Household	178	1.84	1.83	0.01	0.94
Siblings	256	4.84	5.49	-0.66	0.06
Risk[a]	251	6.64	6.48	0.16	0.61
Has credits with banks?	255	0.69	0.68	0.01	0.86
Household owns farm	256	0.84	0.84	0.00	1.00
Years with farm	215	19.89	18.62	1.27	0.60
Land acquisition (owners only)	200				0.95
Purchase		0.62	0.61		
Inheritance		0.33	0.32		
Possession		0.02	0.03		
Other		0.03	0.04		
Type of land tenure (not owners)	31				0.26
Possession		0.38	0.20		
Unformalized inheritance		0.13	0.40		
Rent		0.31	0.33		
Other		0.19	0.07		
Most important life goal	255				0.63
A job in the city		0.03	0.04		
A college degree		0.15	0.17		
Work his/her own land		0.27	0.20		
Being a landowner		0.55	0.60		

[a] Willingness to take risks elicited using Dohmen et al. (2011) risk elicitation question. $p-$value reported for t tests in the case of continuous and dichotomous variables. $p-$value reported for Chi-squared tests in the case of categorical variables. Categories listed in italics.

Table A.3: Balance between treatments: Unconstrained and Constrained conditions

Variable	N (obs.)	Unconstrained	Constrained	Diff.	$p-$value
Gender (=1 if male)	255	0.49	0.50	-0.01	0.85
Age	244	38.02	42.92	-4.89	0.01
Education (years)	256	8.45	8.40	0.05	0.93
Marital status	256				0.61
Domestic partnership		0.37	0.30		
Married		0.33	0.37		
Widowed/Divorced		0.06	0.09		
Single		0.24	0.23		
Farmer	255	0.48	0.57	-0.10	0.12
Income (1,000 COP/month)	215	547,55	608,68	-61,13	0.47
Adults in Household	253	2.71	2.71	0.00	0.99
Children in Household	178	1.80	1.88	-0.08	0.58
Siblings	256	5.13	5.20	-0.08	0.83
Risk[a]	251	6.91	6.21	0.70	0.03
Has credits with banks?	255	0.69	0.68	0.01	0.93
Household owns farm	256	0.85	0.82	0.03	0.50
Years with farm	215	16.54	22.03	-5.49	0.02
Land acquisition (owners only)	200				0.62
Purchase		0.65	0.58		
Inheritance		0.31	0.34		
Possession		0.02	0.03		
Other		0.02	0.05		
Type of land tenure (not owners)	31				0.30
Possession		0.31	0.27		
Unformalized inheritance		0.13	0.40		
Rent		0.44	0.20		
Other		0.13	0.13		
Most important life goal	255				0.27
A job in the city		0.03	0.04		
A college degree		0.20	0.12		
Work his/her own land		0.24	0.22		
Being a landowner		0.53	0.63		

[a] Willingness to take risks elicited using Dohmen et al. (2011) risk elicitation question. $p-$value reported for t tests in the case of continuous and dichotomous variables. $p-$value reported for Chi-squared tests in the case of categorical variables. Categories listed in italics.

Table A.4: Balance within treatments: Role Assignment as Player H or Player L

Variable	N (obs.)	Player L	Player H	Diff.	$p-$value
Gender (=1 if male)	255	0.54	0.46	0.07	0.24
Age	244	41.75	39.23	2.52	0.19
Education (years)	256	8.34	8.50	-0.16	0.78
Marital status	256				0.96
Domestic partnership		0.34	0.33		
Married		0.34	0.35		
Widowed/Divorced		0.07	0.09		
Single		0.24	0.23		
Farmer	255	0.49	0.56	-0.07	0.24
Income (1,000 COP/month)	215	639,92	516,59	123,33	0.14
Adults in Household	253	2.65	2.76	-0.11	0.50
Children in Household	178	1.79	1.88	-0.09	0.53
Siblings	256	5.21	5.12	0.09	0.79
Risk[a]	251	6.72	6.39	0.33	0.31
Household owns farm	256	0.85	0.82	0.03	0.50
Farm ownership	215	0.95	0.94	0.01	0.70
Years with farm	215	20.73	17.70	3.04	0.20
Land acquisition (owners only)	200				0.03
Purchase		0.55	0.68		
Inheritance		0.38	0.27		
Possession		0.05	0.00		
Other		0.02	0.05		
Type of land tenure (not owners)	31				0.17
Possession		0.42	0.08		
Unformalized inheritance		0.26	0.25		
Rent		0.21	0.50		
Other		0.11	0.17		
Most important life goal	255				0.66
A job in the city		0.05	0.02		
A college degree		0.16	0.15		
Work his/her own land		0.24	0.22		
Being a landowner		0.55	0.61		

[a] Willingness to take risks elicited using Dohmen et al. (2011) risk elicitation question. $p-$value reported for t tests in the case of continuous and dichotomous variables. $p-$value reported for Chi-squared tests in the case of categorical variables. Categories listed in italics.

Table A.5: Summary Statistics from Undergraduate Students in the Replication Experiment

Variable	N	Media	Std. Dev.	Min.	Max.
Gender (=1 if male)	120	0.53	0.50		
Age	120	19.30	2.10	16	26
Major	119				
Sciences and engineering		0.54			
Human sciences		0.39			
Other		0.08			
Mother's occupation	120				
Skilled non-agricultural occupation		0.25			
Unskilled non-agricultural occupation		0.72			
Other		0.03			
Father's occupation	117				
Agricultural occupation		0.07			
Skilled non-agricultural occupation		0.27			
Unskilled non-agricultural occupation		0.51			
Other		0.15			
Siblings	119	1.94	1.35	0	8
Risk[a]	120	7.20	1.53	1	10
Household owns farm	120	0.34	0.48		
Most important life goal	117				
A job in the city		0.14			
A college degree		0.59			
Work his/her own land		0.10			
Being a landowner		0.17			
Acquaintances	120	0.15	0.36		

Table A.6: Balance between treatments in the students sample: Low and High Uncertainty conditions

Variable	N (obs.)	Low Uncertainty	High Uncertainty	Diff.	*p-value*
Gender (=1 if male)	120	0.53	0.52	0.02	0.86
Age	120	19.77	18.83	0.93	0.01
Major	119				0.80
Sciences and engineering		0.51	0.57		
Human sciences		0.41	0.37		
Other		0.08	0.07		
Mother's occupation	120				0.40
Skilled non-agricultural occupation		0.30	0.20		
Unskilled non-agricultural occupation		0.68	0.77		
Other		0.02	0.03		
Father's occupation	117				0.43
Agricultural occupation		0.03	0.10		
Skilled non-agricultural occupation		0.25	0.29		
Unskilled non-agricultural occupation		0.56	0.47		
Other		0.15	0.14		
Siblings	119	1.90	1.98	-0.09	0.73
Risk[a]	120	7.37	7.03	0.33	0.23
Household owns farm	120	0.37	0.32	0.05	0.57
Most important life goal	117				0.82
A job in the city		0.12	0.16		
A college degree		0.63	0.55		
Work his/her own land		0.08	0.12		
Being a landowner		0.17	0.17		

Table A.7: Balance between treatments in the students sample: Unconstrained and Constrained conditions

Variable	N (obs.)	Unconstrained	Constrained	Diff.	*p-value*
Gender (=1 if male)	120	0.50	0.57	-0.07	0.44
Age	120	19.10	19.70	-0.60	0.14
Major	119				0.75
Sciences and engineering		0.53	0.55		
Human sciences		0.38	0.40		
Other		0.09	0.05		
Mother's occupation	120				0.44
Skilled non-agricultural occupation		0.24	0.28		
Unskilled non-agricultural occupation		0.72	0.72		
Other		0.04	0.00		
Father's occupation	117				0.98
Agricultural occupation		0.06	0.08		
Skilled non-agricultural occupation		0.27	0.28		
Unskilled non-agricultural occupation		0.53	0.49		
Other		0.14	0.15		
Siblings	119	1.82	2.17	-0.35	0.18
Risk[a]	120	7.22	7.15	0.07	0.80
Household owns farm	120	0.33	0.38	-0.05	0.59
Most important life goal	117				0.23
A job in the city		0.13	0.15		
A college degree		0.54	0.69		
Work his/her own land		0.13	0.05		
Being a landowner		0.21	0.10		

Table A.8: Balance within treatments in the students sample: Role Assignment as Player H or Player L

Variable	N (obs.)	Player L	Player H	Diff.	*p-value*
Gender (=1 if male)	120	0.45	0.60	-0.15	0.10
Age	120	19.38	19.22	0.17	0.67
Major	119				0.17
Sciences and engineering		0.54	0.53		
Human sciences		0.34	0.43		
Other		0.12	0.03		
Mother's occupation	120				0.79
Skilled non-agricultural occupation		0.23	0.27		
Unskilled non-agricultural occupation		0.73	0.72		
Other		0.03	0.02		
Father's occupation	117				0.74
Agricultural occupation		0.07	0.07		
Skilled non-agricultural occupation		0.29	0.25		
Unskilled non-agricultural occupation		0.47	0.56		
Other		0.17	0.12		
Siblings	119	1.92	1.97	-0.05	0.84
Risk[a]	120	7.30	7.10	0.20	0.48
Household owns farm	120	0.37	0.32	0.05	0.57
Most important life goal	117				0.63
A job in the city		0.12	0.16		
A college degree		0.64	0.53		
Work his/her own land		0.10	0.10		
Being a landowner		0.14	0.21		

Table A.9: OLS Regressions in the students sample

	Efficiency		Inequality		Pr(H keeps plot)	
	(1)	(2)	(3)	(4)	(5)	(6)
High Uncertainty	0.90	0.60	2.10	0.54	0.05	0.02
	(0.93)	(0.88)	(3.54)	(3.26)	(0.11)	(0.10)
Constrained Division	5.80***	5.52***	7.70***	6.43**	0.70***	0.66***
	(1.32)	(1.33)	(2.77)	(2.94)	(0.15)	(0.15)
High Uncert. $\times$ Const. Division	0.00	0.42	-2.80	-1.12	0.05	0.11
	(1.74)	(1.76)	(4.17)	(4.22)	(0.20)	(0.20)
H's family has land		0.37		2.22		-0.00
		(0.89)		(3.08)		(0.10)
L's family has land		1.07		2.00		0.11
		(0.81)		(2.48)		(0.09)
Major						
(baseline: other)						
H: Sciences and engineering		1.68*		6.09		0.20**
		(0.94)		(3.68)		(0.10)
L: Sciences and engineering		1.98*		7.05		0.30**
		(1.10)		(4.58)		(0.12)
H: Human sciences		0.82		3.68		0.04
		(1.02)		(3.73)		(0.11)
L: Human sciences		-0.33		0.80		0.05
		(0.92)		(3.85)		(0.10)
Observations	60	59	60	59	60	59
R-squared	0.47	0.57	0.10	0.25	0.51	0.61

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

A.4 Experimental Protocol

General Instructions

Welcome. We want to thank you for your participation in this activity, which will last for approximately one hour. It includes the explanation of the game (about 35 minutes), playing the game (10 minutes) and a short survey at the end (10 minutes). Once the survey is completed we will give you the earnings from the game. This activity has been funded by Universidad del Rosario.

This is a bargaining game in which you and the person with whom you are matched to play the game have jointly inherited a land plot that [*you will have to divide / one of you will keep*]. Each one of you have also inherited some tokens that represent cash. You can use these tokens in case you want to keep [*a larger share of /*] the plot. We will explain how are computed your earnings based on the number of tokens and [*the number of tiles from the land plot you keep / who keeps the land plot*] at the end of the game.

It is important to clarify that earnings from this game do not correspond to a participation fee, so we expect that you participate in other research activities in the future, even if there will be no payment. We introduce earnings to make sure your game decisions have economic consequences, so they seem closer to your everyday decisions. The other participants in this activity will not know, during or after the experiment, anything about your earnings or about your responses in the survey. The game rules you are about to hear might be different from the rules that apply when other participants from this municipality took part in the game. Therefore, the comments you might have heard do not necessarily apply.

Introduction: the Land Division

This activity aims at understanding the production and division decisions of agricultural land in {name of municipality}. You have jointly inherited the plot "The Triangle," composed of nine smaller tiles of equal size [*that you will have to divide /*]. In addition, each one of you have inherited 10 tokens.

`(The monitor delivers the triangular map and the tokens)`

At the end of the game, for each tile you own you will receive a die. [*If you keep one tile, you receive one die; you keep two tiles, you receive two dice, and so on./ If you keep the land plot, with nine tiles, you will receive nine dice.*] All dice will be rolled simultaneously inside a box. The sum of all dice outcomes will be your total output, which will be exchanged for tokens. We will explain later other land production rules in this game.

Keeping [*more tiles / the land plot*] means [*a higher production / you will have an output*] after rolling the dice, but you will need to agree with the other person how many tokens will be exchanged to accept the proposal. You are allowed to use all your tokens in the bargaining game. [*It is possible that one of you keep all nine tiles, or that you find an acceptable division of the plot. / One of you will have to keep all nine tiles, since agreements with land division are not allowed.*]

Keeping [*all, or most, of the tiles / the land plot*] is good because you will roll [*more / the*] dice, so you can produce more tokens. But you will have to bargain on how many of the 10 tokens you will give to the other person.

At the end of the game you will receive $1.000 (Colombian pesos) for every token you own. All the yellow (originally endowed) tokens and all the output tokens are taken into account to compute your earnings.

Land Production

The output of each tile in the land plot could be good, average, or poor. Since not every person is equally productive with land, one of you will roll big dice and the other one will roll small dice at the end of the game. With the big dice, the output per tile could be [**3, 4, or 5 / 2, 4, or 6**] tokens. With the small dice, the output per tile could be [**2, 3, or 4 / 1, 3, or 5**] tokens. Since each number appears twice in each die, the probability that the output of each tile is good, average, or poor is the same.

We will divide you into two groups of players. Each one of you will roll a plastic die. The two persons with the highest number wil form and group, and the two persons with the lowest number will form the other group.

Now we will decide who will have the big and the small dice in each group. Each one will roll again the die, and the person in each group with the highest number will keep the big dice and the other will keep the small dice.

```
 (The monitor assigns participants into groups using the dice rolls,
and then assigns the big and small dice. The monitor delivers just
one of the big/small dice to each participant.)
```

Production Costs: Water

Two out of the three triangles sides are marked with a blue line. This blue line represents the water stream that covers some of the tiles. A tile has access to water when one of the sides of the tile is covered by the blue line. If this is the case, a drop of water is drawn in the middle of the tile. In total, five tiles have access to water, and four tiles do not have access to water.

In the tiles with access to water the production cost is zero. In the tiles without access to water the production cost is one. When we compute your earnings, we will substract one token for each tile without access to water.

Production Costs: Boundaries

[*To be read only in the unconstrained condition*] If you decide to divide the land plot you will need to set the boundaries that divide each person's tiles. When one of you makes a proposal on how to divide the land, we will put one of these red logs to draw the boundaries. Each red log drawing a boundary costs one token to each one of you. When we compute your earnings, we will substract one token for each red log.

```
 (The monitor draws a division and puts in the map the corresponding
red logs)
```

Computing Earnings

You will receive $1.000 (Colombian pesos) for every token you kept at the end of the game. Remember there are two strategies to accrue tokens. You can keep your own tokens and demand tokens from the other person in exchange for land tiles; or you can keep tiles and produce additional tokens by rolling the dice. Remember that you will have a deduction in your earnings for each tile without access to water[*, and for each red log drawing a boundary* /].

The following is a step-by-step summary of instructions:

1. Decide how many tokens would be acceptable [*for the proposed land division and mark the boundaries with the red logs / to leave the land plot to the other person*].
2. Verify the minimum and maximum production according to [*the proposed land division and / whom keeps the land plot*].
3. Subtract one token per tile without access to water [*and per red log* /].
4. Sum the minimum and maximum output after costs and your remaining tokens.
5. Multiply by $1.000 (Colombian pesos) the final number of tokens

Example

[*Unconstrained condition.* See Figure A1.4]

1. You have the big dice. You propose to keep 6 tiles in exchange for 3 tokens.
2. Your minimum output per tile is [**3** / **2**] and your maximum output per tile is [**5** / **6**] tokens. With your six tiles your minimum output is [**18** / **12**] and your maximum output is [**30** / **36**] tokens.
3. Your production cost is 5 tokens. Three tiles do not have access to water and you use two red logs to draw the boundaries.
4. Subtracting your costs and the 3 tokens you give to the other person, your minimum number of tokens will be [**10+18-5-3 = 20** / **10+12-5-3 = 14**] and your maximum number of tokens will be [**10+30-8 = 32** / **10+36-8 = 38**].
5. Your earnings will be between [**$20.000 and $32.000** / **$14.000 and $36.000**] (Colombian pesos) if you reach this agreement.

Example

[*Constrained condition*]

1. You have the big dice and propose to keep the plot in exchange for 9 tokens.

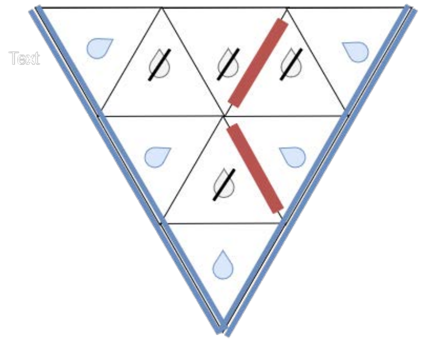


Figure A1.4: Example with a [6:3] plot division.

2. Your minimum output per tile is [**3 / 2**] and your maximum output per tile is [**5 / 6**] tokens. With the nine tiles your minimum output is [**27 / 18**] and your maximum output is [**45 / 54**] tokens.

3. Your production cost is 4 tokens from the tiles that do not have access to water.

4. Subtracting your costs and the 9 tokens you give to the other person, your minimum number of tokens will be [**10+27-4-9 = 24 / 10+18-4-9 = 15**] and your maximum number of tokens will be [**10+45-13 = 42 / 10+54-13 = 51**].

5. Your earnings will be between [**$24.000 and $42.000 / $15.000 and $51.000**] (Colombian pesos) if you reach this agreement.

How to bargain?

You will have 5 minutes to bargain. We will not be present during the bargaining phase, but the conversation will be recorded. This will help us to understand which are the key elements in the bargaining process. Please let us know if you reach an agreement before the time is over.

Any of you can make a proposal. The bargaining might include a tranfer, that must be of at most the 10 endowed tokens. [*You can make an agreement in which the plot is divided, or not, and you might use, or not, the endowed tokens. / Remember that one of you must keep the land plot*].

Once the time is over the player with the big die will make a proposal including [*the land division / who keeps the plot*] and the proposed tokens to be demanded or given. We will record this proposal in the contract sheet. Then, the player with the small die will decide whether to accept or reject the proposal. In case of rejection, he/she could make a counterproposal including [*the land division / who keeps the plot*] and the proposed tokens to be demanded or given. This is the last chance to reach an agreement.

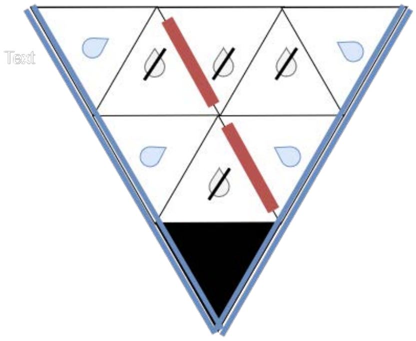


Figure A1.5: Land division if an agreement is not reached.

What happens when an agreement is not reached?

Each person keeps the 10 endowed tokens and received two tiles with access to water, and two tiles without access to water as is shown in the map (see Figure A1.5). Under this land division one of the tiles is lost due to the lawyers' fees to reach this arrangement. In addition, due to the boundaries, each player has an additional production cost of two tokens.

End of the Game

In private, I will give you a die for each tile owned at the end of the game. You will roll all dice inside a box, and only the two of us will know the outcome. In other words, the other person will not know your dice roll outcome nor your final earnings.

`(The coordinator asks if there are questions.)`

If there are no further questions we will read aloud the informed consent. This is a document in which you declare that you are here under your own will and that you have understood the rules of the game. And we declare that all the gathered information will be treated under confidentiality and only with academic purposes.

`(The coordinator reads the informed consent.)`

If you agree with the informed consent, please sign it.

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