Analyzing sugarcane production contracts in Brazil: What do the farmers really want?

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1.0 Introduction

Brazil is one of the world's leading ethanol producer, primarily from sugarcane, and was responsible for almost half of the world's sugarcane production in 2012 (Brazil 2013). The sugar-energy sector in Brazil accounts for approximately 2% of the country's Gross Domestic Product (Neves, Trombin, Consoli, 2011). Brazilian ethanol is produced from sugarcane, a crop that since its introduction in the country, has expanded from the North-Northeast Region to the Center-Southeast, particularly into the Cerrado region, the country's second largest biome. In the Cerrado, this expansion, a result of increasing demand for biofuels, has been most significant in the states of Goias (GO) and Mato Grosso do Sul (MS) (Shikida 2013). From 2000 to 2012 more than 40 mills have been constructed in these states (ProCana Brazil 2013). Although over 50% of Brazil's sugarcane production is located in the state of Sao Paulo, in 2014, these two states (GO and MS) had 1.5 million hectares planted with sugarcane and contributed to 15% of the total amount of sugarcane produced in the country (IBGE, 2016). In addition, the Sugarcane Agroecological Zoning, launched in 2010, mapped 12.6 million hectares in GO and 10.8 million hectares in MS as suitable areas for sugarcane production, promoting further expansion (Manzatto 2009).

Access to sugarcane is a vital factor in the location and operation of an ethanol plant (Queiroz 2008). Sugarcane used in the production of ethanol and sugar is usually obtained by (i) mills contracting directly with farmers or (ii) mills renting farm land and producing sugarcane themselves. A very small fraction is purchased on the open market. The two predominant methods of sugarcane procurement help mills guarantee their supply of sugarcane (Picanço Filho and Marin 2012). Due to time limitations between sugarcane harvesting and processing, as well as, transportation costs, mills acquire their sugarcane supply from lands within a certain radius. Thus, sugarcane is produced on land managed by autonomous farmers (40%) and, by ethanol companies

(mills) (60%). Farmers, may or may not, have a contract with mills (Almeida et al. 2007; Brazil 2013). Transition to sugarcane production in these states has not been smooth. The installation of a mill brings competition for the land which is not always welcomed by all. In fact, in Jatai, a County in Goias, grain farmers wanted to pass a law restricting the land occupied by sugarcane (O Popular 2011). All of this is dependent upon contracts made between farmers, landowners and the mills. By designing contracts that are appealing to landowners and farmers, mills can ensure their supply of sugarcane. Therefore, knowing the attributes and contract types farmers and landowners prefer, is pertinent for future sugarcane expansion.

Although sugarcane expansion in the Cerrado region has been the focus of many studies (Silvia and Miziara 2011; CONAB 2013; Shikida 2013) few have looked into contracts between sugarcane producers and mills (Sant'Anna 2016; Picanço Filho and Marin 2012; Picanço Filho and Marin 2012a). In fact, most of the Brazilian data on contracts comes from sporadic case studies (Almeida and Buainain 2016). No study has investigated farmers willingness to produce sugarcane under different contracts. Research on these contracts could help provide guidance for mills and farmers in contract design and the Brazilian government in policy-making. In particular, the government could design policies aiming at strengthening the contract enforcement, protecting the rights of both parties. The government has a special interest in motivating sugarcane expansion since the installation of a mill also brings benefits to the local community: economic development, improvement in the infrastructure, an increase in job opportunities for the local population, among others (Roberto 2012).

The purpose of this study is to examine landowners' and farmers' willingness to produce sugarcane under different contractual arrangements using a hypothetical stated choice experiment. The objective is to capture respondents' choice preferences with regards to marginal changes in

contract choices. Respondent's willingness to pay for certain contract attributes is estimated from stated choice model results.

2.0 Sugarcane Contracting

A contract is a legal document constraining signing parties. It is a means for an exchange to occur in the presence of transaction costs, asymmetric information and irreversible investments (Vavra 2009). Contracts vary according to the crop, available technology, market development, and other socio and demographic characteristics (Eswaran and Kotwal 1985). An increase in the use of contracts in agriculture is due to forces such as market consolidation, variations in trade patterns, technological developments, and logistic issues (Vavra 2009). These same forces, present in the Cerrado region, make it difficult for a farmer to sell sugarcane without a contract (Picanço Filho and Marin 2012).

A mill may seek to sign various types of contracts with farmers and landowners in order to balance the risks and disadvantages of each contract (Feltre and Paulillo 2015). Three types of contracts are currently used in Brazil: (1) land rental contracts – which give the local mill use of the land for sugarcane planting for a fixed value; (2) agricultural partnership contracts – which give the local mill use of the land for sugarcane planting for a percentage of the production; and (3) supply contracts – by which farmers agree to supply sugarcane to the local mill (Brazil 1966). Numbers from the last Agricultural Census shows 4,374 farms in GO and 2,974 in MS have a land rental contract, and 418 in GO and 282 in MS have an agricultural partnership contract (IBGE 2006; Almeida and Buainain 2016).

Land rental contracts allow mills to select the optimal amount of inputs for sugarcane production. Hence, the mill can control all stages of production, minimizing the risk of losing

sugarcane suppliers to another plant (Feltre and Paulillo 2015). The landowner transfers all of the risks associated with the production process to the mill. However, the risk to the mill of over-utilizing the land or other resources on it, is present (Almeida and Buainain 2016). Landowners may enter into a land rental contract for several reasons (Picanço Ferreira 2010): (1) they are undercapitalized due to previous crises in the rural sector; (2) the costs to form and maintain a sugarcane plantation are high; (3) they are resistant to entering a new sector; (4) the current labor regulations provide too many restrictions; (5) they do not wish to depend on climate and the risks of fire; and (6) they prefer a guaranteed periodical payment with reduced risks (Almeida and Buainain 2016).

The agricultural partnership contract allows the mill and the farmer to share the production risks. Though there is no incentive for over-utilization of the land, it motivates under-utilization of production inputs, since the producer is only entitled to a share of the yield (Almeida and Buainain 2016). The supply contract transfers the costs and risks associated with production to the producer, enabling the mill to concentrate solely on ethanol and sugar production. The mill, though, becomes reliant on the quality of the sugarcane supplied (Feltre and Paulillo 2015).

In Brazil, mills are willing to sign contracts with farmers and/or landowners whose land lies within a distance of 50km from it (Neves, Waack, and Marino 1998). This distance limitation helps to avoid high transportation costs and to prevent saccharose losses from the harvested sugarcane. Harvested sugarcane must be delivered and processed within 72 hours (Neves, Waack, and Marino 1998). In MS and GO most of the sugarcane supply comes from farms less than 40km away from the mill (CONAB 2013).

The distance limitation between mills and sugarcane suppliers increases the bargaining power in contract negotiation of landowners and farmers closer to mills (Picanço Filho and Marin

2012). Nevertheless, the presence of asymmetric information increases the mill's bargaining power when negotiating contracts (Picanço Filho and Marin 2012). A strong presence of the State promotes investments and longer contracts. By enforcing contracts, the State can prevent opportunistic behaviors from the agent and/or the principal (Watanabe and Zylberstein 2014). When the contract enforcement is weak, firms may opt to vertically integrate, internalizing all activities (Watanabe and Zylberstein 2014). In the agribusiness system, State intervention is focused on the farmer, the economically weaker party. This protects the farmer from rules imposed by the agro-industry, who holds more power (Watanabe and Zylberstein 2014).

Farmers are willing to enter into sugarcane production due to the lower risks and high returns it has in comparison to other agricultural or livestock activities (Picanço Filho and Marin 2012). Mills attract sugarcane suppliers by providing free seedling, technical assistance, and product delivery subsidies. Common clauses in contracts signed between mills and farmers are: (1) compensation for the sugarcane not bought by the mill called "cana bisada"; (2) payment methods exercised (i.e. 80% upon delivery and 20% at the end of the harvest year); (3) and fidelity[1] in selling the sugarcane (Picanço Filho and Marin 2012). On average contracts last for one or two sugarcane cycles (i.e. 6 or 12 years) (Picanço Filho and Marin 2012). At the end of the sugarcane cycle the land must be remediated in order for its productivity to be restored (Feltre and Paulillo 2015). Farmers are willing to sign longer contracts when the mill is financially stable (Feltre and Paulillo 2015).

Studies on contracts with varying autonomy and risk (Hudson and Lusk 2004), and on biofuel contracts have been conducted in the United States (Bergtold, Fewell, and Williams 2014) and in Australia (Windle and Rolfe 2005). Bergtold, Fewell, and Williams (2014) look into

[1] By fidelity we mean that the farmer can only supply sugarcane to a particular mill), though a mill may buy from many suppliers (Neves, Waack and Marino 1998).

farmer's willingness to produce biofuel under different contract options using a stated choice experiment. Farmers were presented with different scenarios and must chose a contract from a set of alternatives with varying attributes and a do not adopt option. The authors find that farmers prefer contracts with shorter lengths, higher net returns and with the option of the bio-refinery harvesting and replacing lost nutrients. Although only supply contracts are considered, we expect their results to be similar to ours.

Hudson and Lusk (2004) determined how certain contract attributes make farmers, in Texas and Mississippi, more likely to choose a particular contract. Farmers had the option of contracts with different levels of autonomy and price risk. Results showed farmers derive utility from input provision, shorter contract lengths, autonomy in the decision-making, and from shifting the price risk to the contractor. The authors concluded that risk avoidance plays an important role in contract choice. Furthermore, when the marginal utility of transaction cost attributes outweighs that of risk avoidance, transaction costs will guide contracting decisions. In contrast to Hudson and Lusk's (2004) research, we capture the preference for an attribute in a particular contract. Our contract options differs from that in Hudson and Lusk (2004): (1) each contract has its own particular set of attributes; (2) the level of autonomy is determined by the contract type; and, (3) the risk is assessed in terms of a probability of receiving a late payment.

Windle and Rolfe (2005) use a stated choice experiment to estimate Austrialian sugarcane grower's willingness to diversify farm enterprise income. The authors argue that understanding farmer's willingness to diversify is vital when predicting the speed at which an industry can restructure. Farmers' attitudes to risk, tactical opportunities and institutional impediments may result in less diversification than expected (Windle and Rolfe 2005). This particular characteristic

of the farmer influences his contract choice and is important to bear in mind when analyzing the results from the current study.

3.0 Data

Data was collected through face-to-face enumerated surveys with landowners and farmers in 22 counties in the states of Goiás (GO) and Mato Grosso do Sul (MS) in Brazil. Survey design was based on studies conducted in Quirinopolis, in GO (Picanço Filho and Marin 2012; Picanço Filho and Marin 2012a; Picanço Filho 2010). The survey and stated choice experiment were tested by experts and farmers within the study region prior to its application in the field. The counties surveyed in each state were chosen based on: (i) geographic location of sugarcane production in 2012 using the National Institute for Space Research (INPE) Canasat Project (Rudorff et al. 2010); and, (ii) sugarcane production growth obtained from the Brazilian survey of county-level agricultural production – PAM (IBGE 2015).

Landowners and farmers from sugarcane growers associations, rural syndicates, the Goiás and the Mato Grosso do Sul Federation of Agriculture and Livestock (FAEG and FAMASUL) were contacted to participate in the survey. Information was collected on participants' demographics, farm characteristics, landownership, sugarcane production and contracts, perceptions of mills' interaction with the local community, and land use. The stated choice experiment was the last portion of the survey.

Surveys were conducted in 2014 from June to July. A total of 148 landowners and farmers were interviewed. Of those, 104 either produced sugarcane or rented land for sugarcane production. Though our survey may not represent the entire farmer population in Brazil, respondents fall into the group of commercial farmers that would likely be approached by mills to supply sugarcane or to rent out their land. This is explained by the sample consisting largely of

farmers belonging to associations, rural syndicates, and/or cooperatives involved in sugarcane production. Farmers belonging to one of these organizations managed mostly commercial farms which tend to be larger in size. The average size of the farm in our sample is 913 hectares while that of the 2006 Agricultural Census[2] is 415 hectares (IBGE 2006). This difference is due to the census comprising a much larger number of smaller farms than the survey. The percentage of male farmers in the census is similar to that of the survey. The census reports 92% of farmers are male, while 96% of our survey respondents were male. In terms of education, our survey has a higher percentage of farmers with high school and college degrees than the census. In our survey 37% of the respondents had completed high school and 28% college. In the census 4% had completed high school and 3% college. The average sugarcane production value and yield is also higher in the survey compared to CONAB (2013). CONAB (2013) reports an average yield of 70.30 tons/ha in this region, while our respondents have a yield of 87.71 tons per hectare.

3.1 Stated Choice Experimental

Stated choice modeling was chosen to investigate farmers' preferences for a certain contract type (land rent, agricultural partnership, supply). This planned process generated stated choice data, in which choices and attribute levels of three contract types (land rent, agricultural partnership, supply) were pre-determined and then varied in order to create choice alternatives. Table 1 shows all the contract attributes for the three different contract options examined in the stated choice experiment.

The full factorial design, which considers all possible combinations of all attribute levels and contract options (Table 1), amounted to 884,736 ($= (4 * 3 * 2) * (4 * 4 * 2 * 3) * (4 * 2 * 3 *$

[2] The 2006 Agricultural Census is the most current census.

$2 * 2 * 2 * 2))$ combinations. Due to the many combinations in the full factorial design, a fractional factorial design was created by using PROC OPTEX in SAS 9.3. The fractional factorial considered only the main effects, which captures the differences between the means of an attribute. From the fractional factorial design, 48 profiles were chosen by PROC OPTEX, yielding a D-efficiency score of 92%. The D-efficiency score provides information about the efficiency of the experimental design. The aim is to determine a design that provides balance and orthogonality, therefore one that has a high D-efficiency score (Kuhfeld 2010).

The profiles were grouped into blocks of 8, such that the survey consisted of 8 versions, each with 6 different scenarios. Each scenario had 4 options: a land rental contract, an agricultural partnership contract, a supplier contract and a status quo option. The fourth option ("status quo") provided the respondent the option of staying in his/her current situation (Figure 1). In general, all contract options had information on payment, contract length, and risk of late payment. The probability of late payment was added to reflect the current situation in which financially unstable mills are paying landowners/farmers late.

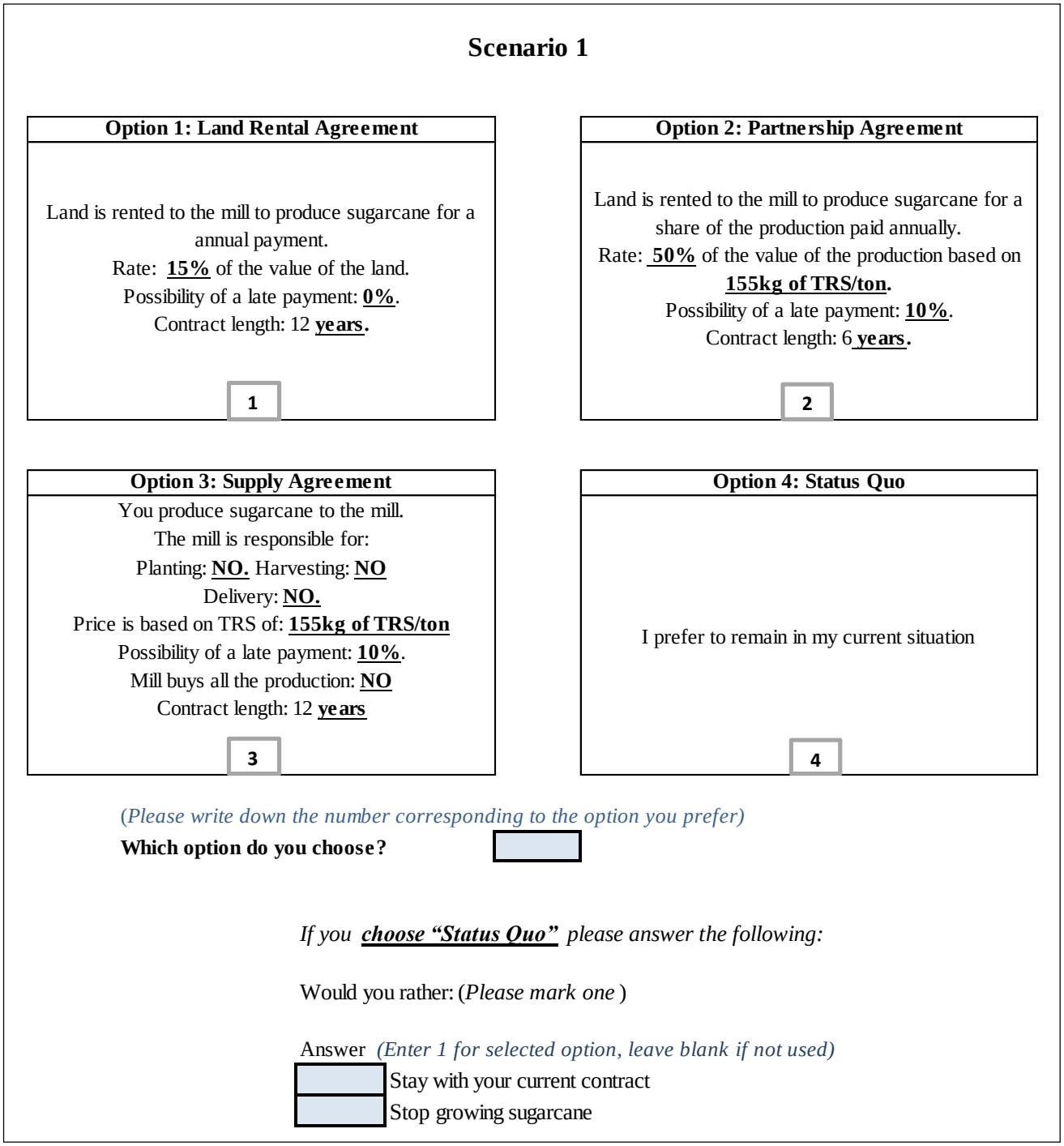

Figure 1: Example choice scenario for the stated choice experiment

Payment type varied by contract. The land rental contract payment is a percentage of the value of the land. The agricultural partnership contract payment is a percentage of the sugarcane

production. The percentage levels of the land rental and agricultural partnership contracts were chosen according to the Brazilian legislation and the National Agricultural Council manual on contracts (CNA 2007; Brazil 1966).

The agricultural partnership and the supply contract payments both depend on sugarcane yield and TRS (total recoverable sugar) levels. TRS pricing is set by the Council of Sugarcane, Sugar and Ethanol producers of the state of Sao Paulo (CONSECANA) (Valdes 2011). This determines the value of the sugarcane. In this experiment TRS levels are the minimum, average and maximum observed in the two states (CONAB 2013; Picanço Filho 2010). Apart from the TRS levels, the supply contract has further attributes that affect payment. There is the attribute of the mill only buying part of the sugarcane produced. This simulates the possibility of the mill buying only the sugarcane it needs and not the farmer's entire production. Mills, in GO and MS, may stipulate in contract further services that they offer. These services include harvesting, hauling and delivery and the provision of seedlings or a loan (Picanço Filho 2010). These attributes were also included in the experiment as either being offered or not (i.e. binary) (Table 1).

Table 1: A description of contract attributes and levels for the stated choice experiment

Attribute	Contract Type(s)	Description	Levels
Late payment	LR, AP, S	Probability of the mill paying late the amount in the contract	0%, 10%, 20%
Length of contract	LR, AP, S	Time commitment in consecutive years of the contractual agreement	6 or 12 years
TRS	AP, S	Total Recovered Sugar (TRS) value used to calculate the monetary value received for the payment in sugarcane	110 kg of TRS 125 kg of TRS 140 kg of TRS 155 kg of TRS
Rate of LR	LR	Amount received by the landowner in return for giving up his rural property to the mill.	5%; 10%; 15% and 20% of the land value.
Share payment (rate of AP)	AP	Percent of the total production paid by the mill for the use of the land for sugarcane production.	20%, 30%, 40%, 50% of the total sugarcane production
Planting	S	"Yes": mill provides the farmer with seedlings or a loan for the formation of the sugarcane plantation. "No": planting costs fall upon the supplier.	Yes or No
Harvesting	S	"Yes": mill is responsible for harvesting "No": supplier is responsible for harvesting.	Yes or No
Hauling and delivery	S	"Yes": mill is responsible for hauling and delivery "No": supplier is responsible for hauling and delivery.	Yes or No
Mill buys all	S	"Yes": mill buys all the production. "No": mill buys only the amount of sugarcane it needs. It pays the rest of the production as "cana bisada" (i.e. at 50% the value of the harvested sugarcane).	Yes or No

Abbreviations: LR: land rental contract. AP: agricultural partnership contract. S: supply contract.

4.0 Conceptual Model

It is assumed that the principal, the mill, will only offer contracts that maximize the farmers' and the mills' combined welfare or utility (Fukunaga and Huffman 2009). In our study, the agent, the farmer and landowner's utility is the focus. The conceptual framework is based upon research conducted by Hudson and Lusk (2004) and Bergtold, Fewell, and Williams (2014). Farmer *i* derives utility from each of the attributes in contract *j* (Hudson and Lusk 2004). That is:

$$U_{ij} = u_{ij}(R_j, Late, L, CS_j) \quad (1)$$

where *R* refers to the return that can be made from each contract, *Late* refers to the probability of receiving payments late, and *L* refers to the length of the contract. Apart from that, each contract has contract specific attributes denoted as *CS* (Table 3). The farmer will choose the contract which maximizes their utility in (1). It is assumed that the farmer prefers higher returns$\left(\frac{\partial U}{\partial R_j} > 0\right)$and a lower probability of a late payment $\left(\frac{\partial U}{\partial Late} < 0\right)$. The preference for the length of the contract is more ambiguous. Given the irreversible nature of start-up costs for growing sugarcane it can be expected that farmers may prefer longer contracts $\left(\frac{\partial U}{\partial L} > 0\right)$. Farmers may also prefer shorter contracts if they wish to have more management flexibility (Bergtold, Fewell and Williams 2014) or if contract enforcement is not guaranteed $\left(\frac{\partial U}{\partial L} < 0\right)$.

Contract specific (CS) attributes include the TRS values in the supply and agricultural partnership contracts. In the supply contract, CS attributes are planting, harvesting, hauling and delivery and mill buys all (Table 1). A higher TRS value for the sugarcane implies a higher return to the farmer, since the sugarcane sold is valued at a higher quality. Due to the high costs associated with entering into sugarcane production (Silva e Miziara, 2011), a contract with the mill providing

financial aid for planting is preferred to one that does not. Due to the machinery and infrastructure needed for harvesting, hauling and delivery, it is likely that farmers will prefer a contract that offers these services over a contract that does not. Finally, the farmer would prefer that the mill buy all of the sugarcane they produce and not just a part of it. Thus, the CS attributes are expected to be seen as beneficial to the farmer $\left(\frac{\partial U}{\partial CS_j} > 0\right)$.

5.0 Empirical Model and Estimation

The empirical model is based on the random utility modelling (RUM) framework, given the researcher can only observe the actual contract choice by a respondent. RUM defines the utility function in (1) as having both an observed (V) and a random component (e), such that the utility of farmer i who chooses contract j is (Hudson and Luck 2004; Bergtold, Fewell, and Williams 2014):

$$U_{ij} = V_{ij}\left(R_j, Late, L, CS_j, E_{ij}\right) + e_{ij} \quad (2)$$

where V_{ij} is the nonrandom component of utility, which is a function of the observed attributes of the contract. E_{ij} are error components, which allow for correlation among contract types and the multiple choice situations faced by the respondent. Lastly, e_{ij} is the random component of utility and is assumed to be independent and identically distributed extreme value Type 1 (Train 2009; Bergtold, Fewell, and Williams 2014).

Error components are incorporated in the empirical model given by equation (2) to capture correlation among alternative contract and repeated contract choice situations (Train 2009). The error components can be modeled as:

$$E_{ij} = \theta_j' z_{ij} \quad (3)$$

where μ_i is a vector of mean zero random terms related to farmer *i* and z_{ij} is a vector of individual specific design variables for contract type j (Train 2009). The main goal is to specify design variables z_{ij} that induce correlation over the contract choices to provide realistic substitution patterns between contracts (Train 2009). In addition, error components allow for the model to capture dependence between contract choice situations across respondents.

The functional form of the observed component of utility, V_{ik}, will vary according to the contract chosen. Each contract has contract-specific attributes and general attributes that are common to all of them (e.g. length of contract). Thus, there are four random utility functions, one for each contract choice. Following Bergtold, Fewell and Williams (2014), the observed component of utility for each contract (land rental (LR), agricultural partnership (AP), supply (S), and status quo (SQ)) is given by:

$$V_{iLR} = a_0 + a_1 R_{LR} + a_2 Late + a_3 L + \sum_{j=LR,AP,S} \theta_j E_{ij} + a_4 MS \tag{4}$$

$$V_{iAP} = b_0 + b_1 R_{AP} + b_2 Late + b_3 L + b_4 TRS + \sum_{j=LR,AP,S} \theta_j E_{ij} + b_5 MS \tag{5}$$

$$V_{iS} = c_0 + c_1 Late + c_2 L + c_3 TRS + c_4 P + c_5 H + c_6 D + c_7 B + \sum_{j=LR,AP,S} \theta_j E_{ij} + c_8 MS \tag{6}$$

$$V_{iSQ} = \theta_{SQ} z_{iSQ}. \tag{7}$$

Preferences for each attribute, even the ones that are common to all contracts, such as length of the contract, were allowed to vary between contract options. The intercept was also allowed to vary. This allows for the average preference for each contract to be different, and allows for each contract type to be viewed on average differently due to its nature. To illustrate, a risk

adverse farmer may have a higher preference for a land rental contract regardless of other contracts having higher payback. This same farmer, though, has a preference for a shorter contract length that is independent of the contract type. The coefficients of the variable MS captures the probability of a farmer or landowner in the state of Mato Grosso do Sul in signing a particular contract. The term $\sum_j \boldsymbol{\theta}_j \boldsymbol{z}_{ij}$ for a contract, controls for the correlation between unobserved factors from each choice. A description for each of the variables used in the empirical model is presented in Table 2.

Table 2: Description of the variables in the econometric model

Variable	Description
R_{LR}	The payment for the land rental (LR) contract that is based on the value of land
R_{AP}	The payment for the agricultural partnership (AP) that is a share of the yield
$Late$	The probability of the mill making a late payment.
L	The length of the contract in years.
TRS_k	The Total Recovered Sugar (TRS) value used to calculate the price received for the harvested sugarcane in the agricultural and supply contracts.
P	A *dummy* indicating whether the mill provides the farmer with seeds or a loan for planting
H	A *dummy* indicating whether the mill is responsible for harvesting the sugarcane
D	A *dummy* indicating whether the mill is responsible for hauling and delivery of the sugarcane
B	A *dummy* indicating whether the mill is responsible for buying all the sugarcane produced by the supplier or not
θ_j	Standard deviation of the error component associated with E_{ij} for (j=LR, AS, S, SQ)
E_{ij}	Error component with mean zero and variance of 1 that account for variation that does not change due to the choice made.
MS	A *dummy* indicating whether the respondent produces in Mato Grosso do Sul.

The observed data indicates only the choice made by a respondent. Thus, the probability of choosing a particular contract choice, given the attributes can be modeled. The probability that farmer *i* chooses contract *k* instead of *j* is given by the probability that the utility derived from contract *k* is greater than or equal to that derived from contract *j*, in a set of alternatives C (Hudson and Lusk 2004):

$$Pr\{k\ is\ chosen\} = Pr\{V_{ik} + e_{ik} \geq V_{ij} + e_{ij};\ \forall\, j \neq k;\ j, k \in C\} \qquad (4)$$

The unconditional probability of choosing contract *k* can be obtained from the integral of the conditional multinomial choice probability over all possible values of θ_i (Train 2009; Bhat 1998):

$$\Pr(k_i) = \int \left[\frac{\exp(V_{ik} + e_{ik})}{\sum_j \exp(V_{ij} + e_{ij})} \right] f(\theta) d\theta \tag{9}$$

Equation (9) is a form of mixed logit probability (Train, 2009). The distribution of $f(\theta)$ is assumed to be iid multivariate normal($N(\mathbf{0}, \mathbf{\Omega})$), where $\mathbf{\Omega}$ is the covariance matrix of θ (Train 2009). The advantage of using an error components (or mixed) logit is that it is not sensitive to the independence of irrelevant alternatives condition, meaning that the relative odds of an alternative *k* over *j* is not considered independent from the benefits of any other choices (Swait 2006). The estimation of the model is done in NLOGIT 4.0 using a simulated maximum likelihood with 1000 Halton draws using the BFGS Quasi-Newton Algorithm. Results from the estimation are used to calculate the willingness to pay for certain attributes. Willingness to pay (WTP) for a particular contract attribute follows the calculations proposed in Green (2011). Normally, though, the coefficient associated with net return or price is used. In this case, the coefficients used to represent these returns differs from one contract to the other. In the land rental contract, WTP is found by dividing the coefficient of the attribute (β_i) by that of the payment rate (β_{Rate}):

$$\frac{\beta_i}{\beta_{Rate}} \tag{10}$$

Similarly, willingness to pay for a particular contract attribute in both the agricultural partnership and the supply contracts is found by dividing the coefficient of the attribute (β_i) by that forthe TRS (β_{TRS}):

$$\frac{\beta_i}{\beta_{TRS}} \quad (11)$$

Hence, when referring to the land rental contract, willingness to pay is expressed in terms of percentage of the land value the farmer or landowner is willing to forgo per year for that attribute. In the supply and agricultural partnership contracts, willingness to pay is expressed in units of TRS the farmer or landowner is willing to give up for more or less of a particular attribute.

6.0 Results

The results presented in Table 3 are similar to those from previous studies (Bergtold, Fewell, and Williams' 2014; Hudson and Luck 2004). Results also confirm the assumptions made earlier. The McFadden Pseudo R^2 of 0.32 indicates a decent fit to the data. The error components are all statistically significant at a 1 percent level of significance, indicating the presence of preference heterogeneity across farmers for contracts and dependence across choice situations. In contrast to Bergtold, Fewell and William's (2004) it was found that farmers and landowners' in the two states are just as likely to sign a contract. The coefficient for the variable indicating if the farmer is from Mato Grosso do Sul was not statistically significant.

Differently from findings by Hudson and Lusk (2004), the alternative contract specific constant (intercepts) are statistically significant and negative. This indicates farmers' and landowners', in general, dislike signing contracts. In terms of the magnitude of the intercept, the supply contract has a lesser likelihood of being signed. Since the contracts in this study are not generic, given that this is a labeled experiment, this result is probably due to a respondent's systematic preference for a particular contract, a result that Hudson and Lusk (2004) did not find in their study. Although authors did find that farmers were more willing to sign contracts with more autonomy than that with less, our study found the opposite result. The land rental contract,

where the agent has less autonomy, brings less disutility to the farmer than the supply contract, where the farmer can manage all stages of sugarcane production. The stronger preference for the land rental contract may be due to the farmer preferring to be less involved in sugarcane production or not wanting to change his current agricultural or livestock activities.

In general, farmers and landowners favor contracts with higher net returns, validating our assumption that farmers receive utility from higher returns. In the land rental contract, returns are represented by the percentage of the value of the land which calculates the payment. With a 1% statistical significance level, an increase in the percentage of the value of the land increases the landowner's likelihood of signing a land rental contract. In the agricultural partnership and supply contracts, returns are represented by the level of TRS used in the calculation of the sugarcane. This coefficient is only statistically significant in the case of the agricultural partnership contract. Thus increases in TRS increases the likelihood of a farmer or landowner signing an agricultural partnership contract. The lack of significance in the supply contract could be due to the fact that other contract attributes are of more importance to those that prefer this contract. Nevertheless, the coefficient for returns is positive in all three cases. These results are similar to those found in Bergtold, Fewell and Williams' (2014), who point out the importance of the level of net returns as a contract attribute.

Further contract attributes that increase the farmer or landowner's returns were also found to have positive statistically significant coefficients. An increase in the percentage of the production received by an agent increases their likelihood of signing an agricultural partnership contract. In fact, with a statistical significance level of 5%, farmers and landowner's are willing to accept 1.53 units less of TRS for a one percentage increase in the percentage of the sugarcane production received. In the supply contract, the fact that the mill buys the farmer's total production,

increases the likelihood of a supply contract being signed. Though the willingness to pay for this option though is not significant, its importance as a contract attribute was expected. The famer is usually unable to sell the sugarcane to another buyer, given that there is generally only one mill in their vicinity. Also, we had assumed that farmers and landowners would prefer to sign a contract where the mill offered services such as the provision of seedlings "planting", harvesting and hauling, or delivery. Although the coefficients of these attributes are positive, they are not statistically significant. Thus differently from Bergtold, Fewell and Williams (2004) these services are not as important to farmer's willing to sign a supply contract in this context.

Longer contracts reduce the likelihood of farmers and landowners signing a contract. The coefficients of the contract length attribute were positive and statistically significant for all three types of contracts. In the land rental contract, farmers and landowners were willing to accept a payment reduction of 6.6% per year, to sign a six year contract instead of a twelve year one. In the agricultural partnership, farmers and landowners were willing to sign a longer contract if they received yearly an extra 25.68 per kilo of TRS per ton. According to Bergtold, Fewell and William's (2004) the preference for shorter contracts comes from the farmer's preference for more flexibility in farming activities. In our case, we additionally believe that this preference may also come from weak contract enforcement by the State, making agents prefer shorter contracts, as Watanabe and Zylberstein (2014) argue.

Similar to Hudson and Lusk (2004), we find that farmers and landowners prefer to avoid risk. The probability of receiving the payment late was negative for all three contracts, though only statistically significant in the land rental and supply contracts. Therefore, as we had assumed previously, increases in the probability of being paid late decreases the likelihood of either of these contracts being signed. Landowners are willing to accept a contract with a 1% higher probability

of late payment as long as the land rental rate received increases by 0.39% per year. Willingness to pay for a lower probability of late payment was not significant in the cases of the agricultural partnership and supply contracts. The reason may be because agents signing these contracts usually are paid at the end of the growing season which is dependent on harvest timing. Thus there is not a set date for the payment as is the case with the land rental contract.

Table 3: Results from the conditional error component model and willingness to pay estimates

Attribute	Land Rental (LR)		Agricultural Partnership (AP)		Supply (S)	
	Coefficient Estimate	Willingness to Pay	Coefficient Estimate	Willingness to Pay	Coefficient Estimate	Willingness to Pay
Intercept	-1.85 ***		-4.68 ***		-3.98 ***	
	(0.52)		(1.15)		(1.34)	
Rate of LR	0.09 ***					
	(0.02)					
TRS			0.02 ***		0.01	
			(0.01)		(0.01)	
Late Payment	-0.04 ***	-0.39 **	-0.03	-1.17	-0.04 **	-3.42
	(0.01)	(0.18)	(0.02)	(1.09)	(0.02)	(2.89)
Length	-0.62 ***	-6.61 **	-0.55 **	-25.68 *	-0.85 ***	-66.76
	(0.23)	(3.01)	(0.23)	(13.62)	(0.3)	(53.02)
Share payment			0.03 ***	1.53 **		
			(0.01)	(0.73)		
Planting					0.44	34.59
					(0.3)	(31.67)
Harvesting					0.23	18.16
					(0.29)	(24.56)
Hauling and delivery					0.49	38.93
					(0.31)	(39.10)
Mill buys all					0.92 ***	72.43
					(0.3)	(56.76)
MS	1.41		1.31		1.53	
	(1.15)		(1.15)		(1.17)	
	Error Components					
Contract LR	2.51 ***					
	(0.12)					
Contract AP	0.77 ***					
	(0.08)					
Contract S	1.9346 ***					
	(0.1)					
Opt Out	-0.72 ***					
	(0.09)					
Log-likelihood	-614.35					
McFadden Pseud R^2	0.32					
AIC	1276.70					
Observations	648.00					

Note: Standard error are in parenthesis. Significance Levels: *** is 1%, ** is 5%, * is 10%

Conclusions

This paper examines farmer's and landowner's willingness to enter into a contract with a local ethanol mill for sugarcane production. A hypothetical stated choice experiment was conducted with farmers and landowners in Goias (GO) and Mato Grosso do Sul (MS). The experiment involved them choosing one of four options: a land rental contract, an agricultural partnership contract, a supply contract or status quo. Data from the stated choice experiment was analyzed using an error components model and the respondent's willingness to pay for contract attributes was calculated. Results made it possible to identify which attributes give farmers and landowners' utility and which disutility. The hypothesis that agents derive utility from higher returns was confirmed. It was also confirmed that agents derive disutility from higher late payment probabilities. The length of the contract, which was assumed to have an ambiguous sign was shown to be positive.

Results indicate that farmers and landowners are more likely to sign contracts that offer higher returns, are shorter in length and have a lower probability of late payments. The fact that farmers and landowners are willing to receive less in order to sign shorter contracts could be indicative of a lack of trust concerning the State's regulation about the enforcement of contracts. Perhaps stronger contract enforcement would make farmers and landowners willing to sign longer contracts.

The preference for shorter contracts has implications for both the mills and the country. If Brazil wishes to expand sugarcane production in the Cerrado it should work on policies aimed at the protection of farmer/landowner's rights, contract regulation and contract enforcement. If mills wish to sign longer contracts it will need to offer higher returns. On a positive note, mills do not need to worry as much in offering special services such as the provision of seedlings, harvesting,

hauling and delivery. Perhaps by not offering these services mills may be able to offer higher returns to farmers and sign longer contracts.

Although the farmers and landowners are heterogeneous, there is no difference in the likelihood of a sugarcane contract being signed in Goias or Mato Grosso do Sul. This implies that the mills only need to develop one strategy when looking to negotiate a contract with farmers and landowners in these states. In order to reduce the transaction costs and facilitate the implementation of an ethanol plant in a particular county mills should focus on designing more attractive contracts. Attractive contracts have higher returns, lower probabilities of late payment, are shorter in length, and, in the case of the supply contract, the mill agrees in buying the total production. The importance of this attribute means that mills need to consider not only the size and productivity of the farms it is looking to negotiate with, but also, their own production capacity and the market situation when negotiating contracts.

References

Almeida, P. J. de, and A. M. Buianain. 2016. "Land leasing and sharecropping in Brazil: Determinants, modus operandi and future perspectives." Land Use Policy 52:206-220.

Almeida, A. M. D. P. de, J. de O. Vargas, D. H. de O. Inacio, and J. G. V. Vieira. 2007. "Colaboracao logistica na cadeia de suprimentos do etanol: o elo atacadista-varejista." Paper presented at Simposio Academico de Engenharia de Producao – III SAEPRO, Vicosa, MG, Brazil, November. Available at: www.agencia.cnptia.embrapa.br/Repositorio/SA06_000fk423hun02 wyiv80sq98yqtgkf8vb.pdf. (Accessed March 7, 2014)

Bergtold, J.S., J. Fewell, and J. Williams. 2014. "Farmers' Willingness to Produce Alternative Cellulosic Biofuel Feedstocks Under Contract in Kansas Using Stated Choice Experiments." *BioEnergy Research* 7 (3): 876–84.

Brazil. Decree 59.566, 14th of Novembro 1966. Regulamenta as Seções I, II e III do Capítulo IV do Título III da Lei nº 4.504, de 30 de Novembro de 1964, Estatuto da Terra, o Capítulo III da Lei nº 4.947, de 6 de abril de 1966, e dá outras providências". Available at: http://legislacao.planalto.gov.br/legisla/legislacao. (Accessed in May 2, 2014)

____. Ministério da Agricultura, Pecuária e Abastecimento. 2013. *Statistical Yearbook of Agrienergy*. Brasilia: MAPA/ACS. 284 p.

CNA – Confederação da Agricultura e Pecuária do Brasil. 2007 "Cana-de-açúcar: Orientações para o Setor Canavieiro. Ambiental, Fundiáaria e Contratos." Brasília: Embrapa. Available at: www.agencia.cnptia.embrapa.br/Repositorio/Cana-de-acucar_orientacoes_para_o_setor_ canavieiro_000fipw96tk02wyiv80z4s4733kvhu6q.pdf. (Accessed May 7, 2015)

CONAB - Companhia Nacional de Abastecimento. 2013. *Perfil do Setor do Açúcar e do Etanol no Brasil.* Brasília: CONAB. Available at: www.conab.gov.br/OlalaCMS/uploads/arquivos/ 13_10_02_11_28_41_ perfil_sucro_2012.pdf. (Accessed Apr 12, 2016)

Eswaran, M., and A. Kotwal. 1985 "A Theory of Contractual Structure in Agriculture". *American Economic Review* 75 (3): 352-367.

Feltre, C., and L. F. de O. e Paulillo. 2015. "Plurality in different groupings: sugarcane supply in Brazil." *British Food Journal* 117 (9): 2265-2281.

Fukunaga, K., and W.E. Huffman. 2009. "The Role of Riak and Transactions Costs in Contract Design: Evidence from Farmland Lease Contracts in the U.S. Agriculture." *American Journal of Agricultural Economics* 91(1): 237-249.

Hudson D., and J. L. Lusk. 2004. "Risk and Transactions Cost in Contracting: Results from a Choice-Based Experiment." *Journal of Agricultural & Food Industrial Organization* 2 (1): 1–17.

IBGE – Brazilian Institute of Statistics and Geography. 2014. "Produção Agrícola Municipal (PAM)." Available at: http://www.sidra.ibge.gov.br/. (Accessed Feb 15, 2015)

_____. 2006. “Censo Agropecuario 2006.” Available at: http://www.sidra.ibge.gov.br/. (Accessed Dec 12, 2014)

Kuhfield, W.F. 2010. “Experimental Design: Efficiency, Coding, and Choice Designs.” SAS Technical Papers - MR-2010C. Available at: http://support.sas.com/resources/papers/tnote/tnote_marketresearch.html. (Accessed May 1, 2016)

Manzatto, C.V., E.D. Assad, J.F.M. Bacca, M.J. Zaroni and S.E.M. Pereira. 2009. *Zoneamento agroecológico da cana-de-açúcar.* Rio de Janeiro: Embrapa Solos.

Neves, M.F., V.G. Trombin, and M. Consoli. 2011. “The sugar and ethanol map of Brazil.” In: Leão, E.L. de S., and I.C. Macedo, eds. *Ethanol and Bioelectricity: Sugarcane in the Future of the Energy Matrix.* São Paulo: Unica. pp. 14-43.

Neves, M.F., R.S. Waack, and M.K. Marino. 1998. “Sistema Agroindustrial da Cana-de-Açúcar: Caracterização Das Transações Entre Empresas de Insumos, Produtores de Cana e Usinas.” In *Agronegócios Brasileiros: Desafios e Perspectivas*. Brasília: Sociedade Brasileira de Economia e Sociologia Rural. Available at: http://pensa.org.br/wp-content/uploads/2011/10/O_sistema_agroindustrial_da_cana_de_acucar_1998.pdf. (Accessed Dec 15, 2014)

O Popular. 2011. *Jataí Aprova Legislação Restritiva ao Cultivo da Cana-de-Açúcar*. Available at: www.opopular.com.br/editorias/economia/jata%C3%AD-aprova-legisla%C3%A7%C3%A3o-restritiva-ao-cultivo-da-cana-de-a%C3%A7%C3%BAcar-1.81340. Accessed in Oct. 2014

Picanço Filho, A.F., and J.O.B. Marin. 2012. “Sugarcane Supply Agreement: The Power Asymmetry Between Agents.” *INTERAÇÕES* 13 (2): 191–202.

____. 2012a. “The Sugar Cane Political Network and its Power Resources in The Goiás State, Brazil.” *Pesquisa Agropecuária Tropical* 42 (2): 189–97.

Picanço Filho, A.F. 2010. “Contratos Agrários na Agroindústria Canavieira em Goiás: Legalidades e Conflitos.” MS thesis, University of Goias.

Queiroz, S. de T. P. 2008. “Usinas de alcool – fatores influents no processo de escolha da localizacao de novas usinas”. MS Thesis, University of Brasilia.

Rudorff, B.F.T., D.A. Aguiar, W.F. Silva, L.M. Sugawara, M. Adami, and M.A. Moreira, M.A., 2010. “Studies on the Rapid Expansion of Sugarcane for Ethanol Production in São Paulo State (Brazil) Using Landsat Data.” *Remote Sensing* 2 (4), 1057-1076.

Sant'Anna, A.C., G. Granco, J.S. Bergtold, M.M. Caldas, T. Xia, P. Masi, T. Link, W. Lorenzani. 2016. “The Challenges of the Sugarcane Expansion: How do Producers and Landowners Think and Act?” In: Santos, G. ed. *Forty Years of Ethanol in Brazil: Hide or Confront the Crises?* Brasilia: IPEA.

Shikida, P.F.A. 2013. "Expansão canavieira no Centro-Oeste: limites e potencialidades." *Revista de Política Agrícola* XXII (2):122.

Silva, A.A., and F. Miziara. 2011. “Sucroalcohol Sector and Agricultural Frontier Expansion in the Goiás State, Brazil.” *Pesquisa Agropecuária Tropical* 41 (3): 399–407.

Swait, J. 2006. “Advanced Choice Models.” In Kanninen, B.J. ed. *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice.* Arlington, VA: Springer, pp. 229-294.

Train, K. E. 2009. *Discrete Choice Methods with Simulation.* New York: Cambridge University Press.

Valdes, C. 2011. *Brazil’s Ethanol Industry: Looking Forward.* United States Department of Agriculture. Available at: http://www.ers.usda.gov/media/126865/bio02.pdf. (Accessed May 1, 2016)

Varva, P. 2009. “Role, Usage and Motivation for Contracting in Agriculture.” *OECD Food, Agriculture and Fisheries* 16. Available at: http://dx.doi.org/10.1787/225036745705. (Accessed April 30, 2016)

Watanabe, K., and D. Zylbersztajn. 2014. “Contract farming in the Brazilian agribusiness system: private institutions and State intervention.” *Uniform Law Review* 19(3): 459-479

Windle, J., and J. Rolfe. 2005. “Diversification Choices in Agriculture: A Choice Modelling Case Study of Sugarcane Growers.” *Australian Journal of Agricultural and Resource Economics* 49 (1): 63–74.