

Sugarcane contracts in Brazil: How sweet is the deal?

Ana Claudia Sant'Anna. *PhD Candidate*
Kansas State University, Department of Agricultural Economics
e-mail: acsantanna@ksu.edu

Jason Scott Bergtold. *Professor*
Kansas State University, Department of Agricultural Economics
e-mail: bergtold@ksu.edu

Marcellus M. Caldas. *Associate Professor*
Kansas State University, Department of Geography
e-mail: caldasma@k-state.edu

Gabriel Granço. *PhD Candidate*
Kansas State University, Department of Geography
e-mail: ggranco@ksu.edu

Version: April 2018

Sugarcane contracts in Brazil: How sweet is the deal?

1 Introduction

Biofuels have been globally encouraged as an alternative to fossil fuels, not only, as a means to reduce carbon emissions, but also, to promote rural development and guarantee energy security. Biofuel production relies on the availability of biofuel feedstock which, depending on the asset specificity of the market, may be geographically limited. For countries interested in expanding biofuel production this may imply a higher reliance on farmer's willingness to supply biofuel feedstock. In countries looking to expand or introduce biofuels, setting a stable procurement base may entail convincing farmers to switch from their current production into that of biofuel feedstock. In addition, increasing collaboration between agriculture and the industry have meant a gradual replacement of spot markets by other forms of vertical coordination (e.g. contracts) (Hendrikse and Bijman 2002). Thus, understanding farmer's contract preferences is pertinent to ensure biofuel expansion.

Brazil provides a rich example of the challenges faced by policy makers, farmers and processors, when expanding biofuel production into a new region. Sugarcane expansion into the Cerrado region is part of the Brazilian National Policy on Climate Change, aimed at reducing greenhouse gas emissions from 36.1% to 38.9% by 2020 (Brazil 2009). From 2000 to 2012 over 40 mills were constructed in the states of Goiás (GO) and Mato Grosso do Sul (MS) (Procana 2013). Together, these states have the potential of planting over 22 million hectares of sugarcane (Manzatto et al. 2009).

The sustainability of ethanol expansion into the *Cerrado*, though, depends on farmer's willingness to grow sugarcane. This may be challenging since this region (i.e. Goias and Mato

Grosso do Sul) have established grain and livestock supply chains (Sant'Anna, Granco, et al 2016). Thus, on the farmer's side, sugarcane expansion into the *Cerrado* requires convincing traditional livestock and grain producers to switch to sugarcane production, a 5-year cycle crop. On the processor's side, geographic and temporal asset specificities of the sugarcane market limits sugarcane procurement to a 30-mile radius (Neves, Waack and Marino 1998). Therefore, access to sugarcane is a vital factor in the mill's decision on where to locate and operate (Queiroz 2008). In Goiás and Mato Grosso do Sul sugarcane is obtained by (i) mills contracting directly with farmers (40%) or (ii) mills renting farm land and producing sugarcane themselves (60%) (Brazil, 2013).

Although sugarcane expansion in the *Cerrado* region has been the focus of many studies (Silva and Miziara 2011; CONAB 2013; Shikida 2013) few have considered contracting negotiations between producers and processors (Sant'Anna, Granco, et al. 2016; Picanço Filho and Marin 2012a; Picanço Filho and Marin 2012b). Most of the Brazilian data on contracts comes from case studies (de Almeida and Buainain 2016). No study has investigated farmers' willingness to produce sugarcane under different contractual agreements (i.e. land lease, supply and crop share contracts) as we do. 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. In addition, we use a methodology that considers choices with an unbalanced number of attributes and multiple opt-out options. Results provide guidance to mills and farmers on contract design and to policy makers on the effect of contracting policy. The paper is divided into seven parts. In the first section, we introduce the study and explain the purpose of the paper. Section two examines sugarcane contracting in Brazil and the advantages and disadvantages of different contracts is highlighted. The third section presents the data gathered and compares it with

that of the Brazilian Census in order to illustrate the representativeness of the sample. The fourth section, goes over the conceptual model for this study, while the fifth section presents the empirical estimation of the models. The sixth section presents the results, comparing it to the expectations presented in the conceptual model section, while the last section wraps up the article by highlighting the conclusions and possible implications of the study.

2 Sugarcane contracting

It is difficult for a farmer to market and produce sugarcane without a contract in the *Cerrado* region (Picanço Filho and Marin 2012a, Sant'Anna, Granco, et al. 2016). The three types of contracts are currently used in Brazil are: (1) land rental contracts – which give the local mill use of the land for sugarcane production for a fixed rental rate; (2) agricultural partnership contracts – which give the local mill use of the land for sugarcane production for a percentage of the harvested crop; and (3) supply contracts – by which farmers agree to supply sugarcane to the local mill for an agreed price and quantity (Brazil 1966). Numbers from the last Agricultural Census in 2006 relate that from 135,683 farms in GO and 64,862 farms in MS, 4.6% of producers in MS and 3.2% in GO have a land rental contract (IBGE 2006). The percentage of producers with an agricultural partnership is smaller: 0.31% in GO and 0.43% in MS for all types of agricultural commodities (IBGE 2006; Almeida and Buainain 2016). Though the 2006 Agricultural Census has no information on supply contracts we can predict how many producers are on a supply contract by looking at producers working on their own property. The percentage of producers using their own property is 87% in Goiás (GO) and 75% in Mato Grosso do Sul (MS) (IBGE 2006).

Keep in mind that these facts are for all agricultural commodities and livestock and reflects information from 2006.

2.1 Advantages and disadvantages of each contract type

Each contract has its advantage and disadvantage. Land rental contracts allow mills to select the optimal amount of inputs for sugarcane production. The mill controls all stages of production, minimizing the risk of losing sugarcane suppliers to a competing plant (Feltre and de Oriani e Paulillo 2015). The landowner transfers all risks associated with the production process to the mill. However, the landowner incurs the risk of the mill potentially over-utilizing the land or natural resources associated with it (Almeida and Buainain 2016). Landowners and farmers may prefer a land rental contract because (Picanço Filho 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) current labor regulations are too restrictive; (5) they are averse to climate and fire risks; or (6) they prefer a guaranteed periodic fixed payment under contract (Almeida and Buainain 2016).

In the agricultural partnership contract the mill and the farmer share production risks. There is an incentive for the producer to use less factors of production than under the land rental contract and over-utilize the landowners' factors of production (e.g. land and soil nutrients). This situation arises because the producer only receives a share of the harvest (Almeida and Buainain 2016). Preference for an agricultural partnership may be due to the fact that higher revenue may be achieved depending on the quality or yield of sugarcane, providing, potentially, greater return than the land rental contract at a lower risk than entering into a supply contract.

The supply contract transfers the production costs and risks from the mill to the producer, enabling the mill to concentrate solely on ethanol and sugar production. The payment of the supply contract depends on the yield and the quantity supplied. The choice of the supply contract over other options may be due to producers wanting more autonomy over production and land use. In the case of the supply contract, since the producer and the landlord are usually the same person, over-utilization of land may not be in their best interest. From the mill's perspective, while supply contracts may reduce production risks, mills become reliant on the quality of the sugarcane supplied from the producer (Feltre and de Oriani e Paulillo 2015).

2.2 Factors associated with sugarcane contracting in the *Cerrado* region

The *Cerrado* region has a long tradition in grain and livestock production. A factor that motivated farmers to produce sugarcane in the past was soybean rust (2004) and low cattle prices (Picanço Filho and Marin 2012a; Sant'Anna, Granco, et al. 2016). 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 2012a). Therefore, sugarcane may present a means for farmers and landowners to diversify their agricultural activities. In addition, mills have provided free seedlings, technical assistance, and product delivery subsidies to attract sugarcane suppliers (Sant'Anna, Granco, et al. 2016).

Mills seek farmers and/or landowners whose land lies within 50km from the mill to sign contracts (Neves, Waack and Marino 1998). Harvested sugarcane must be delivered and processed within 72 hours (Neves, Waack and Marino 1998). The distance limitation helps to avoid high transportation costs and to prevent saccharose losses from the harvested sugarcane. 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 (i.e. 80% upon delivery and 20% at the end of the harvest year); (3) and fidelity¹ in sugarcane sales (Picanço Filho and Marin 2012a).

On average, contracts last for one or two sugarcane cycles (i.e. 6 or 12 years) (Picanço Filho and Marin 2012a). At the end of the sugarcane cycle the land must be remediated (e.g. by rotating with soybeans or peanuts) for its productivity to be restored (Feltre and de Oriani e Paulillo 2015). Farmers have historically been willing to sign longer contracts with financially stable mills (Feltre and de Oriani e Paulillo 2015).

Farmers willingness to sign longer contracts can also be motivated by a strong presence of the State. By enforcing contracts, the State prevents opportunistic behaviors from either party (i.e. the agent or the principal) (Watanabe and Zylbersztajn 2014). When 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 generally holds more power (Watanabe and Zylberstein 2014).

In terms of bargaining power, farms closer to the mill and/or larger in size may hold more bargaining power than other farms when signing a contract (Picanço Filho and Marin 2012a; Sant’Anna, Granco, et al. 2016). Closer farms to the mill provide less saccharose losses during transportation, at lower transportation costs. Larger farms can guarantee a larger amount of sugarcane supply in one contract (Picanço Filho and Marin 2012a). Mills, though, also hold bargaining power due to the presence of asymmetric information (Picanço Filho and Marin 2012a). Since this area has only recently started to produce sugarcane, mills generally have a broader

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).

understanding of sugarcane production and quality, as well as, of ethanol and sugar markets. Knowledge of these factors influences expected sugarcane yields and the expected prices of sugar and ethanol, giving them an advantage over the producers who may not have the same information.

2.3 Previous studies on contracting

Studies on contracts with varying autonomy and risk (Lusk and Hudson 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) examined farmers' willingness to produce biofuel under different contract options using a stated choice experiment. Farmers were presented with different scenarios and asked to choose a contract from a set of alternatives with varying attributes and a do not adopt option. The authors found that farmers prefer contracts with shorter lengths, higher net returns and with the option of the bio-refinery harvesting the biomass and replacing lost soil nutrients. Although only supply contracts were considered, we expect our results to be similar to theirs, as both studies consider large commercial farming operations.

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 (i.e. provision of seeds), shorter contract lengths, autonomy in decision-making, and from shifting price risk to the contractor. The authors concluded that risk avoidance and autonomy play an important role in contract choice. Producers were willing to forgo 4% of their annual income (\$5,950.78) in order to pass on the full risk to the contractor (Hudson and Lusk 2004). To give up their autonomy, producers need to be compensated \$9,800 per year (Hudson and Lusk

2004). In contrast to Hudson and Lusk's (2004) research, in our study the number of attributes vary by contract type. The level of autonomy is also determined by the contract type. Risk is assessed in terms of a probability of receiving a late payment. Furthermore, we capture the producers' preference not to grow sugarcane or to keep their current contract.

Windle and Rolfe (2005) used a stated choice experiment to estimate Australian sugarcane grower's willingness to diversify farm income. The authors argue that understanding farmers' willingness to diversify is vital when predicting the speed at which an industry can restructure (e.g. farm agglomeration). Farmers' attitudes to risk, tactical opportunities and institutional impediments² may result in less diversification than expected (Windle and Rolfe 2005). The authors concluded that to avoid risk, producers may not be willing to diversify production, even though gross margins play an important role in decision making. In our study we have the opposite case, it is grain and livestock producers that must be willing to diversify to sugarcane production for the sugarcane expansion into the *Cerrado* to be successful. As in Windle and Rolfe (2005) farmers may opt not to produce sugarcane to avoid risks. The form of diversification (i.e. the type of contract farmers preference) has implications for rural development, the environment and the sustainability of ethanol expansion in the *Cerrado*.

3 Data

Data was collected using 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

² E.g. the sugar quota production system stopped producers from leaving the sugar industry for there was no guarantee of regaining the quota afterwards.

was based on studies conducted in Quirinópolis, in GO (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 2014).

Landowners and farmers from sugarcane growers' associations, rural syndicates, and, the Federation of Agriculture and Livestock of Goiás (FAEG) and of Mato Grosso do Sul (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. The team that applied the survey was composed of 10 enumerators (graduate and undergraduate students), a Professor from the State University of Sao Paulo and a Professor (the Co-Principal Investigator) from Kansas State University. The team was split in three cars which ran over 1864 miles. Each survey lasted about an hour to complete. A total of 148 landowners and farmers were interviewed, a considerable size given the limitations and difficulties faced: (1) landowners residing in another state; (2) dirt roads; (3) isolated and extensive farms; (3) respondents cancelling or not showing up for the survey. Of those, 104 either produced sugarcane or rented land for sugarcane production. From the survey, there were 110 landowners and farmers that responded to the hypothetical experiment, 69 of which either produced sugarcane or rented their 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 commercial sugarcane production. These are large farm owners with high education levels and productive yields. The average size of the farm in our sample is 913 hectares while that of the 2006 Agricultural Census³ is 415 hectares (IBGE 2006). This difference is due to the census comprising a large number of small farms than our survey. The percentage of male farmers in the census is similar to that of the survey. In terms of education, our survey has a higher percentage of farmers with high school and college degrees than the census. The average sugarcane production value and yield is also higher in the survey compared to CONAB (2013) (Table 1).

3.1 Stated choice experiment

Stated choice methods were chosen to investigate farmers' preferences for a certain contract type (land rent, agricultural partnership, supply). Stated choice methods were chosen over revealed preference methods as it provides more variation than revealed data. Given the presence of a single sugarcane buyer to the respondent, there could be a tendency for similar contract types or attributes to be offered. In addition, contract information is usually classified. For example, contract payment amounts were confidential. Hence, stated choice data allows us to assess a potential change in behavior when farmers and landowners would hypothetically have more contract options with different levels of attributes.

³ The 2006 Agricultural Census is the most current census.

In order to capture choice differences specific to each type of contract we conducted a labelled stated choice experiment. 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 to create choice alternatives. Table 2 shows all the contract attributes for the contract options examined in the stated choice experiment.

The full factorial design, which considers all possible combinations of all attribute levels and contract options, amounted to 884,736 ($= (4 * 3 * 2) * (4 * 4 * 2 * 3) * (4 * 2 * 3 * 2 * 2 * 2 * 2)$) combinations. Due to the many combinations in the full factorial design and concerns about respondent burden, a fractional factorial design, with main effects, was created using PROC OPTEX in SAS 9.3. From the fractional factorial design, 48 profiles were chosen by PROC OPTEX, yielding a D-efficiency score of 92%⁴. The generated profiles were grouped into blocks of 8, such that the survey consisted of 8 versions, each with 6 different contract scenarios. In each scenario, the respondent had to choose between land rental contract, agricultural partnership contract, supplier contract, or the status quo option. Those who chose status quo then had to indicate whether they wanted to keep their current contract or not to grow sugarcane (Figure 1).

Generally stated choice studies use one of two kinds of opt-out options: a “do not adopt” (or “do not purchase”) and “keep my current brand” (or “status quo”) (Banzhaf, Johnson and Mathews 2001). Previous studies (Adamowicz et al. 1997; Carson et al. 1994) have focused on how different opt-out options (e.g. status quo or keep my current brand) can impact the results from the study. In this study, we expand the stated choice model to include two opt-out options:

⁴ The D-efficiency score ranges between 0% and 100% and provides information about the efficiency of the experimental design. The aim is to determine a design that provides balance and orthogonality, therefore a higher D-efficiency score is desired (Kuhfeld 2005).

“keep my current contract” and “not to grow sugarcane”. This unique design, to our knowledge never before used, has the benefit of eliminating uncertainty about why a respondent chooses the status quo option. It allows us to distinguish between the choices of not to grow sugarcane and to keep their current contract (Figure 1). For example, in our case, over half (51%) of the 660 responses opted the status quo option. At a first glance one could erroneously interpret these preliminary results as a preference not to grow sugarcane. When considering the two opt-out model, though, we notice that out of those that chose the status quo, 40% preferred their current contract and 11% opted not to grow sugarcane.

All contract options had information on payment methods, contract length, and risk of late payment. The probability of late payment, a risk attribute for signing the contract, was added to reflect the current situation in which financially unstable mills are paying landowners/farmers late. Late payments result in financial burden to farmers who are then unable to pay input suppliers and third party services (e.g. fertilization services) (Picanço Filho and Marin 2012a). In this survey, we found that late payments occurred at least once a year with 20% of respondents complaining about mills not fulfilling their side of the contract (Sant’Anna, Granco, et al. 2016).

Payment methods varies by contract. The land rental contract payment is a percentage of the value of the land, while the agricultural partnership contract payment is a percentage of the sugarcane production. These percentages were determined following the Brazilian legislation and the National Agricultural Council contract manual (CNA 2007; Brazil 1966). The agricultural partnership and the supply contract payments both depend on sugarcane production (i.e. yields and sugarcane quality). Sugarcane price varies according to its quality (i.e. level of TRS - total recoverable sugar). TRS pricing is, in turn, set by the Council of Sugarcane, Sugar and Ethanol producers of the state of São Paulo – CONSECANA (Valdes 2011). 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, there are other attributes normally offered by mills in Goiás and Mato Grosso do Sul which may affect the producer's revenue. These services are: the mill buying part or total sugarcane production, the provision of seedlings and of harvesting, hauling and delivery services (Picanço Filho 2010). When the mill only buys part of the sugarcane produced then it compensates the farmer by paying the remaining sugarcane as *cana bisada* (i.e. at 50% of its value). The services were included in the experiment as binary attributes (i.e. they are offered or not) (Table 2).

4 Conceptual model

In our study, we focus on the farmer and landowner's utility. 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:

$$U_{ij} = u_{ij}(R_j, Late, L, CS_j, More1) \quad (1)$$

where R refers to the returns from contract j , $Late$ refers to the probability of receiving payments late, and L refers to the length of the contract. Each contract has contract specific attributes denoted as CS_j (see Table 2). Lastly, $More1$ is a dummy that takes on the value 1 if there is more than one mill in the area that the farmer can sell to, and 0 otherwise.

A farmer will choose the contract which maximizes their utility given by equation (1). We hypothesize that farmers prefer higher returns $\left(\frac{\partial U}{\partial R_j} > 0\right)$ and lower probability of late payment

$\left(\frac{\partial U}{\partial Late} < 0\right)$. The preference for the length of the contract is ambiguous. Given the irreversible nature of start-up costs for growing sugarcane and it being a perennial crop, we could expect farmers to prefer longer contracts $\left(\frac{\partial U}{\partial L} > 0\right)$. After all, it allows profits from sugarcane production to be achieved by spreading out the initial investment over time (Picanço Filho and Marin 2012a). By opting for longer contracts farmers can avoid renegotiation costs and quasi-rental appropriation, as well (Lusk and Hudson 2004; Joskow 1987; Crocker and Masten 1988). Shorter contracts, though, may also be preferred, allowing for more management flexibility or due to weak contract enforcement $\left(\frac{\partial U}{\partial L} < 0\right)$ (Bergtold, Fewell and Williams 2014).

The contract specific (CS) attributes are: TRS values, planting, harvesting, hauling and delivery and “mill buys all” (see Table 2). Thus, the CS attributes are expected to be beneficial to the farmer $\left(\frac{\partial U}{\partial CS_j} > 0\right)$. A higher TRS value for the sugarcane implies in a higher price received by the farmer. Contracts where the mill provides financial aid for planting is probably preferred to one that does not, due to the high costs associated with entering sugarcane production (Silva and Miziara 2011). Farmers will likely prefer a contract offering harvesting, hauling and delivery services, due to the machinery and infrastructure needed for that. Finally, the farmer would prefer that the mill buys all of the sugarcane they produced rather than only a part of it.

The number of mills located near a sugarcane producer may impact his/her choice among the contract options and status quo. In counties with more than one sugarcane buyer, farmers may have more bargaining power allowing them to demand better contract conditions and higher payments. Hence, we expect *More1* to bring disutility to the option not to grow sugarcane $\left(\frac{\partial U}{\partial More1} < 0\right)$ and utility to the other contract options option $\left(\frac{\partial U}{\partial More1} > 0\right)$.

5 Empirical model and estimation

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

$$U_{ij} = V_{ij}(R_j, Late, L, CS_j, More1) + e_{ij} \quad (3.2)$$

where V_{ij} is the nonrandom component of utility, which is a function of the observed attributes of contract j , and e_{ij} is a random component of utility and is assumed to be independent and identically distributed extreme value Type 1 (Train 2009; Bergtold, Fewell and Williams 2014).

The functional form of the observed component of utility (V_{ij}) varies by contract choice. Each contract has contract-specific attributes (e.g. planting and harvest assistance) and general attributes, that are common to all of them (e.g. length of contract and probability of late payment). In the case of the model with the two opt-out options there are five random utility functions that are compared, one for each option and the opt-out choices. Following Bergtold, Fewell and Williams (2014), the observed component of utility for each option (land rental (LR), agricultural partnership (AP), supply (S), not to grow sugarcane (NS) and keep current contract (KC)) is given by:

$$V_{iLR} = a_{0i} + a_1 R_{LR} + a_2 Late + a_3 L + a_4 More1, \quad (3)$$

$$V_{iAP} = b_{0i} + b_1 R_{AP} + b_2 Late + b_3 L + b_4 TRS + b_5 More1, \quad (4)$$

$$V_{iS} = c_{0i} + c_1 Late + c_2 L + c_3 TRS + c_4 P + c_5 H + c_6 D + c_7 B + c_8 More1, \quad (5)$$

$$V_{iNS} = d_{0i} + d_1 More1, \text{ and} \quad (6)$$

$$V_{iKC} = e_{0i} + e_1 More1 \quad (7)$$

where V_{ij} are linear additive functions in the attributes pertaining to each option, where $j=LR, AP, S, NS, KS$ (Louviere, Hensher and Swait 2000). The intercepts or alternative specific constants (ASC) ($a_{0i}, b_{0i}, c_{0i}, d_{0i}, e_{0i}$) in equations (3) to (7) are contract and individual specific, allowing the ASC to capture individual specific preferences for each option in relation to “keep current contract”, the base. This approach allows for the average marginal utility to vary among each individual and allows for each contract type to be viewed on average differently due to its nature. We assume that each ASC varies across the sample following a normal distribution, that is modeled as (Louviere, Hensher and Swait 2000):

$$a_{0i} = \alpha + \sigma_a \mu_{ai}, \quad (8)$$

$$b_{0i} = \beta + \sigma_b \mu_{bi}, \quad (9)$$

$$c_{0i} = \tau + \sigma_c \mu_{ci}, \quad (10)$$

$$d_{0i} = \delta + \sigma_d \mu_{di}, \text{ and} \quad (11)$$

$$e_{0i} = \varepsilon + \sigma_e \mu_{ei}. \quad (12)$$

Equations (8) to (12) indicate that the ASC is a function of the unconditional mean ($\alpha, \beta, \tau, \delta, \varepsilon$) and a random term (i.e. $\mu_{ai}, \mu_{bi}, \mu_{ci}, \mu_{di}, \mu_{ei}$), which is assumed to have a normal distribution

$N(0,1)$. $\sigma_a, \sigma_b, \sigma_c, \sigma_d, \sigma_e$ represent the standard deviation of the distribution of each ASC (Louviere, Hensher and Swait 2000). To estimate the proposed model, the utility V_{iKC} is set as the base and, as such, it is normalized to be zero (i.e. $V_{iKC} = 0$). This is possible given that utility functions are ordinal and, as such, the preference relation is not distorted by affine linear transformations of the utility function.

In this study, we run both the single opt-out model, resembling stated choice models commonly found in the literature, and a new model with two opt-out options. The two opt out model accounts for omitted choices, such as the case of the choice to keep the current contract. If only the one opt-out model is run, then the coefficients may be biased due to omitted variables (choices). In the results section, we compare both models to show how controlling for the choice not to grow sugarcane is important to explain the estimates.

In the case of the single opt-out model, there are four observed utilities, one for each contract and a fourth for the status quo option. The status quo option is the combined observed utility of not to grow sugarcane and of keep my current contract. Hence equations (11) and (12) are combined to form the status quo option (i.e. $f_{0i} = (\varepsilon + \delta) + (\sigma_e \mu_{ei} + \sigma_d \mu_{di})$). The status quo option is set as the base case of the single opt-out model (i.e. $V_{i\text{statusquo}} = 0$). A description of the variables⁵ used in the empirical model is presented in Table 3.

The observed data indicates the choice made by a respondent. The probability that farmer i chooses option k instead of j is given by the probability that the utility derived from k is greater than or equal to that derived from j , from a set of alternatives C (Hudson and Lusk 2004):

⁵ A dummy for the state was also considered as there have been studies (e.g. Bergtold, Fewell, Williams 2014) that have noted a difference between willingness to grow biofuels between respondents in different regions. In our case, over 60% of respondents in Goiás and 13% of the respondents in Mato Grosso do Sul had more than 1 mill to sell their sugarcane to. We believe this effect is also being captured by the *More1* dummy, so to avoid collinearity we have decided to keep only the *More1* dummy. Also in previous modeling the dummy state was not statistically significant.

$$Pr\{k \text{ is chosen}\} = Pr\{V_{ik} + e_{ik} \geq V_{ij} + e_{ij}; \forall j \neq k; j, k \in C\} \quad (13)$$

The unconditional probability of choosing k can be obtained from the integral of the conditional multinomial choice probability over all possible values of θ_0 (Train 2009; Bhat 1998):

$$Pr(k_i) = \int \left[\frac{\exp(\theta_{0k} + \theta_k' x_{ik})}{\sum_j \exp(\theta_{0j} + \theta_j' x_{ij})} \right] f(\theta_0) d\theta_0 \quad (14)$$

where θ_0 is a vector containing all random ASC's and θ_k is a matrix containing the other parameters in each utility function, $k =$ land rental, agricultural partnership, supply, keep current contract and not grow sugarcane. The distribution of $f(\theta_0)$ is assumed to be iid multivariate normal ($N(\mathbf{0}, \mathbf{\Omega})$), where $\mathbf{\Omega}$ is the covariance matrix of θ_0 (Train 2009). Equation (14) is a form of mixed logit probability (Train 2009). The advantage of using the mixed logit is that it is not sensitive to the independence of irrelevant alternatives (Swait 2006). The mixed logit also has the benefit of allowing θ_0 to vary among individuals accounting for their individual specific “tastes” or heterogeneous contract preferences (Broch and Vedel 2011; Train 2009). The model was estimated using NLOGIT 4.0, a simulated maximum likelihood with 1000 Halton draws, and the BFGS Quasi-Newton Algorithm.

To capture the substitutability between contracts and how changes in attributes affect the probability of choosing a contract, direct and cross elasticities were estimated. Cross elasticity and direct elasticity measures were calculated using the following formulae (Louviere, Hensher and Swait 2000):

$$E_{X_{jsi}}^{Pki} = \frac{\partial P_{ki}}{\partial X_{jsi}} \cdot \frac{X_{jsq}}{P_{ki}} \quad (15)$$

$$E_{X_{jsi}}^{Pji} = \frac{\partial P_{ji}}{\partial X_{jsi}} \cdot \frac{X_{jsq}}{P_{ji}} \quad (16)$$

The cross elasticity measure ($E_{X_{jsi}}^{Pki}$) is the elasticity of the probability of individual i choosing option k with respect to a marginal change in the s th attribute describing the utility from contract j , where $j \neq k$, by the individual i . The direct elasticity measure ($E_{X_{jsi}}^{Pji}$) is the elasticity of the probability of the individual i choosing option j with respect to a marginal change in the s th attribute describing the utility from contract j , by the individual i (Louviere, Hensher and Swait 2000).

In order to calculate the value of each contract attribute to the individual, willingness to pay measures were estimated. Willingness to pay (WTP) for a particular contract attribute follows the calculations proposed by Hensher, Rose and Greene (2015). In this study, since payment methods differ between contracts, the coefficients used to represent these returns are not always the same. 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}):

$$\frac{\beta_i}{\beta_{Rate}} \quad (17)$$

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

$$\frac{\beta_i}{\beta_{TRS}} \quad (18)$$

In summary, in 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 an attribute. Asymptotic standard errors were estimated using the delta method (Greene 2008).

6 Results

The results for the single opt-out model (i.e. the model with the three contract options and a status quo) and those for the two opt-out model are presented in tables 4 and 5, respectively. They are similar to those from previous studies (Bergtold, Fewell and Williams 2014; Hudson and Luck 2004) and confirm the assumptions made in the conceptual model (section 4). The McFadden Pseudo R^2 of 0.36 and 0.41, respectively, indicate a decent fit to the data. The random alternative specific constants (ASC) are all statistically significant at a 1 percent level of significance. The statistical significance of the random components of the ASC's (standard deviation) indicate the presence of preference heterogeneity across farmers for different contract types.

6.1 Single versus two opt-out

The single opt-out model and the two opt-out model present similar parameter values, though the two opt-out model provides more explanatory power. The two opt-out model explains

the status quo option by distinguishing between the individual's choice not to grow sugarcane or to keep their current contract. Results from the single opt-out (Table 4) might lead us to conclude that farmers in Goiás and Mato Grosso do Sul prefer not to sign contract nor to produce sugarcane. Yet, the marginal disutility of choosing not to grow sugarcane is the highest among all other choices. This result is in line with Picanço Filho and Marin's (2012a) findings that farmers in this area are willing to grow sugarcane due to its lower risks and higher returns.

If there is more than 1 mill buying sugarcane, then disutility from not growing sugarcane is even greater. This is expected for as the number of sugarcane buyers increases, mills lose their monopsony power while sugarcane producers gain in bargaining power. More bargaining power means more flexibility in contract negotiations and, possibly higher returns, in states where over 90% of sugarcane states is procured through contracts⁶.

Differently from Hudson and Lusk (2004) the random alternative specific constants for each contract type are statistically significant and negative. This indicates farmers' and landowners', in general, receive higher utility from their current contract compared to the ones in the experiment. This may be a result of individually specific contract peculiarities in their current contract that could not be captured in the experiment. Given its better fit and explanatory power the remaining result sections will focus on the results from the two opt-out model (Table 5).

6.2 Contract preferences

Differently from Hudson and Lusk (2004), our results indicate a preference for less rather than more autonomy. The land rental contract option, where the agent has less autonomy, brings

⁶ Recall that sugarcane spot markets in this region are nonexistent. Around 2% of what mills acquire in sugarcane comes from spot markets.

less disutility to the farmer than the supply or the agricultural partnership contract options, where the farmer has more control over sugarcane production. This preference may arise as a means to minimize production risks. The land rental contract, in comparison with the other two contract options, has the lowest production risk and a fixed payment. This finding is similar to that of Hudson and Lusk (2004) that farmers and landowners prefer contracts with less risk. When looking at sugarcane producers in Goiás, Picanço Filho and Marin (2012a) find that, to avoid risk, sugarcane producers were switching to land rental contracts upon expiration of their supply contracts. Apart from risk, late payments was another reason for them to prefer land rental contracts (Picanço Filho and Marin 2012a).

The attribute, probability of late payment, was negative for all three contracts and statistically significant in the land rental and supply contracts. One would expect late payments to be of greater concern to farmers than to landowners, since late payments can cause financial hardship to farmers who miss payment deadlines of input suppliers. Our results, though, show landowners willing to forgo 0.37% in yearly rental rate to reduce in 1% the probability of receiving a late payment, while willingness to pay for a lower probability of late payment was not significant in the case of the supply contract. It appears that even though late payments bring disutility, they are not willing to pay to avoid late payments. Late payments may not be impacting them as much as we expected. One reason for the statistical insignificance of the willingness to pay may be because supply contracts are usually paid at the end of the harvest season. This date could be more flexible than the payment dates of the land rental contracts.

Although sugarcane has high start-up costs and is a perennial crop with a life cycle of 6 years, longer contracts bring disutility to farmers and landowners. In the land rental contract, farmers and landowners were willing to accept a payment reduction of 6.25% per year, to sign a

six-year instead of a twelve-year contract. In the agricultural partnership, farmers and landowners were willing to sign a longer contract if they received an extra 27.8 units of TRS per kilo yearly. Reasons for the preference for a shorter contract may vary. Shorter contracts may be preferred to allow for more flexibility in farming activities (Bergtold, Fewell and William 2004), due to weak contract enforcement (Watanabe and Zylberstein 2014) or due to concerns about the financial stability of the mill⁷.

As in Bergtold, Fewell and Williams' (2014), we also find the level of returns to be important attributes in a contract. The coefficients related to attributes related to contract payments (i.e. rate of LR, share payment, TRS and mill buys all) were all positive and statistically significant, indicating that farmers and landowners, as rational agents, receive utility from higher returns. In the land rental contract, returns are represented by the percentage of the value of the land while in the agricultural partnership and supply contracts, returns are represented by the quality of the sugarcane (i.e. the level of TRS used in the calculation of sugarcane prices). Other attributes that may increase returns were also positive and statistically significant. For instance, farmers gain utility from the mill offering to buy all their production instead of a portion, and from increases in the share of the production received. In fact, with a statistical significance level of 5%, farmers and landowners are willing to accept 1.26 units less of TRS per kilo for a one percentage increase in the percentage of the sugarcane production received.

Although there have been reports (Picanço Filho and Marin 2012a) of the mills in Goiás and Mato Grosso do Sul attracting sugarcane suppliers by offering certain services (e.g. planting, harvesting, hauling and delivery), results show that farmers are not willing to pay for these

⁷ Sant'Anna, Granco, et al. (2016) find that 72% of sugarcane producers and landowners in Goiás and Mato Grosso do Sul state as their main concern about sugarcane production is the mill's financial situation.

services. Out of the coefficients associated with service attributes, only planting is statistically significant. Hence, as Hudson and Lusk (2004) find, the provision of inputs has some on the farmer's marginal utility. Differently from Bergtold, Fewell and Williams (2004), these services do not seem to be a deciding factor in the farmer's willing to sign a supply contract as they are not willing to pay for them.

6.3 Substitutability between contracts

Cross and direct elasticity measures from the two opt-out model were calculated for attributes with continuous variables and arc elasticities for dummy attributes. Direct elasticities capture how attribute changes affect the probability of an individual choosing a contract over other competing options. Cross-elasticities allow for the analysis of the substitutability between contract options (Tables 6 to 9). Elasticity measures indicate that farmers and landowners are unwilling to switching from a contract to not growing sugarcane. When there is more than one mill in the area, the likelihood of choosing not to grow sugarcane decreases by 0.11% while the likelihood of choosing any of the other options is around 0.03% (Table 9).

When considering the substitutability between contract options within the experiment (e.g. land rental, agricultural partnership and supply contracts), a one percent increase in the rate of land rental payment increases the probability of the land rental contract being chosen by 0.66% and decreases the probability of agricultural partnership and supply being chosen by 0.15% and 0.16%, respectively (Table 6). A one percent increase in the TRS value increases the probability of the agricultural partnership agreement and the supply contracts being chosen by 1.57% and 1.20%, respectively (Tables 7 and 8). This increase in TRS decreases the chance of the land rental and the supply contracts by 0.30% and in 0.20%, respectively, being chosen over the agricultural

partnership agreement (Table 7). For the supply contract, an increase in one percent of the value of the TRS reduces the chance of the land rental agreement or the agricultural partnership agreement of being chosen by 0.10% and 0.13%, respectively (Table 8).

Farmers seem to be willing to switch from their current contract when other options provide higher revenues. A one percent increase in TRS per kilo decreases the probability of an individual preferring his current contract instead of an agricultural partnership by 0.58% (Table 7) and instead of a supply by 0.23% (Table 8). In the land rental contract, rate changes have a larger impact on the probability of switching from the current contract. A one percent increase in the rate paid decreases the likelihood of an individual preferring to keep their own contract by 0.23% (Table 6). Out of the services offered by the mill (e.g. planting, hauling and delivery, and the mill buys all), all the production being bought by the mill has the largest direct elasticity, increasing 0.20% the probability of the supply contract being chosen. The mill buying all the production would also reduce the farmers' probability of keeping their current contract by 0.03% (Table 8).

Interestingly increases in risk (i.e. the probability of late payment) do not increase the probability of a farmer choosing not to grow sugarcane, though it does increase the probability of farmers resorting to their current contract. For example, an increase in 1% in the probability of late payment in the supply contract increases the probability of the farmer choosing his current contract by 0.05%. The same effect occurs when the contract length changes from 6 to 12 years. Hence, changes in risk and contract length increases the probability of the farmer keeping his current contract. In the end, farmers are willing to switch from their current contracts if attributes associated with returns increase (i.e. changes in rate, sharepay and TRS). Hence, if mills want farmers to switch from their current contracts they should offer higher returns.

7 Conclusions

This paper examines farmer's and landowner's willingness to sign a contract with a local ethanol mill in the Brazilian *Cerrado*. It contributes to the understanding of the ethanol expansion that has occurred in this region, and to the literature on stated choice modeling by providing a novel manner to deal with omitted choices masked by the status quo option. A hypothetical stated choice experiment was conducted with farmers and landowners in Goiás and Mato Grosso do Sul. The experiment involved farmers and landowners choosing between three contract options (land rental contract, an agricultural partnership contract, a supply contract) and a status quo option. If the status quo option was chosen, individuals had to decide whether they wanted to keep their current contract or not grow sugarcane. We ran a single and a two opt-out model. The two opt-out model, not used in past stated choice studies, allows for a better interpretation of the single opt-out model, commonly found in the literature. Data from the stated choice experiment was analyzed using a random parameter model and the respondent's willingness to pay for contract attributes was calculated. Direct and cross-elasticity measures were also calculated to interpret the substitutability between contract options. Results made it possible to identify which attributes gave farmers and landowners' utility and which disutility.

Attractive contracts have higher returns, lower probabilities of late payment, are shorter in length. Other services previously used by mills to entice farmers into growing sugarcane were not found to be as important to producers as may have been thought. Hence, when signing a contract with the mill, farmers should negotiate the removal of these services in exchange for higher remuneration. In addition, the second-best option after keep current contract seemed to be the land rental contract. Farmers and landowners seem to prefer land rental contracts over other contract options (except the option to keep their current contract). This preference has implications for the

sugarcane industry, potentially motivating mills to vertically integrate. A mill's decision to vertically integrate may have environmental and development implications.

Land rental contracts may be preferred over other contracts because of the lower production risks it presents. Nevertheless, results warn farmers about the potential hazards of giving up their autonomy on sugarcane production by signing a land rental contract. Mills and farmers working on their land may adopt conservation practices differently, which has environmental consequences. As discussed (section 2.1), a tenant may have an incentive to overuse the land, which may result in environmental degradation. In turn, farmers producing on their own land may be more willing to adopt conservation practices to ensure the quality of the land for years to come.

The decision of the mill to vertically integrate may have implications for rural development. If by vertically integrating mills hire workers from other states, then the implementation of a new mill may not imply in a decrease in local unemployment. In turn, local farmers may prefer to hire local workers, since these have local references or are known to them. In this case, the economic activities of the local farmer may have a greater impact on rural development than those of the mill. In addition, the mill's decision to vertically integrate can make the sustainability of the sugarcane expansion in the *Cerrado* more susceptible to the financial stability of the mill. If one mill controls the sugarcane production in a County, then its closure will imply in the end of ethanol and sugarcane production in that County. Hence, it may be in the interest of the Brazilian government to promote agricultural production by farmers, as well as the installation of more than one mill in a location.

Results showed that when there are more mills in a location (i.e. more buyers), farmers and landowners will prefer to grow sugarcane. This is probably linked to their increase in bargaining power when negotiating with the mill. In areas with one buyer farmers may decide not to grow

sugarcane themselves and rent the land to the mill to diversify their revenue and protect themselves from low grain or cattle prices. This fact allied with farmers' preference for shorter contracts may point to the ethanol expansion in the *Cerrado* being sensitive to commodity prices. In other words, as grain and livestock become more profitable farmers will want their lands back for grain and cattle production. With shorter contracts (i.e. 6-year contracts), this switch could be done after the first sugarcane cycle.

The fact that farmers and landowners are willing to receive less to sign shorter contracts could be indicative of a lack of trust concerning contract enforcement, the financial situation of the mills, or the desire for more flexibility in their farming operations. Given that sugarcane production requires high initial investments costs that are diluted throughout its production cycle (i.e. six to twelve years), the first two reasons appear to be a better explanation for the preference for shorter contracts. The Brazilian government should be interested in promoting longer contracts as a form to guarantee sugarcane production in the *Cerrado* after public policies subside. Therefore, it should focus on policies that promote contract enforcement as well as the establishment of producer associations. Associations have the advantage of providing farmers and landowners with more information allowing for better transparency when negotiating a contract with the mill. In order to understand the impact of contract enforcement and asymmetric information on the sustainability of the sugarcane expansion in the *Cerrado* further studies will need to be conducted. Studies should focus on farmers and landowners' willingness to sign contracts at different levels of asymmetric information or trust.

Findings from this study guide, not only, Brazilian farmers, landowners, mills and policy makers, but also stakeholders in countries seeking to expand biofuel production. It highlights the complexity of expanding the production of a biofuel feedstock into a region with previously

established crop and livestock production. The sustainability of biofuel expansion may be threatened by high commodity prices if farmers are signing a short-term sugarcane contracts as a means of revenue diversification. In addition, preference for land rental contracts motivates vertical integration, bringing consequences to rural development, the environment and the sustainability of the expansion of the production of the biofuel crop.

8 References

- Adamowicz, W., J. Swait, P. Boxall, J. Louviere, and M. Williams. 1997. "Perceptions versus objective measures of environmental quality in combined revealed and stated preference models of environmental valuation." *Journal of Environmental Economics and Management* 32(1):65–84.
- de Almeida, P.J., and A.M. Buainain. 2016. "Land leasing and sharecropping in Brazil: determinants, modus operandi and future perspectives." *Land Use Policy* 52:206–220.
- Banzhaf, M.R., F.R. Johnson, and K.E. Mathews. 2001. "Opt-out alternatives and anglers' stated preferences." *The choice modelling approach to environmental valuation*. Edward Elgar, London:157–177.
- 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):876–884.
- Bhat, C.R. 1998. "Accommodating flexible substitution patterns in multi-dimensional choice modeling: formulation and application to travel mode and departure time choice." *Transportation Research Part B: Methodological* 32(7):455–466.
- Brazil. 1966. Decree No. 59,566. 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. Brasília: Presidência da República.
- Brazil. 2009. Law No. 12,187. Institui a Política Nacional sobre Mudança do Clima – PNMC e dá outras providências. Brasília: Presidência da República. Available at: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/112187.htm.
- Broch, S.W., and S.E. Vedel. 2011. "Using choice experiments to investigate the policy relevance of heterogeneity in farmer agri-environmental contract preferences." *Environmental and Resource Economics* 51(4):561–581.
- Carson, R.T., J.J. Louviere, D.A. Anderson, D.S. Bunch, D.A. Hensher, R.M. Johnson, W.F. Kuhfeld, D. Steinberg, J. Swait, H. Timmermans, and J.B. Wiley. 1994. "Experimental analysis of choice." *Marketing Letters* 5(4):351–367.
- CNA, Confederação da Agricultura e Pecuária do Brasil. 2007. *Cana-de-açúcar: orientações para o setor canavieiro. ambiental, fundiária e contratos*. Brasília: Embrapa. Available at: http://www.agencia.cnptia.embrapa.br/Repositorio/Cana-de-acucar_orientacoes_para_o_setor_canavieiro_000fipw96tk02wyiv80z4s4733kvhu6q.pdf.
- CONAB, Companhia Nacional de Abastecimento. 2013. *Perfil do setor do açúcar e do etanol no Brasil Yearly*. Brasília: CONAB. Available at: <http://www.conab.gov.br/OlalaCMS/>

- uploads/arquivos/13_10_02_11_28_41_perfil_sucro_2012.pdf [Accessed November 14, 2014].
- Crocker, K.J., and S.E. Masten. 1988. "Mitigating contractual hazards: unilateral options and contract length." *The RAND journal of economics*:327–343.
- Eswaran, M., and A. Kotwal. 1985. "A theory of contractual structure in agriculture." *The American Economic Review* 75(3):352–367.
- Feltre, C., and L.F. de Oriani e Paulillo. 2015. "Plurality in different groupings: sugarcane supply in Brazil." *British Food Journal* 117(9):2265–2281.
- Fischer, C. 2013. "Trust and communication in European agri-food chains." *Supply Chain Management: An International Journal* 18(2):208–218.
- Goforth, C. 2015. "Using and interpreting Cronbach's Alpha." *University of Virginia Library*, Available at: < <http://data.library.virginia.edu/using-and-interpreting-cronbachs-alpha>.
- Greene, W.H. 2008. *Econometric analysis* 6th ed. Upper Saddle River, New Jersey: Pearson Prentice Hall.
- Hensher, D.A., J.M. Rose, and W.H. Greene. 2015. *Applied choice analysis*. Cambridge University Press.
- IBGE, Brazilian Institute of Geography and Statistics. 2006. *Censo Agropecuario 2006*. IBGE. Available at: http://biblioteca.ibge.gov.br/visualizacao/periodicos/51/agro_2006.pdf.
- IBGE, Brazilian Institute of Geography and Statistics. "Produção Agrícola Municipal – PAM." Available at: www.ibge.gov.br [Accessed May 20, 2015].
- Joskow, P.L. 1987. "Contract duration and relationship-specific investments: empirical evidence from coal markets." *The American Economic Review*:168–185.
- Kim, J.O., and C.W. Mueller. 1978. *Introduction to factor analysis: what it is and how to do it*. SAGE.
- Kuhfeld, W.F. 2005. "Experimental design, efficiency, coding and choice design." *SAS Technical Support T's-722C*.
- Louviere, J.J., D.A. Hensher, and J.D. Swait. 2000. *Stated choice methods: analysis and applications*. Cambridge University Press.
- Lusk, J.L., and D. Hudson. 2004. "Willingness-to-pay estimates and their relevance to agribusiness decision making." *Review of Agricultural Economics* 26(2):152–169.

- Manzatto, C.V., E.D. Assad, J.F.M. Baca, M.J. Zaroni, and S.E.M. Pereira. 2009. “Zoneamento agroecológico da cana-de-açúcar: expandir a produção, preservar a vida, garantir o futuro.” *Embrapa Solos. Documentos*.
- MAPA, Ministry of Agriculture, Live Stock and Supply. 2013. *Anuário estatístico da agroenergia 2012: Statistical yearbook of agrienergy*. Brasília: Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Produção e Agroenergia.
- Neves, M.F., V.G. Trombin, and M. Consoli. 2011. “The sugar-energy map of Brazil.” In E. L. Leao de Sousa and I. de 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 Anais. XXXVI Congresso da Sociedade Brasileira de Economia e Sociologia Rural - SOBER. Poços de Caldas, M.G.: SOBER, pp. 559–572. Available at: http://pensa.org.br/wp-content/uploads/2011/10/O_sistema_agroindustrial_da_cana_de_acucar_1998.pdf [Accessed November 30, 2014].
- O Popular. 2011. “Jataí aprova legislação restritiva ao cultivo da cana-de-açúcar.” *O Popular*. Available at: <http://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 December 20, 2014].
- Picanço Filho, F.A. 2010. “Contratos agrários na agroindústria canavieira em Goiás: legalidades e conflitos.” Available at: http://ppagro.agro.ufg.br/up/170/o/DISSERTA%C3%87%C3%83O_FINAL_ART%C3%8AMIO_2008.pdf?1354556732 [Accessed December 9, 2014].
- Picanço Filho, F.A., and J.O.B. Marin. 2012a. “Sugar-cane supply agreement: the power asymmetry between agents.” *Interações (Campo Grande)* 13(2):191–202.
- Picanço Filho, F.A., and J.O.B. Marin. 2012b. “The sugar cane political network and its power resources in the Goiás state, Brazil.” *Pesquisa Agropecuária Tropical* 42(2):189–197.
- Procana. 2013. *Brazilian sugar and ethanol guide 2013*. Ribeirão Preto: ProCana Brasil.
- Queiroz, S. de T.P. 2008. *Usinas de álcool: fatores influentes no processo de escolha da localização de novas unidades*. Master Thesis. Brasília: Universidade de Brasília. Available at: <http://repositorio.unb.br/handle/10482/4927> [Accessed October 10, 2014].
- Roberto, C. 2012. “Cana leva progresso e esperança ao Centro-Oeste.” *CANAMIX* 5(45):38–55.
- Rudorff, B.F.T., D.A. Aguiar, W.F. Silva, L.M. Sugawara, M. Adami, and M.A. Moreira. 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, and W. Lorenzani. 2016. "The challenges of the sugarcane expansion: how do producers and land owners think and act?" In G. R. Santos, ed. *Forty years of ethanol in Brazil: hide or confront the crises?* Brasilia: IPEA, pp. 113–142.
- Sant'Anna, A.C., A. Shanoyan, J.S. Bergtold, M.M. Caldas, and G. Granco. 2016. "Ethanol and sugarcane expansion in Brazil: what is fueling the ethanol industry?" *International Food and Agribusiness Management Review* 19(4):163–182.
- Sartorius, K., and J. Kirsten. 2007. "A framework to facilitate institutional arrangements for smallholder supply in developing countries: an agribusiness perspective." *Food Policy* 32(5–6):640–655.
- Shikida, P.F.A. 2013. "Expansão canvieira no Centro-Oeste: limites e potencialidades." *Revista de Política Agrícola* 22(2):122–137.
- 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.
- StataCorp, L. 2015. *Multivariate statistics reference manual*. Stata Press. Available at: <http://www.stata.com/bookstore/multivariate-statistics-reference-manual/>.
- Swait, J. 2006. "Advanced choice models." In *Valuing environmental amenities using stated choice studies*. Springer, pp. 229–293.
- Train, K.E. 2009. *Discrete choice methods with simulation*. New York: Cambridge University Press.
- Valdes, C. 2011. "Brazil's ethanol industry: looking forward." Outlook No. BIO-02, Available at: <http://www.ers.usda.gov/publications/bio-bioenergy/bio-02.aspx> [Accessed May 20, 2015].
- Vavra, P. 2009. "Role, usage and motivation for contracting in agriculture." No. 16, Available at: http://www.oecd-ilibrary.org/agriculture-and-food/role-usage-and-motivation-for-contracting-in-agriculture_225036745705 [Accessed March 30, 2017].
- Watanabe, K., and D. Zylbersztajn. 2014. "Contract farming in the Brazilian agri-business system: private institutions and State intervention." *Uniform Law Review - Revue de droit uniforme* 19(3):459–478.
- Weesie, J. 1997. "Enhancements to the alpha command." *Stata Technical Bulletin* 6(35). Available at: <https://ideas.repec.org/a/tsj/stbull/y1997v6i35sg66.html>.
- 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.

Table 0.1: Statistics from the 2006 Agricultural Census versus statistics from our survey

Characteristics	Census (2006)*	Our survey
Average area of the farm (hectares)	415	913
Percentage who own land	87	78
Participation in Association or Cooperative		
Percentage participating in cooperatives	11	49
Percentage participating in an association	11	49
Gender:		
Percentage of males	92	96
Education – Percentage who completed:		
5th - 8th Grade	4	7
High School	4	37
Have a college degree	3	28
Farms with sugarcane production:		
Average sugarcane yield (ton/ha)*	70.30	87.71
Average Value of Sugarcane Production (R\$1000)	330.18	1035.24

Source: IBGE 2006.

*The average yield of sugarcane comes from CONAB 2013.

Scenario 1

Option 1: Land Rental Agreement

Land is rented to the mill to produce sugarcane for a annual payment.

Rate: 15% of the value of the land.

Possibility of a late payment: 0%.

Contract length: 12 years.

1

Option 2: Partnership Agreement

Land is rented to the mill to produce sugarcane for a share of the production paid annually.

Rate: 50% of the value of the production based on 155kg of TRS/ton.

Possibility of a late payment: 10%.

Contract length: 6 years.

2

Option 3: Supply Agreement

You produce sugarcane to the mill.

The mill is responsible for:

Planting: NO. Harvesting: NO

Delivery: NO.

Price is based on TRS of: 155kg of TRS/ton

Possibility of a late payment: 10%.

Mill buys all the production: NO

Contract length: 12 years

3

Option 4: Status Quo

I prefer to remain in my current situation

4

(Please write down the number corresponding to the option you prefer)

Which option do you choose?

*If you **choose "Status Quo"** please answer the following:*

Would you rather: *(Please mark one)*

Answer *(Enter 1 for selected option, leave blank if not used)*

Stay with your current contract

Stop growing sugarcane

Figure 0.1: Example choice scenario for the stated choice experiment

Table 0.2: 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 harvested sugarcane. "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

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

Table 0.3: 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 <i>dummy</i> indicating whether the mill provides the farmer with seeds or a loan for planting
H	A <i>dummy</i> indicating whether the mill is responsible for harvesting the sugarcane
D	A <i>dummy</i> indicating whether the mill is responsible for hauling and delivery of the sugarcane
B	A <i>dummy</i> indicating whether the mill is responsible for buying all the sugarcane produced by the supplier or not
$More1$	A <i>dummy</i> indicating whether there is more than one mill in the vicinity to which the producer can sell sugarcane to.

Table 0.4: Results from the random parameter model with single opt-out and willingness to pay estimates

Attribute	Choices					
	Land Rental (LR)		Agricultural Partnership (AP)		Supply (S)	
	Coefficient Estimate	Willingness to Pay	Coefficient Estimate	Willingness to Pay	Coefficient Estimate	Willingness to Pay
Intercept	-3.97 *** (0.84)		-6.75 *** (1.43)		-6.50 *** (1.73)	
Rate of LR	0.16 *** (0.03)					
TRS			0.03 *** (0.01)		0.02 * (0.01)	
Late Payment	-0.06 *** (0.02)	-0.37 ** (0.15)	-0.04 (0.03)	-1.18 (0.95)	-0.06 ** (0.02)	-3.20 (2.26)
Length	-1.01 *** (0.33)	-6.37 ** (2.58)	-0.87 *** (0.29)	-27.59 ** (12.56)	-1.17 *** (0.40)	-62.06 (41.19)
Share payment			0.04 *** (0.01)	1.27 ** (0.55)		
Planting					0.71 * (0.38)	37.55 (28.06)
Harvesting					0.41 (0.37)	22.05 (22.44)
Hauling and delivery					0.68 * (0.42)	36.42 (32.57)
Mill buys all					1.32 *** (0.4)	70.52 (46.76)
More than 1 buyer	0.62 (0.84)		0.04 (3.13)		0.50 (0.75)	
<i>Distances of Random Parameters Standard Deviations</i>						
Contract LR	3.30 *** (0.50)					
Contract AP	3.01 *** (0.45)					
Contract S	2.84 *** (0.53)					
Log-likelihood	-588.59					
McFadden Pseud R ²	0.36					
AIC	1223					
Observations	660					

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

Table 0.5: Results from the random parameter model with two opt-outs and willingness to pay estimates

Attribute	Choices						
	Land Rental (LR)		Agricultural Partnership (AP)		Supply (S)		Not grow sugarcane
	Coefficient Estimate	Willingness to Pay	Coefficient Estimate	Willingness to Pay	Coefficient Estimate	Willingness to Pay	Coefficient Estimate
Intercept	-3.75 *** (0.98)		-6.20 *** (1.42)		-5.55 *** (1.67)		-23.62 *** (7.56)
Rate of LR	0.17 *** (0.03)						
TRS			0.03 *** (0.01)		0.02 * (0.01)		
Late Payment	-0.06 *** (0.02)	-0.37 ** (0.15)	-0.04 (0.03)	-1.14 (0.92)	-0.06 *** (0.02)	-3.28 (2.29)	
Length	-1.04 *** (0.33)	-6.25 ** (2.53)	-0.87 *** (0.29)	-27.75 ** (12.33)	-1.16 *** (0.39)	-62.60 (42.92)	
Share payment			0.04 *** (0.013)	1.26 ** (0.53)			
Planting					0.68 * (0.38)	36.70 (27.61)	
Harvesting					0.41 (0.37)	21.92 (22.13)	
Hauling and delivery					0.64 (0.41)	34.28 (31.97)	
Mill buys all					1.30 *** (0.39)	70.16 (46.57)	
More than 1 Mill	0.86 (0.93)		-0.30 (0.68)		-0.03 (0.67)		-9.74 *** (3.43)
<i>Distances of Random Parameters Standard Deviations</i>							
Contract LR	3.71 *** (0.64)						
Contract AP	2.74 *** (0.39)						
Contract S	2.47 *** (0.4)						
Opt Out	30.37 *** (8.99)						
Log-likelihood	-623.93						
McFadden Pseud R ²	0.41						
AIC	1300						
Observations	660						

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

Table 0.6: Direct and cross-elasticities in the land rental contract

	Land Rental	Agricultural Partnership	Supply	Current Contract	Not grow Sugarcane
Rate	0.66	-0.16	-0.16	-0.23	-0.02
Risk	-0.17	0.04	0.04	0.06	0.01
Length	-0.07	0.02	0.02	0.03	0.00
More1	0.09	-0.02	-0.02	-0.03	0.00

Note: Length and More1 are arc elasticities since these are dummy variables.

Table 0.7: Direct and cross-elasticities in the agricultural partnership contract

	Land Rental	Agricultural Partnership	Supply	Current Contract	Not grow Sugarcane
Risk	0.01	-0.07	0.02	0.02	0.00
Length	0.02	-0.10	0.03	0.05	0.00
Sharepay	-0.10	0.53	-0.14	-0.20	-0.02
TRS	-0.30	1.57	-0.40	-0.58	-0.05
More1	0.01	-0.03	0.01	0.01	0.00

Note: Length and More1 are arc elasticities since these are dummy variables.

Table 0.8: Direct and cross-elasticities in the supply contract

	Land Rental	Agricultural Partnership	Supply	Current Contract	Not grow Sugarcane	
Risk		0.02	0.03	-0.27	0.05	0.00
Length		0.01	0.02	-0.09	0.03	0.00
TRS		-0.10	-0.13	1.20	-0.23	-0.02
Planting		-0.01	-0.01	0.10	-0.02	0.00
Harvesting		0.00	-0.01	0.05	-0.01	0.00
Hauling and delivery		-0.01	-0.01	0.09	-0.02	0.00
Mill buys all		-0.01	-0.02	0.20	-0.03	0.00
More1		0.00	0.00	0.00	0.00	0.00

Note: Length, Planting, Harvesting, Hauling and delivery, Mill buys all and More1 are arc elasticities since these are dummy variables.

Table 0.9: Direct and cross-arc elasticities for the presence of more than 1 mill in the option not to grow sugarcane

	Land Rental	Agricultural Partnership	Supply	Current Contract	Not grow Sugarcane
More1	0.03	0.03	0.03	0.03	-0.11