CITRUS PRODUCERS´ CHOICE OF PRICE RISK MANAGEMENT TOOLS

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Abstract: The purpose of this study is to analyze producer hedging behavior, using a sample of 98 São Paulo (Brazil) citrus growers. Producer marketing behavior is modeled as a choice between cash sales, short- and long-term forward contracts. Multinomial logistic regression model is employed to evaluate the role of behavioral, personal and managerial variables on producer marketing adoption. Results indicate that the factors that explain the use of forward pricing by citrus producers are risk propensity, selling to juice processing companies, farming diversification, overconfidence in management, participation in pools, use of management tools and technical assistance. The empirical results can be useful for farmers, policy makers, government agencies, traders, and extension agents.

Keywords: price risk, forward contracts, risk management, citrus marketing.

1. Introduction

In agriculture, farmers usually face different types of risk simultaneously. Five major sources of risk can be distinguished: production, price, financial/credit, institutional and operational (OECD 2009).

The focus of this paper is price risk. One way to mitigate adverse price variability involves the use of derivative contracts such as forward contracts, future contracts, options, and swaps. Several factors determine the adoption of derivative contracts by farmers. Previous studies point to four groups of factors: farmers' characteristics (such as age, education level and experience); farmers' behavioral attitudes (such as risk perception, risk aversion, and overconfidence); farming characteristics (such as product category, farm location, leverage, and production size); farmers' preferences regarding risk management tools – in addition to using derivative contracts, farmers can adopt other strategies such as farming diversification, off-farm income, vertical integration, diversification of distribution channels, and government programs (Velandia *et al*. 2009; Pennings and Leuthold 2000).

In the citrus industry, price risk is especially pervasive. Orange is a perennial crop culture with medium/long term returns. A citrus grove has a lifespan of about 20 years. Farmers face high initial costs to establish the orchard in the first three years and zero

crop revenue during this period. Revenues start in the third year, but yield is still very low. Crop yield increases in the following years, decreasing in the final crops. Farmers may continue their operations even when prices are below unit production cost for some years, as long as they maintain expectations of recovery for the years to come. This situation may result in indebtedness and gradual capital loss if their positive expectations are not realized. Therefore, short- and long-term forward contracts are usually adopted by citrus producers to mitigate price risk.

In Brazilian citrus market, short-term forward contracts are standard contracts offered by juice processing companies. They are negotiated a few months before harvest and are associated to season production. In general, these contracts have some standard clauses, allowing for price differentiation according to volume, fruit quality, and the moment of the season. Long-term forward contracts are associated to two or more succeeding seasons. In this case, the selling price is formed by a standard minimum price and an additional premium which depends on ICE orange juice futures price. The minimum price and the premium are subjected to negotiation between citrus grower and processing firm. Price differentiation depends mainly on volume, fruit quality and the moment of the season. Both contracts have fixed price (minimum price) to be paid at fixed date in the future. Usually, long-term forward contracts present more terms and rules than the short-term forward contracts.

Despite the number of studies that have examined the factors that affect producers' marketing choices, no study has comprehensively explored how these factors influence citrus growers' hedging decisions. The objective of this paper is to evaluate producer hedging behavior adopted by citrus farmers, identifying the factors that influence the choice of marketing strategy. The analysis can be useful for farmers, policy makers, government agencies, traders, and extension agents. To our knowledge, this is the first study to consider factors affecting farmers' adoption of risk management tools in citrus industry.

The remainder of the paper is organized as follows. The next subsection contains a literature review on the factors (farmer/farm characteristics) influencing adoption of risk management strategies. Subsequently, the research method is described, followed by the empirical results and conclusions.

2. Previous studies

Many empirical studies have analyzed factors influencing farmers' risk management strategies. Most of them have focused on U.S. markets and used qualitative choice models. Table 1 provides a summary of this literature and the following paragraphs explore the studies published over the last 10 years.

In the U.S. grain markets, Franken and Pennings (2009) found that farmers' age, experience, education level, debt-to-asset ratio, and risk aversion influenced farmers' risk management strategy. Velandia *et al.* (2009) provided new empirical evidence about farmers' risk strategy considering the possibility of simultaneous adoption of different risk management tools (rural insurance, forward contracts, and spreading sales). Results indicated that farm size, off-farm income, education level, age, and degree of business risks were important variables to understand farmers' hedging decisions.

Dorfman and Karali (2010) also contributed to this debate exploring the effect of habit on farmers´ hedging decisions for corn, soybeans, wheat, and cotton. Their findings indicated that habit, educational level, percentage of income from farm activity, and use of the internet as an information source played an important role on hedging decisions. In addition, Franken *et al*. (2014) evaluated the influence of risk attitudes on hedging choices in hog and corn markets. The results suggested that producers with larger operations, higher education level, smaller age, higher leverage, and greater risk aversion are more likely to adopt risk management tools in their marketing strategies.

Using a sample of U.S. cotton farmers, Dorfman *et al*. (2010) evaluated the effect of habit on hedging decision and found that it played an important role in a segment of cotton farmers, which represented 65% of the sample. Pace and Robinson (2012) found that farmers' education, planted area size, off-farm activities, participation in cooperatives, beliefs about the price in pre-harvest period, beliefs on the performance of merchant pools, and willingness to take lower prices to reduce price risk affected cotton farmers' marketing decisions. Focusing on Illinois cotton farmers, Tudor *et al*. (2014) pointed that farmer's age and gross farm income were the main predictors of the risk management strategy.

In addition, Wolf (2012) investigated the use of price risk management tools by the U.S. dairy farmers. The results showed that herd size, land operated, farmers' age, and farm organization played an important role on hedging decisions.

Table 1: Summary of literature review on factors influencing farmers' adoption of risk management strategy.

Reference	Sample /Year of the interview	Method	Determinants of risk management tools adoption
Shapiro and Brorsen (1988)	42 U.S. grain producers / 1985	Tobit	Education, experience, farm size, leverage, outside income, degree that producers see themselves as good administrators, expected income from the hedging operation, and perception that hedging would stabilize income
Markus *et al.* (1990)	595 U.S. producers / 1986, 1987, or 1988	Probit	Location, farm size, education, previous use of forward contract, and membership in a marketing club
Goodwin and Schroeder (1994)	509 U.S. producers / 1991	Probit	Participation in educational programs, farm size, crop size, inputs intensity, leverage
Musser, Patrick, and Eckman (1996)	62 U.S. grain producers / 1992-93	Tobit	Age, education, farm location, leverage, expectation about price, and risk preference variables
Patrick, Musser, and Eckman (1998)	U.S. grain producers: 58 in 1993, 49 in 1994 and 37 in 1995 / 1993 - 1995	Statistical analysis	Farmer decisions were not solely based on static strategies related to a long run portfolio. Dynamics rules were used
Sartwelle *et al.* (2000)	352 U.S. grains producers / 1996-97	Multinomial logit	Farmer experience, farm size and location, activity specialization, use of crop insurance and use of storage
Pennings and Leuthold (2000)	440 German hog producers	Cluster analysis and covariance structure equation models	Knowledge about futures markets, producers' opinion of agents, and perception on the futures contracts performance
Isengildina and Hudson (2001)	108 U.S. cotton producers / 1999	Multinomial logit model	Producer preferences, farm size, use of crop insurance, risk aversion, income from government payments and off-farm income.
Katchova and Miranda (2004)	2,662 U.S. corn producers; 2,829 soybean, 2,192 wheat	Two-step econometric model	Level of specialization, use of one type of contract against other, personal and farm characteristics
Vergara *et al*. (2004)	549 U.S. cotton producers / 1999	Multinomial logit model	Age, planted area size, farmer risk aversion, crop insurance use, and market advisory service utilization
Jordaan and Grové (2007)	78 South African maize producers / 2005	Logit and factor analysis	Proportion of land rented, use of pivot irrigation, specialized crop production, marketing skills, and risk aversion. Reasons to use no risk management tools: lack of capacity, distrust the effectiveness, and bad experiences.
Velandia *et al.* (2009)	871 U.S. corn and soybean farmers / 2001	Multivariate and multinomial probit approaches	Proportion of owned acres, off-farm income, education level, age, and degree of business risks
Woolverton and Sykuta (2009)	52 South African and 44 U.S. maize producers / 2006 and 2007	Pooled regression	Presence of an income supporting marketing environmental

Table 1: Summary of literature review on factors that influence marketing technique adoption by farmers (cont.).

Reference	Sample /Year of the interview	Method	Determinants of risk management tools adoption
Franken and Pennings (2009)	48 U.S. grain producers / 2006	Cragg's (1971) hurdle model	Age, experience, education, debt-to-asset ratio, and risk aversion
Dorfman, Pennings and Garcia (2010)	72 U.S cotton producers / 2001-02	Mixture regression	For 35% of the farmers: land ownership and perceived profitability. For 65% of the farmers: habit
Dorfman and Karali (2010)	57 U.S. farmers (corn, soybeans, wheat, and cotton)/ 1999-2002	Panel model	Habit, educational level, percentage of income from farm activity, and use the internet
Mattos and Fryza (2012)	20,371 Canadian wheat producers / 2003-04 through 2008-09	Linear Regression	Previous use of a certain marketing contract, previous year marketing performance and price signals
Pace and Robinson (2012)	263 U.S. cotton farmers / 2012	Multinomial Logit	Education, planted area size, off-farm income, historical participation in cooperative pools, beliefs about the price in pre-harvest period, beliefs about the performance of merchant pools, and willingness to take lower prices to reduce price risk had effect on farmer marketing decisions
Wolf (2012)	458 and 225 U.S. dairy farmers / 1999 and 2011	Probit	Herd size, land operated, farm organization, and age. Reason to do not use: cost, basis risk, lack of understanding, and participation on risk management programs offered by cooperative
Mofokeng and Vink (2013)	31 maize farmers from Gauteng – South Africa	Probit	Gender, age, education, grain association member, experience in the activity, farm size, off-farm income, insurance utilization, and presence of rented land
Carrer *et al*. (2013)	86 Brazilian beef cattle farmers / 2010	Logit	Farm income, technological intensity and business leverage
Silveira *et al*. (2014)	244 Brazilian coffee producers / 2010	Multinomial Logit	Risk propensity, overconfidence in management, level of market monitoring, education and crop size
Anastassiadis *et al*. (2014)	136 German grain producers / 2012 (analysis of the past five years)	Mixed logit	Price expectation, risk attitude, and storage capacity influenced the use of risk management tools against cash sales
Tudor *et al*. (2014)	459 U.S. grain and livestock producers/ 2009	Multinomial logit	Age and gross farm income
Franken *et al*. (2014).	50 U.S. hog producers and 49 U.S. corn producers/ 2006	Regression analysis	Operation level, education, age, leverage, and risk aversion
Ullah *et al*. (2015)	300 Pakistanis farmers / 2012 and 2013	Bivariate probit and multinomial probit	Age, education, risk aversion, risk perception, monthly income, and ownership of the land

Recent studies have also explored the factors that influence farmers' strategies in other countries. Mattos and Fryza (2012) investigated the decisions of Canadian wheat producers during 2003/04-2008/09 crop years and found that previous use of marketing contract, previous year marketing performance, and price signals influenced on marketing decisions. Considering hedging decisions among German farmers, Anastassiadis *et al*. (2014) showed that price expectations, risk attitude, and storage capacity influenced risk management strategies of grain farmers.

Jordaan and Grové (2007) evaluated marketing strategies among maize producers in South Africa. The authors indicated that human capital and risk aversion affected the farmers' decision-making process. Carrer *et al*. (2013) and Silveira *et al.* (2014) studied Brazilian markets. While Carrer *et al.* (2013) found that farm income, technological intensity, and business leverage influenced beef cattle producers' hedging decisions, Silveira *et al.* (2014) showed that behavioral variables, farmer's education and crop size impacted the strategies adopted by coffee producers. Ullah *et al*. (2015) found evidence that farmers' characteristics such as age, education, risk aversion, risk perception, income, and land ownership impacted the adoption of risk management tools among Pakistani farmers.

Finally, Woolverton and Sykuta (2009) analyzed the impact of income support program on grain farmers' hedging decisions, comparing data from South Africa and the U.S.; two countries with different agricultural policies. Results suggested that the South African farmers, operating within a non-supported agricultural marketing environment, tend to hedge a larger percentage of expected maize yields than U.S. farmers, which operates within a market price support environment.

Overall, a number of studies have found evidence that not only personal and business characteristics influence hedging decisions; producers' behavior also plays an important role on choices.

3. Method

3.1. Data

A survey was designed to collect data by means of in-person interviews with citrus growers of the State of São Paulo, Brazil. The questionnaire comprised 83 questions on socioeconomic characteristics of growers and farms, including adoption of management

tools and risk behavior. The interviews were carried out in the first semester of 2014, allowing the collection of data regarding 2013/14 crop year. A random sample of 98 citrus farms was used to represent citrus belt of the State. In 2013/14 crop year, the sampled farms produced 5,809,627 boxes of 40.8 kg of citrus fruit (around 2% of São Paulo total production), in 9,441 hectares.

Orange juice processing companies are the main buyers of orange in the State of São Paulo. They adopt three main strategies in their transactions with growers: spot market, short- and long-term forward contracts. Other buyers, such as wholesalers and retailers, rely mainly on spot market. According to the survey data, 66% of the growers adopted hedging strategies (forward contracts) in the 2013/14 crop year: 49 growers adopted short-term forward contracts and 16 growers adopted long-term forward contracts. The survey also revealed that 32 producers adopted the mixed strategy of selling most of their production using forward contracts, but also selling a small portion in the spot market. Short-term contracts establish the terms of transaction of the current crop year production, while long-term contracts establish the terms for two years. Orange juice processing firms negotiate forward contracts a few months before the harvest season. In general, these contracts have some standard clauses; long-term contracts usually present more terms. ICE orange juice futures prices are usually adopted as a reference for a standard minimum price. A premium can also be adopted. Both the minimum price and the premium are negotiated in advance, allowing price differentiation, which depends on volume, product quality and period of the year.

3.2. Econometric model

A multinomial logistic regression model was used to analyze factors determining the growers' decisions on the adoption of short-term and long-term forward contracts (equation 1). The dependent variable is based on three possible choices, where the choice parameter *j* is: 0 if most of the citrus was negotiated in the cash market; 1 if the majority of the product was marketed through a short-term forward contract; 2 if most of the crop was sold using long-term forward contract.

$$\log\left(\frac{\Pr(Y = j \mid \mathbf{X})}{\Pr(Y = 0 \mid \mathbf{X})}\right) = \mathbf{X}\boldsymbol{\beta} + \varepsilon \qquad (1)$$

where the probability of adopting forward contracts (j = 1 for short-term contract and j = 2 for long-term contract) to sell most of the crop relative to the spot market (base scenario) is a function of explanatory variables (**X**) and random errors (ε). β is a vector of coefficients, which shows the impact of changes in the explanatory variables (**X**) on the probability of use forward contracts relative to the base scenario. The parameters of equation 1 are estimated by maximum-likelihood.

3.3. Variables and hypotheses

Explanatory variables may be summarized into three categories: growers' characteristics; farming and marketing aspects; growers' behavior and attitudes (Table 2).

The first set includes three variables – education level, age, and participation in grower pools. The level of formal education and the farmer´s age (as proxy for experience) are used to evaluate the role of human capital accumulation (Velandia et al 2009). Thus, we hypothesize that growers with higher level of education (hypothesis 1) and more experience/higher age (hypothesis 2) adopted a more complex selling strategy such as forward contract rather than the spot market.

The pools of orange growers in the State of São Paulo are mainly dedicated to orange selling and/or purchasing of inputs. Members are not necessarily members of any formal cooperative. They can be independent growers who join in a pool to discuss and plan joint strategies to sell oranges and purchase inputs. Economies of scale are the most important incentive. In this case, the contact with each other is a way to share information about production technologies and marketing alternatives, so it can be hypothesized that growers who are members of pools have higher probability of adopting forward contracts (hypothesis 3) (Pennings and Leuthold 2001). In addition, the pools may generate economies of scale, which stimulate the adoption of long-term contracts.

Table 2: Description of variables.

Variable	Description
Forward contract (Y)	0 if the grower sold most of the crop in cash market; 1 if the most of citrus production is sold through a short-term forward contract; 2 if the grower used long-term forward contracts to sell the majority of the crop.
Age (X_1)	Age of the grower.
Education (X_2)	Years of formal education of the grower.
Pools (X_3)	1 if the grower is member of a pool for selling oranges and/or purchasing inputs; 0 otherwise.
Size (X_4)	Area of the citrus grove (in hectares)
Selling to processing (X_5)	1 if the farmer sold citrus to juice processing industries; 0 otherwise
Farming concentration (X_6)	A Herfindahl concentration index was calculated by taking the share of each crop/pasture in total area of the farm allocated to them in 2013/2014 crop year. The index value ranges from 0 to 1, with high values indicating concentration.
Management tools (X_7)	This variable is an index representing the level of adoption of management tools. Growers indicated the adoption, 0, or non-adoption, 1, of seven tools: cost control methods; stock control procedures; electronic recording of data on production, yields and diseases; integrated management systems; internet to access market information; precision agriculture; and quality certifications. The index is the summation of these instrumental variables, ranging from zero to seven.
Technical or managerial assistance (X_8)	1 if the grower received visits from agronomists or market/management experts in 2013/14 crop year; 0 otherwise.
Risk perception (X_9)	Growers indicated their perception with respect to the statement "*The citrus market is very risky*" by choosing a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).
Risk propensity (X_{10})	Growers indicated their perception with respect to the statement "*I trust in my intuition when I choose the best moment to sell oranges*" by choosing a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).
Overconfidence in management (X_{11})	Growers indicated their perception with respect to the statement "*I manage my farm better than the average farmers in my region*" by choosing a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).
Overconfidence in price (X_{12})	1 if the farmer was overconfident in prices; 0 otherwise

The second set of variables is based on five aspects of farming and marketing process: size of the grove, farming concentration, technical assistance, adoption of management tools, and selling to juice processing companies. Size was measured as the number of hectares of the grove. It is assumed that some unit transaction costs are

reduced because economies of scale. Therefore, we can hypothesize that growers who own larger groves have higher probability of adopting a more complex price risk management strategy, such as forward contracts (hypothesis 4) (Goodwin and Schroeder 1994). However, farming concentration, in opposition to farming diversification, can be a risky production strategy, so growers that use this strategy would have higher probability of adopting forward contracts (hypothesis 5). By diversifying their production, the farmer is already adopting price risk management strategy, since it reduces the dependence of their total revenue in only one product (McNamara and Weiss, 2005). A Herfindahl concentration index was calculated and used as a proxy for farming concentration, as explained in Table 2.

The role of management in the adoption of forward contracts was evaluate through two variables. The first one specifies if the grower received technical or managerial assistance of experts in the 2014/2015 crop year. The second one is an index to measure the level of adoption of management tools which takes into consideration seven tools (Carrer *et a*l. 2015). Growers receiving technical or managerial assistance (hypothesis 6), as well as growers with high level of adoption of management tools have higher probability of adopting forward contracts (hypothesis 7) (Vergara et al. 2004). It is expected that producers using management tools and technical assistance services will most likely choose marketing pricing techniques that require close monitoring of price movements, such as forward contracts.

Mello and Paulillo (2009) found that citrus growers' sales to juice processing companies in Brazil are more likely to be coordinated through short- and long-term forward contracts, while sales to other channels (wholesalers, cooperatives, agri-food retailers, etc.) are usually coordinated through spot market. A binary variable that specifies if the grower sells to juice processing firms was then included in the model. So, hypothesis 8 can be stated: growers who sell to juice processing firms are more likely to adopt forward contracts.

Previous research showed evidence about the relevant role of behavioral attitudes on farmers' marketing decisions (Pennings and Leuthold 2000; Isengildina and Hudson 2001; Franken and Pennings 2009; Franken et al. 2014). In order to test hypotheses on these subjects, a third group of four variables based on growers' behavior and attitudes was included in the model: risk perception, risk propensity, overconfidence in

management and overconfidence in price. The questionnaire included three questions based on growers' perceptions about market risk and their management ability, along with their propensity to assume risk. Growers were asked to indicate their agreement with the statement "*The citrus market is very risky*". They should choose from a five-points Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). Therefore, the variable "risk perception" was obtained; the higher the score the higher their risk perception. In the same way, growers provided their choice for the statement "*I trust in my intuition when I choose the best moment to sell oranges",* so the variable "risk propensity" was obtained; the higher the score the higher the propensity to take risk. Finally, the variable "overconfidence in management" was created from the statement "*I manage my farm better than the average farmers in my region*"; stronger agreement with this statement suggests better-than-average effect, indicating farmers' tendency to evaluate themselves more favorably than average-peer. These variables were used to test three hypotheses: farmers with higher risk perception have higher probability to adopt forward contracts (hypothesis 9), growers with higher propensity to take risk have lower probability to adopt forward contracts (hypothesis 10), and growers who are more overconfident in their management have lower probability to adopt forward contracts (hypothesis 11).

Finally, "overconfidence in price" is a binary variable that indicates if the grower is, or not, overconfident in his/her forecast of orange prices (Table 2). Overconfidence in price was measured by comparing the citrus market price variance in the State of São Paulo during 2000 and 2015 with the grower´s subjective orange price variance. The latter was calculated using the survey data on growers' perceptions about future prices. In the questionnaire, the grower should provide his/her perception about the probabilities of seven ranges of orange prices three months into the future[1]. The grower provided seven probability values, for which summation should equal 100%. The subjective price variance was then calculated for each grower. The grower was considered overconfident in price if his/her subjective orange price variance was lower than the citrus market price variance, therefore a binary variable (1-overconfident, 0-otherwise) could be generated.

Table 3 shows descriptive statistics of the independent variables used to test the hypotheses. The mean age of the growers was around 47 years old, while the mean

[1] The price ranges were: R$ 4.00-6.00; R$ 6.01-8.00; R$ 8.01-10.00; R$ 10.01-12.00; R$ 12.01-14.00; R$ 14.01-16.00; higher than R$ 16.01. This values were established after examining citrus price in the State of São Paulo provided by Institute of Agricultural Economics (IEA 2015).

number of years of formal schooling was 12 years. The mean size of their groves was 75.31 hectares in 2013/14 crop year. In addition, 33% of the growers participated in pools, 59% sold oranges to juice processing firms, and 51% received technical or managerial assistance in 2013/14 crop year. The mean of the index for farming concentration was 0.60, with the minimum of 0.14 and maximum of 1. The mean of the index representing the level of adoption of management tools was 3.18 (the index ranges from 0 to 7). The behavioral variables showed that growers presented high risk perception (mean 4.63, in a range from 1 to 5), medium level of risk propensity (mean 2,74, in a range from 1 to 5), medium to high level of overconfidence in management (mean 3.76, in a range 1 to 5), and 40% of the growers showed overconfidence in price.

It is important to note that the mean of "risk perception" was quite high. This result reveals a structural characteristic of the citrus market in Brazil, which was very clear for growers in the period of the survey interviews. The crop years of 2011/12, 2012/13 and 2013/14 were characterized by increasing incidence of pests and diseases in citrus groves, high volatility of citrus prices, and instability in the trade relations between citrus growers and juice processing firms (IEA 2015). Many farmers left the citrus industry during those years. Orange prices dropped dramatically during the 2012/13 and 2013/14 crop years as a result of a large excess production in the 2011/12 due to exceptional good weather conditions, high stocks of orange juice and decreasing world demand of orange juice. This scenario may have increased citrus farmers' risk perception.

Table 3. Descriptive statistics of the explanatory variables (n = 98).

Variable	Mean	Median	Mode	Min.	Max.	Std Dev.
Age (X_1)	47.58	48	50	19	82	12.29
Education (X_2)	12.40	16	16	2	18	4.95
Pools (X_3)	0.33	0	0	0	1	0.47
Size (X_4)	75.31	44.8	8	1.9	639	103.7
Selling to processing (X_5)	0.59	1	1	0	1	0.49
Farming concentration (X_6)	0.60	0.55	1	0.14	1	0.27
Management tools (X_7)	3.18	3	2	0	7	2.04
Technical or managerial assistance (X_8)	0.51	1	1	0	1	0.50
Risk perception (X_9)	4.63	5	5	1	5	1.00
Risk propensity (X_{10})	2.74	3	1	1	5	1.69
Overconfidence in management (X_{11})	3.76	3	3	1	5	1.05
Overconfidence in prices (X_{12})	0.40	0	0	0	1	0.49

4. Results

Table 4 shows the results of model estimation. Appendix I presents the correlation matrix for all independent variables. The results suggest that there is no multicollinearity problem among these variables. The dependent variable is a qualitative one, Y_i, that represents the marketing decision adopted by the ith grower. Y_i equals 0 if most of the crop was sold in the cash market, equals1 if the farmer i sold most of his or her production using short-term forward contracts, and equals 2 if most of citrus production was marketed through long-term forward contract. The likelihood ration (LR) test allows for rejection of the joint hypothesis in which all coefficients of the explanatory variables are equal to zero. Consequently, the estimated model can be used to explain the factors that influence adoption of forward contracts.

Estimated coefficients of the multinomial logit model reflect the effect of changes in explanatory variables on the probability of adopting short-term forward contracts or long-term forward contracts relative to spot market (base scenario). Results show that the probability of selecting short-term forward contracts over spot market is directly related

to “selling to juice processing companies” and “management tools adoption”, and inversely related to “farming concentration”, “risk propensity”, and “overconfidence in management”. The probability of selecting long-term forward contracts over spot market is directly related to participation in “pools”, “technical or managerial assistance” and “selling to juice processing companies”, and inversely related to “farming concentration” and “risk propensity”.

Table 4. Parameter estimates of the probability of adopting short-term and long-term forward contracts relative to cash selling.

Variable	**ln(P_1/P_0)**	**ln(P_2/P_0)**
	Coefficient	***Coefficient***
Intercept	3.264	-5.890
Age (X_1)	-0.018	0.018
Education (X_2)	0.061	-0.019
Pools (X_3)	-0.029	3.081 **
Size (X_4)	0.005	0.011
Selling to processing (X_5)	2.602 ***	4.810 ***
Farming concentration (X_6)	-2.387 *	-4.220 *
Management tools (X_7)	0.371 **	0.016
Technical or managerial assistance (X_8)	0.023	2.896 **
Risk perception (X_9)	-0.139	0.438
Risk propensity (X_{10})	-0.431 **	-1.024 ***
Overconfidence in management (X_{11})	-0.582 *	0.054
Overconfidence in prices (X_{12})	0.339	-0.370
Log-likelihood function	-58.33	
Chi squared (24 d.f.)	81.109	
p-value (significance level)	0.000	
R^2 McFadden	0.410	

Notes: ln(P_1/P_0) represents the probability of using short-term forward contracts relative to spot market (base scenario); ln(P_2/P_0) represents the probability of using long-term forward contracts relative to spot market (base scenario).

*** Significance at 1%; ** Significance at 5%; * Significance at 10%.

Results indicate that the juice processing firms' strategy of adopt forward contracts to enhance their supply predictability is tied to growers' demand for some hedging. However, growers' independent strategies are also important determinant of adoption. The parameter for the variable "risk propensity" was negatively and significantly related to the adoption of forward contracts. Growers who agreed with the statement "*I trust in my intuition when I choose the best moment to sell oranges*" have lower probability to adopt forward contracts. This is consistent with the results of Ullah *et al*. (2015) Franken and Pennings (2009), Silveira et al. (2014), Franken et al. (2014), Isengildina and Hudson (2001), and Pennings and Leuthold (2000), who suggest that risk attitude plays a relevant role on marketing choices.

The variable "farming concentration" was found negatively and significantly related to adoption of both short-term and long-term forward contracts. A high value of this explanatory variable indicates that the production is more concentrated in one or few products. Consequently, growers who rely on one or few crops have lower probability to adopt long- and short-term forward contracts. This result contradicts the hypothesis established in this paper, in which was stated that growers adopting this crop concentration would have higher probability of adopting forward contracts as a hedge for price. Adoption of forward contracts as an additional strategy to deal with price risk is a plausible explanation. Growers who diversify production are more risk-averse and seek other strategies to minimize the risks. Therefore, diversification and hedge can be considered as complementary strategies to mitigate risk.

The probability of adoption of short-term forward contracts as a hedging strategy is also related to the use of management tools, as showed by the positive and significant parameter of variable "management tools". Growers with high level of management have greater probability of adoption of hedging strategies. This result is in line with the study of Vergara et al. (2004). However, growers who are overconfident in their management have lower probability of adoption, as showed by the negative and significant parameter of variable "overconfidence in management". This result is consistent with Silveira et al.'s (2014) findings, in which higher overconfidence in management may indicate excessive risk taking and lower incentive to adopt more sophisticated risk management tools.

Adoption of long-term forward contracts was positively and significantly related to participation in pools, as showed by the parameter of the variable "pool". This finding is consistent with Mofokeng and Vink (2013) and Wolf (2012). For them cooperatives usually offer educational training programs and provide an environment that stimulates information exchange between members, which may influence on marketing strategies. In the case of the sampled citrus growers, the pools provide the necessary scale volume to negotiate better terms in long-term forward contracts. The adoption of this kind of contract is also positively and significantly associated with technical or managerial assistance from experts, public extension service or private consultants, as showed by the parameter of the variable "technical or managerial assistance". This is an external source of information on marketing tools, which can motivate the adoption of forward contracts.

No evidence that age, education, crop size, risk perception, and overconfidence in price influence the adoption of forward contracts. Theses result contradicts recent findings for famers' age, education level, and crop size (Mofokeng and Vink 2013; Franken et al. 2014; Ullah et al. 2015).

5. Conclusions

This study used a survey data of São Paulo (Brazil) citrus growers to evaluate the factors that influence farmers' hedging decisions. To the best of our knowledge, this is the first work that evaluates the determinants of marketing choices in citrus market. Face-to-face interviews were employed in 2014 to collect data from 98 citrus growers in the most important citrus-producing area in the world.

The survey shows that 66% of sampled growers sold most of the crop using short-term and long-term forward contracts in 2013/14 crop year. While 49 growers adopted short-term forward contracts to sell most of their crop, 16 growers sold most of their production using long-term forward contracts. In addition, the survey reveals that citrus growers tend to use a combination of marketing tools. We verified that 25 (7) growers sold their oranges using short-term (long-term) forward contracts and spot market simultaneously. In these cases, a small percentage of the production was sold in spot market.

The results of a multinomial logit model suggested that farming and marketing characteristics play the most important role on hedging decisions. All explanatory

variables of this group, except crop size, have a significant influence on citrus growers' marketing choices. The probability of adopting forward contracts over cash selling is directly related to the use of management tools and sales to juice processing companies, confirming hypothesis 6, 7, and 8. In addition, the adoption of forward contracts is inversely related to farm concentration, refuting hypothesis 5.

Behavioral variables also play relevant role in marketing choices, confirming hypothesis 10 and 11. Growers who are overconfidence in management were less inclined to use short-term forward contracts, while growers with higher risk propensity tend to adopt short- and long-term forward contracts. On the other hand, the other two variables of this group, "overconfidence in prices" and "risk perception", have no significant effect on marketing decisions. With respect to growers' characteristics, only one variable, "participation in pools", has a significant influence on the probability of using long-term forward contracts relative to spot market (base scenario), confirming hypothesis 3. By contrast, results suggest no evidence that human capital accumulation (represented by age and years of formal education) influences marketing choices.

This research provides new insights on citrus growers marketing strategies and contributes to the ongoing concern regarding the factors that affect farmers marketing decisions regarding risk. Beyond describing the usual marketing strategies among citrus growers in Brazil, this study provides an evaluation of factors affecting farmers' decisions to mitigate risk. It helps to understand the decision-making process related to risk management and marketing. The adoption of risk management tools is a critical issue in citrus market, which are characterized by high price volatility and high exit barriers associated with long-run investments.

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