ASSESSMENT OF CREDIT RESTRICTIONS TO FARMERS IN RURAL SETTLEMENTS´ IN THE WESTERN REGION OF THE STATE OF SÃO PAULO, BRAZIL

Sandra Cristina de Oliveira[1]
Luana Possari Maziero[2]
Maria Luiza Vicente de Oliveira[3]
Leonardo de Barros Pinto[4]

Abstract

Conceding of credit is a decisive factor for the development of farmers in rural settlements. The factors that contribute towards obstacles for its concession and default risks in financial modalities are highly relevant. Current analysis comprises data collection and investigation on farmers in rural settlements in the western region of the state of São Paulo, Brazil, specifically in the municipality of Rancharia. The several types of credit for the farmers, especially the PRONAF program, are analyzed to verify the risks inherent to such financial transactions. Statistic techniques, based on the multivariate analysis, were employed to identify variables or their combinations that provide restrictive conditions to credit. Results show the possibility that

Recebimento: 27/10/2014 • Aceite: 30/10/2015

[1] Doutora em Ciências da Computação e Matemática Computacional pela Universidade de São Paulo. Professora da Universidade Estadual Paulista Júlio de Mesquita Filho, Tupã, SP, Brasil. E-mail:

[2] Bacharel em Administração pela Universidade Estadual Paulista Júlio de Mesquita Filho, UNESP. Analista administrativo na Diretoria de Ensino - Região de Tupã, Tupã, SP, Brasil. E-mail:

[3] Bacharel em Administração pela Universidade Estadual Paulista Júlio de Mesquita Filho, UNESP, Região de Tupã, Tupã, SP, Brasil. E-mail:

[4] Doutor em Engenharia Agrícola pela Universidade Estadual de Campinas. Professor Doutor da Universidade Estadual Paulista Júlio de Mesquita Filho, Botucatu, SP, Brasil. E-mail:

farmers in rural settlements may be banned from credit depends on the time of permanence on the land, technical follow-up and non-agriculture-based family income (derived from different sources other than land, such as retiree/pensioner).

Keywords: Rural credit; Family agriculture; Multivariate analysis; Rural settlements

ANÁLISE DA RESTRIÇÃO AO CRÉDITO A PRODUTORES DE ASSENTAMENTOS RURAIS DA REGIÃO OESTE PAULISTA

Resumo

A concessão de crédito é um fator decisivo para o desenvolvimento dos produtores rurais assentados e, entender os fatores de impedimento a este recurso, bem como os riscos de inadimplência que estão embutidos nas modalidades de financiamentos, é de extrema relevância. O objetivo deste trabalho foi coletar e analisar informações sobre os produtores de assentamentos rurais da região oeste do estado de São Paulo, especificamente do município de Rancharia, no que diz respeito às várias modalidades de créditos existentes para a categoria, sobretudo, a partir do PRONAF, verificando os riscos inerentes às transações financeiras. Para tanto, foram utilizadas técnicas estatísticas baseadas em análise multivariada, a fim de identificar variáveis ou uma combinação delas que influenciavam na condição do assentado de ter ou não uma anotação restritiva. Os resultados mostraram que descrever a chance de um produtor assentado ter anotação restritiva envolve aspectos relacionados ao tempo de permanência deste no lote, ao acompanhamento técnico e à renda não agrícola da família (obtida fora do lote e, ou por aposentadoria ou pensão).

Palavras-chave: Crédito rural; Agricultura familiar; Análise multivariada; Assentamentos rurais

Introduction

Family agriculture in Brazil has been institutionally defined by Law 11.326 of 2006 which established guidelines for the National Policy for Family Agriculture and Rural Family Entrepreneurship. Family agriculture is a rural estate (up to four fiscal modules) that develops economic activities in the area, with family income deriving mostly from such an establishment. The strategic family agriculture is highly underscored by government administrations especially through two programs: the National Program for the Strengthening of Family Agriculture (PRONAF) and the National Program for Land Reform (PNRA). The PRONAF aims at strengthening family agriculture and contributes towards employment and the generation of income in rural and urban areas to improve the life quality of agricultural farmers. The PNRA is a fundamental factor towards the constitution of rural settlements where small rural farmers who collaborate towards family agriculture in Brazil are mostly included. Rural settlements are, therefore, agricultural production units established by public policies to fix the landless farmer on a piece of land or help the farmer with a small parcel of land to work in a team (BERGAMASCO; NORDER, 1996, p.07).

In Brazil, the state of São Paulo has the greatest number of rural settlements among all the other states and provides land and work to some 10,000 families, mostly in the western region of the state, specifically in the Pontal do Paranapanema area (ITESP, 2009). Total area of the western region amounts to 1,356,000 hectares, or 60% of the state. The municipality of Rancharia is an important region with many rural settlements and contributes towards the development of local and regional economy (ITESP, 2009). There are two settlements in Rancharia, namely, the Nova Conquista rural settlement (established in 1998) with 104 estates, and São Pedro rural settlement (established in 2001) with 74 estates, making a total of 4,265.2 hectares, or rather, approximately 3% of total area in Rancharia (INCRA, 2009).

Studies on the formation of rural settlements in the state of São Paulo reveal that, in five municipalities in different regions, settlements lie in small municipalities and actually boost local economy (BERGAMASCO; NORDER, 2003). In fact, Nova Conquista and São Pedro rural settlements in Rancharia have contributed significantly and positively to local economy. Studies on the settlements will indicate the need to strengthen economic strategies and income-producing activities and to establish new practices with this aim in view. Farmers of rural settlements in the municipality of

Rancharia are the subjects of current investigation due to the above and to the relevant role, they have within family agriculture in the state of São Paulo, especially on the western flank.

A previous record analysis is a requirement for the concession of credit by financial agents. The latter takes into consideration the farmers´ capacity to payment, macroeconomic conditions and other variables so that defaults risks could be minimized. The financial agents even demand specific projects that would demonstrate the feasibility of the concession. Tools based on statistical models may be of great help to pinpoint decision factors on possible restrictions for loan concessions to rural farmers.

Restrictive notes in the report of rural farmers demanding financial credit may imply that the latter failed in their commitment, worsening the clients´ risk and impairing them from receiving new loans. The rural farmer may have such restrictive notes due to debts listed by SERASA; SPC (Credit protection Service); CADIN (Information Register for non-paid debts in the government sector); other non-paid credits conceded by the PRONAF and others).

Current analysis collects and analyzes information on farmers of rural settlements in Rancharia SP Brazil with regard to several credit modalities to verify the risks inherent to financial transactions for this group. Specific aims are

- to characterize rural farmers in settlements in Rancharia SP Brazil, with regard to their economic, financial and productive infrastructure conditions by evaluating which notes in their records actually restrict credit due;
- to identify the variables or their combinations that affect the condition of rural farmers in settlements in having or not having restrictive notes which signal to credit restrictions, or rather, to describe the chances of a rural farmer to have restrictive notes as a function of certain social, economic, cultural and financial variables, quantitatively and qualitatively.

Bibliographical Review

Rural settlements in the state of São Paulo and their relation to rural credit

Rural settlements in the state of São Paulo are the result of land conflicts by squatters, renters, sharers and small farm owners evicted

by dam constructions. They are also the result of sugar-cane cutters and landless farmers roaming the state territory for engagement in social movements and rural trade unions to definitely fixing themselves on rural estates (BERGAMASCO; NORDER, 2003). Government institutions that aim at strengthening agriculture are:

1) Institute for Land in the State of São Paulo (ITESP), a segment of the Secretary for Justice and Defense of Citizenship, plans and executes agrarian and land policies in the state of São Paulo; it also legally acknowledges Quilombo Communities or erstwhile Ex-Slave Communities.

ITESP provides technical assistance to more than 6,500 families in 172 rural settlements in the state of São Paulo by means of projects involving digging of wells, community development by providing limestone, seedlings, seeds, small animals, reforestation and environmental education. It is actually present in 54 municipalities that harbor settlements, many of which are in the state´s western region called Pontal do Paranapanema, with 106 settlements comprising 5,581 families. Family agriculture in the state of São Paulo is mainly represented by rural settlements with almost 223,000 hectares, comprising 131 settlements on state government-owned land, provided by the ITESP, and 41 settlements in federal-government owned lands, sequestered by National Institute for Settlement and Land Reform (INCRA) to benefit some 10,200 families (ITESP, 2009). Table 1 gives in detail the division of these lands.

Table 1: Rural settlements in the state of São Paulo, Brazil, 2009

Region	Settlements	Ex-slave communities	Total number of families
North	17	0	1318
Northeast	20	0	1879
East	11	2	458
Southeast	2	2	250
South	0	17	841
Southwest	16	2	928
West	106	0	5581

Source: ITESP, 2009.

The importance of the Pontal do Paranapanema region for family agriculture is evident since approximately 49.6% of the families

live in the western region of the state. Milk, manioc, corn, fruits and vegetables are the main cash crops planted by the families concerned.

2) National Program for the Strengthening of Family Agriculture (PRONAF) was established in 1996 by the Brazilian federal administration and aims at strengthening family agriculture, employment and income in the rural and urban areas by improving the life quality of family farmers.

Its principal activity is the concession of credit to finance costs and investments which are adjusted over time for proper and constant updating. Farmers are classified according to their income so that payments and differentiated subsidies may be established. PRONAF also acts in joint venture with states and municipalities to eliminate obstacles, which may be impairing rural development in areas where family agriculture is prevalent. This may boil down to such events as the installation of electricity to attend an area in which small farmer families are concentrated. Resources may also be directed to family-production based agro-industries

3) Resources for the Expansion of Agribusiness in São Paulo (FEAP) was established in 1961 by the Secretariat for Agriculture of the state of São Paulo to fund rural farmers, cooperatives and associations for the benefit of the agricultural and cattle-breeding sector of the state.

As from 1995, FEAP experienced heavy growth in which policies for income increase and for the maintenance of farmers in the rural area caused a rise in credit volume and contracts. The main aims were the professionalization of the farmers so that they could improve production performance so that it could be significant with great competitiveness in the sector. The program is linked to the Secretariat of Agriculture and Supply, which provides assets for research, technical assistance and agricultural-stockraising defense.

Rural credit

PRONAF and FEAP are the two most important credit modalities for agriculture. The family agricultural farmers must use the best credit that would meet their needs and aims so that the required resources for their agricultural projects could be obtained. Credit available by **PRONAF are** Costs; Investments; Pronaf Agroindustry; Pronaf Agroecology; Pronaf Eco; Pronaf Forest; Pronaf Semi-Arid; Pronaf Women; Pronaf Young People; Pronaf Costs and Commercialization of Family Agroindustries; Pronaf Shares; Rural Microcredit; Pronaf More Food.

Credit available by FEAP may also be state-extensive, such as Beekeeping, Subsidies to small agro-industries; Broiler breeding; Buffalo-raising; Quality Coffee; Goat and Sheep raising; Flowers and Ornamental Plants; Forest; Fruit growing; Community machines and equipment; Oleaginous plants in protected environments; Goat raising; Daily Cattle; Fish breeding in Tanks; Conventional Fish breeding in dams and fish-farms; Tillage in Hay; Milk Quality; Seeds and Seedlings; Silk Culture; Rural Tourism and others.

There are indications that farmers are in dire straits due to the credit conceded according to the type of activity, or rather, seasonality and climate are contributing towards defaults in financial contracts. There are actually a considerable number of farmers, who could use rural credit but fail to do so because of public policies. They could increase production and contribute towards the development of the country. Estimates show that only 15% of rural farmers are benefitted with rural credit, or rather, a very small percentage within the great possibility of the country for developing more extensively its agricultural and stock-raising potential.

The numberless settlements, their importance for the development of family agriculture and the diversity of credit modalities supplied constitute a relevant investigation to promote the development of families in settlements and to multiply efforts by the different institutions. Since most of the projects of the family farmers in the municipality of Rancharia use the PRONAF, current analysis will focus on this modality.

Methodological Procedures

Data collection

A survey on rural farmers on the Nova Conquista and São Pedro rural settlements in Rancharia is undertaken in current analysis. The former comprises 104 land estates with approximately 17.5 hectares/estate, while the later comprises 74 estates with an area of approximately 18 hectares/estate. Data were collected by applying a form which was answered by a proportional systematic sample (according to the number of estates in each settlement), made up of 38 estates in the Rural Settlement Nova Conquista and 27 estates in the Rural Settlement São Pedro, with a total of 65 estates. Estates were selected at random and the names of the owner-farmers that composed the sample or any data that would identify them were omitted. Due to a finite population and the dependent variable (binary qualitative

response) as the most relevant in current analysis, the sample size was defined by a 10% error and a 95.5% confidence level (MARTINS, 2006).

Data collection tool was elaborated so that the dependent variable was that which indicated whether the farmer had or had not any restrictive note. The variable was defined specifically by debt list insertion in SERASA; SPC (Credit Protection Service); CADIN (Information Register for non-paid debts in the government sector); other non-paid credits conceded by the PRONAF. Rural farmers in the municipality of Rancharia were characterized according to their economic, financial and productive infrastructure conditions within the following variables: date of enrolment in the settlement, family composition, age, sources of income, composition of the rural entrepreneurship, occupation and use of land, use of employees, list of machinery and equipment, form of acquisition, productive infrastructure, whether there existed access to credit, credit modalities obtained, interest in any new access, existence and motives of restrictions (aspects of production; aspects related to commercialization and/or institutional aspects).

So that the restrictive remarks that impaired rural farmers from obtaining credit could be evaluated, the variable response was formulated as a function of explicatory (quantitative and qualitative) variables. Definition of these variables was based on similar analyses (PEREIRA et al., 2011; DINIZ; LOUZADA, 2012) in which techniques of multivariate analyses were employed based on logistic regression for the analysis of credit risk.

Multiple model of logistic regression

Multiple model of logistic regression takes a set of independent variables *k*, which may be numerical or not, to predict the probability of the variable response Y. The model is expressed by:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \varepsilon \quad (1)$$

By defining expected rate, conditional mean for dichotomy data will be given by $E(Y \mid \mathbf{X}=\mathbf{x}) = \pi(\mathbf{x})$. Therefore,

$$E(Y \mid \mathbf{X}=\mathbf{x}) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k = \pi(\mathbf{x}) \quad (2)$$

Since $E(Y \mid \mathbf{X}=\mathbf{x})$ should be between 0 and 1, or rather,

$$\begin{aligned} &0 \le E(Y \mid \mathbf{X}=\mathbf{x}) \le 1 \\ &0 \le \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k \le 1 \end{aligned} \quad (3)$$

When the variable response is a qualitative binary, the error $\varepsilon = 1 - \pi(\mathbf{x})$ does not have normal distribution and variance is heterogeneous, since it may take any of the two rates:

$$\begin{aligned} &Y = 1 \Rightarrow \varepsilon = 1 - \pi(\mathbf{x}), \text{ with probability } \pi(\mathbf{x}) \\ &Y = 0 \Rightarrow \varepsilon = -\pi(\mathbf{x}), \text{ with probability } 1 - \pi(\mathbf{x}) \end{aligned} \quad (4)$$

So that response Y may be expressed as a probability, a linking function between $\pi(\mathbf{x})$ and the linear predictor $\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k$ is required. The use of such a function allows the linearization of the logistic function, which frequently has a curving response function providing a mean response which is the probability of occurrence of the event (JOHNSON; WICHERN, 1998). The link function *logit* was employed in current analysis, or the *logit* transformation of probability $\pi(\mathbf{x})$, which satisfies:

$$\ln\left\{\frac{\pi(\mathbf{x})}{1-\pi(\mathbf{x})}\right\} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k \quad (5)$$

.

Expressed in terms of linear predictor (CORRAR, et al., 2009):

$$\pi(\mathbf{x}) = \frac{e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k}}{1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k}} \quad (6)$$

In this case, the multiple model of logistic regression may be expressed as $E(Y \mid \mathbf{X} = \mathbf{x}) = \pi(\mathbf{x}) = \frac{e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k}}{1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k}}$.

The term $\ln\left\{\frac{\pi(\mathbf{x})}{1-\pi(\mathbf{x})}\right\}$ in (6) is called mean response *logit*, in which the ratio $\frac{\pi(\mathbf{x})}{1-\pi(\mathbf{x})}$ is called *odd ratio*. If $x = x_j$ so that $chance_{(j)} = \frac{\pi(x_j)}{1-\pi(x_j)}$ and if $x = x_j + 1$ so that $chance_{(j+1)} = \frac{\pi(x_j + 1)}{1-\pi(x_j + 1)}$, then, if, under the same conditions, the event fails to occur, the probability that it occurs is called odds ratio and is expressed by:

$$OR_j = \frac{chance_{(j+1)}}{chance_{(j)}} = e^{\beta_j},\ j = 1,2,\ldots,k \quad (7)$$

The application of the maximum likelihood method first consists in the construction of the likelihood function. Estimates of unknown parameters are chosen to maximize this function and are called estimates of maximum likelihood. Resulting estimates are very close to data reported (MONTGOMERY et al., 2001).

Given a randomized sample composed of *n* pairs of observations $(X_i, Y_i), i = 1,2,\ldots,n$, in which Y_i represents rates of the variable response and X_i represents rates of independent variables *k*, a convenient form to express the contribution of a likelihood function for pairs (X_i, Y_i) is given by the formula below:

$$F(x_i) = [\pi(x_i)]^{y_i} [1 - \pi(x_i)]^{1-y_i} \quad (8)$$

Since observations are independent, the likelihood function is the product of the terms in the previous expression (HILL, 2003):

$$L(\boldsymbol{\beta}) = \prod_{i=1}^{n} F(x_i) = \prod_{i=1}^{n} [\pi(x_i)]^{y_i} [1 - \pi(x_i)]^{1-y_i} \quad (9)$$

in which $\boldsymbol{\beta} = (\beta_0, \beta_1, \ldots, \beta_k)$. Natural logarithm is applied (log likelihood) to make calculation easy:

$$\ln L(\boldsymbol{\beta}) = \sum_{i=1}^{n} y_i (\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k) - \sum_{i=1}^{n} \ln\left(1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k}\right) \quad (10)$$

which will be maximized if $\frac{\partial \ln L(\boldsymbol{\beta})}{\partial \boldsymbol{\beta}} = 0$. Estimates of maximum likelihood are reached by numerical methods. Estimates should be replaced in (10) to obtain the adjusted response function.

Systemization and statistical analysis of data were performed on Microsoft Excel and Minitab Statistical Software sheets. The latter calculates the adjusted and optimized model for the multiple logistic regression method by an iterative algorithm to obtain estimates of the required parameters.

The selection process of predictor variables for a regression model was performed by hypothesis tests of the existence of parameters $\beta_0, \beta_1, \beta_2, \ldots, \beta_k$. Procedure consists of testing the null hypothesis, that is, a certain parameter is equal to zero. If the hypothesis is rejected at a level of significance α, then, one may say that a certain independent variable affects the variable response. When the model is defined and the estimates of the parameters are given, one should assess the quality of the model´s adjustment to data,

based on measures that should be calculated by linking function and maximum likelihood.

Goodness-of-fit tests evaluate the quality of results obtained, or rather, the validation of the model´s adjustment. The null hypothesis is tested to show that adjustment of the model to data is good against the hypothesis that the adjustment is bad. The usual methods, based on the chi-square distribution, are Pearson (which verifies how many observations are satisfactorily predicted by the model); Deviance (which compares the logarithm of the model adjusted to the likelihood logarithm of the entire model); and Hosmer-Lemeshow (which assesses the adjusted model, verifying whether the frequencies observed and the expected frequencies of the variable response are close). If p-values for the tests described above are between 0.37 and 0.85, there is no sufficient evidence that the model does not adjust itself to the data adequately; if *p*-value $\leq \alpha$, hypothesis H_0 is rejected that the adjustment of the model is adequate (PINO, 2007).

When one or more explicative variables are quantitative, data are highly dispersed for use in Pearson´s and Deviance adherence tests. Best results may be actually obtained by the Hosmer-Lemeshow´s test.

The model´s adjustment quality may be assessed by co-relationship indexes, with Somers´s D Index, Goodman-Kruskal´s Gamma Index and Kendall´s Tau-a index as those most employed. Indexes vary between 0 and 1: the higher the rates are, better is the prediction capacity of the model (PINO, 2007).

The dependent variable (response) in current assay is a binary qualitative response. In regression analysis, the lack of restrictive notes is 0 and the presence of at least one note is 1, forming the variable mentioned above. Table 2 displays initial independent variables (or explicative) of current analysis.

Application, Results and Discussion

São Pedro rural settlement

Since the start of the entrepreneurship, only 3.6% of the estates in the rural settlement São Pedro failed to receive loans. Since the time of the occupation of the estates in 2001, the regularization documents of the estates are still due. Regularization of estate documents is relevant so that the farmer family may receive the modalities of credit at a rate of 2% a year when contrasted to rates ranging between 5.5% and 9.5% in commercial agriculture.

Table 2: Independent (or explicative) variables of the logistic model

Symbol	Type of measurement	Name of variable
X1	Quantitative	Age of the head of the settlement estate
X2	Quantitative	Date of admittance to the settlement (time of permanence on the estate, in years)
X3	Quantitative	Percentage of non-agrarian income to total income (in R$)
X4	Quantitative	Loan amount (in R$)
X5	Qualitative	Whether production aspects (low productivity; late sowing; pest attack; climatic adversities or high production costs) affected or did not affect the liquidation of debts
X6	Qualitative	Whether aspects related to commercialization (low prices; difficulty in transporting produce or lack of conditions to store produce) affected or did not affect the liquidation of debts
X7	Qualitative	Whether institutional aspects (credit conditions; unforeseen expenses with family members; decrease or extinction of income of a member of the family; quality of technical assistance; forgetfulness or problems with local trade) affected or did not affect the liquidation of debts
X8	Qualitative	Whether there was or whether there wasn´t any technical follow-up
X9	Qualitative	Whether produce was insured or not
X10	Qualitative	Whether a renegotiation of debts was proposed or not

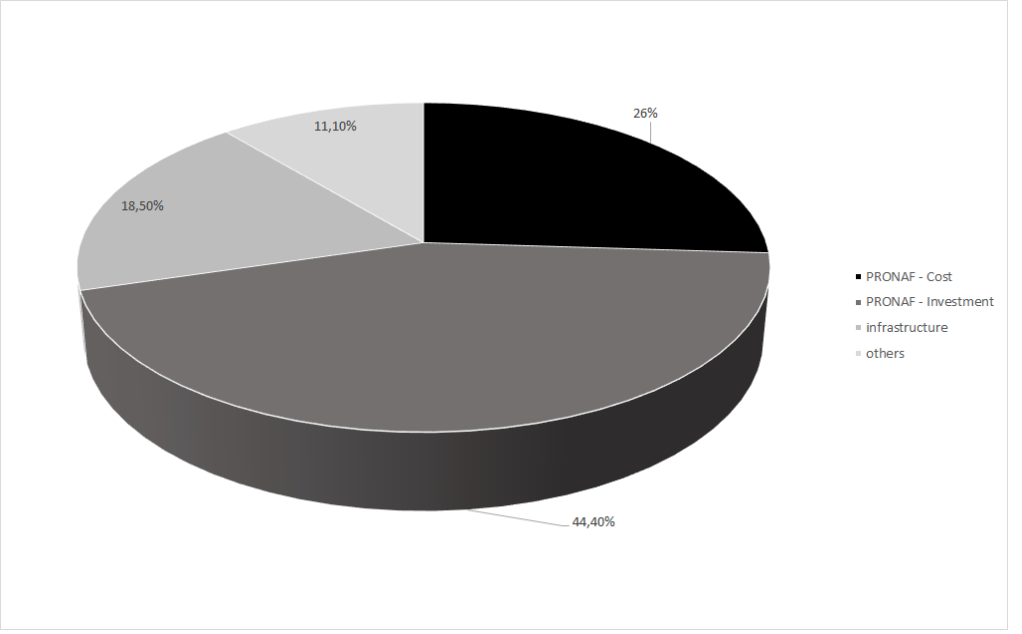
Figure 1 shows that about 44% of farmers who received credit loans accepted the PRONAF investment modalities such as, productive infrastructure (rural buildings, machines or implements), fertilizers and buying of cattle, among others, since the main activity was cattle-breeding due to the strategy that the activity represented for the maintenance of the family.

Resources obtained by investment modalities ranged between R$ 2,300 and R$ 21,500, according to the plan designed by the farmers as a joint venture with INCRA and ITESP. Resources were more frequent between 2002 and 2005, during which the farmers had a three-year grace period to start paying the seven-year loan, with one yearly installment. Buying of cattle for dairy activities was the main aim (approximately 42% of farmers) of the loan.

Research reported that 52% of farmers who obtained loans since their arrival at the settlement have or had some sort of restrictive note. Further, the origin of 93% of the above percentage was the insolvency of any agrarian debt by the farmer (PRONAF, FEAP or any other credit-conceding program). According to the 10% error margin established for current research, it was inferred that a

percentage between 42% and 62% of the farmers of the São Pedro rural settlement would have a restrictive note that impaired the concession of loan, at 95.5% confidence.

Figure 1: The most frequent credit modality in the São Pedro rural settlement



In fact, 93% of farmers on São Pedro rural settlement attributed credit restrictions to lack of payment (PRONAF, FEAP or any other program) and the main causes for non-payment of debts were low price in the commercialization of the products (71%), low productivity (43%) and climate conditions (29%), respectively. Approximately 30% of the farmers, characterized by restrictions, renegotiated their debts and henceforth they could have a new access to the financing of the subsidized resources. Moreover, 75% of the farmers have great interest in obtaining loans since they acknowledge their importance for propping up family agriculture.

Multiple logistic regression models were employed to analyze data from the São Pedro rural settlement to estimate odds ratio rates and describe the main variables that would make the farmer have such restrictions. Two farmers were not included in the analysis since they did not inform the amount of loans taken, even though they had access to credit.

A first analysis was undertaken by taking into consideration all the predicted variables described in Table 2. Many variables were not significant to the model since the *p* rate was higher than the 10% significance level established. Consequently, non-significant variables were gradually eliminated till obtaining a model in which the quantitative variable "time of permanence on the estate, in years" was the best for its explanation. The qualitative variable "whether there was or whether there wasn´t any technical follow-up", almost significant at the level under consideration, was included in the model since it did not interfere in the quality of the model´s adjustment and supplemented the analyses and the interpretations on the adjusted model. Table 3 shows the best adjustment model and may be described as:

$$\hat{\pi} = P(Y=1) = \frac{e^{-5.1603+0.2916X_2+1.8118X_8}}{1+e^{-5.1603+0.2916X_2+1.8118X_8}} \qquad (11)$$

where X_2: is the time of permanence on the estate (in years) and X_8: there was or there was not any technical follow-up.

Table 3: Logistic regression: São Pedro rural settlement.

Predictor	Coef	SE Coef	Z	p_value	Odds Ratio	95% CI Lower	Upper
Constant	-5.16029	2.49539	-2.07	0.039			
X_2	0.29159	0.126583	2.30	0.021	1.34	1.04	1.72
X_8	1.81182	1.52418	1.19	0.135	6.12	0.31	121.41

Log-Likelihood = -13.516
Test that all slopes are zero: G = 8.857, DF = 2, p_value = 0.012

Goodness-of-Fit Tests

Method	Chi-Square	DF	p_value
Pearson	3.98353	10	0.948
Deviance	5.39267	10	0.863
Hosmer-Lemeshow	0.96058	5	0.966

Measures of Association:
(Between the Response Variable and Predicted Probabilities)

Pairs	Number	Percent	Summary Measures	
Concordant	128	76.2	Somers' D	0.63
Discordant	22	13.1	Goodman-Kruskal Gamma	0.71
Ties	18	10.7	Kendall's Tau-a	0.33
Total	168	100.0		

Positive coefficient of the variable 'time of permanence on the estate' (0.2916) coupled to its odds ratio (1.34) suggests that the longer the farmers´ time of permanence on the estate, the greater is their

chance to have credit restrictions. The chance increases approximately 34% for every year. In the case of technical follow-up, the estimated coefficient is also positive (1.8118) and, in this case, with the other variables constant, the chance of having restrictions increases approximately six times when the farmers have no assistance.

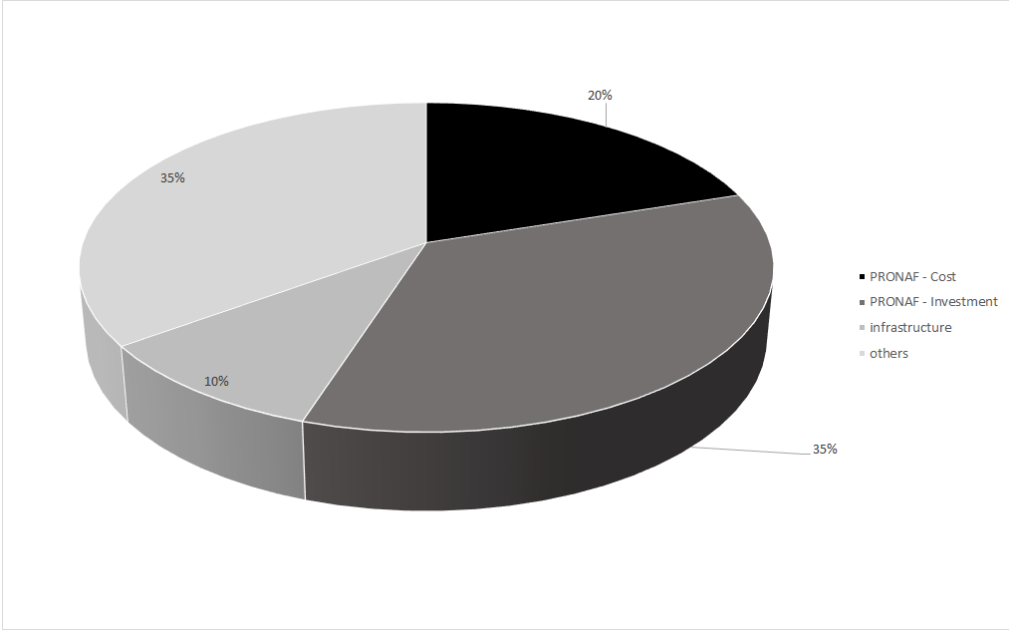
Statistical G was analyzed. It tested the null hypothesis that all coefficients associated to the explicative variables are equal to zero versus the alternative that, at least, one of them is equal to zero. Results show that G = 8.875 and *p*_rate was 0.012. The above indicated that there is sufficient evidence to state that, at least, one of the coefficients is different from zero, since the *p* rate is below the established level of significance (10%). Since *p* rates of adherence tests ranged between 0.863 and 0.966 and they were higher than the 10% significance level, the test did not reject the null hypothesis of an adequate adjustment of data. *Hosmer-Lemeshow´*s test, which evaluates whether the adjusted model represents the data adequately, confirms that frequencies are really close to those expected. Table 3 displays also the concordant, discording and tied pairs and shows that the experiment has 168 pairs with different responses, of which some 76% are concordant. This means that in approximately 76% of the cases when research data reveal that the farmer has credit restrictions, the model is adjusting a big chance of having such a restriction, with a discordance of approximately 13.1%.

In correlation tests, Somers´s D, Goodman-Kruskal´s Gamma and Kendall´s Tau-a Indexes verify the prediction capacity of the estimated model. Two indexes had rates close to 1 (or 100%). They show that the adjusted model has a good capacity to predict the probability of credit restriction occurrence.

The Nova Conquista rural settlement

Approximately 8% of the farmers in the Nova Conquista rural settlement did not contract loans since they started to live on the estate in 2008. The estates have still to be regularized and delay in receiving the documents is long due. Further, 39% of the farmers who received credit contracted loans from PRONAF, as Figure 2 shows.

Figure 2: Most frequent credit modality: Nova Conquista rural settlement.



Similar to what occurred in the São Pedro rural settlement, buying dairy cattle was the main aim for the loans which ranged between R$ 3,000 and R$ 20,000 as investments, with a three-year grace period. Fifty-seven percent of the farmers with credit access since they started on the settlement have had some type of restrictive note. According to the 10% error margin established for current research, it was inferred that a percentage between 47% and 67% of the farmers of the Nova Conquista rural settlement would have a restrictive note that would impair the concession of loan, at 95.5% confidence. Non-payment of any sort of debts (PRONAF, FEAP or any other credit concession program) was the main source of credit restriction for farmers in the Nova Conquista rural settlement, with 60% of occurrences. The main causes for non-payment of debts were low commercialization price of products (30%), climate conditions (30%) and credit conditions (15%), respectively. Approximately 35% of the farmers renegotiated their debts to contract more loans and to remain on their estate. In fact, actually 74% of the farmers analyzed desire to have access to credit, which they acknowledge as highly important to improve the estate.

The statistical analysis of data from the Nova Conquista rural settlement employed the logistic regression model used for the São Pedro settlement. Information by three farmers was rejected since they had not contracted any loans due to their recent arrival on the settlement. At a 10% significance level, the adjusted model has the significant independent variables "percentage of non-agrarian income to total income" as a quantitative variable, and "whether there was or whether there wasn´t any technical follow-up", as a qualitative variable. Even though almost significant at the level under analysis, the quantitative variable "time of permanence on the estate, in years" was included in the model since it did not interfere in the quality of its adjustment and supplemented analyses and interpretations on the adjusted model. Table 4 shows the best adjusted model:

$$\hat{\pi} = P(Y=1) = \frac{e^{-2.4051+0.1290X_2-2.3366X_3+1.3956X_8}}{1+e^{-2.4051+0.1290X_2-2.3366X_3+1.3956X_8}} \quad (12)$$

where X_2: time of permanence on the estate (in years); X_3: percentage of non-agrarian income as a proportion to total income; X_8: whether or not a technical follow-up occurred.

The variable "time of permanence on the estate" had a positive coefficient (0.1290) and indicated a direct proportional behavior to the variable response. Coupled to odds ratio (1.14), it demonstrates that the chance of the farmer having credit restrictions increases approximately 14% for each year of permanence when the other variables are constant. In the case of technical follow-up, the positive coefficient (1.3956) also demonstrated a four-fold chance for the occurrence of restricted credit than when the farmers did not have any technical guidance. The variable "percentage of non-agrarian income as a percentage of total income" had a negative coefficient (-2.3366) and indicated an inversely proportional behavior to the variable response. In other words, the higher the non-agrarian income, the lower is the farmer´s chance of credit restriction. Odds ratio (0.10) shows that increase (in 1%) of non-agrarian income decreases in 90% probability the chance that the farmer has for credit restriction, when all the other variables are constant.

Table 4: Logistic regression: Nova Conquista rural settlement

Predictor	Coef	SE Coef	Z	p_value	Odds Ratio	95% CI Lower	Upper
Constant	-2.40507	1.70125	-1.41	0.157			
X_2	0.128972	0.087942	1.47	0.142	1.14	0.96	1.35
X_8	1.39561	0.833850	1.67	0.094	4.04	0.79	20.70
X_3	-2.33663	1.30610	-1.79	0.074	0.10	0.01	1.25

Log-Likelihood = -20.120
Test that all slopes are zero: G = 7.563, DF = 3, p_value = 0.056

Goodness-of-Fit Tests

Method	Chi-Square	DF	p_value
Pearson	33.6553	29	0.252
Deviance	37.4683	29	0.135
Hosmer-Lemeshow	5.5295	8	0.700

Measures of Association:
(Between the Response Variable and Predicted Probabilities)

Pairs	Number	Percent	Summary Measures	
Concordant	228	76.0	Somers' D	0.53
Discordant	68	22.7	Goodman-Kruskal Gamma	0.54
Ties	4	1.3	Kendall's Tau-a	0.27
Total	300	100.0		

Statistical G = 7.563 and *p* rate = 0.056 indicated that there were sufficient evidences that, at least, one coefficient of the explicative variables was different from zero for the significance level adopted (10%). In the case of adherence tests, *p*_rates ranged between 0.135 and 0.700 and showed that the null hypothesis of a data-adequate adjustment cannot be disposed of, since results were higher than the 10% significance level established. Result of Hosmer-Lemeshow´s test (0.700) confirmed that expected and observed frequencies were close.

Analysis revealed that there were approximately 76% of concordant pairs and 23% of discordant pairs, or rather, 76% of cases, when research data showed that the farmer had credit restriction. The model is adjusting a big chance of having such a restriction, with a discordance of approximately 23%.

Somers´s D, Goodman-Kruskal´s Gamma and Kendall´s Tau-a Indexes reveal that the prediction capacity of the estimated model is close to 54% with a good capacity to predict the probability of credit restriction occurrence by significant independent variables.

Discussions and comparisons between the two settlements

The São Pedro rural settlement had the highest number of farmers who received rural credit since their integration into the community. All the farmers received the PRONAF investment

modality and the percentage of farmers in the São Pedro rural settlement is double that from the Nova Conquista rural settlement. This was due to the fact that the farmers of Nova Conquista demanded a more diversified financial modalities.

The Nova Conquista rural settlement featured 4% more farmers with restrictive notes over the São Pedro. On the other hand, 93% of farmers in the São Pedro rural settlement attributed restriction notes to non-payment of loans (credit modalities of PRONAF, FEAP or other agricultural credit concession program), contrasting 60% of farmers from the Nova Conquista. Low price on commercializing produce and climatic adversities that compromised the harvest were the main motives for non-payment of loans.

The farmers of the Nova Conquista rural settlement were more satisfied with technical assistance provided than those from the São Pedro (more than half the farmers classified as second-rate or bad). Indexes corroborate regression analyses and show the reason that the variable "technical follow-up" was significant in the models adjusted to estimate chance in credit restriction.

It should be underscored that results and specifically the significant variables in the measurement of chances for restrictive notes in the concession of loans, are a warning to the INCRA and ITESP technicians that they should help older settlers since they may possibly been having difficulties from lack of information which probably does not occur in the recently settled farmers. This is especially true for improvement of the productive infrastructure, increase in productivity, product quality and, consequently, their income.

Final Considerations

The economic, financial and productive infrastructure characterization of rural farmers in settlements in Rancharia SP Brazil provided important results about the type of debts that restricted credit.

The variables that affected conditions for the farmer to have or not any restriction to loans, the origin of these restrictions and indications that may lead towards credit restrictions (production, commercialization, institutional aspects and other) were identified.

Following the models proposed, the chance that a farmer may have a restriction note involves aspects related to the time of permanence on the settlement, to technical follow-up and to the

family´s non-agrarian income (derived from labor outside the estate or from pension).

It is expected that, through the results above, some measures may be taken to minimize the credit-restricting risks that farmers of rural settlements. Farmers´ organization for a better negotiating power with other agents in the production chain, the demand of better technical assistance, specialized courses on production management, guidance on produce insurance, among other, are activities that provide the farmers with higher potentiality in their activities in technical and administration terms. The above will surely guarantee the multiplication of farmer families in settlements and their power.

Credit access may be more important as from the several modalities on the market. Restrictions are making difficult and impairing new and varied development strategies which are compatible with the intrinsic diversity to the production systems of family agriculture.

Sponsoring Information: The authors would like to thank PROPe/UNESP for its financial support (Ed. 14/2012 – RENOVE Program) and to FAPESP for funding current Scientific Initiation scholarship (Proc. 2010/17647-9).

References

BERGAMASCO, S. M. P. P.; NORDER, L. A. C. **A alternativa dos assentamentos rurais: organização social, trabalho e política.** São Paulo: Terceira Margem, 2003.

BERGAMASCO, S. M. P. P.; NORDER, L. A. C. **O que são assentamentos rurais**. São Paulo: Brasiliense,1996.

CORRAR, L. J.; PAULO, E.; DIAS FILHO, J. M. **Análise multivariada para os Cursos de Administração, Ciências Contábeis e Economia**. Atlas, São Paulo, 2009.

DINIZ, C. A. R.; LOUZADA, F. **Modelagem Estatística para Risco de Crédito**. 1º Edição, São Paulo: ABE - Associação Brasileira de Estatística, 2012. 178p.

HILL, P. C.; GRIFFITHS, W. E.; JUDGE, G. G. **Econometria**. Saraiva, 2º Edição, São Paulo, 2003. 471p.

INCRA. **Área do Projeto, Capacidade de Assentamento, Número de Famílias Assentadas**. São Paulo, 2009.

ITESP (Inst. de Terras do Est. de São Paulo)**. A instituição**. São Paulo, 2009. Available at : < http://www.itesp.sp.gov.br/br/info/instituicao/quemsoMos.aspx>. On 19/9/2009.

JOHNSON, R. A.; WICHERN, D. W. **Applied Multivariate Statistical Analysis**. 4th Edition, Prentice-Hall, Englewood Cliffs, N.J., 1998.

MARTINS, G. A. M. **Estatística Geral e Aplicada**. Atlas, 2º Edição, São Paulo, 2006. 417p.

MONTGOMERY, D. C.; PECK, E. A.; VINING, G. G. **Introduction to linear regression analysis**. 3th. Edition, John Wiley & Sons, New York, 2001. 641p.

PEREIRA, D. F.; OLIVEIRA, S. C.; PENHA, N. L. J. Logistic regression to estimate the welfare of broiler breeders in relation to environmental and behavioral variables. **Engenharia Agrícola**, Jaboticabal, v. 31, n. 1, p. 33-44, 2011.

PINO, F. A. Modelos de decisão binários: uma revisão. **Revista de Economia Agrícola**, São Paulo, v. 54, n. 1, p. 43-57, 2007.

SANTOS, C. R.; RAPOSO, M. C. F; CUNHA, R. C. Estimativa do "credit scoring" para emitentes de cheques usando regressão logística. In: SIMPÓSIO BRASILEIRO DE PROBABILIDADE E ESTATÍSTICA, Estância de São Pedro-SP. **Anais**..., julho de 2008.