It's all about location?: An analysis of the factors that affect the location decision of sugarcane processing mills in Goiás and Mato Grosso do Sul, Brazil

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

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

Jason Scott Bergtold. *Associate 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

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Ana Claudia Sant'Anna[1] Gabriel Granco[2] Jason Bergtold[3] Marcellus Caldas[4]

[1]PhD Student (GRA), Department of Agricultural Economics; [2]PhD Student (GTA), Department of Geography; [3]Associate professor, Department of Agricultural Economics; [4]Associate Professor, Department of Geography

Introduction

Sugarcane is the main input in ethanol production in Brazil, which has risen significantly in the states of Goiás and Mato Grosso do Sul: from 2005 to 2012. Figure 1 shows the large expansion and construction of sugarcane mills for producing both ethanol and sugar in these states. Many factors influence a mill's decision on where to locate, but ideally it will choose a place where production costs are minimized. In the case of sugarcane processing mills, they cannot be located far from suppliers, for sugarcane begins to lose sucrose as soon as it is harvested. This study conducts a cross-sectional analysis for the year of 2010 when the Sugarcane Agro-ecological Zoning (ZAE CANA) policy was launched. This policy maps out the areas suitable to grow sugarcane in these states. In total 324 counties were considered, 246 pertaining to the state of Goiás and 78 to the state of Mato Grosso do Sul.

Purpose

To identify the significant factors (eg. labor availability, infrastructure, land-use, presence of another mill, and distances to market) influencing the location of a sugar/ethanol mill in the Brazilian states of Goiás and Mato Grosso do Sul.
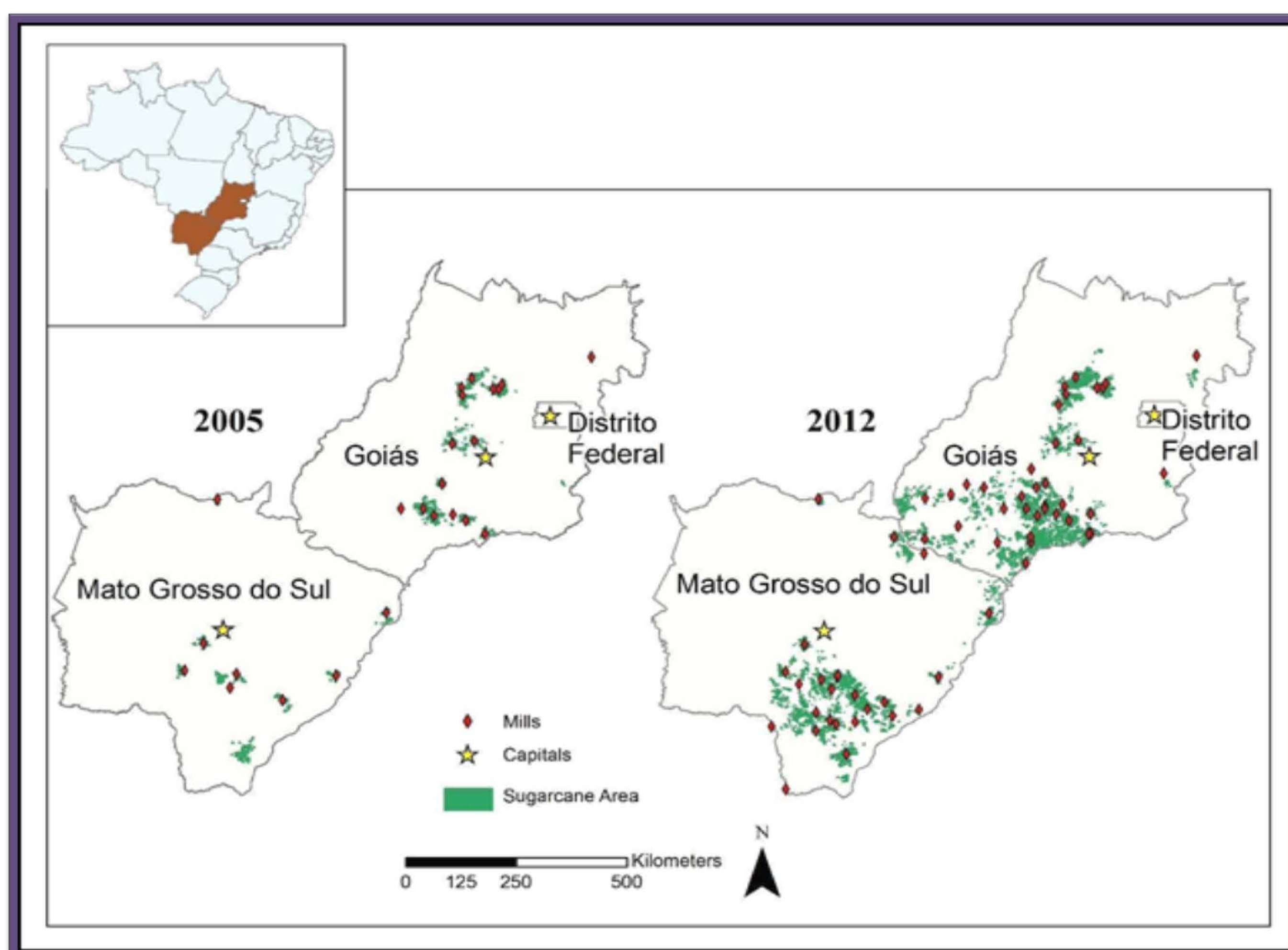

Figure 1: Expansion of the area under sugarcane production and the number of mills from 2005 to 2012 in Góias and Mato Grosso do Sul.
Source: MT, 2010; Rudoff et al., 2010.

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Data and Methods

Mills will choose the location of a mill in county i over another j if the cost associated with locating and operating in county i is smaller than in j.

$$C^i(q^i, \boldsymbol{w_i}) < C^j(q^j, \boldsymbol{w_j})$$

where C^i, C^j are the production cost at location i and j respectively; q^i and q^j are the mill capacities at locations i and j respectively; w_i and w_j are the costs associated with the inputs at location i and j respectively. The observed location decision is represented by S^* as (Lambert et al. 2008):

$$S_i^* = C^j(q^j, \boldsymbol{w_j}) - C^i(q^i, \boldsymbol{w_i}) = \boldsymbol{x_i'}^*(\boldsymbol{w_i} - \boldsymbol{w_j}) + E[\delta_j - \delta_i] = \boldsymbol{x_i'}\beta + \varepsilon_i$$
$$S_i = 1 \ if \ S_i^* > 0; S_i = 0 \ if \ S_i^* < 0 \text{, where}$$

$S_i^* > 0$ indicates costs relative to other locations j, $j \neq i$, are higher than at location i and location i will be preferred; $S_i^* < 0$ indicates costs relative to other locations j, $j \neq i$, are lower than at county i and location j will be preferred.

Given the binary relationship of S_i^*, a logit model was used to empirically model the above relationship. The explanatory variables in the model are provided in Table 1 with summary statistics. Data was obtained for 324 counties: 246 in Goiás and 78 in Mato Grosso do Sul.

Results and Discussion

Results are presented in Table 2 as the marginal effects of each explanatory variable from the estimated logit model. Results show that:

➢ Mills prefer to be near the raw input. A 1% increase in the share of sugarcane production increases the probability of a mill locating in a particular county by 0.53%.

➢ The presence of a rural syndicate in the county increases the likelihood by 12% of the mill locating there. Rural Syndicates act as a mediator between mills and farmers, reducing time otherwise spent when trying to guarantee sugarcane supply with growers.

➢ By locating close to another mill, the mill is in an area already producing sugarcane, with an established infrastructure (e.g. roads), in a county with a certain level of economic development brought by the establishment of the previous mill. Thus a reduction in the distance between mills by 1 km increases the likelihood that a mill locates in a particular county by 0.3%.

➢ In general land closer to the capital of the state are more expensive than land farther away. Aiming at reducing its production costs, an increase in the distance from the capital increases the likelihood of plant locating in a particular county by 0.03%.

➢ Although only some factors had statistically significant marginal effects (Table 2) the model does a good job in predicting the location of mills in counties where a mill is already observed (Figure 2).

Mills are rational and prefer a location where production costs are minimized. This can be achieved by having easy access to sugarcane supply (ex. in the zoning areas) at reduced transportation and transaction costs (ex. locating near other mills, near sugarcane suppliers and in counties with rural syndicates).

Table 1: Descriptive statistics and sources of the variables used in the Logit Model

Variable	Units	Mean	Std Dev	Source
Labor	People/km^2	1.593	5.54	IBGE, 2010
Roads	km	12.9	12.50	MT, 2010
Electricity	km	21.9	23.40	MT, 2010
Distance to Capital	km	463.94	309.12	MT, 2010
Distance to SP	km	868.64	160.86	MT, 2010
Distance to other mill	km	441.83	282.35	MT, 2010
Pipeline	Dummy	0.02		MT, 2011
Land price	R$/ha	3,936.70	1,482.54	FNP, 2010
Zoning	hectares	7,2513.15	115,087.08	Manzatto et al., 2009
Rural Syndicate	Dummy	0.60		CNA, 2015
Soybeans	share (ha)**	0.06	0.11	IBGE, 2010a
Corn	share (ha)**	0.03	0.05	IBGE, 2010a
Pasture*	share (ha)**	0.30	0.14	IBGE, 2010b
Sugarcane	share (ha)**	0.02	0.05	IBGE, 2010a

*Area calculated by authors using an estimate of 1.5 heads of cattle per hectare. ** Ratio of the area specified over total arable land. Arable land is the sum of areas with agriculture and pasture.

Table 2: Marginal effects for the Logit Model

	Marginal Effects	Standard Error
Sugarcane	0.53414**	0.27252
Soybeans	0.02155	0.18528
Corn	0.22255	0.33909
Pasture	-0.05271	0.08420
Distance to SP	0.00007	0.00015
Distance to Capital	0.00036	0.00019
Distance to another Mill	-0.00386***	0.00101
Roads	0.00005	0.00014
Electricity	-0.00012	0.00021
Zoning	0.00000*	0.00000
Labor	0.00088	0.00182
Land Price	0.00000	0.00002
Rural Syndicate	0.12256***	0.04290
Pipeline	0.03543	0.08545
Model Fit Statistics		
Log likelihood	-65.196	
McFadden's R^2	0.453	

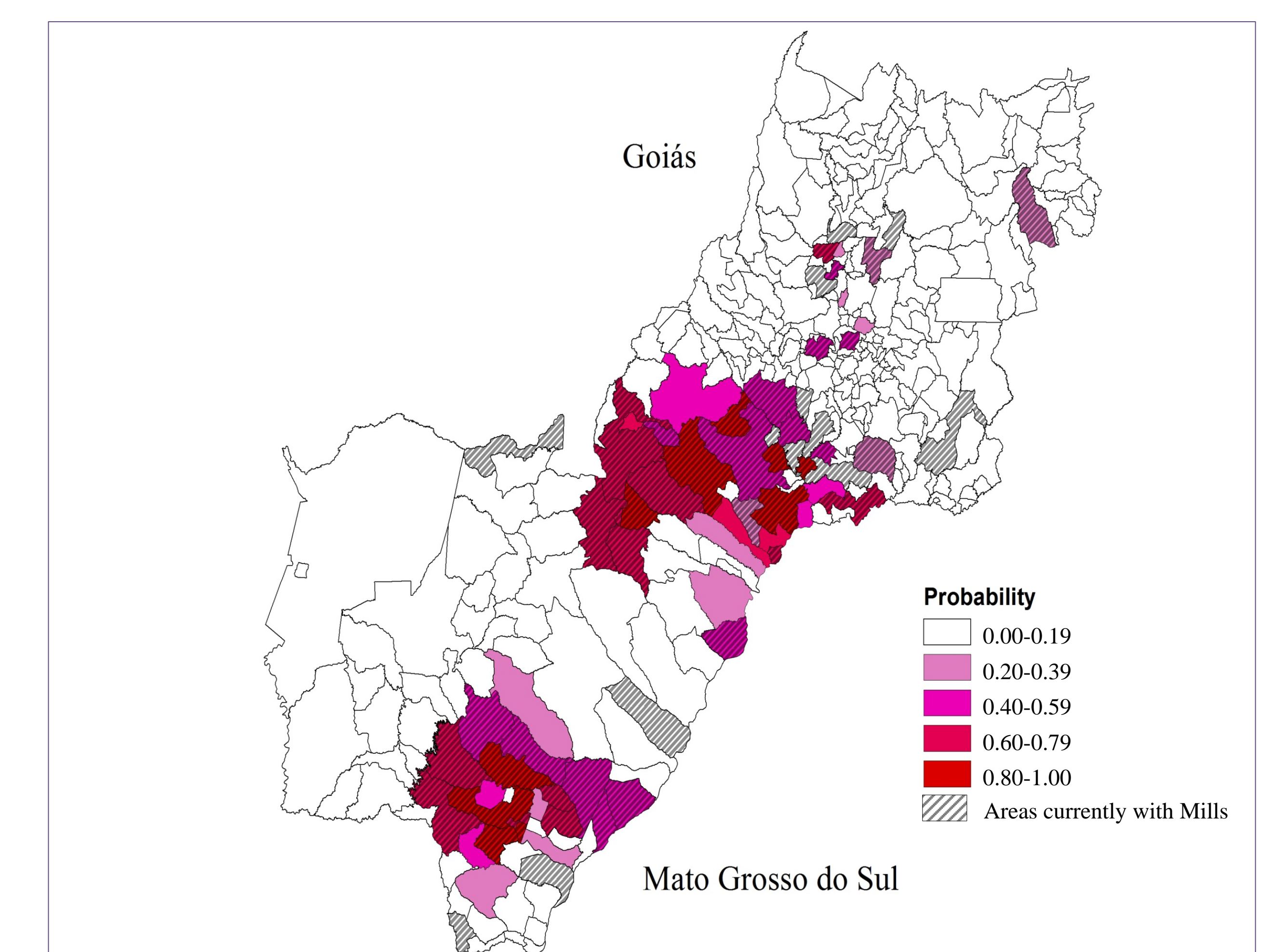Std Err: Standard errors. *** p<0.01, ** p<0.05, * p<0.1

Figure 2: Contraposition of predicted probabilities of a mill locating in a county with counties where there is already a mill.