Analysis of Land Cover and Land Use Dynamics in the State of Tocantins

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State of Tocantins

Introduction

- Currently the discussions about the dynamics of cover and land use has been the focus of attention from the scientific and political community, mainly because of its relation to the processes of global climate changes, especially in the intensification the greenhouse effect.
- Multitemporal remote sensing data incorporated into a GIS environment are often employed for spatial analysis of changes in cover and land use over a period (Campbell, 2006; Lambin, Geist, 2006), taking into account that disturbances, both natural and of anthropic origin in the environment, produce detectable variations in the spectral response of the target or of the phenomenon studied.
- These temporal maps allow identifying trends of the dynamics of the study area, including their net and gross rates for each analyzed period, as well as the evolution of these rates over time (Soares Filho, 2005).
- In those studies to detect changes or landscape dynamics, different techniques have been employed (Maldonado *et al*., 2007; Shalaby , Tateishia, 2007; Verburg, Overmars, 2007) , with the processes of change in cover and land use, commonly represented in relation to the loss of vegetation (Souza Jr., 2006; Grace *et al.* , 2007; Lu *et al*. , 2008.).

Introduction

- The surveys on cover and land use, depicting the shapes and their dynamics of occupation, also represent valuable instrument for evaluating the environmental supporting capacity, contributing to the identification of alternative promoters of sustainable development (IBGE [*Brazilian Institute of Geography and Statistics*], 2006).
- Understanding of the dynamics of cover and land use for environmental planning, emphasizes the need to characterize the agents involved in this process, that is to say, the relationships between changes in land use with physical, biological, social - economic and political factors (Lorraine, Lambin, 2008; Silva *et al*., 2008; Soler *et al.*, 2008.).
- The Brazilian Amazon has historically been subject to anthropic activities (INPE*[“Instituto Nacional de Pesquisas Espaciais”- National Institute of Spatial Research]*, 2008), with the conversion of forested regions into areas for ranching and agricultural activities (Morton *et al.,* 2006; Souza Jr., 2006; Nepstad *et al.,* 2008), contributing to the change of environment and biodiversity decrease (Costa *et al*., 2007).
- In the specific case of Tocantins, inserted into a contact region of the Amazon and “Cerrado”[*TN: Brazilian Savannah*] biomes (IBGE, 2004), the scarceness of data regarding the expansion of the occupation, and consequently the reduction of natural vegetation areas, highlights the need for a State updated mapping, considered the historical factor of its landscape, yet.

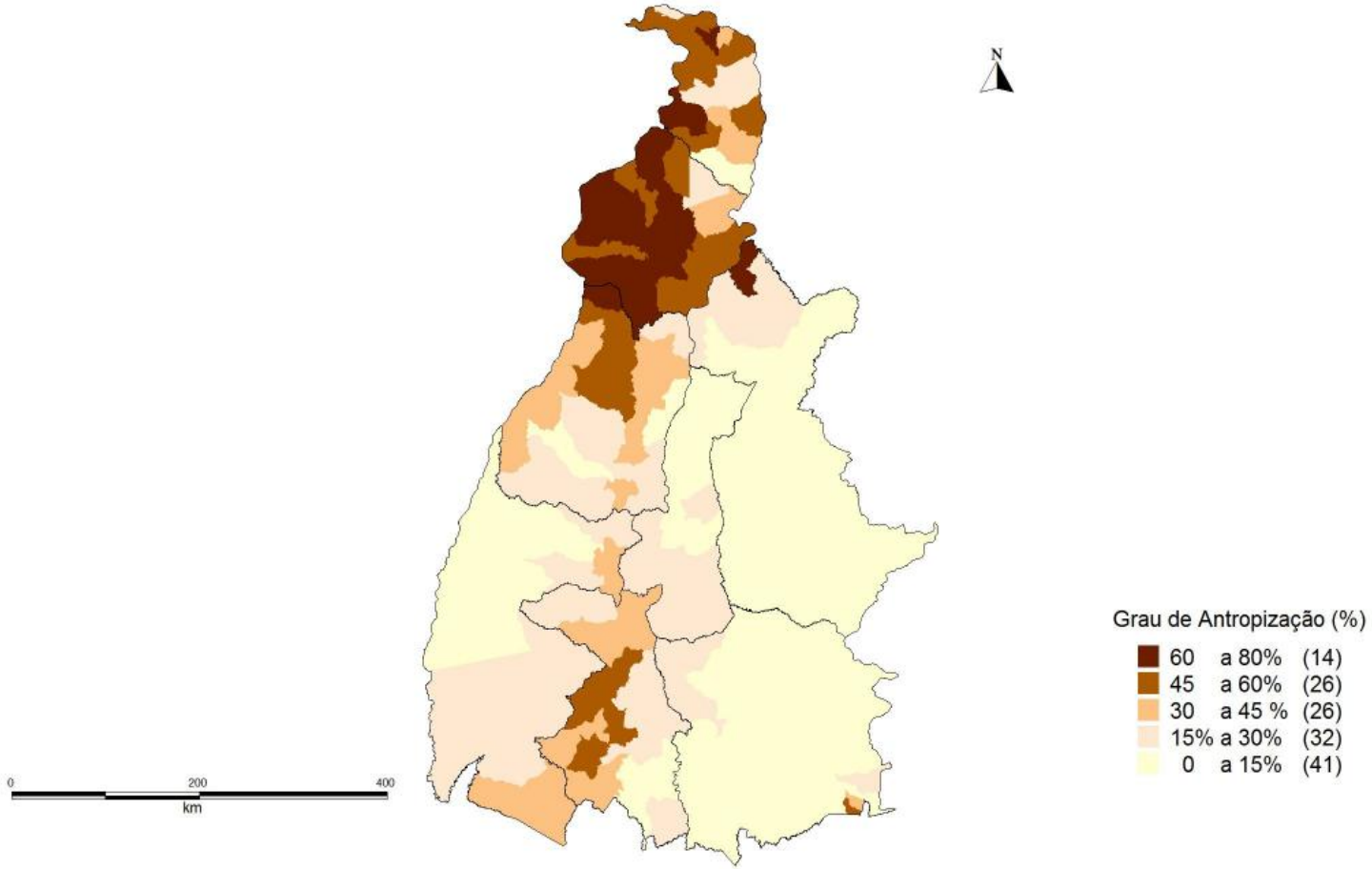
Data

- The data on deforestation were obtained from satellite images LadSat and have been duly treated and organized to prepare the dynamics, which included the mapping of land use and cover of 1990, 2000, 2005 and 2007.
- To follow we used spatial analysis to analyze the data for use and occupation of the land, especially the evolution of anthropic area.
- The intersection of the maps was performed pairing data, 1990 and 2000, 1990 and 2005, 2000 and 2005, 2005 and 2007. Additionally, this operation was performed for the maps of 1990 and 2007, aiming at understanding the dynamics process in an integrated way, considering the whole period, and relating it to the socioeconomic factors.
- Socioeconomic data form various sources – Census, Agriculture, Ranching investigations

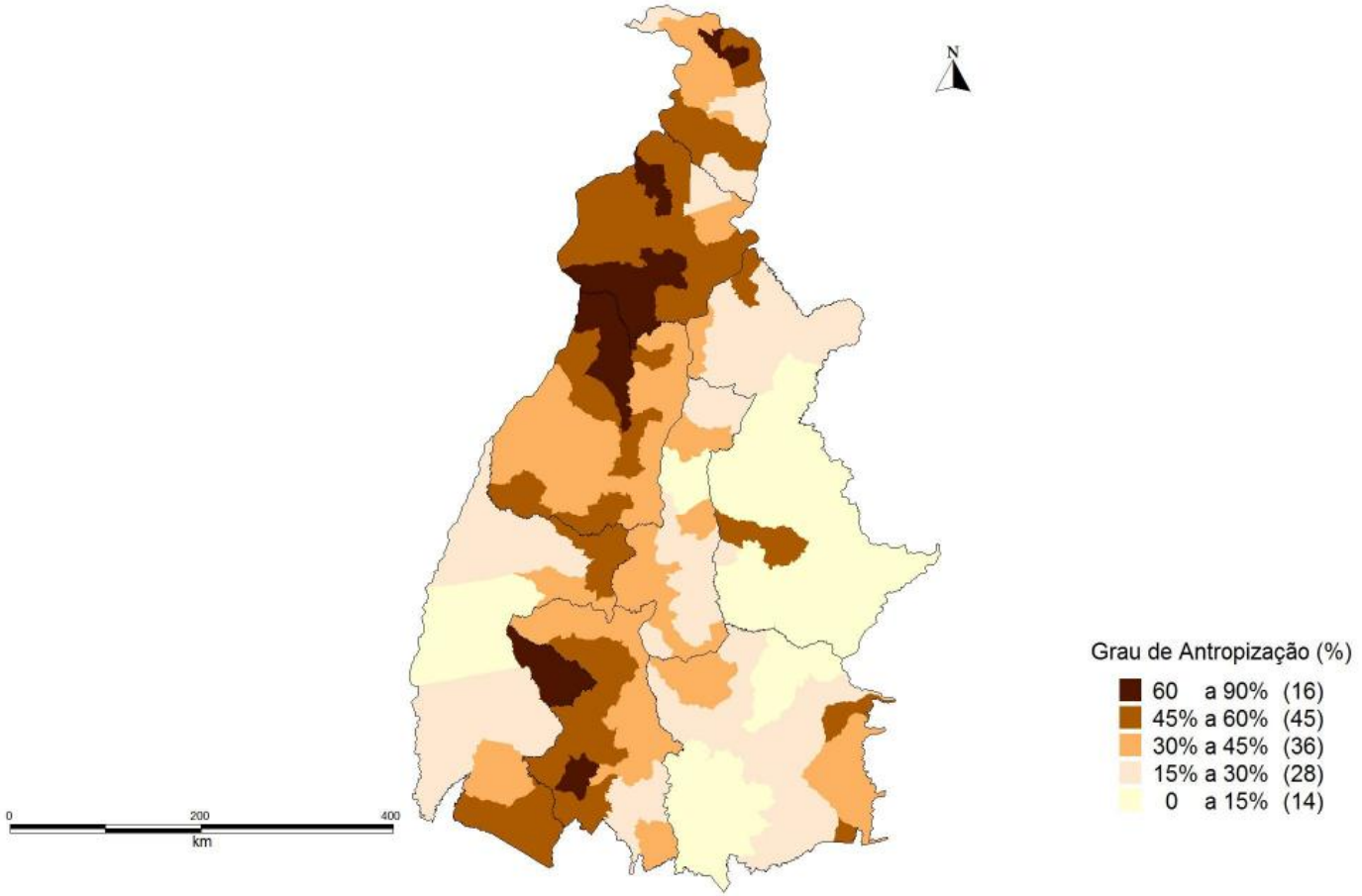
Evolution of anthropization

Microrregião	Variável	1990	2000	2005	2007
Araguaína	Antropic Area (ha)	1.291.114	1.486.493	1.531.472	1.506.788
	% antropic aerea/total area	49%	56%	58%	57%
	% agriculture area / antropic area	99%	100%	99%	99%
Bico do Papagaio	Antropic Area (ha)	420.908	504.420	604.782	626.377
	% antropic aerea/total area	27%	32%	38%	40%
	% agriculture area / antropic area	99%	99%	99%	97%
Jalapão	Antropic Area (ha)	338.829	449.095	573.292	622.610
	% antropic aerea/total area	6%	8%	11%	12%
	% agriculture area / antropic area	97%	93%	84%	84%
Miracema	Antropic Area (ha)	998.096	1.258.658	1.544.995	1.656.658
	% antropic aerea/total area	29%	36%	45%	48%
	% agriculture area / antropic area	98%	99%	97%	98%
Gurupi	Antropic Area (ha)	782.453	980.196	1.110.155	1.133.045
	% antropic aerea/total area	28%	36%	40%	41%
	% agriculture area / antropic area	99%	99%	99%	99%
Dianópolis	Antropic Area (ha)	374.204	597.236	745.790	1.016.948
	% antropic aerea/total area	8%	12%	16%	21%
	% agriculture area / antropic area	91%	88%	88%	91%
Porto Nacional	Antropic Area (ha)	321.286	488.181	558.083	601.835
	% antropic aerea/total area	15%	23%	26%	28%
	% agriculture area / antropic area	97%	92%	92%	91%
Rio Formoso	Antropic Area (ha)	754.112	1.031.517	1.271.451	1.371.981
	% antropic aerea/total area	15%	20%	25%	27%
	% agriculture area / antropic area	95%	96%	95%	95%
Tocantins	Antropic Area (ha)	5.281.002	6.795.796	7.940.020	8.536.242
	% antropic aerea/total area	19%	24%	29%	31%
	% agriculture area / antropic area	98%	97%	95%	95%

Degree of municipal anthropization according to micro regions, 1990.



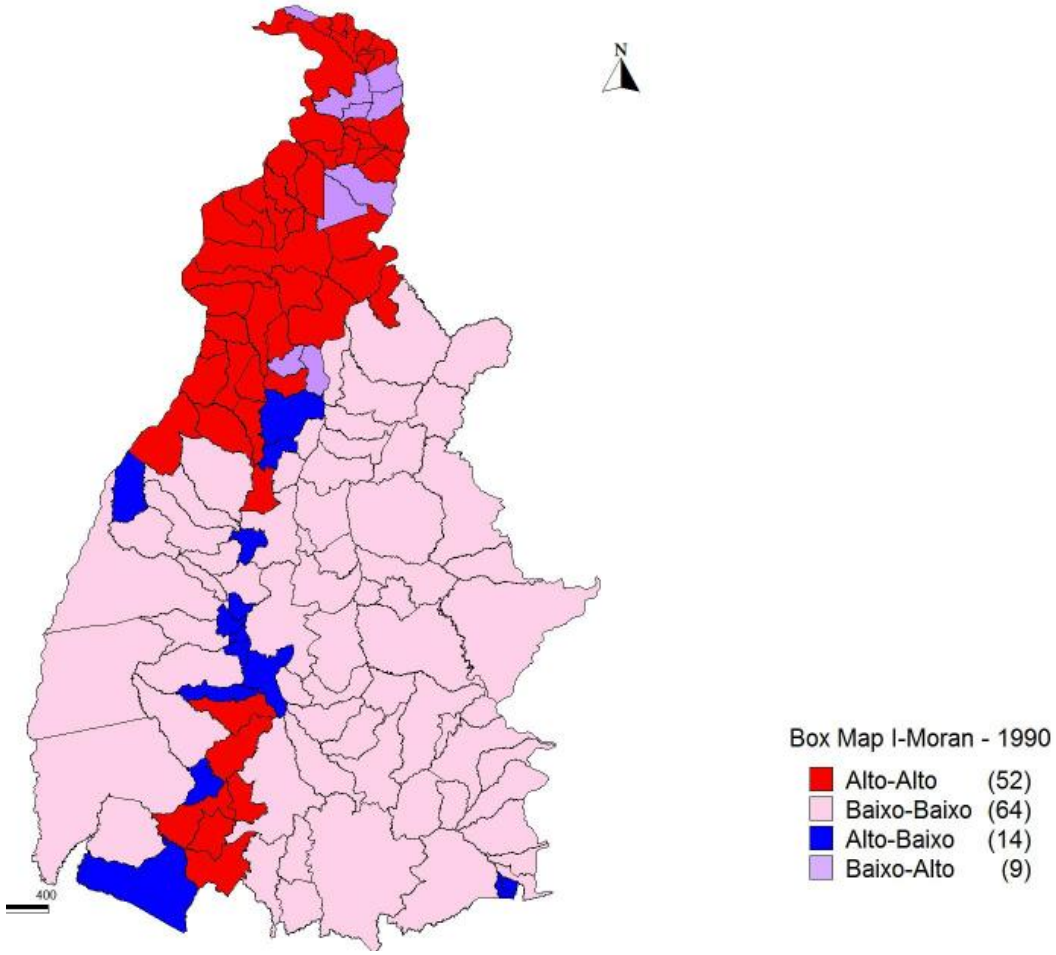
Degree of municipal anthropization according to micro regions,2007



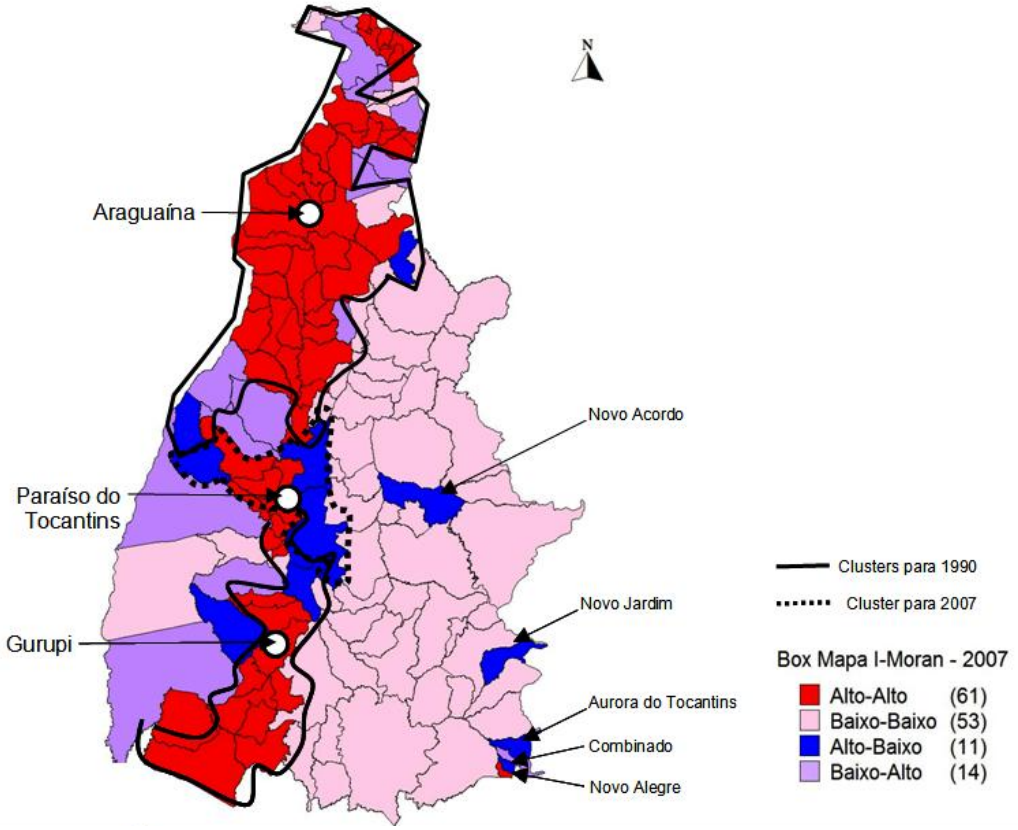
Methodology

- Exploratory spatial data analysis (*Exploratory Spatial Data Analysis* - ESDA) allow to describe and visualize the global and local spatial distributions, discover patterns of spatial association (*clusters*), suggest (*non-stationary*) spatial instabilities and identify atypical situations (*outliers*). LISA and Moran Index.
- Correlation
- Econometric model

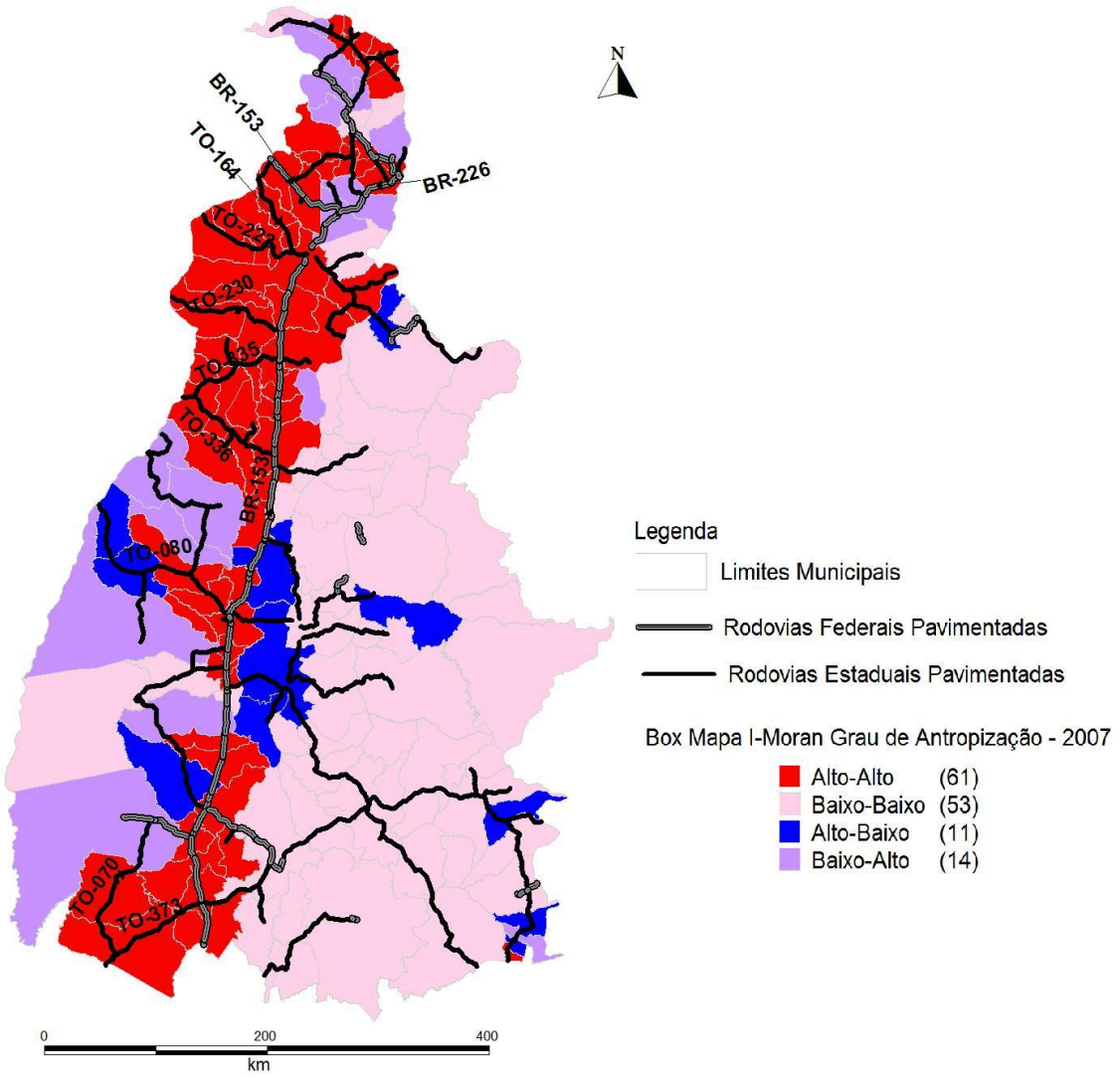
Anthropization Index of Tocantins's Municipalities for the Year 1990



Anthropization Index of Tocantins's Municipalities for the Year 2007



Anthropization Index of Tocantins's Municipalities with Paved Roads



Correlation Analysis

Correlation analysis between anthropic area and variables selected for the 139 municipalities in the years of 2000 and 2007

Variables	Correlation
Population	0.328
Cattle Herd	0.843
Grains	0.394
Agricultural Employment	0.677
Total Employment	0.132
Distance from Capital	-0.107
Settlement Area	0.679
Ranching-agricultural suitability	0.602

Source: Authors' own eleboration

Econometric Model

$$y_{it} = x_{it} b + u_{it}$$

where y_{it} is a column vector representing the dependent variable, which in this case is the anthropized area; x_{it} is the matrix containing the covariates (population density, size of the cattle herd, plant area of grains, etc..), β is a vector parameters and u_{it} is a vector of errors.

Initially the methods used ordinary least squares (OLS) for the estimation of equation (1), as there were data available for the years 2000 and 2007, for 139 municipalities in the state, the data were stacked for each municipality known in the economic literature as *Pooled* OLS.

We also used a fixed effect model that considers that the intercept ($\beta 1i$) varies for each municipality and the angular coefficients remain constant among municipalities.

Results

Variable	MQO *Pooled*	Fixed Effect
Intercept	1.563*** (0.503)	6.879*** (0.953)
Ln(Cattle Herd)	0.603*** (0.065)	0.141^{NS} (0.105)
Ln(Grains)	0.178*** (0.035)	0.021^{NS} (0.030)
Ln(GDP)	0.124*** (0.035)	0.204*** (0.037)
R^2 Total	0.670	0.569
R^2 *Within*	-	0.461
R^2 *Between*	-	0.662
Hausman Prob>χ^2	-	30.71 0.000
Observations	278	278