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Dívida ativa de IPTU do município de Uberlândia-MG: a região de residência influencia a inadimplência?

Active IPTU debt of the municipality of Uberlândia-MG: does the region of residence influence default?

Deuda activa de IPTU del municipio de Uberlândia-MG: ¿la región de residencia influye en la mora?

Bruno Bartasson Ferreira Rosa

Federal University of Uberlândia (UFU)

Address: Av. João Naves de Ávila, 2121 - Santa Mônica, Uberlândia -
MG, 38408-100

e-mail: brunobartasson@ufu.br

<http://orcid.org/0000-0002-6815-8483>

Vinicius Silva Pereira

Federal University of Uberlândia (UFU)

Address: Av. João Naves de Ávila, 2121 - Santa Mônica, Uberlândia -
MG, 38408-100

email: viniciuss56@ufu.br

<https://orcid.org/0000-0002-4521-9343>

Antônio Sergio Torres Penedo

Federal University of Uberlândia (UFU)

Address: Av. João Naves de Ávila, 2121 - Santa
Mônica, Uberlândia - MG, 38408-100

e-mail: penedo@ufu.br

<https://orcid.org/0000-0001-7763-8457>



PALAVRAS-CHAVE
IPTU; dívida ativa;
inadimplência.

Resumo: Este artigo tem como objetivo verificar se a região de residência do contribuinte com débito de Imposto Predial e Territorial Urbano (IPTU) inscrito na dívida ativa do município de Uberlândia-MG influencia a sua probabilidade de inadimplência. Foram analisados dados secundários coletados diretamente na base de dados do sistema financeiro da Administração Direta do município de Uberlândia, em face dos quais foram realizadas análises univariada, bivariada, espacial e de regressão logística. A amostra da pesquisa é composta por 126.344 contribuintes pessoa física que possuíam débitos de IPTU não pagos inscritos em dívida ativa em 31/12/2020, bem como aqueles que já possuíram referidos débitos, mas efetuaram o seu pagamento no período entre 2010 e 2020. Demonstrou-se que há uma maior concentração de inadimplentes em bairros periféricos e em setores territoriais formados por bairros nos quais residem contribuintes com menor rendimento nominal mensal domiciliar. Constatou-se, também, que o setor territorial de residência do devedor influencia a probabilidade de inadimplência. Além destas contribuições, a pesquisa amplia as evidências empíricas acerca dos fatores que podem influenciar a inadimplência da dívida ativa de IPTU do município de Uberlândia, permitindo um melhor aproveitamento do seu potencial arrecadatório. Ainda, indica a necessidade de que o IPTU seja instituído e cobrado de forma mais condizente com a capacidade contributiva dos cidadãos, contribuindo para a redução das desigualdades sociais.

KEYWORDS

Municipal property tax;
active debt; default.

Abstract: This study aims to verify whether the region of residence of the taxpayer with IPTU (Urban and Property Territorial Tax) debt registered in active debt of the municipality of Uberlândia-MG influences its probability of default. Secondary data was analyzed directly from the financial system of the Administration of the municipality of Uberlândia database, in which univariate, bivariate, spatial and logistic regression analysis were performed. The research sample is composed of 126,344 taxpayers who had unpaid IPTU debts registered in active debt on 12/31/2020, as well as those who already had those debts, but paid them between 2010 and 2020. It should be noted that there is a greater concentration of defaulters in peripheral neighborhoods and in territorial sectors formed by neighborhoods in which taxpayers with lower nominal monthly household income reside. It was also found that the debtor's territorial sector of residence influences the probability of default. In addition to these contributions, the research expands the empirical evidence about the factors that can influence the default of the active IPTU debt of the municipality of Uberlândia, allowing a better use of its revenue potential. It also indicates that this tax must be instituted and collected more consistently with the citizens' ability to pay, contributing to the reduction of social inequalities.

PALABRAS CLAVE

IPTU; deuda activa;
incumplimiento.

Resúmen: Este artículo tiene como objetivo verificar si la región de residencia del contribuyente con deuda de IPTU registrado en la deuda activa del municipio de Uberlândia-MG influye en su probabilidad de incumplimiento. Se analizaron datos secundarios recolectados directamente de la base de datos del sistema financiero de la Administración Directa del municipio de Uberlândia, frente a los cuales se realizaron análisis univariada, bivariada, espacial y de regresión logística. La muestra de la investigación está compuesta por 126.344 contribuyentes que tenían deudas de IPTU impagas registradas en deuda activa al 31/12/2020, así como aquellos que ya tenían dichas deudas, pero las pagaron entre 2010 y 2020. Parece que hay una mayor concentración de morosos en barrios periféricos y en sectores territoriales formados por barrios en los que residen contribuyentes con menores ingresos familiares mensuales nominales. También se encontró que el sector territorial de residencia del deudor influye en la probabilidad de incumplimiento. Además de estas contribuciones, la investigación amplía la evidencia empírica sobre los factores que pueden influir en el incumplimiento de la deuda activa de IPTU del municipio de Uberlândia, lo que permite un mejor aprovechamiento de su potencial de recaudación. También indica que este impuesto debe ser instituido y recaudado de manera más consistente con la capacidad de pago de los ciudadanos, contribuyendo a la reducción de las desigualdades sociales.

Introduction

In 2020, the default, which was already high, generally reached historic levels in Brazil amid the new coronavirus pandemic. Approximately 42% of the adult population, which is equivalent to almost 66 million people, was in default in April 2020. With regard to companies, a peak of 6.22 million defaulters was reached in September 2020 (Serasa Experian, 2020).

The finance literature has researched for decades on predicting financial distress in general, such as credit risk and corporate bankruptcy. However, considering the economic importance of unpaid taxes on their due dates, few empirical studies have been published on predicting tax defaults (Abedin et al., 2021; Höglund, 2017), which indicates that this is a relevant area for developing new research.

However, throughout the world, several national and subnational entities suffer from high tax defaults, it is mainly through the receipt of these resources that the public sector bears the costs of various social plans, invests in infrastructure and provides public services (Satu, Abedin, Khanom, Ouenniche, & Kaiser, 2021). In this scenario, property tax stands out as the most traditional source of funding for local governments in the world (Castro & Afonso, 2017).

In Brazil, the tax levied on real estate property is called IPTU, the amount owed by taxpayers must vary, among other aspects, according to the location of the property, under the terms of the rule contained in art. 156 of the Federal Constitution of 1988 (Brasil, 1988). Regarding this tax, there is a consensus among specialists in public finance that there is an enormous potential for collection that is not explored by most Brazilian municipalities (Castro & Afonso, 2017). Despite this enormous potential, municipal entities still face major challenges to overcome the low IPTU collection, among which Fonseca, Lobo and Garcia (2017) highlight the reduction of defaults and the informality of space utilization in municipalities.

The default of IPTU on the due date, generates for the tax authorities the obligation to register them in active debt, so that it can be subject to judicial and extrajudicial collection (Sabbag, 2017). Thus, the active IPTU debt is made up of credits that have not been paid by third parties within the due date, and which are registered in the

public entity's registers for collection purposes, after determining their certainty and liquidity (Brasil, 2018).

Research carried out by Castro & Afonso (2017) assessed the use of IPTU collection potential in Brazilian municipalities. Among the results found, they verified that the municipality of Uberlândia was the fourth worst, among the Brazilian municipalities with more than 500 thousand inhabitants, in taking advantage of its IPTU collection potential, managing to take advantage of only 23% of this potential. Considering that, according to the 2010 Census estimate, the municipality of Uberlândia was the thirtieth largest Brazilian municipality in Brazil (IBGE, 2020), the result of this research is in line with the findings of Sell, Flach and Mattos (2021) in the sense of that the larger the population, the greater the IPTU per capita collected. The low use of the collection potential of this municipality paves the way for conducting research in order to understand the possible reasons, among them perhaps the biggest is default.

Considering this context, and adhering to the suggestion of Gering, Pinto and Vieira (2021), in the sense of carrying out research only with debtors, it will be made an attempt to answer the following research problem: what is the influence of the region of residence of the individual taxpayer on the probability of default of IPTU debts registered in the active debt of the municipality of Uberlândia? Thus, the present work aims to verify the probability of default on IPTU debt, based on the neighborhood and sector of residence of the taxpayers. To achieve this objective, data collected directly from the financial system database of the Direct Administration of the municipality of Uberlândia were analyzed, data based on which univariate, bivariate, spatial and logistic regression analysis were carried out.

The justification for carrying out the study is based on the perception that the high IPTU default represents a great fiscal injustice towards taxpayers who pay this tax on time, it can generate a false perception of the need to increase the tax burden and makes the implementation of public policies unfeasible, to the detriment of society as a whole. Thus, it is hoped, with the present research, to advance and shed light on the important and little discussed issue of IPTU default, allowing public entities to know the variables that may

interfere with its collection and promote its institution and collection in a more efficient and consistent way with the principle of contributive capacity.

Theoretical elements of the research

Wealth, on the rise since the second half of the 20th century, must be taxed so that the State can cope with the growing public debt and the increase in inequalities that have plagued most Western countries (Bonnet, Guillaume, Trannoy, & Wasmer, 2021). In Brazil, the federative pact and the consequent administrative decentralization raised Brazilian municipalities, but mainly those of medium and large size, to increasingly important actors in the achievement of public policies (Santos, 2003).

Municipalities have been required to fulfill a number of essential public services to the population, such as health, education and infrastructure, and to meet these municipal management challenges, providing quality public services, in order to improve the population's life, as well as promoting economic development and income distribution programs and actions, municipal entities make use of the taxation policy (Ramelli & Silva, 2020).

The Brazilian tax system guarantees municipalities part of the tax revenues earned by the States and the Federal Union, as well as the competence to institute their own taxes, such as IPTU, the tax on the transfer of real estate, known by the acronym ITBI, and the tax on services, known by the acronym ISS (Brasil, 1988).

Although municipal entities benefit from the sharing of tax revenues by state and federal entities, the flow of resources from these sources is not usually constant, which combined with a growing demand for public services, programs and municipal actions makes it essential that the collection potential of revenues arising from taxes within its jurisdiction be well explored (Castro & Afonso, 2017).

A direct tax under the jurisdiction of Brazilian municipalities that is considered the most traditional source of financing for local governments in the world is the IPTU, a tax that is levied on real estate property and in relation to which there is a consensus among specialists in public finance in Brazil that there is a huge

collection potential not explored by most Brazilian municipalities (Castro & Afonso, 2017).

The non-commitment to improving IPTU collection keeps municipal public entities dependent on mandatory transfers of State and Federal Union revenues. Furthermore, it causes the potential resources arising from the manifestation of real estate wealth to be retained in the hands of property owners, a portion of the population that, in general, has a better contributory capacity (Ramelli & Silva, 2020).

Real estate ownership is an important component of wealth that has contributed to rising wealth in the world as a whole. This fact is mainly due to the increase in property prices in urban areas and especially in metropolitan regions. Real estate wealth makes up at least 40% of household wealth and housing expenditures account for between 20 and 30% of consumer spending (Bonnet et al., 2021).

Bonnet et al. (2021) argue that a more effective taxation of real estate wealth would make it possible to reduce the tax burden on the worker, who is characterized as not having property rights over land and also already devoid of property rights over capital. In this sense, they argue that taxation of real estate wealth should be high, because if it reaches an optimal level, it allows saving productive capital, contributing to the reduction of social inequalities and to a fairer taxation.

Thus, it is important to explore the full potential of IPTU taxation, characterized as a direct tax, so that urban policy is able to create a fair, less regressive tax system that can contribute to the mitigation of income and wealth distortions (Borges & Sousa, 2004; Ramelli & Silva, 2020).

In Brazil, two legal criteria can be used to promote social justice in IPTU taxation. The progressiveness of the rates can be implemented through calculation methodologies that guarantee rates proportional to the contributory capacity of the citizens. And, an exemption can be also granted to some taxpayers by fulfilling certain requirements provided by law (Sá, Cavalcante, Kalid, & Malveira, 2013).

Progressivity is predicted in art. 156 of the Federal Constitution, which says that IPTU must be progressive due to the value of the property and must have different rates according to its location and use (Brasil, 1988). Thus, the Constitution itself

provides a mechanism for public entities to effect IPTU taxation consistent with the taxpayer's contributive capacity.

A more appropriate use of administrative techniques in survey the IPTU calculation basis could also lead to fairer taxation. However, the intrinsic iniquity of this tax, referring to its frequent inability to capture the real contributory capacity of the owners, has compromised the equitable distribution of the tax burden, affecting more those with lower income (Borges & Sousa, 2004).

Despite the enormous potential for IPTU collection and its potential to reduce social inequalities, municipal entities still face major challenges to overcome its non-use, among the main ones Fonseca et al. (2017) highlight the reduction in defaults and the informal occupation of space in municipalities, resulting from the existence of a high tax burden on household budgets and obstacles to real estate regularization. They also point out that, in many cases, the reason for the deficiency of the tax policy of Brazilian cities is caused by the lack of accurate and detailed information on their part.

It is worth mentioning that failure to collect IPTU by the due date, as well as any other tax or non-tax credit, generates for the tax authorities the obligation to register it in active debt, so that it can be subject to judicial collection and extrajudicial (Sabbag, 2017). Thus, the active IPTU debt consists of the set of credits not paid by third parties on the due date, and which are entered in the public entity's registers for collection purposes, after determining their certainty and liquidity (Brasil, 2018).

The finance literature has researched for decades on predicting financial distress in general, such as credit risk and corporate bankruptcy. However, considering the economic importance of unpaid taxes on their due dates, few empirical studies have been published on predicting tax defaults, which indicates that this is a relevant area for the development of new research (Abedin et al., 2021; Höglund, 2017).

Gering et al. (2021) point out that there is a shortage of studies on default at the municipal level and a still incipient bibliography on IPTU. Seeking to contribute to filling this gap, they conducted a survey in the municipality of Santa Maria-RS, from 2012 to 2016, with 126,190

registrations of land and property. They concluded, using the logistic regression technique, that default is influenced by the rate charged, by the existence of an irregular area, by the increase in the taxable value of the property it is higher when the owner is an individual, it is higher the less central the location of the property is, and higher for taxpayers who have not paid IPTU in the last two years.

Costa, Pecini and Tsunoda (2021) also carried out research with the objective of evaluating the relationship between IPTU payment and the characteristics of properties or unbuilt land. The research was carried out with registration data and IPTU payment data from the municipality of Curitiba, from January to June 2020. They concluded that default is higher in residential properties made of wood or masonry, with a simple finishing standard and a simple average, and that the tribute is paid in installments regardless of the construction standard of the property or the neighborhood in which it is located.

Although the analysis of tax defaults is little explored in the literature (Abedin et al., 2021; Höglund, 2017), there are several studies on the prediction of public revenues, which make use of statistical tools and are considered an important instrument capable of enable a planned action by the State (Lima Filho, Silva, Amorim, Moreira, & Pinheiro, 2014).

Mikessel (2018), when exposing lessons from 40 years in predicting state revenues, mentions that the experience in this area is humiliating, because although analysts trust their prediction, reality may not behave as predicted. Sophisticated modeling techniques do not necessarily produce acceptable quality predictions. The author mentions that someone once joked that a basic rule of economics is that it must provide a number or a date, but never a number and a date, but he also clarifies that this rule must be violated in order to obtain sustainable budgets. So, you have the dilemma that the revenue predictor is wrong, but the wrong forecast is crucial as a starting point for building budgets that can be executed (Mikessel, 2018).

Tax revenue is difficult to be represented by an accurate mathematical model, as it is subject to several qualitatively and quantitatively uncertain factors and, generally, presents non-linear data patterns (Zhiyun, 2013). And with the recent growth of fiscal uncertainty, academics and public finance professionals have faced challenges in

accurately predicting future revenues, a fact that leads them to try to identify the factors that affect the accuracy of revenue prediction (Lee & Kwak, 2019).

Despite these difficulties, important methodological, technological and computational advances have contributed to the creation of several risk measurement tools, providing accurate and detailed information that have generated significant gains for the financial management of organizations (Albuquerque, Medina, & Silva, 2017).

Taking advantage of these methodological gains and considering the finding of Gering et al. (2021) in the sense that non-compliance is higher in properties further away from downtown, the present study advances in the analysis of the theme by verifying not the location of the property, but rather whether the region of residence of the property owner influences the default of IPTU debts registered in the active debt.

The taxpayer's region of residence is analyzed and not the location of the property, considering that it is able to better relate to the taxpayer's ability to pay. For example, a taxpayer residing in a neighborhood with a high monthly household average income may own several properties located in neighborhoods with a low monthly average household income. What matters in this work is the region in which this taxpayer who owns several properties resides and not the location of each of his properties. Thus, the following research hypothesis will be tested:

H1: the region of residence of the debtor of IPTU in the municipality of Uberlândia influences the risk of default.

Methodological elements of the research

Considering the objective of analyzing the influence of the region of residence of the active IPTU debt taxpayer on the probability of default, secondary data were used directly extracted from the database of the financial system of the Direct Administration of the municipality of Uberlândia. Data collection took place directly in the database, considering that the various reports generated by the system do not provide the necessary information for carrying out the study, such as the residence address of each taxpayer.

The researched population is composed of individuals who have already had IPTU registered in active debt. For the default prediction, a sample was selected consisting of 126,344 taxpayers who had unpaid IPTU debts registered in active debt on 12/31/2020, as well as those who already had such debts, but made their payment between the period of 2010 and 2020. The choice of the 11-year period was due to the IPTU being a tax levied annually, which is why it is not reasonable to use a short period of time.

Active IPTU debt consists of the set of credits for this tax that have not been paid on the due date by the respective payers and which are entered in the public entity's active debt registers, after finding out their certainty and liquidity for administrative or judicial collection (Brasil, 2018).

In order to enable the analysis of the probability of default of the individual debtor of IPTU active debt based on the sector of his residence, the 5 Urban Territorial Sectors of the Headquarters District of the municipality of Uberlândia were considered, composed of the 74 districts, as shown in Figure 1 (Uberlândia, 1994, 2020).

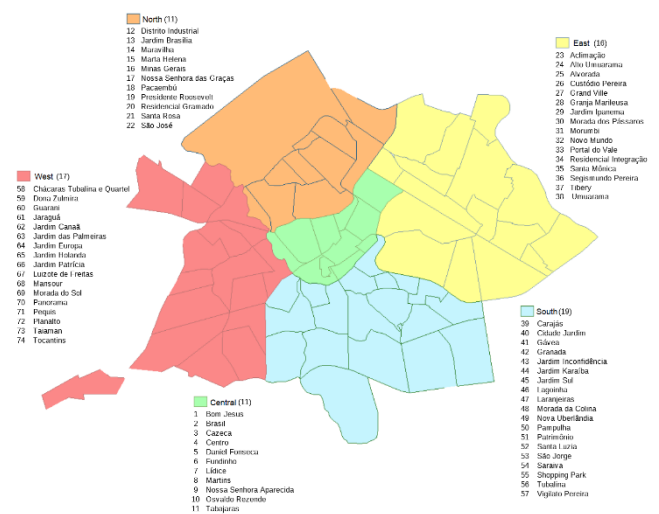


Figure 1 - Neighborhoods and Urban Territorial Sectors of the Headquarters District of the municipality of Uberlândia. Source: elaborated from the research data.

The variables used in the logistic regression model are described in Table 1. It is worth noting that, despite being relevant for the analysis of the research results, the use in the logistic regression model of data on nominal monthly household income in the municipality of Uberlândia was impaired. IBGE (2010) has information on only 51 neighborhoods and Uberlândia currently has 74

neighborhoods, resulting from the creation, union or dismemberment of neighborhoods (Uberlândia, 1994, 2020).

Table 1
Description of variables

Variable	Description	Formulas
Identifying variables		
CPF	Taxpayer's individual registration	
Neighborhood	Taxpayer's district of residence	
Dependent variable		
Default (INAD)	Taxpayer situation in 12/31/2020	Dummy: Default (1); Non-default (0).
Independent variable of interest		
Sector	Territorial sector in which the taxpayer resides	Four dummy variables were created, one for each sector, keeping the Central Sector as a reference: North (1); Other (0). East (1); Other (0). South (1); Other (0). West (1); Other (0).
Independent variables of control		
Negotiation (NEGOC)	The taxpayer adhered to some negotiation	Dummy: Negotiated (1); never negotiated (0).
Number of properties (UMIMO)	Number of taxpayer's property	Dummy: One property (1); More than one property (0).
Tax type (PREDIAL)	Type of tax due	Dummy: property tax (1); property and land tax, or just land tax (0).
Total amount in active debt (LTOT)	Logarithm of the total value of the taxpayer's debts that have already been registered in active debt (paid and unpaid)	Log (TOT)
Average amount in active debt (LMED)	Logarithm of the average value of the taxpayer's debts that have already been registered in active debt (paid and unpaid)	Log (MED)

Notes: TOT = total amount in active debt; MED = average amount in active debt.

Source: elaborated by the authors.

Regarding data analysis techniques, the present study aims to verify, through univariate, bivariate, spatial and Logistic Regression analysis, whether there is a difference in active IPTU debt according to the taxpayer's region of residence.

The univariate analysis consisted of an analysis of the frequency of default, the frequency of default by neighborhood and by sector, as well as the descriptive statistics of the variables total amount and average amount registered in active debt.

A bivariate analysis was also carried out in the same terms as that applied by Albuquerque et al. (2017), which consists of calculating the frequency

between the predictor variables and the response variable, as shown in equation 1. This analysis aimed to identify the variables that discriminate the risk of default. Each variable was categorized according to relative risk, categories that gave rise to the dummy *variables* that were used in the regression model, with the exception of the variables total amount and average amount entered in active debt, which were used in the model through their logarithm.

$$Riscorelativodacategoria = \frac{\frac{\text{totaldefaultersinthecategory}}{\text{totaldefaulters}}}{\frac{\text{totalnondefaultersinthecategory}}{\text{totalnondefaulters}}} \quad (1)$$

Spatial analysis was performed using Moran's Global and Local Indexes. Moran's Global Index varies between -1 and 1, and provides a measure of existing spatial association in the studied region. Values close to -1 and +1 indicate negative and positive spatial correlation, respectively. Values close to 0 indicate absence of spatial correlation. On the other hand, the Moran Local Index provides local indicators that allow identifying clusters with statistical significance (Albuquerque et al., 2017).

Finally, logistic regression was applied, a statistical technique of multivariate analysis that seeks to explain the relationship between a dummy dependent variable and independent explanatory variables, in order to obtain the probability that an observation belongs to one set or another (Hair Jr. et al., 2009). It is pointed out by Lessmann, Baensens, Seow and Thomas (2015) as the standard methodology in the financial sector, commonly used for classification in the development of credit scoring models.

In logistic regression, the model parameters are estimated using the maximum likelihood method, which maximizes the probability of observing Y's data. In this research, the dependent variable Y is binary, and takes the values 0 for default and 1 for default, and varies according to the independent variables X1, X2, ..., Xk, composing equation 2, according to the variables presented in Table 1, and which is known as the cumulative logistic distribution function (Gujarati & Porter, 2011).

$$INAD_i = \frac{1}{1 + e^{\beta_0 + \beta_1 NEGOC + \beta_2 UMIMO + \beta_3 PROPERTY + \beta_4 LTOT + \beta_5 LMED + \beta_6 NORTH + \beta_7 EAST + \beta_8 SOUTH + \beta_9 WEST}} \quad (2)$$

The treatment, cleaning and application of univariate and bivariate analysis techniques and logistic regression were performed using the Stata program. Spatial analysis was performed using the GeoDa program.

Presentation and discussion of results

Univariate and bivariate analysis

Aiming to know the percentages of default in the districts and sectors of the municipality of Uberlândia, as well as the relative risk of default in relation to the categories of each variable in the sample, univariate and bivariate analysis were carried out, respectively.

Tables 2, 3 and 4 present the results of the frequency distribution of the default variable, by neighborhood and by Territorial Sector of the District Headquarters of the municipality of Uberlândia. Table 2 shows that there are 68,578 taxpayers who have open IPTU debts, registered in the active debt of the municipality of Uberlândia, a number that corresponds to 54.3% of the total number of taxpayers who have or have already had IPTU registered in active debt.

Table 2
Frequency distribution of the dependent variable (INAD)

Default	Frequency	Percentage
0 (default)	57,766	45.7%
1 (non-default)	68,578	54.3%
Total	126,344	100%

Source: elaborated from the research data.

Regarding the territorial sectors of residence of IPTU taxpayers with debts registered in active debt, Table 3 shows that the Central area has the lowest percentage of defaults (50%) and the West the highest (57.3%). It is also noted that the sector with the lowest number of defaulters is the North (8,869) and the one with the highest number is the West Sector (18,052).

Table 3
Default Rate by Territorial Sector

Sector	Number of defaulting taxpayers	Total number of contributors	Percentage of default
Central	10,128	20,253	50.00%
North	8,869	16,591	53.50%
East	15,542	28,846	53.90%

South	15,987	29,132	54.90%
West	18,052	31,522	57.30%

Source: elaborated from the research data.

Table 4 presents the percentage of defaults by neighborhood, from which it can be seen that of the 10 neighborhoods with the highest default rate, 5 are located in the East Sector (Grand Ville, Portal do Vale, Morada dos Pássaros, Morumbi, Residencial Integração) and the 10 neighborhoods with the lowest default 7 are located in the South Sector (Jardim Sul, Gávea, Jardim Karaíba, Morada da Colina, Vigilato Pereira, Patrimônio, Nova Uberlândia). It is also interesting to note that the neighborhoods with the highest and lowest percentage of defaults are located in the East Sector, which are, respectively, Grand Ville and Granja Marileusa.

Table 4
Default Rate by District of the Seat District of the municipality of Uberlândia

Sector	Neighborhood	Number of defaulting taxpayers	Total number of contributors	Percentage of default
Central	Nossa Senhora Aparecida	1082	2031	53.30%
	Bom Jesus	391	753	51.90%
	Cazeca	333	645	51.60%
	Daniel Fonseca	579	1125	51.50%
	Oswaldo Rezende	984	1916	51.40%
	Martins	1787	3540	50.50%
	Brasil	1698	3375	50.30%
	Lídice	572	1178	48.60%
	Centro	1693	3508	48.30%
	Tabajaras	853	1839	46.40%
North	Fundinho	156	343	45.50%
	Jardim Brasília	1572	2796	56.20%
	Marta Helena	878	1566	56.10%
	Distrito Industrial	28	50	56.00%
	Maravilha	695	1264	55.00%
	Santa Rosa	1242	2315	53.70%
	Minas Gerais	503	939	53.60%
	Pacaembú	778	1482	52.50%
	Presidente Roosevelt	2015	3853	52.30%
	Nossa Senhora das Graças	835	1667	50.10%

	Residencial Gramado	289	587	49.20%
	São José	34	72	47.20%
	Grand Ville	63	66	95.50%
	Portal do Vale	26	33	78.80%
	Morada dos Pássaros	86	113	76.10%
	Morumbi	2283	3421	66.70%
	Residencial Integração	329	495	66.50%
	Jardim Ipanema	1017	1632	62.30%
	Alvorada	208	350	59.40%
East	Tibery	2284	3867	59.10%
	Aclimação	837	1470	56.90%
	Segismundo Pereira	931	1665	55.90%
	Custódio Pereira	1090	2124	51.30%
	Umarama	551	1139	48.40%
	Alto Umarama	524	1094	47.90%
	Santa Mônica	5160	11004	46.90%
	Novo Mundo	121	268	45.10%
	Granja Marileusa	32	105	30.50%
	Shopping Park	2080	3096	67.20%
	São Jorge	3385	5362	63.10%
	Laranjeiras	1824	3089	59.00%
	Carajás	419	725	57.80%
	Santa Luzia	505	883	57.20%
	Lagoinha	407	730	55.80%
	Pampulha	452	822	55.00%
	Granada	1820	3449	52.80%
	Tubalina	1012	1943	52.10%
	Cidade Jardim	907	1864	48.70%
South	Saraiva	1128	2380	47.40%
	Jardim Inconfidência	127	279	45.50%
	Nova Uberlândia	405	911	44.50%
	Patrimônio	193	440	43.90%
	Vigilato Pereira	333	766	43.50%
	Morada da Colina	467	1113	42.00%
	Jardim Karaíba	420	1015	41.40%
	Gávea	76	186	40.90%
	Jardim Sul	27	79	34.20%
	Panorama	212	307	69.10%
West	Mansour	1038	1588	65.40%
	Tocantins	1664	2577	64.60%

	Guarani	970	1556	62.30%
	Pequis	549	890	61.70%
	Jardim Canaã	1607	2680	60.00%
	Jardim das Palmeiras	1695	2880	58.90%
	Dona Zulmira	526	910	57.80%
	Luizote de Freitas	2174	3798	57.20%
	Taiaman	767	1367	56.10%
	Jaraguá	920	1682	54.70%
	Jardim Europa	1177	2152	54.70%
	Jardim Holanda	995	1837	54.20%
	Planalto	1615	3005	53.70%
	Chácaras Tubalina e Quartel	964	1892	51.00%
	Jardim Patrícia	1114	2225	50.10%
	Morada do Sol	65	176	36.90%

Source: elaborated from the research data.

To facilitate the analysis of the data in Table 4, they were represented in Figure 2 by 4 default percentage ranges. This figure shows that the percentage of default is higher in peripheral neighborhoods, with the exception of some neighborhoods in South Sector, the Morada do Sol neighborhood, which is entirely composed of a gated community, and the Granja Marileusa neighborhood, which is considered planned.

It is noted that the highest percentages of default are present in the West, North and East Sectors, with a high concentration in some neighborhoods of the East Sector, neighboring each other. Lower default rates can be observed mainly in neighborhoods located in the South and Central Sectors, which are neighborhoods inhabited by taxpayers with higher nominal monthly household income (IBGE, 2010).

It is also worth bringing some descriptive statistics of the total amounts of active debt owed by taxpayers, in order to know some characteristics of the sample. Table 5 shows that the average amount registered in active debt for each taxpayer is R\$ 1,766.75, the average is R\$ 682.10, with a minimum value of R\$ 0.49 and a maximum of R\$ 586,129.69, with a total of R\$ 223,217,850.50.

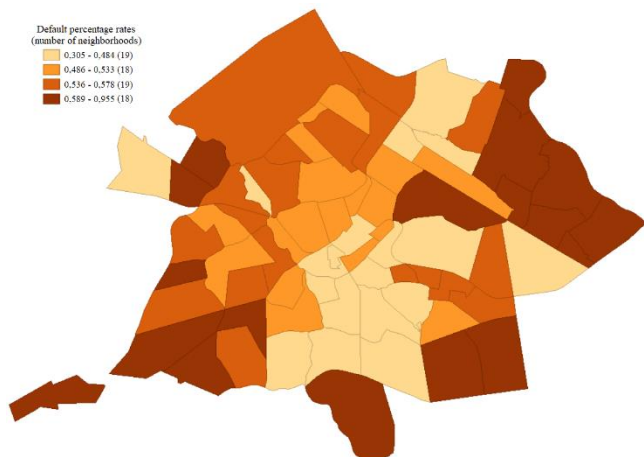


Figure 2 - Spatial distribution of default percentages. Source: elaborated from the research data.

Table 5
Descriptive statistics of the variable total amount in active debt

Variable	Obs.	Average	Median	Minimum	Maximum
Total amount in active debt (unpaid and paid)	126,344	1,766.75	682.10	0.49	586,129.69

Source: elaborated from the research data.

A bivariate analysis was performed, based on equation 1, with the aim of identifying the risk of default for each category of variables. These categories gave rise to the dummy *variables* that were used in the logistic regression model, with the exception of the variables total value and average value registered in outstanding debt, which were converted into logarithms.

Table 6, based on equation 1, demonstrates that taxpayers who have already negotiated an active IPTU debt have a lower relative risk of default than those who have never negotiated any debt. The results also showed that taxpayers who own only 1 property have a lower relative risk of default, as well as those who owe property and land tax, or only land tax. Regarding the Territorial Sector of Residence, the bivariate analysis showed that the lowest relative risk of default is found in the Central Region and that the highest is present in the West Region. With regard to the total value and average value of IPTU debts registered in active debt, those with the highest total value (over R\$ 1,195.38) and with a constant average value of group 2 (between R\$ 126.75 and R\$ 221.59), had a lower risk.

Table 6
Relative risk of variables

Variable	Class	Categorization	Relative Risk	Qty. Good	Qty. Bad	Total
Negotiation	1	Never negotiated	0.993	37,856	45,279	83,135
	2	Negotiated	1.014	19,910	23,299	43,209
Number of properties	1	1 property	1.036	47,163	54,030	101,193
	2	More than 1 property	0.865	10,603	14,548	25,151
Property or Territory	1	Property tax	0.962	45,169	55,770	100,939
	2	Property and land tax, or just land tax	1.167	12,597	12808	25,405
Territorial sector of residence	1	Central	1.186	10,125	10,128	20,253
	2	North	1.033	7,722	8,869	16,591
	3	East	1.016	13,304	15,542	28,846
	4	South	0.976	13,145	15,987	29,132
	5	West	0.885	13,470	18,052	31,522
Total amount in active debt (paid and unpaid)	1	Less than R\$ 393.42	1.685	24,707	17,408	42,115
	2	Between R\$ 393.42 and R\$ 1,195.38	0.933	18,537	23,578	42,115
	3	Over R\$ 1,195.38	0.625	14,522	27,592	42,114
Average amount in active debt (paid and unpaid)	1	Less than R\$ 126.75	1.140	20,635	21,480	42,115
	2	Between R\$ 126.75 to R\$ 221.59	0.800	16,956	25,159	42,115
	3	Over R\$ 221.59	1.092	20,175	21,939	42,114

Source: elaborated from the research data.

Spatial Analysis

Spatial analysis was performed based on Moran's Global and Local Indexes, with the aid of the GeoDa program. The analyzed variable was the percentage of default in each neighborhood in the city of Uberlândia. The Global Moran Index found was 0.257, indicating a low positive correlation between neighborhoods. In the analysis of the Moran Local Index, as shown in figure 3, 1 cluster was found in the South Region characterized by a local correlation with low default rates, and a cluster in the East Region, composed of neighborhoods with high percentages of defaults. Figure 4 demonstrates the statistical significance of the local correlations represented in Figure 3.

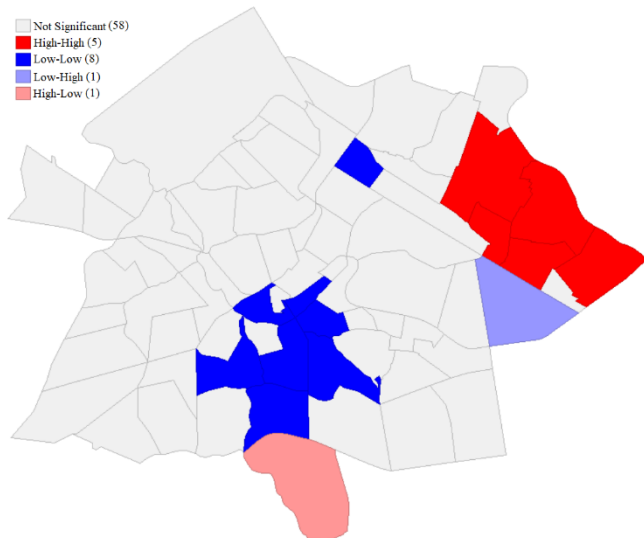


Figure 3 - Map of high and low default clusters.
Source: elaborated from the research data.

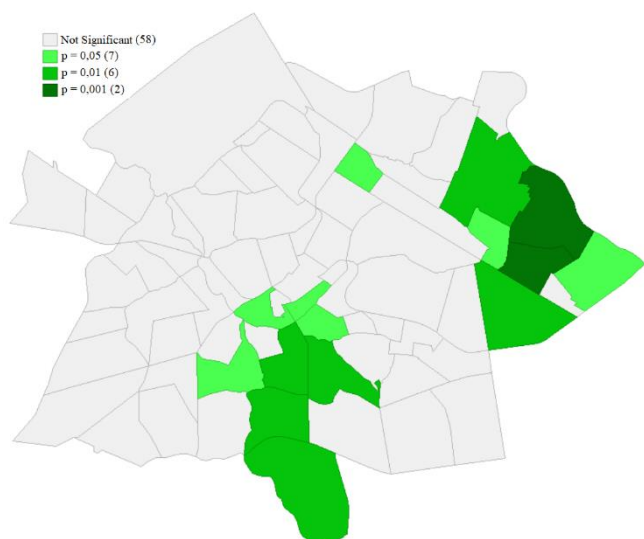


Figure 4 - Statistical significance map of the local correlations represented in figure 3.
Source: elaborated from the research data.

Logistic Regression

All variables were individually significant at the 1% level, which is why the null hypothesis that the coefficients are equal to zero is rejected. The F test of the dummies of the multicategorical variable sector was also significant at the 1% level. Thus, all were maintained in the logistic regression model, as shown in Table 7. The high significance of all variables may be related to the fact that the sample is excessively large, which increases the power of the statistical tests and makes any effect statistically significant (Fernandes, Figueiredo Filho, Rocha, & Nascimento, 2020).

Table 7

Final variables of the model and respective coefficients with marginal effect

Variable	Coef.	Standard error	Stat. of Wald	P-value	95% Conf. Interval
NEGOC	-0.20110	0.00355	-56.68	0.000	-0.208059 - 0.194152
UMIMO	0.1540855	0.00426	36.19	0.000	0.145741 0.16243
PREDIA					0.112487
L	0.1198346	0.00375	31.97	0.000	0.127182
LTOT	0.2401232	0.0021	114.60	0.000	0.236017 0.24423
LMED	0.2330043	0.00298	-78.11	0.000	-0.238851 - 0.227158
NORTH	0.0290396	0.00562	5.17	0.000	0.018027 0.040052
EAST	0.0546842	0.0049	11.15	0.000	0.045076 0.064293
SOUTH	0.0613153	0.0049	12.52	0.000	0.051718 0.070913
WEST	0.0735188	0.00493	14.92	0.000	0.063863 0.083174
CONST.	-2.076313	.052559	4	0,000	-2.179328 - 1.973299

Note: Pseudo R² = 0.0913.

Source: elaborated from the research data.

The INAD response variable has the default occurrence as an event of interest (INAD = 1). Thus, the logistic regression model aims to verify the probability of a given taxpayer being in default. It is noted that all coefficients in the model were consistent with the analysis of the relative risk of default, with the exception of the coefficient of the UMIMO variable. Considering the result of the relative risk analysis, shown in Table 6, it was expected that taxpayers who own only one property would be less likely to be in default, which was not confirmed in the logistic regression model.

If the taxpayer has already carried out any negotiation, the probability of being in default reduces, on average, 20.11% in relation to those who have never done so. If the taxpayer owns 1 property, the probability of being in default increases, on average, 15.40% in relation to the one who owns more than 1 property. If only property tax is owed, the probability of being in default increases, on average, by 11.98% in relation to the person who owes property and land tax, or only land tax. It is also noted that an increase of R\$ 100.00 in the total amount of debts already registered in active debt (opened and paid) generates an increase of 24.01% in the probability that the taxpayer will be in default. On the other

hand, an increase of R\$ 100.00 in the average value of debts already registered in active debt (opened and paid) generates a decrease of 23.30% in the probability that the taxpayer will be in default. Regarding taxpayers residing in the North, East, South and West regions, the probability of being in default increases, on average, respectively, 2.90%, 5.46%, 6.13% and 7.35%, in relation to those residing in the Central region.

Although logistic regression does not have a measure to explain the variation in the dependent variable such as the coefficient of determination in linear regression, some measures were developed for this purpose, such as the pseudo R² and the confusion matrix (Fernandes et al., 2020). The pseudo R² was 0.091, which indicates a relatively low fit. However, it is worth highlighting the warning by Fernandes et al. (2020) in the sense that, in logistic regression models, with regard to the terms of variance explained by the R², one should be less demanding than in a linear regression model.

Another measure of the model's predictive capacity is the classification table, also known as the confusion matrix, shown in Table 8 (Fernandes et al., 2020). The classification table showed that the accuracy of the model, represented by the correct classification of defaulting and non-defaulting cases (true defaulters + true defaulters / total), is 63.40%. The sensitivity characterized by the proportion of bad debtors correctly classified by the model (true defaulter / true defaulter + false defaulter) was 72.64%. The specificity is the proportion of good payers who were classified correctly by the model (true defaulter / true defaulter + false defaulter) was 54.61%. In this research, the predictive capacity of the model is considered satisfactory, considering that the objective is to predict default, for which the model has an accuracy of 72.64%.

Table 8
Confusion matrix

		Real		Total
		Default	Non-default	
Predicted	Default	49,818	26,222	76,040
	Non-default	18,760	31,544	50,304
	Total	68,578	57,766	126,344

Source: elaborated from the research data.

Final Considerations

This research aimed to verify whether the region of residence of the taxpayer of IPTU in the municipality of Uberlândia-MG influences the probability of default. This analysis was based on the legal definition that the IPTU value should vary according to the location of the property, justifying the test of the hypothesis that this factor could also influence its default. To carry out this analysis, 126,344 taxpayers who had unpaid IPTU debts and registered in active debt on 12/31/2020 were considered, as well as those who already had such debts, but made their payment between the period of 2010 and 2020. Two conclusions were reached through univariate, bivariate, spatial and logistic regression analysis techniques.

From the analysis of the default percentages through univariate, bivariate and special techniques, it was found that taxpayers residing in neighborhoods where families with higher household nominal monthly income reside have lower default percentages in relation to neighborhoods where this index is lower, as well as a high spatial correlation between some neighborhoods in the South region, with low percentages of default, and some neighborhoods in the East region, with high percentages of default. Using the logistic regression technique, it was found that there are territorial sectors with higher percentages of default, sectors which, according to the proposed logistic regression model, interfere in the default percentage of taxpayers with active IPTU debt in the city of Uberlândia-MG.

The theoretical contribution of the research is reflected in the finding that the region of residence influences the default of individual taxpayers of IPTU active debt in the municipality of Uberlândia. Taxpayers residing in neighborhoods and regions where families with lower nominal monthly income live have greater difficulties in paying IPTU. The managerial contribution is evident in the expansion of empirical evidence about the factors that can influence the default of the active IPTU debt of the municipality of Uberlândia, allowing a better use of its collection potential. The social contributions of the study comes from these findings, in the sense that there is an indication of the need for the IPTU to be instituted and charged in a way that is more consistent with the contributory capacity of

citizens, contributing to the reduction of social inequalities.

Among the limitations of this work, it is worth mentioning the lack of comparison of the accuracy of the logistic regression model with a Geographically Weighted Logistic Regression (GWLR) model, as proposed by Albuquerque et al. (2017), although these authors, in their research, did not find an advantage in the alternative model. Another limitation of the research is the non-use, due to the unavailability of data, of more variables based on previous research on tax defaults or defaults in general, which can also be justified by the exploratory nature of the present research and the high statistical significance of all the coefficients of the analyzed variables.

Considering the aforementioned limitations, future research can analyze IPTU defaults through Geographically Weighted Logistic Regression, incorporate other variables already commonly used in research on public revenue prediction, as well as replicate the analysis carried out in this study in order to verify whether the results are confirmed in different Brazilian municipalities.

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