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NO PUBLIC SURVEYS, NO DATA? A PROPOSAL FOR INCOME FORECAST IN BRAZILIAN MUNICIPALITIES

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Abstract

Objective: Due to the lack of regularity from the census in Brazil, the proposal to use alternative indicators is relevant. The population's income, primary census information, is a variable used in studies in different areas such as public policies, forecasting, and planning a new business. However, on average, this information is released every ten years in Brazil; thus, it is necessary to explore frequency variables to estimate the population's income. In this sense, this study proposes a predictive income model based on technological and communication aspects.
Method: We choose two variables: internet and cable TV access. Our study included the analysis of the 5570 Brazilian municipalities through linear (OLS) and spatial models (Spatial Auto-Regressive [SAR] and Geographically Weighted Regression [GWR]).
Results: The results with the spatial models showed better results. The autoregressive spatial regression (SAR) presented a more significant explained variance (R^2 = 0.51) than the linear model (R^2 = 0.41) and the GWR model (R^2 = 0.44), which indicates a significant spatial dependence and contribution of the geographic perspective in modeling and explaining the phenomenon.
Conclusion: The results were found to contribute to the development of public policies in regions with difficult access to information on the population's income and with managers and companies in the technology area that seek to plan the improvement and expansion of the provision of digital communication services through a model updated with secondary public data.

Keywords: forecast income, spatial statistics, public data, public policies, census.

SEM PESQUISAS PÚBLICAS, SEM DADOS? PROPOSTA DE PREVISÃO DE RENDA NOS MUNICÍPIOS BRASILEIROS

Resumo

Objetivo: Com à falta de regularidade da divulgação do censo no Brasil a proposta de utilização de indicadores alternativos é relevante. A renda da população, informação primária do censo, é uma variável utilizada em estudos em diversas áreas como políticas públicas, previsão e planejamento de novos negócios. Porém, em média, essas informações são divulgadas a cada dez anos no Brasil; assim, é necessário explorar variáveis divulgadas com frequência para estimar a renda da população. Nesse sentido, este estudo propõe um modelo preditivo de renda baseado em aspectos tecnológicos e de comunicação.
Método: Duas variáveis foram utilizadas para a previsão da renda das 5.570 cidades brasileiras: acesso à internet e TV a cabo. Para a análise adotamos modelos lineares (OLS) e espaciais: regressão espacial autorregressiva (SAR) e regressão geograficamente ponderada (GWR).
Resultados: Os resultados com os modelos espaciais mostraram melhores resultados. A regressão espacial autorregressiva (SAR) apresentou uma variância explicada maior (R2 = 0,51) do que o modelo linear (R2 = 0,41) e o modelo GWR (R2 = 0,44), o que indica uma dependência espacial significativa e contribuição da perspectiva geográfica no fenômeno investigado.
Conclusão: Os resultados contribuem para o desenvolvimento de políticas públicas em regiões com difícil acesso a informações sobre a renda da população. E ainda, com gestores e empresas da área de tecnologia que buscam planejar a melhoria e ampliação da oferta de serviços de comunicação digital por meio de um modelo atualizado com dados públicos secundários.

Palavras-chave: previsão de renda, estatísticas espaciais, dados públicos, políticas públicas, censo.

¿SIN ENCUESTAS PÚBLICAS, SIN DATOS? LA PROPUESTA DE PREVISIÓN EN LOS MUNICIPIOS BRASILEÑOS

Abstracto

Objetivo: Debido a la falta de regularidad del censo en Brasil, la propuesta de utilizar indicadores alternativos es relevante. El ingreso de la población, información primaria del censo, es una variable utilizada en estudios en diferentes áreas como las políticas públicas, la previsión y la planificación de un nuevo negocio. Sin embargo, en promedio, esta información se publica cada diez años en Brasil; por lo tanto, es necesario explorar variables de frecuencia para estimar los ingresos de la población. En este sentido, este estudio propone un modelo predictivo de ingresos basado en aspectos tecnológicos y de comunicación.
Método: Elegimos dos variables: acceso a internet y televisión por cable. Nuestro estudio incluyó el análisis de los 5570 municipios brasileños a través de modelos lineales (OLS) y espaciales (Spatial Auto-Regressive [SAR] y Geographically Weighted Regression [GWR]).
Resultados: Los resultados con los modelos espaciales mostraron mejores resultados. La regresión espacial autorregresiva (SAR) presentó una varianza explicada más significativa (R2 = 0.51) que el modelo lineal (R2 = 0.41) y el modelo GWR (R2 = 0.44), lo que indica una dependencia espacial significativa y aporte de la perspectiva geográfica en modelización y explicación del fenómeno.
Conclusión: Los resultados fueron encontrados para contribuir al desarrollo de políticas públicas en regiones con difícil acceso a la información sobre los ingresos de la población y con empresarios y empresas del área de tecnología que buscan planificar la mejora y ampliación de la prestación de servicios de comunicación digital a través de un modelo actualizado con datos públicos secundarios.

Palabras clave: previsión de ingresos, estadísticas espaciales, datos públicos, políticas públicas, censo.

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Introduction

The recent cut in the Brazilian Institute of Geography and Statistics (IBGE) budget for 2020, more than 2 billion reais, has compromised the continuity of several types of research, especially those with field collection (IBGE, 2021). The next Census starts collecting at the end of 2022 (Brasil, 2022), and this delay impacts the development of studies and the updating of socioeconomic indicators. With the systematic availability of public data, it is possible to contribute to public policy decision-making and economic, digital, social insertion, and new business planning.

The advancement of technology for assessment and prediction through computational and economic models depends on the volume of publicly available, frequent, and granular data (Walker, 2023). In this sense, regulatory agencies, such as the National Telecommunications Agency (Anatel), are now contributing to the systematic availability of public data in regions, states, and municipalities. Data provided by Anatel, such as internet access and cable TV, contribute to the assessment of social exclusion, support the planning of economic market research, and contribute to the estimation of income (Carlsson-Szlezak et al., 2020).

Previous studies have presented models for predicting the population's income from different variables obtained through the public data (Rehman et al., 2022). Francisco (2010) proposed a model using energy consumption in the municipalities of São Paulo to establish a household and regional research approach using spatial statistics. The information was analyzed and processed based on a standardized and replicable methodology. With the study, it was possible to determine the income in different regions of the state of São Paulo and the feasibility of monthly updating recurrence, depending on the availability of consumption databases. However, energy consumption information is not available in a granular way. All Brazilian municipalities are due to the different concession companies in the country, thus hindering the replicability of models that seek to show the scale of the 5570 Brazilian cities (Boing et al., 2021).

In this sense, this work aims to evaluate the use of communication information as a predictor of income for all Brazilian municipalities, considering the availability of data by a single agency and updated in a granular and frequent way. We also use socioeconomic variables such as average income, municipal human development index (IDHM), and municipal gross domestic product, *per capita* income. The chosen communication-related variables proposed the average cable TV access and internet consumption per Mbps. As a contribution to the study, the proposed model is expected to contribute to studies that need to use socioeconomic variables or directly impact the consumption (Widjaja & Gregory, 2020) and apply spatial models for predictive income analysis at the municipal level.

Relevance of Geography in Predictive Studies

Social and economic data treatment approaches use statistical and econometric models. Francisco (2010) argues that “although relevant and useful, they do not allow us to consider the

geographic space," a relevant variable that characterizes specific places and promotes the association between different phenomena, delimiting similarities and differences based on information in space. In this study, spatial statistical methods were used to analyze data collected from Anatel; it is essential to assess possible relationships between geography and its technological and informational aspects, which can be seen as strategic in decision-making and planning, whether in the public and governmental or private sector.

Geographic space is confused and often limited to the study of landscapes, incorporated into physical space and social and economic information, representing localized relationships between man and nature (Santos, 2012, p. 103). From a conceptual review of the work of geographer Milton Santos, three definitions are reached: set of fixed and flux (Santos & Silveira, 2001), territorial configuration and social relations (Santos, 2012), object systems, and action systems (Santos, 2002). We will focus on the last definition because it helps understand the spatial dimension of the treated statistical information. The method of objects comprising the geographic space stands out for encompassing any material and immaterial infrastructure whose reason is given by operationalizing production processes. They are mainly technical objects; their structure, functioning, and conception are derived from research and science fields (Schabenberger & Gotway, 2017). To Santos (2012, p. 215), they are "scientific-technical and equally informational objects," and the system of actions refers to agents that operate some interaction on the territory – be it the population, companies, or government.

From the characterization of the definition of Geography, it is possible to have the notion of geographic space as a variable that can be instrumentalized and valuable to society and economic decisions, forming what is conventionally called a technical-scientific-informational environment (Santos, 1978). This concept unites the strategic character of statistical data with the spatial dimension and vice versa. Technical objects tend to be increasingly technological due to the high scientific quotient incorporated and informational objects. The density of information that is available about geographic space contributes to strategic decision-making and planning actions, whether in densely populated spaces, which Santos & Silveira (2001) called luminous spaces (metropolises and large urban axes) or in opaque spaces (small urbanized and natural rural spaces). The instrumental use of geographic information forms, in this sense, geographic intelligence, a resource that tends to benefit companies that coordinate production processes at different scales, government sectors, and social agents in general (Janowicz et al., 2020).

The advance in the geographic dimension of informational density moves toward incorporating information and geolocation technologies into technical objects in the geographic space, such as smartphones and automobiles, among others. The objects that comprise the geographic space take on a new function: conversion into sensors, making almost any object capable of reading and transmitting the information. In other words, geographic intelligence is not limited to the mere disposition of objects located and circulating through territories but to the administration of a volume of information that forms the databases.

Another relevant advance, which expresses the geographic dimension of the information collected from the territory, is the emergence of the Geographic Information Systems (GIS) (Lü et al., 2019). These geotechnologies allow the integration of databases through geographic location and the spatial visualization of variables collected through research and represented in thematic maps using colors, polygons, legends, and other visual cartographic tools. For Francisco (2010), these systems seek to integrate a database to a geographic base (such as a map of municipalities), allowing the visualization of spatial patterns of various phenomena and their usefulness, which ranges from the spatialization of a problem to the accurate translation and measurable data, which can still be subjected to spatial analysis of geographic data and spatial statistics.

Demographic Census and the Risk of a Statistical Blackout

The Demographic Census was planned to have a ten-year frequency in Brazil in 1991, 2000, and 2010. It provides the statistical granularity (Francisco, 2010, p. 28) and information necessary for state action in public policies with a level of detailing from the federal to the municipal level. The production of the demographic census by the IBGE and other comprehensive surveys carried out by special agencies in Brazil are valuable instruments for decision-making. Silva (2012) argues that "censuses are our central tool for diagnosing the living conditions of a country's population, and one of its main characteristics is the ability to provide detailed portraits of the multiple realities in which this population finds itself." In this sense, Jannuzzi (2018) points out that "statistical information plays a relevant instrumental role in the implementation stages of a public program, from formulation to evaluation, and plays a fundamental role in the dimensioning of latent social issues." These statistical data have been critical variables for non-governmental organizations that work in the territory on different issues.

Other studies related to the areas of marketing and consumer science have been seeking to replace market research with analyses that aim to forecast the demand for the consumption of products and services using information that is already available (and with some frequency) by a particular agency, establishing the use of data on the territory. Another less well-known point is the reciprocity data-producing institutions maintain with the organizations that use their information. To Cavalcante & Lotta (2021) "when government agencies start using statistics constantly, statistical organizations are encouraged, and a two-way street is established, contributing to a relationship based on mutual benefit." In other words, it can be said that statistics are produced on demand, which resulted in the need for more and better information (Lotta & Pires, 2023).

Although the arguments above are relevant, frequent attacks on census operational processes in Brazil have been observed since mid-2019, which intensified with the announcement of the new direction of IBGE in 2021. This movement is done in a way comparable to the sharp decrease in the resources available for the census, the criticism of the IBGE, and the methodologies used in data collection by the federal government, as occurred with the National Household Sample Survey (PNAD)

(IBGE, 2023). The reduction of resources by the Ministry of Economy calls into question the autonomy of the IBGE. It goes against the recommendations of the institution's technical teams (Silva et al., 2012) and the UN statistical agency itself, the United Nations Statistic Division (UNSD), which guided countries to direct more resources to operationalize censuses due to the pandemic, reinforcing the strategic importance of producing data capable of capturing the effects caused by Covid-19 (World, 2023). In this sense, continuous investment in census research is essential so researchers and public policymakers can make decisions based on the correct diagnosis analysis, especially during pandemics and other crises (Abreu et al., 2021).

This context converged to the emergence of the term “data blackout” and “statistical blackout” to characterize the situation in Brazil to the lack of available information about the population and with granularity at the local level. The worsening of the condition by the government is interpreted as statistical misgovernance, reinforcing the census as a manifestation of political intervention, which must be understood as infrastructure, in the same way that we understand the state's investments in education, roads, essential elements that will sustain the development of a country (Toledo Villacís, 2021). In this sense, one can see how much this situation puts public and private policies and investments at risk, demonstrating a more fragile governance and society. However, despite the need to strengthen the IBGE and expand the capacity to produce statistical data with an adequate level of detail for regional and state agencies, and in agreement with the voices that come to the public criticizing the federal government's lack of interest in solving the "blackout of data,” the present work sought to explore a gap that aims to face this problem of inconstancy and absence of data, through the construction of alternative indicators that can be used in production processes and also for the targeting of resources for public action.

Relevance of Alternative Indicator

Previous research evaluated the relation of income to consumption of different natures. Rural households' socioeconomic changes in South Africa were analyzed from 2001-2013 using the household asset indicators (Kabudula et al., 2017). This study of South Africa used data corresponding to a part of the country's population. The study evaluated the impact of income variation on household water consumption. It showed that countries with higher incomes have greater water consumption and must discuss that water consumption is linked to the region's socioeconomic situation and population analyzed. Another study carried out in Japan with data from 1960 to 2007 showed the relationship between exports, energy consumption, and *per capita* income, which during the study period was the third-largest economy, and identified the increase in energy consumption with the rise in the population's real *per capita* income (Sami, 2011). Other studies did not use consumption factors to define income or economic status. Still, the neighborhood matrix model, such as the SAR, assesses the temporal cost between public and private transport, generating similarities and comparisons. A study using the SAR and GWR models was carried out at the Brazilian level to analyze the vote distribution of the political party in Brazil and identified a positive and significant autocorrelation (Lascala et al., 2018).

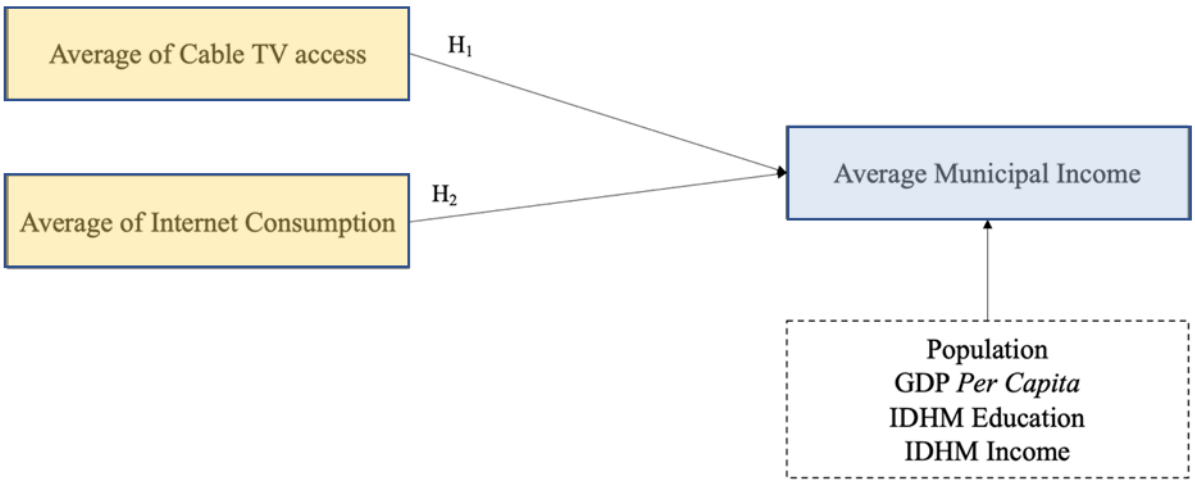
Thus, based on the relevance of research that addresses access to information to predict the population's formal income, this study presents hypotheses that will be evaluated, and Figure 1 presents the proposed model of this study:

H_1: The average cable TV access positively impacts the average income of Brazilian municipalities.

H_2: The average of internet consumption positively impacts the average income of Brazilian municipalities.

Figure 1

Sources of data used in this research



Source: The authors.

Method

For the study proposal, evaluation, and access to technology in the prediction of municipal income, all 5570 Brazilian municipalities were selected, representing a population of 213,392,891 million people, a total area of 8,510,345.358 km2, GDP *per capita* of R$ 33,593.82 million (IBGE, 2023), the life expectancy of approximately 75.4 years and unemployment of 14.7% in the first quarter of 2021. This increase in unemployment and the decrease in life expectancy was due to the COVID-19 pandemic, proposing new indicators to assess income for socioeconomic indicators even more relevant.

Among the variables for the study are the average cable TV access and internet consumption per Mbps. In addition to these variables, information on the municipalities' economic and social aspects was collected: IDHM of income and GDP *per capita*. Table 1 presents the study variables.

Table 1

Sources of data used in this research

Variable	Source	Period
Income	Brazilian Institute of Geography and Statistics	2010
GPD *per capita*	Brazilian Institute of Geography and Statistics	2010
Average of cable TV access	National Telecommunications Agency	2020
Average of Internet consumption	National Telecommunications Agency	2020
IDHM of Education	Programa das Nações Unidas para o Desenvolvimento (PNUD)	2010

Source: The authors.

As analysis techniques, we use regression models (linear and spatial) to predict municipalities' income, both from technological aspects, internet, and cable TV, being controlled by the education human development index, GDP *per capita*, and income. Linear regression (OLS – Ordinary Least Squares) and spatial models (Spatial Autoregressive model – SAR and Geographically Weighted Regression – GWR) will be evaluated.

The ordinary least squares regression model (OLS) seeks to predict income from the equation $y = X\beta + \varepsilon$ (Greene, 2000; SEADE, 2021). To assess the spatial effect, the Spatial Autoregressive (SAR) model (Anselin & Florax, 2012) and a Geographically Weighted Regression (GWR) model were used. The SAR model includes the global spatial autocorrelation indicator, Moran's *I*, and the Local Indicator of Spatial Autocorrelation (LISA) in the evaluation through the lag of the dependent variable, y, such that $y = \rho Wy + X\beta + \varepsilon$. The GWR regression model is used to assess the relationship between the dependent variable (y) and the independent variables ($X1, X2, ..., Xn$) considering the geographic aspect, $y\ (gi) = X\ (gi)\ x\ \beta\ (gi) + \varepsilon$. The method presents a local model of the predicted variable (y) by fitting a regression equation to each feature in the dataset.

Results

For a better evaluation of the linear and spatial models, the stepwise method was used from the variables proposed in the study to identify the best subset of predictor variables, followed by a comparison between the linear and spatial models.

Results Analysis

Regression Models

Ordinary Least Square Model (OLS)

For the study, two independent variables were chosen to predict the average income of Brazilian municipalities. The chosen perspective represented the evaluation based on technological elements like cable TV and internet consumption. The independent variable of average cable TV access and internet consumption returned significantly to the dependent variable of income. The model returned as significant, F-statistic = 995.037, p <0.001, df 5559. The respective coefficients and values are presented in Table 2. The total explained variance of the model was $R^2 = 0.42$. The Log-likelihood was -1937.82, the Akaike information criterion (AIC) was 3885.63, and the Schwarz criterion was 3918.75. The multicollinearity condition returned a value of 11.00, indicating no problem. The average internet consumption returns negative and can be explained by the constant drop in cable TV subscribers throughout Brazil. On the other hand, more than 120 million Brazilians are connected to the internet. They have become consumer content through streaming video and music, among others (Mari, 2020), justifying the presence of the internet on cable TV in the socioeconomic impact on families.

Table 2

Results of the OLS Model

Variable	Coefficient	S.E.	T-Statistics	Probability
constant	1.27138	0.0299781	42.4103	0.00000
average_cable_TV	-0.0002030	0.0003048	-6.66173	0.00000
internet_consumption	0.0011046	0.00067887	16.2717	0.00000
gdp_per_capita	0.0008287	0.0002061	40.243	0.00000
idhm_income	0.870406	0.0562828	15.4649	0.00000

Source: The authors use GeoDA 1.18. **Note:** Coefficients are small due to the high values in the variables and high variance because the analysis was conducted at the municipal level in Brazil

Autoregressive Spatial Model (SAR)

The model presented a better fit than the OLS and explained variance greater than 0.09 ($R^2 = 0.51$) and better indicators. The Log-likelihood (-1538.02), AIC (3088.04), and Schwarz criterion (3127.79). Details of the results with the SAR model are presented in Table 3. The independent variables proposed in the study to predict the average income were significant, demonstrating that the income forecast from communication and in the spatial context proves promising for prediction.

Table 3

Results of the SAR Model

Variable	Coefficient	S.E.	Z-Value	Probability
W_income	0.408567	0.0139776	29.301	0.00000
constant	0.771664	0.0319197	24.1751	0.00000
average_cable_TV	-0.0001366	0.00028014	-4.77123	0.00000
internet_consumption	0.00086216	0.00062824	13.7235	0.00000
gdp_per_capita	0.00069626	0.1934847	35.9853	0.00000
idhm_income	0.371208	0.0547172	6.78412	0.00000

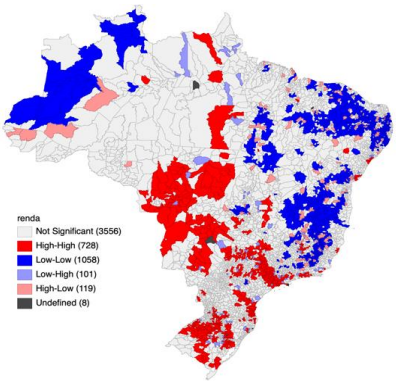
Source: The authors used software GeoDA 1.18.
Note: Coefficients are small due to the high values in the variables and high variance because the analysis was done at the municipal level in Brazil. Line Wy (W_income) is highlighted with the spatial autoregressive term (significant).

We evaluate the variable from a spatial perspective. Figure 2 shows the spatial autocorrelation maps for the dependent and independent variables with a positive relationship in the model.

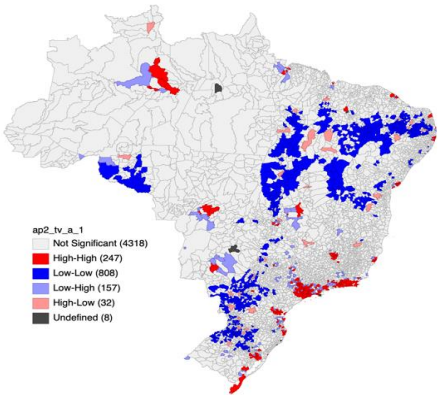
Figure 2

Local Moran's and Moran's I for (1) income, (2) average cable TV access, (3) average internet consumption, (4) GDP per capita, (5) IDHM education

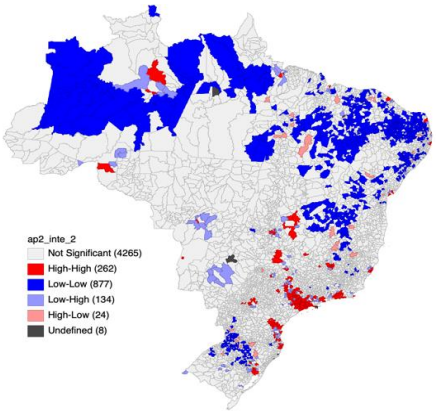
(1) Dependent Variable: Income
Moran's I: 0.436



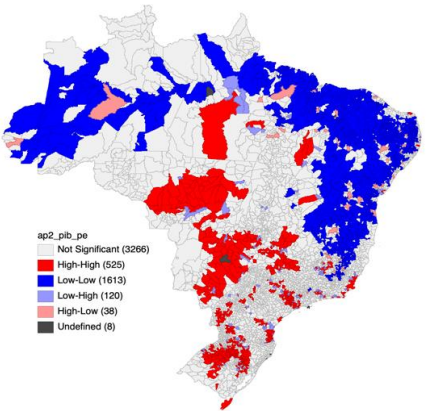
(2) Independent Variable: Average of Cable TV Access
Moran's I : 0.147



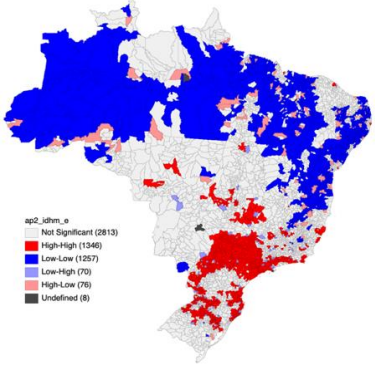
(3) Independent Variable: Average Internet Consumption Moran's I: 0.327



(4) Independent Variable: GDP per capita Moran's I : 0.325



(5) Independent Variable: IDHM of Education Moran's I: 0.703



Source: The authors used the software GeoDA 1.18.

Geographically Weighted Regression (GWR)

The GWR model presented an explained variance like the OLS model (R2 = 0.41). The model indicators were Log-likelihood (-6392,733) and a smaller AIC (12795,465). The function used in the GWR model was the Gaussian kernel and presented an AICc of 12797,481 with an estimated sigma of 0.594.

Table 4

Results of the GWR Model

Variable	Mean	Standard Deviation	Min	Median	Max	Global
X.Intercept	-0.031	0.543	-3.004	-0.049	4.185	1.27138
average_cable_TV	0.260	3.329	-27.724	0.188	30.292	-0.0002030
internet_consumption	0.181	1.933	-17.314	0.250	8.784	0.0011046
gdp_per_capita	0.573	0.615	-1.922	0.465	5.658	0.0008287
idhm_income	0.036	0.259	-0.710	0.007	1.292	0.870406

Source: The authors, using the software MGWR.
Note: 5564 local regressions were performed compared with global ones (OLS)

Hypothesis Assessment

Two hypotheses were proposed to evaluate the model presented in this study, communication variables to predict municipalities' income. The first hypothesis was that the average number of cable TV subscribers would positively impact the income of Brazilian cities. However, the hypothesis that we purpose not be confirmed did not support this hypothesis because the variable returned significant in the evaluated models (OLS, SAR, and GWR) but negative. This result demonstrates that the Brazilian population has followed a worldwide trend of exchanging the amount spent on cable TV subscriptions for streaming packages. This phenomenon has been called "cableless" and has been increasing continuously due to accessibility for different audiences. The second hypothesis, a positive impact on average internet consumption, was supported. All models tested in this study returned as positive and significant. Thus, among the proposed hypotheses that used communication as a context, only the one involving the internet was confirmed, evidencing the need to expand the use of the internet by the population due to accessibility to educational and financial platforms, among others that positively impact the increase of income of municipalities.

Discussion of Results

Previous studies that sought to predict the population's income through different indicators showed that technology has a strong relevance (Boing et al., 2021; Rehman et al., 2022). For example, Francisco (2010) validated that electricity consumption would be a statistically relevant indicator for predicting household income in households served by an energy company. In this sense, our research also considered the perspective of technology; after all, the greater the energy consumption, the longer the time expected in electronic devices that provide entertainment and education through the internet and TV sets. Thus, in line with previous studies that sought to predict household income, we present a model based on data collected from all municipalities, considering technology as the main dimension. Thus, based on the results obtained with the proposed model, the evaluation of internet consumption to estimate public policymakers can systematically replicate municipal income; after all, it is information systematically disclosed by Anatel.

Final remarks

With the increasing access to information by the population, this study sought to assess whether access to pay TV and contracted internet speed also contribute to predicting the income of Brazilian municipalities. This evaluation occurred through linear and spatial models, which evaluated the study hypotheses and is in line with the scenario of the extension of the Brazilian Census. Among the variables raised is income which represents an interest in application in marketing, economic, and public management models.

The first hypothesis, about the positive impact of the number of pay-tv plans, returned significantly. The variable coefficient was significant and negative in the three models, including access to pay TV. This result can be explained by the increase in the population's access to the internet and streaming packages with more affordable values than more expensive cable TV packages. The second hypothesis, about the contracted speed, also returned as significant but positive. With the democratization of Internet access through packages offered by telecommunications companies and signal replicators, the population has had more access to the Internet, consequently generating a more significant impact on average income. Even during a pandemic, the federal government paid for internet access for low-income students to continue their studies. One aspect that should be highlighted is that the proposed variables, such as access to information, proved significant, with a low coefficient. For this, it would be essential to carry out a future study that would evaluate the municipalities from clusters that considered the educational aspect, such as the IDHM of education and the GDP *per capita* of the cities. Among the study's limitations is the absence of analyses that consider the temporal perspective due to the difficulty of a linear comparison of the same periods of the variables used.

Thus, the study contributes to the proposal and validation of two new variables to predict the population's income and the impact of the population's GDP *per capita* in all Brazilian municipalities.

The choice of other regions and the inclusion of new social and economic variables can contribute to access to technology and communication to broaden the assessment of income estimates, as they have updated data more frequently than those published by the IBGE Census. Retail and financial market companies, and public authorities in general, can benefit from this indicator, which certainly presents as more available and updated due to its nature of information derived from utility services.

References

Abreu, L. C. de, Elmusharaf, K., & Siqueira, C. E. G. (2021). A time-series ecological study protocol to analyze trends of incidence, mortality, lethality of COVID-19 in Brazil. *Journal of Human Growth and Development*, *31*(3), 491–495. https://doi.org/10.36311/jhgd.v31.12667

Anselin, L., & Florax, R. (2012). *New directions in spatial econometrics*. Springer Science & Business Media.

Boing, A. F., Boing, A. C., & Subramanian, S. (2021). Inequalities in the access to healthy urban structure and housing: An analysis of the Brazilian census data. *Cadernos de Saúde Pública*, *37*, e00233119. https://doi.org/10.1590/0102-311X00233119

Brasil, A. (2022, January 25). *Coleta de dados do Censo Demográfico 2022 começa em 1º de agosto*. Agência Brasil. https://agenciabrasil.ebc.com.br/geral/noticia/2022-01/coleta-do-censo-demografico-2022-comeca-em-1o-de-agosto

Carlsson-Szlezak, P., Reeves, M., & Swartz, P. (2020). What coronavirus could mean for the global economy. *Harvard Business Review*, *3*(10).

Cavalcante, P., & Lotta, G. S. (2021). Boundary-Crossing Strategies: Managing Macro Policies in a Federal Government. *Revista de Administração Contemporânea*, *25*, e200012. https://doi.org/10.1590/1982-7849rac2021200012.en

Francisco, E. D. R. (2010). *INDICADORES DE RENDA BASEADOS EM CONSUMO DE ENERGIA ELÉTRICA: ABORDAGENS DOMICILIAR E REGIONAL NA PERSPECTIVA DA ESTATÍSTICA ESPACIAL*. https://doi.org/10.13140/RG.2.2.36634.03524

Greene, W. H. (2000). Econometric analysis 4th edition. *International Edition, New Jersey: Prentice Hall*, 201–215.

IBGE. (2021, December 13). *IBGE reafirma plena confiança no orçamento de R$ 2,292 bilhões para o Censo 2022*. https://www.ibge.gov.br/novo-portal-destaques/32553-ibge-reafirma-plena-confianca-no-orcamento-de-r-2-292-bilhoes-para-o-censo-2022.html

IBGE. (2023). *IBGE | Portal do IBGE | IBGE*. https://www.ibge.gov.br/

Jannuzzi, P. de M. (2018). *A importância da informação estatística para as políticas sociais no Brasil: Breve reflexão sobre a experiência do passado para considerar no presente*. SciELO Brasil. https://doi.org/10.20947/S0102-3098a0055

Janowicz, K., Gao, S., McKenzie, G., Hu, Y., & Bhaduri, B. (2020). GeoAI: spatially explicit artificial intelligence techniques for geographic knowledge discovery and beyond. *International Journal of Geographical Information Science*, *34*(4), 625–636. https://doi.org/doi.org/10.1080/13658816.2019.1684500

Kabudula, C. W., Houle, B., Collinson, M. A., Kahn, K., Tollman, S., & Clark, S. (2017). Assessing Changes in Household Socioeconomic Status in Rural South Africa, 2001–2013: A Distributional Analysis Using Household Asset Indicators. *Social Indicators Research*, *133*(3), 1047–1073. https://doi.org/10.1007/s11205-016-1397-z

Lascala, A. J., Silva, B. M. A., & de Rezende Francisco, E. (2018). Organização partidária e votos no Legislativo: Estudo das organizações municipais do PT e PSDB no estado de São Paulo a partir da composição e influência geográfica Party organization and votes in the legislature: Study of the municipal organizations of the PT and PSDB in Sao Paulo state from the composition and geographical influence. *Revista Brasileira de Pesquisas de Marketing, Opinião e Mídia*, *11*(2), 175–189.

Lotta, G., & Pires, R. (2023). *Public Policy Implementation in a Context of Extreme Inequality: Between Universalist Ambitions and Practical Selectivity*. https://doi.org/10.1108/978-1-80262-655-120231019

Lü, G., Batty, M., Strobl, J., Lin, H., Zhu, A.-X., & Chen, M. (2019). Reflections and speculations on the progress in Geographic Information Systems (GIS): A geographic perspective. *International Journal of Geographical Information Science*, *33*(2), 346–367. https://doi.org/10.1080/13658816.2018.1533136

Mari, A. (2020, November 10). *Digital Services Surge Among Poor Brazilians Amid Pandemic*. Forbes. https://www.forbes.com/sites/angelicamarideoliveira/2020/11/10/digital-services-surge-among-poor-brazilians-amid-pandemic/

Rehman, A. U., Saleem, R. M., Shafi, Z., Imran, M., Pradhan, M., & Alzoubi, H. M. (2022). *Analysis of Income on the Basis of Occupation using Data Mining*. 1–4. https://doi.org/10.1109/ICBATS54253.2022.9759040

Sami, J. (2011). Multivariate cointegration and causality between exports, electricity consumption, and real income per capita: Recent evidence from Japan. *International Journal of Energy Economics and Policy*, *1*(3), 59–68.

Santos, M. (1978). *Por uma geografia nova da crítica da geografia a uma geografia crítica*.

Santos, M. (2002). *A natureza do espaço: Técnica e tempo, razão e emoção* (Vol. 1). Edusp.

Santos, M. (2012). *Metamorfoses do espaço habitado: Fundamentos teóricos e metodológicos da geografia*.

Santos, M., & Silveira, M. L. (2001). *O Brasil: Território e sociedade no início do século XXI*.

Schabenberger, O., & Gotway, C. A. (2017). *Statistical methods for spatial data analysis*. CRC press.

SEADE. (2021). *Conjunto de dados—SEADE Repositório*. https://repositorio.seade.gov.br/dataset/

Silva, J. J. O., Zerboni, F., & Prado, M. (2012). Lubrax by Petrobras. *Emerald Emerging Markets Case Studies*, *2*(8), 1–25. https://doi.org/10.1108/20450621211291798

Toledo Villacís, M. (2021). Estrategias post-COVID 19 para reactivar el Turismo local en el Ecuador: Caso provincia de Tungurahua. *Green World Journal, 2021, Vol. 4, Num. 1-003, p. 1-12*. https://dspace.uib.es/xmlui/handle/11201/155324

Walker, K. (2023). *Analyzing us census data: Methods, maps, and models in R*. CRC Press.

Widjaja, T., & Gregory, R. W. (2020). Monitoring the Complexity of IT Architectures: Design Principles and an IT Artifact. *Journal of the Association for Information Systems*, *21*(3), 4. https://doi.org/10.17705/1jais.00616

World, H. O. (2023). *Global research on coronavirus disease (COVID-19)*. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/global-research-on-novel-coronavirus-2019-ncov